

Detection of Ineffective efforts during expiration in the mechanical ventilation of neonates

(Bachelor Thesis)



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Motivation

This thesis is part of the NANNI project on the ventilation of prematures and newborns.

Especially preterm neonates need mechanical ventilation as their lungs are not fully developed yet. During ventilation many different types of problems can occur. Ineffective efforts during expiration (IEE) are an asynchrony problem between patient and ventilator. An IEE occurs when the mechanical ventilation and the ventilated patient have a mismatch between demand and support during expiration. Patients that have a significant amount of IEEs can have inspiratory muscle damage, need a longer time of mechanical ventilation and have a shorter ventilator free survival.[1]

State of the art

There are rule based approaches on detecting IEEs such as BetterCare® by Blanch et al.[2], which use a mathematical function to determine if a breath is classified as an IEE. In this function first an ideal breath is fabricated based on the patient and every breath containing deviations is analyzed on asynchronies and then compared to the ideal breath resulting in a heuristic approach to the problem.

Secondly there also exists a machine learning approach by Casagrande et al[3]. This approach uses the sub-breath-loops as a classifier for IEEs. It uses feature extraction to improve sensitivity and then feeds this into a neural network giving the wanted results.

All current approaches however focus on detecting IEEs in ventilated adults, whereas this thesis focuses on the detection of IEEs in neonates. Since the physiology of neonates differs from the adult physiology the current approaches are insufficient to detect IEEs in the ventilation of neonates.

Goals

The aim of this work is to develop an algorithm that detects IEEs in the ventilation of neonates and output the amount of IEEs in a prior defined time interval. This should happen online in the NANNI control software to give the medical personal additional information and to aid them in making further adjustments to the care of the patient.

Planned Approach

Suitable current approaches will be further researched and adapted from the needs of adults to the needs of neonates. The chosen approach will then be tested on annotated data given by the Uniklinik Aachen and adjustments based on the results will be implemented. Furthermore, the results will be implemented as a plugin in the NANNI viewer, to evaluate the results on recorded data.

1: Georgopoulos, D., Ineffective efforts during mechanical ventilation: the brain wants, the machine declines, 2012

2: Blanch, L., Validation of the Better Care® system to detect ineffective efforts during expiration in mechanically ventilated patients: a pilot study, 2013

3: Casagrande, A., An effective pressure–flow characterization of respiratory asynchronies in mechanical ventilation, 2020