

AI for Good:

Utilizing Machine Learning Tools to Navigate Late Onset Neonatal Sepsis

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Abstract

Late-onset neonatal sepsis is a global issue that affects thousands of infants in the neonatal intensive care unit (NICU) every year. With mortality and morbidity remaining a significant outcome of late-onset neonatal sepsis and progress plateauing, this article will explore how artificial intelligence can be utilized as a tool to assist NICU providers and nurses in administering timely treatment. Through exploring the use of machine learning in the NICU, we can hope to see a new standard of care developed for infants worldwide and prevent unnecessary death in our tiniest patients.

Introduction

In healthcare, some of the most vulnerable patients are those that cannot speak for themselves. The neonatal intensive care unit (NICU) is a unit that cares for sick neonates of varying gestational ages. Neonates are defined as newborn babies less than 28 days old. Some neonates are full term, born between 37 and 40 weeks' gestation, while others are preterm, born between 23 and 37 weeks. There are varying levels of care available for neonates depending on how early they are born, and some of these patients spend up to four months in the hospital immediately after birth. When infants are NICU patients, they cannot express what is wrong or if they are experiencing pain. Nurses must analyze vital signs, complete thorough physical assessments, and rely on lab values to learn when an infant has a condition yet to be diagnosed. Many times, these critically ill infants do not show signs of infection until the disease process has progressed, often presenting with non-specific symptoms such as lethargy or increased respiratory effort.¹ Due to the broad nature of these symptoms, it can be challenging to diagnose an infection in its early stages. Most infection diagnoses occur after decompensation, and treatment tends to be non-specific until blood cultures and lab work comes back with definitive pathogens.

In the NICU, late-onset sepsis (LOS) is defined by an infection that occurs in neonates more than 72 hours after birth that is caused by a pathogen obtained from inside the hospital. In neonates, LOS is a major concern. It is one of the primary causes of mortality and morbidity in preterm neonates, with a mortality rate upwards of 19% globally.¹ Due to the unknown nature of most LOS infections and lack of screening tools, it is challenging to provide prophylactic measures to protect these infants, and diagnosis tends to be a slow process taking 48 to 72 hours after symptoms of infection present. Often, these infants are provided with empiric antibiotics to treat the assumed infection until a more tailored course of treatment can be made after confirming the infection source with a blood or cerebrospinal fluid culture.² This can lead to unnecessary antibiotic use and potential development of antibiotic-resistant strains of bacteria, further complicating treatment in the future for other infants. If these infections could be caught even 12 hours sooner, the treatment plan could be designed specifically to target the identified bacteria

and be administered in the quickest time frame possible. What if the use of artificial intelligence (AI) within the NICU could decrease the time between infection and diagnosis?

Artificial Intelligence in the NICU

Many people think about AI and wonder “is a robot going to take my job?” However, utilizing AI for predictive analysis in the NICU has the potential to improve outcomes. The AI that most people are familiar with may seem new, but the healthcare field has been utilizing AI tools for over 60 years.³ Though previously these tools were more simplistic and emphasized mimicking human decisions and actions, they laid the groundwork for the more sophisticated tools being used in healthcare today. These newer tools have the potential to positively impact nearly all medical specialty areas around the world. Most NICUs do not utilize AI currently, and standardization for AI tools is lacking in most healthcare specialties.

Machine learning tools, a subset of AI, are currently being developed to support the neonate population. These tools rely on analyzing large sets of patient data to determine microtrends that appear in vital signs, lab work, and biosignals a patient may be exhibiting prior to developing a diagnosed infection.⁴ Current research around machine learning in the NICU often focuses on training the AI to interpret data sets with specific parameters for diagnosing LOS. Some focus on noninvasive biosignals from vital sign monitors while others use lab values from blood tests such as blood cell counts, electrolytes, and blood gas values.⁵ The models with the greatest benefit are those that focus on noninvasive values and don't require routine blood draws. These models fully rely on vital signs such as heart rate, oxygen saturation, blood pressure, temperature, and respiratory rate. Noninvasive values are already checked routinely by nurses every two to three hours in most NICUs and by training AI tools with these values; more accurate data sets are created.⁶ When relying on models that are trained with blood tests alone, tool reliability is limited because most patients receive blood tests less frequently than vital sign checks.

With any machine learning tool, false positives are possible, especially if an infant falls out of the dictated norm for the vital signs data set. Some infants have a naturally high heart rate or borderline temperatures, and infection isn't always the cause of an infant's health decline.⁶ That is why teams involved in patient care using AI must proceed with careful consideration and in conjunction with thorough physical assessment and patient history. Ideally, these tools will allow NICU clinicians to diagnose infections earlier and alert clinicians to any potential trends in status.

Conclusion

Though still in various stages of development, many of these machine learning algorithms have the potential to become part of the blueprint for sepsis identification and treatment in the NICU. The next step will be to determine a recommendation for biosignal and vital sign parameters that sepsis identification algorithms should follow. Ultimately, AI is a tool to help guide physicians and nurses in their treatment of potentially septic infants. Artificial intelligence is not a replacement for healthcare providers, but by using it as a resource and by further investing in the development and research of AI tools, we are investing in the future of our patients and improving their outcomes.

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