Predicting delirium risk for the following 24 hours in critically ill patients using deep learning

Anirban Bhattacharyya
Cleveland Clinic Foundation
Cleveland, OH, USA

Sudhir Krishnan
Cleveland Clinic Foundation
Cleveland, OH, USA

Seyedmostafa Sheikhalishahi
Fondazione Bruno Kessler
Research Institute
Trento, Italy

Abhijit Duggal
Cleveland Clinic Foundation
Cleveland, OH, USA

Siddharth Dugar
Cleveland Clinic Foundation
Cleveland, OH, USA

Venet Osmani
Fondazione Bruno Kessler
Research Institute
Trento, Italy

I. INTRODUCTION

Delirium adversely affects both short- and long-term patient outcomes. Current methods of identifying patients at risk of delirium are based on questionnaires with moderate accuracy, or through more advanced predictive models requiring hundreds of variables. We propose developing a delirium prediction model using Deep Artificial Neural Networks (DNN) and using only commonly available parameters. Studying the relationship between these parameters over 24-hours temporal length through DNN, we aim to predict the risk of delirium in the following 24 hours.

II. METHODS

First, From the eICU database, we retrospectively studied patients aged between 18 and 90 years and were admitted to the ICU between 2014 and 2015. A positive CAM-ICU score was considered positive for delirium. The study evaluated DNN-based model to predict delirium risk 24 hours in advance, using 42 clinical variables, selected a priori as relevant and consistently available in electronic health records. The predictive model is based on bidirectional DNN called Long Short-Term Memory for its ability to incorporate past information in establishing relationships between variables. We evaluated predictive capability of the model using 20% randomly selected patients.

III. RESULTS

Patients who had at least one valid CAM-ICU reading were selected for analysis, resulting in 15619 patients (median age 63 years, 47.5% female); 3671 (23.5%) patients were ventilated and 2224 (14%) were being administered sedation through a continuous intravenous drip. At the end of the 48 hours of observation 1475 (9.4%) patients experienced delirium. The model was evaluated on another 3124 (20%) randomly selected patients. Setting specificity at 90%, the model had a 47% (95% CI, 88.5% - 90.8%) sensitivity, 31% (95% CI, 28.0% - 35.0%) positive predictive value and 94% (95% CI, 93.8% - 94.9%) negative predictive value, with an AUC of 0.79.

IV. CONCLUSIONS

This is one of the first studies predicting the likelihood of not developing delirium up-till 24 hours in advance. Furthermore, using fewer variables and those that are commonly recorded we achieved similar accuracy compared to models using hundreds of variables. Further training to optimize accuracy with external and/or prospective validation is required before this can be adopted to patient use.