Prediction of Acute Kidney Injuries in ICU

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INTRODUCTION

Acute Kidney Injury (AKI), is a clinicopathologic entity characterized by a sudden decrease in kidney function, leading to retention of metabolic waste products and the dysregulation of electrolyte homeostasis (1). Despite our progress in understanding the pathophysiology and a precise clinical definition and staging for diagnosis, AKI remains a global public health concern impacting approximately 13.3 million patients per year and resulting in 1.7 million deaths per year (2).

In our study, we are interested in the AKI acquired from the hospital setting because this is often caused by medical procedures and/or medications and may be preventable. Recent studies have concluded that early nephrology consultations leading to preventative measures decreases both the incidence and severity of AKI (3-5). Furthermore, electronic medical records and e-Alerts offer the potential for identifying high-risk patients and warning the use of nephrotoxic medications (6-8). Therefore, a reliable predictive machine learning model could address this unmet need.

GOAL: To predict a risk probability for developing AKI within the following 24 hours for patients admitted to the ICU based on all available prior electronic medical data

RESULTS

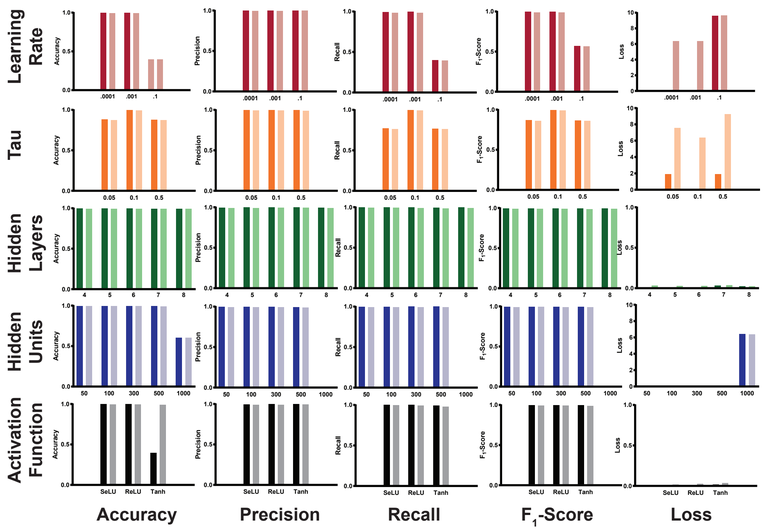


Figure 1: Results of experiments to determine parameters for neural network. *Final model with 6 hidden units, 300 units/layer, dropout rate 0.1, learning rate 0.001, tau = 0.1, mini batch size of 128, ran with 30 epochs. Darker color represents Training Set. Lighter color represents Dev Set.*

Figure 2: Final Model Results

	Training Set	Dev Set	Test Set
Loss	0.013	0.036	0.040
Accuracy	99.6%	99.2%	99.1%
Precision	0.998	0.991	0.986
Recall	0.998	0.989	0.992
F1-score	0.998	0.999	0.989

DISCUSSION

Our method demonstrates that the application of deep learning to ICU patient data can reliably predict onset of AKI within 24 hours with good accuracy, recall, and precision. High recall and accuracy indicate that our model has potential applications in clinical decision support. Specifically, a model with high recall allows physicians to identify patients for early intervention and prevention.

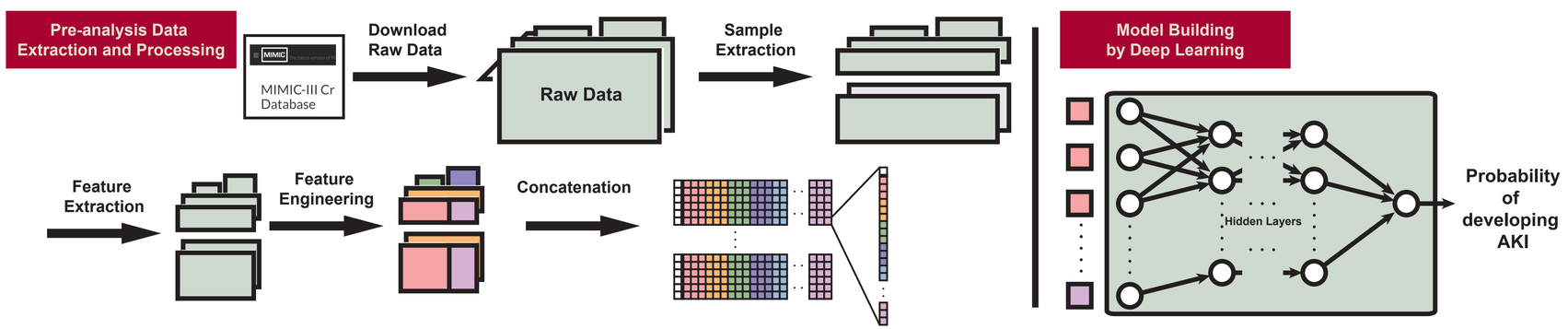
Identifying high risk patients will not only help reduce ICU mortality rate but also significantly reduce cost. A patient diagnosed with AKI in the ICU will cost the health system in excess of $8,000 on average. With approximately 75,000 patients afflicted each year, our model can lower expenditure by hundreds of millions of dollars annually.

FUTURE DIRECTION

Given our very high performance metrics, we investigated the possibility that some features could be very highly correlated with the outcome and therefore allow the model to easily make accurate predictions.

After sequentially removing features to identify potential strong contributors, we identified a list of features that were highly correlated with AKI onset in our dataset. This list was primarily made up of medications, including epinephrine, diltiazem, diphenhydramine, and entacapone. While, clinically, the relationship between medications that regulate blood pressure might be more clearly related with AKI onset through renal hypoperfusion, the strong correlation with diphenhydramine and entacapone warrants further investigation given that they are not known to be nephrotoxins.

METHODS



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