Title:
The Accuracy of Machine Learning to Predict Cardiac Arrest: A Systematic Review

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ACCEPTED

Session Title:
Rising Stars of Research and Scholarship Invited Student Posters

Slot:
RS PST1: Sunday, 17 November 2019: 11:45 AM-12:15 PM

Applicable Category:
Clinical, Academic, Students, Leaders, Researchers

Keywords:
Cardiac Arrest, Machine Learning and Prediction

References:


Abstract Summary:
This systematic review sought to determine if machine learning models more accurately predict in-hospital cardiac arrest when compared to the modified early warning score. Five of five studies demonstrated that machine learning models more accurately predicted cardiac arrest hours before the event occurred with fewer false alarms.

Content Outline:
I. Introduction
Cardiac arrest is a syndrome, which may result from various conditions, with the underlying pathophysiology of a loss of cardiac mechanical activity leading to circulatory failure. The incidence of in-hospital cardiac arrest in the United States is estimated at 209,000 annually. Cardiac arrest is a medical emergency and is often fatal without swift action. The average survival rate of an in-hospital cardiac arrest is less than 26 percent. Additionally, 40 percent of those surviving an in-hospital cardiac arrest will have moderate to severe functional impairment at discharge. The chance for a meaningful recovery is low; for that reason, the best strategy is early recognition with proactive steps to halt their clinical decline.

II. Body
Last year patients at a 191-bed Midwestern Community hospital experienced 74 cardiac arrests. The majority of these occurring outside of the intensive care unit (ICU) on units without advanced monitoring, where nurses care for five to seven patients, and most staff have less than two years’ experience. Recognition of a patients’ decline depends on observation and judgment on units with limited technology, resources, and low levels of clinical information to base these critical decisions.

The traditional hospital-based ‘track and trigger’ system, developed nearly 20 years ago, have failed to produce consistent and reliable predictions of clinical deterioration. Recent advancements in other industries have shown the benefits of harnessing predictive analytics, such as machine learning to interpret complex datasets with remarkable accuracy. Therefore, this systematic review aims to examine if machine learning models more accurately predict in-hospital cardiac arrest in adults aged 18 and older compared to the modified early warning score.

A systematic search was conducted with the results summarized using the preferred reporting items for systematic reviews and meta-analysis (PRISMA) guidelines. Inclusion criteria consisted of machine learning models applied to hospitalized adult patients (> 18 years), experiencing a cardiac arrest, from peer-reviewed journals, written in English, with full text available, within the last seven years. Academic journals were examined from 2012 to present using the following key terms: “machine learning” OR
“artificial intelligence” AND “cardiac arrest” OR “heart arrest” AND “modified early warning score” OR “MEWS.”

Five studies, one prospective, and four retrospectives were included in this review, ranging in level of evidence from II to III. These studies included over 500,000 patients from hospitals in the United States, South Korea, and Singapore. Outcomes were cardiac arrest, unexpected death, and ICU transfer. Machine learning applications included support vector machine, stacked ensemble, random forest, deep learning, gradient boosting machine, and neural network.

III. Conclusion

All five studies showed the incidence of in-hospital cardiac arrest was more accurately predicted when machine learning models (AUROC 0.78-0.86) were utilized compared to the modified early warning score (AUROC 0.55-0.70). Major trends in the studies included the use of deep learning models for variable selection.

Machine learning has the potential to provide more accurate predictions in real-time, enabling a proactive approach to the patient who stands to benefit the most. While there is indication through this work that machine learning models should be available to all clinicians, there are notable gaps in the availability of this technology at the bedside. Further research is needed to ensure the translation of this novel technology to the clinical practice setting.

Topic Selection:

Rising Stars of Research and Scholarship Invited Student Posters (25201)

Abstract Text:

**Problem**: Last year, patients at a 191-bed Midwest community hospital experienced 74 cardiac arrests. The majority occurring outside of the ICU, on units without advanced monitoring, where nurses care for five to seven patients, and most staff have less than two years experience. Recognition of a patient’s decline depends on nursing observation and clinical judgment on units with limited technology, medical resources, and low levels of clinical information to base critical decisions. Even with quick action, the average survival rate of an in-hospital cardiac arrest is less than 25 percent. The chance for a meaningful recovery is low; therefore, the best strategy is early recognition with proactive steps to halt their decline. The early recognition of patients most likely to experience a cardiac arrest in hospitalized adults, therefore, is a priority to nursing.

**Purpose**: The purpose of this systematic review was to assess the state of research to determine if machine learning models more accurately predict in-hospital cardiac arrest when compared to the modified early warning score.

**Search Strategy**: A review of the literature was conducted in January 2019. Databases searched included CINAHL, EBSCO, and PubMed. Inclusion criteria included machine learning principles applied to hospitalized adult patients experiencing cardiac arrest, from peer-reviewed articles, written in English, with full text available, within the last seven years. Exclusion criteria included those in the ambulatory setting, pediatric studies, and studies lacking machine learning models, studies failing to predict cardiac arrest, and studies failing to compare to the modified early warning score. Five studies were included for review.
Results of Literature Search: Five studies, one prospective, and four retrospectives were included in this review, ranging in level of evidence from II to III. These studies included over 500,000 patients from hospitals in the United States, South Korea, and Singapore. Outcomes were cardiac arrest, unexpected death, and ICU transfer. Machine learning applications included support vector machine, stacked ensemble, random forest, deep learning, gradient boosting machine, and neural network. Models were trained from routine demographics, biochemical, and physiological data then compared to the modified early warning score.

Synthesis of Evidence: All five studies showed the incidence of in-hospital cardiac arrest was more accurately predicted when machine learning models (AUROC 0.78-0.86) were utilized compared to the modified early warning score (AUROC 0.55-0.70). Major trends in the studies included the use of deep learning models for variable selection.

Implications for Practice: Machine learning has the potential to provide more accurate predictions in real-time, enabling a proactive approach to the patient who stands to benefit the most. While there is indication through this work that machine learning models should be available to all clinicians, there are notable gaps in the availability of this technology at the bedside. Further research is needed to ensure the translation of this novel technology to the clinical practice setting.