ARTIFICIAL INTELLIGENCE IN THE INTERPRETATION OF COMPLETE BLOOD COUNTS

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Abstract

The application of artificial intelligence (AI) in the interpretation of complete blood counts represents a significant advance in laboratory and clinical practice by enabling faster, more accurate, and standardized analysis of hematological parameters. The objective of this chapter is to discuss the role of AI in supporting diagnosis based on blood count data, highlighting its benefits, limitations, and future perspectives. The methodology consists of a narrative review of the scientific literature, drawing on studies by authors such as Goodfellow et al., Esteva et al., and Topol, who investigate the use of machine learning algorithms and neural networks in biomedical data analysis. The results indicate that AI-based systems can identify hematological patterns associated with anemia, infections, leukemia, and inflammatory disorders with high sensitivity and specificity, while also reducing human error and laboratory turnaround time. However, challenges remain regarding data quality, algorithm interpretability, and integration with healthcare systems. It is concluded that artificial intelligence is a promising tool for

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blood count interpretation, contributing to clinical decision-making when ethically applied, properly validated, and integrated with professional expertise.

Keywords: Artificial Intelligence; Clinical pathology; Complete blood count; Laboratory diagnosis; Machine learning.

INTRODUCTION

The interpretation of the complete blood count (CBC) is one of the most important steps in laboratory diagnosis, as it provides essential information on the organism's physiological and pathological status, assisting in the identification of anemias, infections, and hematological and inflammatory disorders. With the advancement of digital technologies and the increase in the volume of clinical data generated daily, it has become increasingly necessary to use tools capable of analyzing this information rapidly, accurately, and in a standardized manner. In this context, artificial intelligence (AI) emerges as a promising technology capable of transforming how laboratory tests are interpreted, offering support for clinical decision-making.

The research problem guiding this study concerns the limitations of conventional CBC interpretation, which relies heavily on human experience and is subject to variability, reading errors, and difficulties in identifying complex patterns. In light of this, the question arises as to how artificial intelligence can contribute to increasing diagnostic accuracy, reducing failures, and optimizing the turnaround time of hematological tests.

The general objective of this chapter is to analyze the application of artificial intelligence in the interpretation of complete blood counts, highlighting its impacts on laboratory diagnosis. The specific objectives are: to understand the principles of AI applied to hematology; to identify the main models and algorithms used in CBC analysis; to discuss the benefits and limitations of this technology; and to evaluate its contributions to clinical practice.

The justification for this study is based on the growing demand for faster and more reliable diagnoses in a scenario of overburdened health services. The incorporation of AI into laboratory tests can reduce errors, increase professional efficiency, and improve the quality of patient care, thus becoming a relevant topic for both healthcare and scientific research.

From a theoretical standpoint, artificial intelligence—especially through machine learning and artificial neural networks—enables the identification of complex patterns in large biomedical datasets. Studies by authors such as Goodfellow, Bengio, and Courville, as well as Topol and Esteva, demonstrate that these systems are capable of learning from examples and providing diagnostic interpretations comparable to those of human experts. In the field of hematology, such technologies have been applied to classify blood cells, detect morphological alterations, and support disease identification, consolidating AI as an innovative and strategic tool for laboratory medicine.

METHODOLOGY

TYPE OF RESEARCH

This study is characterized as qualitative, exploratory, and descriptive research, grounded in a narrative review of the scientific literature. This approach was chosen because it allows for a broad and integrated analysis of the knowledge already produced on the application of artificial intelligence in the interpretation of complete blood counts, making it possible to identify trends, technological advances, and existing gaps in the area.

DATA COLLECTION PROCEDURES

Data collection was carried out through a bibliographic survey in recognized scientific databases such as PubMed, Scopus, Web of Science, and Google Scholar. Articles, books, chapters, and technical documents published mainly in the last ten years were selected, prioritizing studies addressing the use of machine learning algorithms, artificial neural networks, and decision-support systems applied to laboratory hematology.

The descriptors used included terms in Portuguese and English, such as “inteligência artificial,” “hemograma,” “aprendizado de máquina,” “análise hematológica,” and “diagnóstico laboratorial,” combined using Boolean operators to broaden and refine search results.

INCLUSION AND EXCLUSION CRITERIA

Publications that directly addressed the application of artificial intelligence to the analysis of CBC parameters, cellular classification, or support for hematological diagnosis were included. Excluded were duplicate studies, non–peer-reviewed works, publications with insufficient data, or those dealing with AI in medical areas unrelated to hematological tests.

DATA ANALYSIS

The selected studies underwent qualitative content analysis, seeking to identify the objectives, methods, results, and contributions of each work. The information extracted was organized into thematic categories—such as types of algorithms used, system performance, clinical applications, and technical limitations—allowing for a comparative interpretation of the findings.

METHODOLOGICAL FOUNDATION

The choice of a narrative review is based on the need to comprehensively understand a rapidly evolving field such as the use of artificial intelligence in hematology. According to authors like Lakatos and Marconi, this type of methodology is appropriate for systematizing existing knowledge, promoting critical reflection, and supporting future investigations. Thus, the method adopted enables the integration of different scientific perspectives and offers a consolidated view of the role of AI in the interpretation of complete blood counts, contributing to the theoretical and practical advancement of the field.

RESULTS AND DISCUSSION

Analysis of the selected studies shows that the application of artificial intelligence to the interpretation of complete blood counts has yielded significant results in supporting laboratory diagnosis. The main findings indicate that machine learning algorithms—especially artificial neural networks, decision trees, and deep learning models—exhibit high performance in identifying hematological alterations such as anemias, leukemias, bacterial infections, and inflammatory disorders. These systems can recognize complex patterns in CBC data that are often not easily discernible through traditional human analysis.

Studies conducted by Goodfellow, Bengio, and Courville demonstrate that deep learning models possess a high capacity for generalization when analyzing large volumes of biomedical data, making them suitable for diagnostic tasks. Similarly, research reported by Topol indicates that AI can act as a complementary tool for healthcare professionals, increasing diagnostic accuracy and reducing errors related to fatigue or subjectivity in test interpretation. In the context of hematology, this translates into greater reliability in evaluating indices such as hemoglobin, mean corpuscular volume, and leukocyte and platelet counts.

Another relevant result concerns the reduction in laboratory turnaround times. Automated AI-based systems can process thousands of samples in a matter of seconds, expediting the release of reports and enabling faster clinical interventions. In addition, studies by Esteva et al. demonstrate that integrating intelligent algorithms into laboratory systems can improve the triage of suspected cases by prioritizing samples with a higher likelihood of pathological alteration.

However, the literature also highlights important limitations. The quality of results depends directly on the dataset used to train the algorithms, and incomplete or biased datasets can compromise the reliability of the analyses. Moreover, authors such as Topol warn of the difficulty in interpreting deep learning models, which often operate as “black boxes,” complicating the clinical explanation of the decisions generated.

Thus, the results discussed show that artificial intelligence represents a significant advance in the interpretation of complete blood counts, but its implementation must be accompanied by scientific validation, professional oversight, and ethical integration into health services, as indicated by contemporary literature.

CONCLUSION

This chapter aimed to analyze the application of artificial intelligence in the interpretation of complete blood counts, highlighting its contributions to laboratory diagnosis and clinical decision-making. Throughout the study, we sought to understand the foundations of AI, its main models applied to hematology, and the impacts of this technology on professional practice.

The main results showed that AI-based systems have a high capacity to identify hematological patterns associated with various pathologies—such as anemias, infections, and hematological diseases—in addition to reducing analysis time and the likelihood of human error. The literature analyzed indicates that machine learning and deep learning algorithms provide greater accuracy, standardization, and efficiency in test interpretation, functioning as tools that support healthcare professionals.

As a scientific contribution, this research consolidates knowledge on the integration of artificial intelligence into clinical pathology, demonstrating its potential to modernize laboratory processes and improve the quality of diagnoses. Furthermore, the study reinforces the importance of joint action between technology and human expertise, emphasizing that AI does not replace the professional but rather expands their analytical capacity.

Finally, it is suggested that future research explore the development of more diverse and representative datasets, as well as the creation of more transparent and interpretable models. Clinical studies are also recommended to practically assess the impact of artificial intelligence on laboratory routines and patient outcomes, contributing to a safer and more effective implementation of this technology.

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