Vital Signs Monitoring and Interpretation for Critically Ill Patients

In current clinical practice, vital signs such as heart rate, blood pressure, oxygen saturation level, respiratory rate and temperature are continuously measured for critically ill patients. Monitored by medical devices, each vital sign provides information about basic body functions and allows medical staff to intervene if health deteriorates. It has been documented that most of the alarms provided by the devices do not require actions, and that this occurs mainly because the signals are treated individually without context. The overload in alarms forces medical staff to make priority decisions, and can cause critical scenarios leading to a patient’s death to be overseen. The focus of this project was investigating clinical applicability of combining vital signs for critically ill patients. Several approaches were developed and tested with increasingly homogeneous patient groups. The first study presents a data-driven approach to representation of a patient’s physiological condition by combining vital signs into Early Warning Scores (EWS). Data were collected for 57 critically ill patients who had each been admitted to the intensive care unit at Bispebjerg Hospital for several days. To evaluate the estimation of physiological condition, text-based electronic health records (EHR) were collected, and time-labeled entries were extracted through algorithms from Natural Language Processing (NLP). The combination of EWS and NLP enabled the development of a system which could present and quantify a physiological condition timeline for patients. Promising results were obtained with EWS as measure, in which patients with EWS ≥ 8.5 passed away while all patients who were admitted for over 53 hours with EWS < 6.5 survived. The second study focused on ischemic stroke patients at Zealand University Hospital. Since all patients had same cause of admission and similar comorbidities, they were a more homogeneous critical patient group than in the first study. To predict the degree of disability after one day of admission, features based on vital signs and medical history were used in two prediction models. An introduced queue-based multiple linear regression (qMLR) model achieved best results with a root mean square error (RMSE) of RMSE = 3.11 on a Scandinavian Stroke Scale (SSS) where degree of disability ranged from 0 - 46. Worse outcomes were observed in patients who had pulse > 80 and a negative correlation between systolic and diastolic blood pressures during the first two hours of admission. The final study dealt with classification of diabetes mellitus (DM) in ischemic stroke patients, where current findings indicate that one third of patients have unrecognized DM. A support vector machine was trained using vital signs and medical history, and correctly classified whether patients had DM with an accuracy of 87.5%. The overall conclusion is that vital signs have high potential in applications for critically ill patients. Context-awareness through grouping with existing admission data is a prerequisite, unless vital signs are used to detect a specifically defined pathological events.

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