Title: Machine learning predicting hypotension in operating room: application of deep neural networks on continuous physiologic waveforms for early prediction of intraoperative hypotension

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Background and Aims:

Intraoperative hypotension (IOH), defined as mean arterial pressure (MAP) less than 65 mmHg during operation, is associated with increased rates of postoperative organ damages which may be fatal. [1,2] Our previous work reported that Machine learning can predict hypotension using feature extractions upon physiologic waveforms in limited numbers of patients [3]. In this research, we proposed a framework employing Deep Neural Networks (DNN) on continuous physiologic waveforms for early prediction of intraoperative hypotension without no feature extraction and applied our framework in high fidelity dataset.

Methods:

Machine Learning of Physiological Waveforms and Electronic Health Record Data to Predict, Diagnose, and Treat Hemodynamic Instability in Surgical Patients (MLORD) dataset, collected at University of California Los Angeles (UCLA), was analyzed in this study. A total of 7062 patients' physiologic waveforms over 17,655 hours was collected at UCLA between 2019 and 2022 during operations, which increased fidelity of dataset compared to other clinical data collected outside operating room. Each waveform, arterial blood pressure (ABP), photoplethysmography (PPG), and electrocardiography (ECG), was preprocessed into 30 seconds of windows as inputs into DNN predicting IOH, defined as mean arterial pressure less than 65 mmHg during operation. Receiver-operating characteristic curve (ROC) analysis with mean [standard deviation] evaluated performance of our framework in predicting IOH. The patients were split into two groups; (1) training set (n=5,021) for training of DNN; and (2) test set (n=2,041) for the performance evaluation.

Results:

Among 7062 surgery cases, 1038 episodes (14.7%) of IOH occurred. In the test set, DNN predicted IOH (1) 10 mins before with ROC of 0.93 [0.90 to 0.96], (2) 5 mins before with ROC of 0.96 [0.95 to 0.97]; (3) 1 min before with ROC of 0.99 [0.98 to 0.99].

Conclusions:

DNN achieved excellent performance in early prediction of IOH using physiologic waveforms including ABP, PPG, and ECG during operations.

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