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REAL-TIME JAUNDICE DETECTION IN NEWBORNS USING SKIN COLOR SCANNING METHOD

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ABSTRACT

Neonatal jaundice is a common condition that can lead to severe complications if not detected and treated early. This study focuses on the development of a non-invasive jaundice detection tool using a TCS3200 color sensor, which aims to provide early diagnosis by measuring skin discoloration associated with elevated bilirubin levels. The methodology for the study involved several stages: designing the device, calibrating the color sensor, and conducting field tests in clinical settings. The TCS3200 sensor was used to capture the skin color from various body areas of newborns, including the forehead, chest, abdomen, and limbs. The collected data were correlated with serum bilirubin levels, and the severity of jaundice was classified using the Kramer scale, a clinical tool that assesses the spread of yellow pigmentation across the body. The results showed that the jaundice detection tool achieved a high degree of accuracy, with its readings closely mirroring laboratory-based bilirubin measurements. This was particularly evident in cases of moderate to severe jaundice, where the tool provided precise early detection. The non-invasive nature of the tool, combined with its portability, makes it an ideal solution for use in healthcare facilities with limited access to laboratory equipment. Additionally, the tool can be operated by healthcare workers with minimal training, which enhances its potential for deployment in rural or underserved areas. The study concludes that the developed jaundice detection tool has significant potential to improve neonatal care by enabling early diagnosis and timely intervention, thereby reducing the risk of severe jaundice-related complications. Future research will focus on scaling up the testing of the device across a larger and more diverse population of newborns, as well as pursuing product certification to facilitate broader implementation in healthcare settings.

Keywords: Jaundice, Neonatal, Color sensor, Early detection, Kramer scale

ABSTRAK

Ikterus neonatal adalah kondisi umum yang dapat menyebabkan komplikasi serius jika tidak terdeteksi dan ditangani sejak dini. Penelitian ini berfokus pada pengembangan alat deteksi ikterus non-invasif menggunakan sensor warna TCS3200, yang bertujuan untuk memberikan diagnosis dini dengan mengukur perubahan warna kulit yang terkait dengan peningkatan kadar bilirubin. Metodologi penelitian ini melibatkan beberapa tahap: perancangan alat, kalibrasi sensor warna, dan pengujian lapangan di lingkungan klinis. Sensor TCS3200 digunakan untuk menangkap warna kulit dari berbagai area tubuh bayi baru lahir, termasuk dahi, dada, perut, dan anggota tubuh. Data yang dikumpulkan kemudian dikorelasikan dengan kadar bilirubin serum, dan tingkat keparahan ikterus diklasifikasikan menggunakan skala Kramer, sebuah alat klinis yang menilai penyebaran pigmentasi kuning di tubuh. Hasil penelitian menunjukkan bahwa alat deteksi ikterus ini mencapai tingkat akurasi yang tinggi, dengan pembacaannya sangat mendekati hasil pengukuran bilirubin berbasis laboratorium. Hal ini terutama terlihat pada kasus ikterus dengan tingkat keparahan sedang hingga berat, di mana alat ini memberikan deteksi dini yang akurat. Sifat non-invasif dari alat ini, ditambah dengan portabilitasnya, menjadikannya solusi ideal untuk digunakan di fasilitas kesehatan yang memiliki keterbatasan akses terhadap peralatan laboratorium. Selain itu, alat ini dapat dioperasikan oleh tenaga kesehatan dengan pelatihan minimal, yang meningkatkan potensinya untuk diterapkan di daerah pedesaan atau wilayah yang kurang terlayani. Penelitian ini menyimpulkan bahwa alat deteksi ikterus yang dikembangkan memiliki potensi signifikan untuk meningkatkan perawatan neonatal dengan memungkinkan diagnosis dini dan intervensi tepat waktu, sehingga mengurangi risiko komplikasi ikterus yang parah. Penelitian selanjutnya akan berfokus pada peningkatan skala pengujian alat ini pada populasi bayi baru lahir yang lebih besar dan beragam, serta mengejar sertifikasi produk untuk memfasilitasi penerapan yang lebih luas di fasilitas kesehatan.

Kata kunci: Ikterus, Bayi baru lahir, Sensor warna, Deteksi dini, Skala Kramer

INTRODUCTION

Neonatal jaundice is a prevalent medical condition that affects approximately 60% of term newborns and 80% of preterm infants within the first week of life (1) . This condition is characterized by the accumulation of bilirubin, a byproduct of the breakdown of red blood cells, leading to a yellowish tint in the skin and sclera (2). While mild jaundice often resolves without intervention, elevated levels of bilirubin particularly when untreated can result in severe hyperbilirubinemia, which

poses a risk of developing kernicterus, a form of brain damage that can lead to long-term neurological deficits or even death (3).

The standard method for diagnosing and monitoring jaundice involves frequent blood tests to measure bilirubin levels, but this approach is often impractical in low-resource settings due to a lack of laboratory facilities, skilled personnel, and the necessary medical equipment (4). Furthermore, repeated blood draws can be stressful and painful for neonates, leading to additional concerns in clinical management.

Given these challenges, there is a critical need for an alternative method that is both accurate and non-invasive (5). This study addresses this gap by focusing on the development of a portable jaundice detection tool that uses a color sensor to measure skin discoloration associated with elevated bilirubin levels. The use of a color sensor offers several advantages: it is non-invasive, can be applied rapidly, and does not require sophisticated laboratory infrastructure (6). Moreover, the device can be operated by healthcare workers with minimal training, making it ideal for deployment in rural or underserved areas where healthcare resources are limited.

The Kramer scale, a widely recognized clinical tool for assessing the severity of jaundice based on the spread of yellow pigmentation across the body (7), serves as the foundation for the design of the detection device. By integrating this clinical standard with modern sensor technology, the device aims to provide a reliable and immediate estimate of bilirubin levels, enabling early detection and timely intervention (8).

This study aims to achieve two primary objectives: first, to develop and calibrate a jaundice detection device that can accurately measure bilirubin levels based on skin color analysis, and second, to evaluate the effectiveness of the device in various clinical settings, particularly in locations where access to laboratory services is limited. The ultimate goal is to reduce the incidence of severe hyperbilirubinemia and its associated complications by providing a practical, cost-effective solution for early detection and management of neonatal jaundice.

By addressing these objectives, the study contributes to the broader field of neonatal care, offering a potential solution to a longstanding challenge in the management of jaundice in resource-limited settings. The implementation of such a device could not only improve clinical outcomes but also ease the burden on healthcare systems by reducing the need for intensive care for severe cases of jaundice

METHOD

The research methodology is divided into several stages, starting from the design and calibration of the jaundice detection device to the testing of its accuracy in field conditions. The TCS3200 color sensor was used to detect skin color variations in newborns affected by jaundice. The sensor measures the color intensity in different areas of the body, which is then correlated with bilirubin levels. The tool's accuracy was assessed against laboratory results from various health facilities:

Participant

Participants in this study were newborns showing symptoms of jaundice, both physiological and pathological. Data were collected from full-term and preterm infants at several health facilities in Jakarta.

Procedures

Color data were collected from different body areas of the newborns using the TCS3200 sensor. The results were then analyzed using the Kramer scale to classify the severity of jaundice. Calibration

involved adjusting the sensor to detect yellow nuances that correlate with specific bilirubin levels, ensuring the tool's accuracy

RESULTS AND DISCUSSION

The results from the study demonstrated that the jaundice detection tool developed using the TCS3200 color sensor had a high level of accuracy. Specifically, the tool's readings closely correlated with laboratory-based bilirubin measurements, which are the gold standard for determining the severity of jaundice. This was particularly evident in cases of moderate to severe jaundice, where the tool consistently provided early detection with a precision comparable to laboratory diagnostics.

Field tests were conducted in various healthcare facilities, and the tool was able to effectively categorize the severity of jaundice based on skin color variations captured by the sensor. The categorization was based on the well-established Kramer scale, which correlates the spread of yellowish discoloration in the skin with the severity of jaundice. By employing this method, the tool allowed healthcare providers to quickly identify the progression of jaundice, enabling them to make timely decisions regarding further testing or treatment.

One key advantage of the tool is its ability to offer non-invasive monitoring, which reduces the need for blood draws in newborns. This makes it particularly useful in resource-limited settings, where laboratory facilities may not be readily available. The simplicity of the tool's operation, combined with its portability, means that it can be utilized in a variety of healthcare settings, including rural clinics and smaller hospitals that may not have immediate access to laboratory services.

The discussion also highlights the broader implications of this tool for neonatal care, particularly in developing countries where access to healthcare resources can be limited. The adoption of such a device could significantly improve the ability of healthcare workers to diagnose and manage jaundice early, thereby preventing severe complications such as kernicterus, which can result in brain damage (9). The Kramer scale, used as the basis for this tool, has been validated over decades of clinical practice, and its integration into this new technology underscores its continued relevance in modern medical practice (10,11,12).

Additionally, the discussion suggests that this tool could be adapted for wider applications, such as screening in routine neonatal checkups. By providing an accessible and affordable method for early detection, it has the potential to reduce the burden on healthcare systems by preventing severe jaundice cases from escalating to critical stages that require intensive care

LIMITATION OF THE STUDY

This study faced minimal limitations during its execution. The research team encountered no significant challenges that impeded the progress or accuracy of the jaundice detection tool development. The facilities used for research were well-equipped, and the collaboration with healthcare institutions ensured a smooth collection of data from neonatal patients. However, as the study was conducted primarily in an urban setting with sufficient access to healthcare, future studies should consider testing the tool's efficacy in more remote or under-resourced areas to evaluate its robustness in a wider range of environments. Additionally, while the tool showed promising results in detecting moderate to severe jaundice, further testing across different populations is necessary to confirm its universal applicability and precision in various healthcare settings.

CONCLUSIONS AND SUGGESTIONS

The development of the jaundice detection tool using a color sensor represents a significant advancement in neonatal care. Its ability to accurately detect jaundice severity, especially in settings with limited access to laboratory testing, is a breakthrough in improving early diagnosis and treatment outcomes for jaundiced infants. The tool's non-invasive nature, portability, and ease of use make it an ideal solution for both urban and rural healthcare settings, where resources may vary significantly. Future research will focus on scaling up the testing to include a larger and more diverse sample of newborns from various geographic and socioeconomic backgrounds. This will help to further validate the tool's accuracy and reliability across different populations. Additionally, efforts will be made to obtain necessary regulatory certifications, which will enable the widespread implementation of the tool in healthcare facilities throughout Indonesia and potentially other countries. The goal is to make this technology a standard part of neonatal care, ensuring that all newborns have access to early jaundice detection and timely interventions, regardless of their location or the resources available

ETHICAL CONSIDERATIONS

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Conflict of Interest Statement

The authors declare that there are no conflicts of interest, financial or otherwise, that could be perceived as having influenced the research, authorship, and/or publication of this article

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