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EDITORIAL

Intensive care unit-acquired weakness: Unveiling significant risk factors and preemptive strategies through machine learning

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Abstract

This editorial discusses an article recently published in the *World Journal of Clinical Cases*, focusing on risk factors associated with intensive care unit-acquired weakness (ICU-AW). ICU-AW is a serious neuromuscular complication seen in critically ill patients, characterized by muscle dysfunction, weakness, and sensory impairments. Post-discharge, patients may encounter various obstacles impacting their quality of life. The pathogenesis involves intricate changes in muscle and nerve function, potentially leading to significant disabilities. Given its global significance, ICU-AW has become a key research area. The study identified critical risk factors using a multilayer perceptron neural network model, highlighting the impact of intensive care unit stay duration and mechanical ventilation duration on ICU-AW. Recommendations were provided for preventing ICU-AW, emphasizing comprehensive interventions and risk factor mitigation. This editorial stresses the importance of external validation, cross-validation, and model transparency to enhance model reliability. Moreover, the application of machine learning in clinical medicine has demonstrated clear benefits in improving disease understanding and treatment decisions. While machine learning presents opportunities, challenges such as model reliability and data management necessitate thorough validation and ethical considerations. In conclusion, integrating machine learning into healthcare offers significant potential and challenges. Enhancing data management, validating models, and upholding ethical standards are crucial for maximizing the benefits of machine learning in clinical practice.

Key Words: Intensive care unit-acquired weakness; Risk factors; Machine learning; Clinical medicine; Treatment decision

Core Tip: This editorial emphasizes the importance of recognizing the risk factors linked to intensive care unit-acquired weakness and highlights the vital role of machine learning in identifying and managing these factors to improve patient outcomes and enhance the quality of care in clinical settings.

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INTRODUCTION

Intensive care unit-acquired weakness (ICU-AW) is a debilitating neuromuscular complication that occurs in patients undergoing intensive care treatment in the intensive care unit (ICU)[1]. It is characterized by skeletal muscle dysfunction, leading to various clinical manifestations such as limb muscle weakness, atrophy, diminished deep tendon reflexes, and sensory impairments[2]. Importantly, patients with ICU-AW may also experience a range of challenges after being discharged from the hospital, including physical dysfunction, cognitive impairment, depression, and anxiety disorders [3]. The pathogenesis of ICU-AW is complex and involves intricate functional and structural changes in both muscles and nerves. This condition not only has the potential to result in severe outcomes like tetraplegia or paraplegia but can also lead to long-term disability, significantly impacting the quality of life for patients post-discharge. Given its profound impact on ICU patients, ICU-AW has become a prominent research topic of great interest to scholars worldwide, attracting extensive attention both domestically and internationally[4].

DISCUSSION

An article published by Wang and Long[5] offers a comprehensive exploration of the risk factors associated with ICU-AW. Through the use of a multilayer perceptron neural network model, the study successfully identified critical risk factors for ICU-AW, emphasizing the substantial impact of ICU stay duration and mechanical ventilation duration on its development. These findings provide actionable recommendations for managing these factors to mitigate the risk of ICU-AW within clinical settings. However, it is essential to recognize that the occurrence of ICU-AW is influenced by various other factors, necessitating comprehensive interventions to reduce its incidence. The study's insights serve as valuable reference information for clinicians, aiding in informed decision-making for the prevention and treatment of ICU-AW. It is recommended to further explain the differences between these risk factors identified by machine learning and actual medical practices and to process the data through an iteratively updated machine-learning approach.

While the article demonstrates significant progress in researching ICU-AW risk factors, there are opportunities for improvement in model construction and validation. To enhance the model's robustness, future studies should incorporate external validation[6] to ensure generalizability and employ cross-validation techniques to improve stability and reliability. To avoid the bias that older data may have on machine learning models, it is recommended to group the data by year or time period. This helps to identify the impact of data over different time periods on the model results and to assess the possibility of time bias. Additionally, comparing the multilayer perceptron neural network approach with other common machine learning algorithms would offer valuable insights into its advantages. It is also recommended that researchers share optimal model parameters, make data and model code publicly available, and encourage reproducibility of the study's results.

We propose the following specific recommendations for preventive strategies and interventions regarding ICU-AW. First, the article suggests that reducing the length of ICU stay and duration of mechanical ventilation on ICU-AW effectively lowers the probability of ICU-AW. This finding highlights the significance of early rehabilitation and ventilator withdrawal, offering a new perspective for clinical practice. Second, nutritional interventions and exercise interventions emerge as key strategies for preventing ICU-AW[7]. Nutritional support helps maintain muscle tissue metabolic balance and reduce muscle breakdown, while exercise interventions preserve muscle mass and function through muscle contraction and strength training. The simultaneous implementation of both approaches is expected to yield superior preventive outcomes. Lastly, the application of an early multidisciplinary collaboration in critically ill patient rehabilitation has demonstrated significant achievements. This early multidisciplinary collaboration facilitates close interdisciplinary and cross-disciplinary cooperation, delivering comprehensive and systematic rehabilitation services. Not only does this approach effectively prevent complications like ICU-AW, but it also substantially shortens patients' rehabilitation duration and enhances their daily functioning, muscle strength, and overall, quality of life[8]. This successful practice offers a novel and effective intervention strategy for rehabilitating critically ill patients. Future research is required to determine the extent to which efforts to prevent muscle weakness in the ICU are effective in terms of actual patient prognosis and activities of daily living. The effect of specific strategies such as shortening the duration of mechanical ventilation, early rehabilitation and intervention during deventilation, active nutrition intervention, and even exercise intervention during mechanical ventilation on the prevention of muscle decline in the model should be estimated by machine learning.

All in all, while the article provides valuable insights, it is crucial to enhance the model's stability and reliability through improvements in out-of-sample validation, cross-validation, algorithm comparison, and ensuring transparency in data and code. Moving forward, concrete preventive strategies and interventions for ICU-AW, including reducing ICU stay and mechanical ventilation duration, implementing nutritional and exercise interventions, and promoting early multidisciplinary collaboration in critically ill patient rehabilitation, are recommended. These suggestions provide essential guidance for future clinical practice and research, with the aim of effectively preventing ICU-AW, improving patient recovery outcomes, and enhancing overall quality of life.

CLINICAL APPLICATIONS AND CHALLENGES OF MACHINE LEARNING

In recent years, the utilization of machine learning in clinical medicine has expanded, showcasing its unique advantages. Machine learning provides healthcare professionals with a deeper understanding of disease causation and influencing factors, offering a scientific basis and decision support for clinical treatment. For instance, in colorectal cancer diagnosis, traditional methods face limitations that can be overcome by integrating machine learning with medical imaging, which enables more effective early screening[9]. Machine learning also aids in monitoring aggressive lymphomas and provides critical evidence for cases requiring early intervention[10]. Furthermore, in predicting macrosomia during pregnancy, machine learning empowers healthcare professionals to make more precise risk assessments, facilitating timely interventions for the well-being of both mothers and children[11].

In the realm of clinical pharmacy, machine learning demonstrates significant potential across drug development and clinical implementation. By leveraging drug-target knowledge to train predictive models capable of assessing interactions between new drugs and targets, machine learning offers valuable insights for drug development[12]. Moreover, when constructing predictive models for adverse drug reactions, integrating data from various sources helps reduce the risks associated with such reactions for patients and the healthcare system[13]. Additionally, machine learning-based Clinical Decision Support Systems (CDSSs) play a pivotal role in enhancing patient safety by providing clinicians with clinically valid alerts, improving decision-making processes, and minimizing medication errors[14]. The implementation of CDSS not only ensures patient safety but also enhances the efficiency and reliability of clinical decision-making within healthcare systems.

Despite the widespread application of machine learning, we must address potential challenges. Ensuring the reliability and stability of constructed and validated machine learning models is crucial. Rigorous data set divisions, cross-validation techniques, and other tools are essential to thoroughly evaluate model performance[15]. Efficient collection, processing, and utilization of the increasing volume of clinical data pose another challenge, necessitating the development of robust data processing methods, enhanced data quality management, and reinforced data security measures. Furthermore, legal and ethical issues in the clinical application of machine learning should be addressed through regulatory frameworks, legislative measures, and strengthening the ethical review process[16].

CONCLUSION

In conclusion, while machine learning offers immense potential in clinical medicine and pharmacy, addressing associated challenges is paramount. Through continuous technological advancements, improved data management practices, and ethical reviews, machine learning is poised to play an increasingly vital role in the pharmaceutical sector, contributing significantly to human health. Anticipating further progress in machine learning applications across diverse fields, we look forward to the continued evolution and impact of this technology.

FOOTNOTES

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