

REVIEW ARTICLE

Microbial infection disease diagnosis and treatment by artificial intelligence

Laith M Abbas Al-Huseini[1], Nisreen Jawad Kadhim[2], Mohammed Salih Mahdi[2], Raed H. Ogaili[3], Orooba Al-hammood[4]

[1]DEPARTMENT OF PHARMACOLOGY, COLLEGE OF MEDICINE, WARITH AL-ANBIYAA UNIVERSITY, KARBALA, IRAQ
[2]DEPARTMENT OF MICROBIOLOGY, COLLEGE OF MEDICINE, WARITH AL-ANBIYAA UNIVERSITY, KARBALA, IRAQ
[3]COLLEGE OF VETERINARY MEDICINE, UNIVERSITY OF KERBALA. KARBALA, IRAQ
[4]DEPARTMENT OF BIOLOGY, COLLEGE OF SCIENCES, AL-NAHRAIN UNIVERSITY, BAGHDAD, IRAQ

ABSTRACT

Aim: The main objective of this study was to examine current perspectives on initiatives to identify viable approaches for more accurate diagnosis of infectious diseases.

Materials and Methods: Indexed databases, such as EMBASE, Scopus, and PubMed/Medline, and online searches were performed. Cross-referencing of important articles led to additional references. This study reviews important clinical applications and provides an overview of several Artificial intelligence algorithms used in diagnosis of diseases caused by pathogenic microorganisms.

Conclusions: Artificial intelligence technologies could be used in nearly every area of medicine. Before these new technologies may be used in actual clinical settings, more carefully planned clinical trials are required.

KEY WORDS: Microbial, Infection, Artificial Intelligence

Wiad Lek. 2025;78(2):442-447. doi: 10.36740/WLek/200511 DOI

INTRODUCTION

The term artificial intelligence (AI), first coined in 1956, refers to digital systems that attempt to solve problems and continuously improve their data processing skills by using algorithms that mimic human intellect. These days, artificial intelligence has expanded too many industries and started to help them thanks to the rise in data entry, the usage of more potent coding languages, and the application of sophisticated algorithms [1]. This implies that they should also play a bigger role in bacterial epidemiology. For instance, at major hospitals, machine learning algorithms can forecast patients' likelihood of contracting Clostridium diffusible infection in advance, enabling medical staff to take proactive precautions before an infection happens [2, 3]. Contact tracing in the emergency room can be done more quickly and effectively with real-time locator devices than with tracing techniques that depend on electronic medical data. This maximize the utilization of time and money while significantly increasing the number of potentially susceptible individuals identified. Selling hospitals and payers on the usefulness of sophisticated microbiology diagnostics is one of the largest problems facing the clinical microbiology community. It would be highly beneficial to provide explicit guidance on how to identify and demonstrate treatment value [4, 5]. There are two technologies used in medicine: visual and artificial intelligence, the latter of which is related to web design. These features include electronic health records, appointment scheduling, prescribing, drug interactions, imaging and osteoporosis, and score systems for diagnosis and verification. Conversely, physical components include post-operative technical support, social assistive technology used in elder care, rehabilitation, and televiewing [6, 7]. Artificial intelligence is the imitation of human intelligence via the use of computers. This new science explores and creates ideas, methods, instruments, and strategies to duplicate, improve, and broaden human knowledge. Machine learning, a branch of artificial intelligence, allows machines to learn tasks by identifying patterns in data. Neural networks are adaptable mathematical models that can use a range of methods to express intricate relationships in big data sets. Artificial intelligence, particularly its variations like as deep learning and convolutional neural networks (CNNs), is currently the most used machine learning technique. Data is sent to the input layer, which uses a hidden multi-layer algorithm to process it. The outcomes are displayed in the results. Instead of being a straightforward neural network with one or a few convolutional layers between the input and output layers, deep learning may be thought of as a computational process with several hidden layers. The hidden layers can be piled endlessly to create a machine with greater sensitivity and accuracy as processing power increases [8].

AIM

This study sought to investigate how AI can raise the degree of individualized treatment and the precision and effectiveness of clinical diagnosis in light of the potential obstacles to its clinical deployment. It was based on a careful examination of existing literature and findings from recent studies. By providing medical professionals with an in-depth understanding of how AI can be used to diagnose and treat infectious diseases, by working together to advance the use of AI to combat infectious diseases, and by providing patients with more accurate and efficient healthcare , this will not only be important in improving global public health.

MATERIALS AND METHODS

METHODOLOGY AND INTEGRATION OF THE SEARCH

Indexed databases, such as EMBASE, Scopus, and PubMed/Medline, were separately searched in English only, without regard to time constraints. Cross-referencing of important articles led to additional references. This study reviews important clinical applications and provides an overview of several Artificial intelligence algorithms used in diagnosis of diseases caused by pathogenic microorganisms.

REVIEW AND DISCUSSION

USING ARTIFICIAL INTELLIGENCE TO DIAGNOSE MICROORGANISMS

Every diagnostic method, from sample collection to identification and susceptibility testing, poses challenges to traditional microbiology. Improper sample processing causes problems and can lead to incorrect conclusions [9]. The presence of antibiotics in clinics makes the process of cultivating and isolating germs more difficult and prone to false negative results (Fig.1-2). The inherent delay in traditional microbiological detection can result in antibiotic resistance through empirical therapy by letting diseases deteriorate [10]. The early detection of pathogens and the development of successful prevention measures depend on AI algorithms' ability to quickly and accurately identify trends and abnormalities in large microbial datasets [11, 12]. Artificial intelligence's predictive modeling predicts microbial activity based on historical data, which aids in improving treatment approaches, anticipating illness outbreaks, and better understanding patterns in antibiotic resistance [13].

STRUCTURE AND ROLE OF ARTIFICIAL INTELLIGENCE IN CLINICAL MEDICINE

Artificial intelligence in healthcare can be separate into two collection depending connected how it works: visual and physical [14]. The term "physical AI" describes devices that may help with and carry out a range of useful functions, such as surgery and the deployment of robots in medical procedures. Virtual artificial intelligence includes any program that can process, analyze, and pass on with other inclination connected to a system (Fig.3). More precisely, artificial intelligence computes data and provides a deterministic response using two methods. AI software may be able to make accurate decisions about a patient's health and treatment in "real-time" thanks to machine learning (ML), which is the capacity of an AI system to develop suitable algorithms that generate decisions and/or predictions based on the data generated [15]. This method, known as the "flow chart technique," mimics how a doctor would compile information from a patient's medical history and clinical test results. AI programs can also use a more complex type of flow chart.

MONITORING AND IDENTIFYING EMERGENCIES

By gathering and examining data on risk factors, clinical outcomes, and patterns of disease transmission, AI can also be a helpful tool in case analysis. Healthcare practitioners might use this to pinpoint high-risk groups, track the transmission of illnesses, and anticipate any outbreaks. This tends to maximize resource use while improving early intervention tactics [16]. Thus, as has been emphasized throughout history, detection and management of disease outbreaks are critical. Conventional surveillance techniques require manual data collection, which eventually results in underreporting or delays in the reporting of infectious

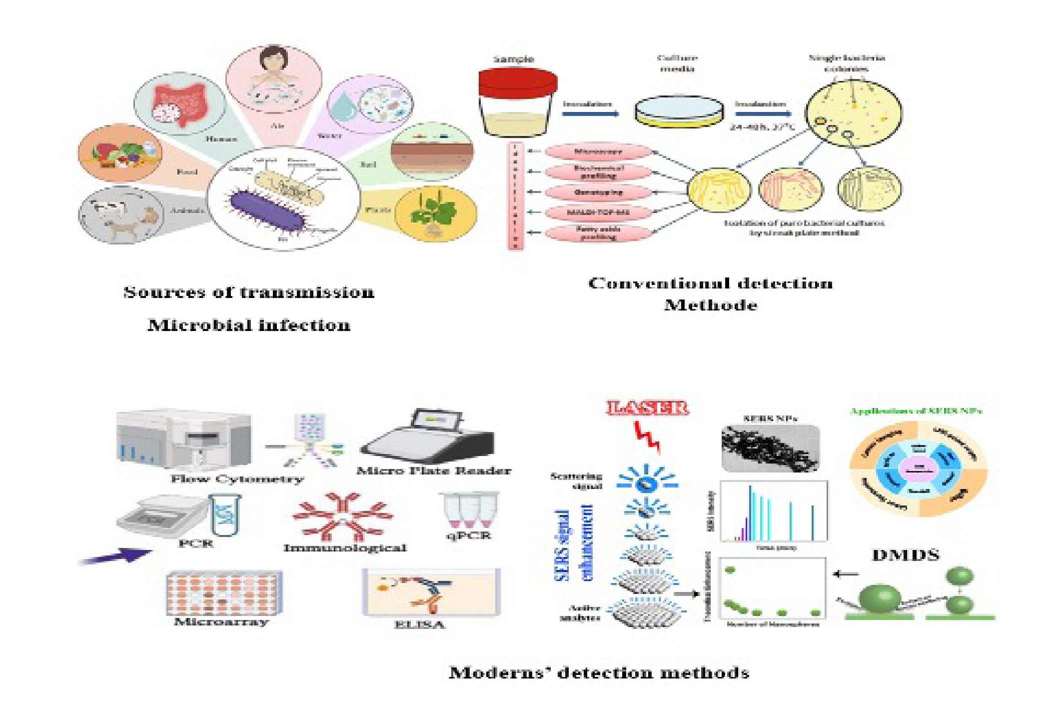

Fig. 1. Flow chat of future diagnostics microbial infection identification of diseases by traditional methods of detection and current (modern methods of identification).

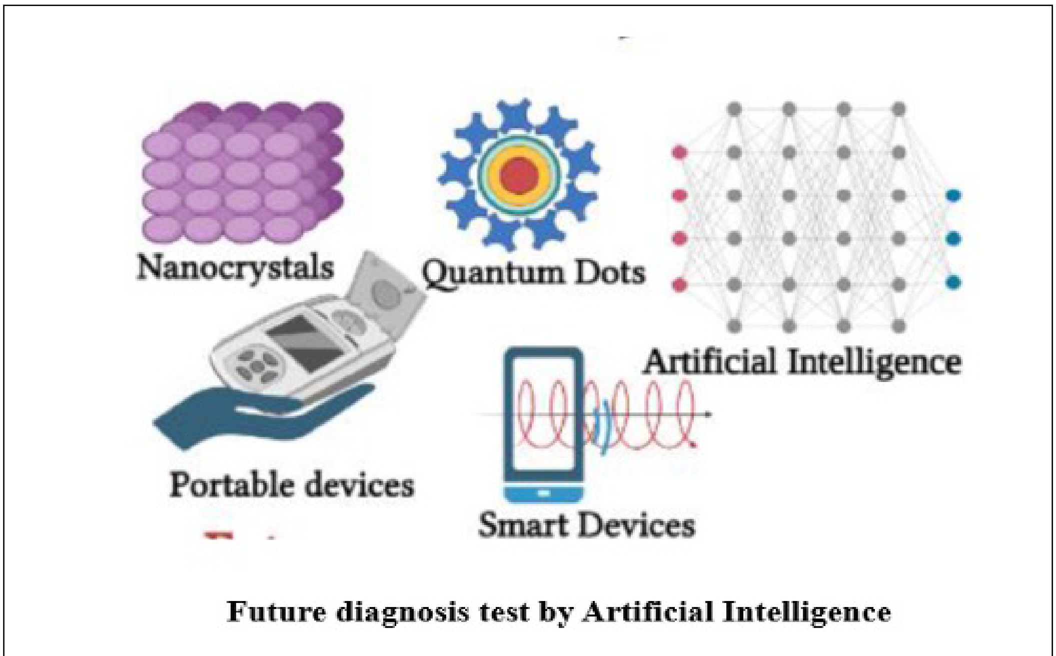

Fig. 2. Flow chat of future diagnostics microbial infection identification of diseases by Artificial Intelligence.

disease cases. AI-based surveillance systems, on the other hand, automatically gather information from social media and medical records while evaluating real-time data streams to improve public health response and situational awareness [17]. At the extremely least, machine learning-based alert systems have been created that detect deviations in disease rates or the ways infectious diseases are spread, alerting health authorities to potential outbreaks [18]. AI has shown great potential in the tract of learned profession imagination, which is essential for diagnosis. Profound eruditeness systems, a different kind of artificial intelligence, have demonstrated accuracy in analyzing medical pictures, including X-ray and histopathology CT scans. All things considered, the application of AI in TDM may lead to improved patient outcomes. Improve the precision and effectiveness of medical care delivery to lower medical expenses. It is anticipated that AI will become more significant in TDM as it develops [19].

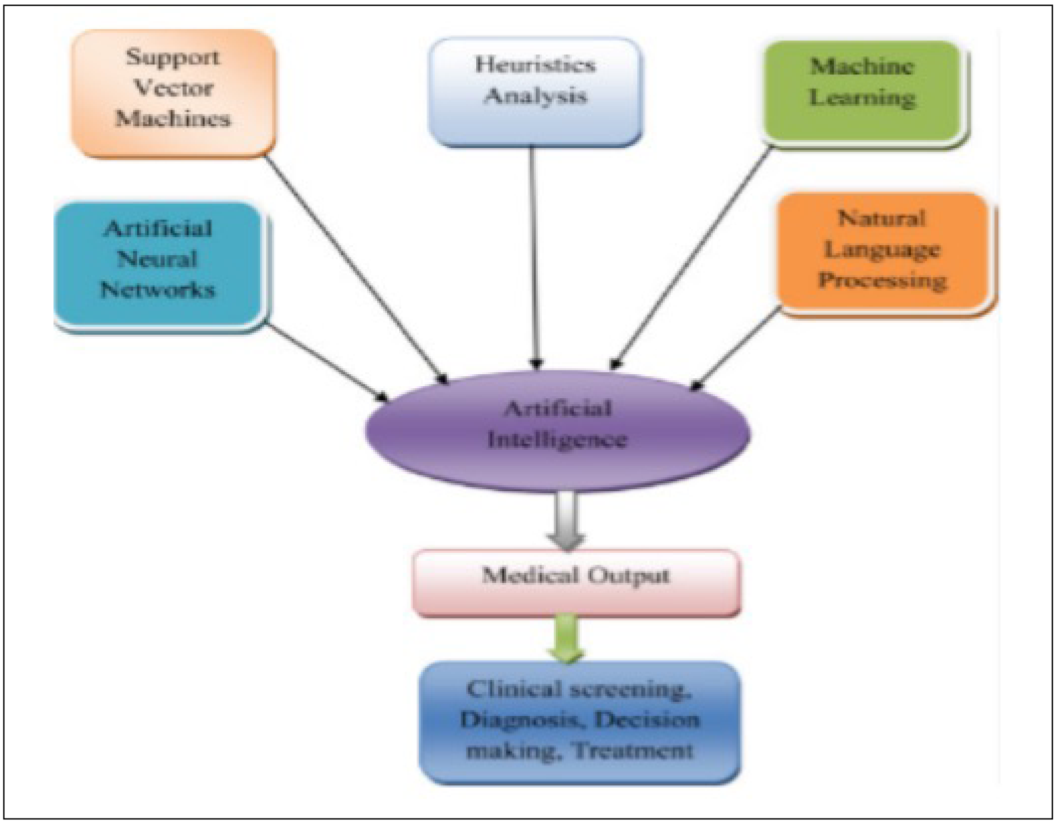

Fig. 3. Structure and functions of artificial intelligence in clinical medicine.

RISKS, ETHICS, AND LEGAL ISSUES RELATED TO AI IN MEDICAL FIELD

Developing AI technology for use in healthcare, safe practices, services, and policies is costly and risky. It is becoming more and more crucial to safeguard the financial interests of AI and data-driven healthcare advances [20]. Previously, vital signs such as blood pressure, heart rate and glucose levels could only be monitored by medical personnel [21], however, the ongoing collecting of this data is now made possible by contemporary mobile applications. The ethical issues surrounding the application of AI technology must be addressed, particularly those pertaining to patient autonomy, informed consent, and abuse of data privacy and confidentiality [22]. The GDPR introduces comprehensive data protection legislation within the EU, causing a shift in data protection globally, whereas HIPAA primarily protects sensitive health information processed by lawful organizations [23-26]. The introduction of AI into the healthcare system may distort patient data and affect important medical examination results. Cyber-attacks have increased [27]. Certain cyber threats can be identified and avoided with the use of predictive algorithms. A comprehensive examination of cyber security and the cyber risk environment of healthcare systems is necessary to protect data privacy and preserve system integrity [27]. It is possible to mitigate the risk of relying solely on one solution by utilizing multiple reliable AI algorithms. Artificial intelligence in healthcare offers numerous benefits, including process simplification, increased productivity, time and resource savings, support for research, and a reduction in medical stress, despite concerns about data privacy and security breaches. The impact of digital technologies on healthcare supply chain stakeholders was assessed using an epistemological framework for ethical assessment that places a high priority on ethical awareness, transparency, and accountability [28].

CUSTOMIZATION OF TREATMENT

AAI can provide creative answers for monitoring epidemics and providing individualized care. Algorithms in microbial identification powered by artificial intelligence have shown impressive accuracy and efficacy in identifying pathogenic microorganisms from a variety of clinical samples [29]. These algorithms swiftly and accurately diagnose infections by analyzing massive databases of genomic, proteomic, and clinical data, enabling healthcare to create individualized treatment programs [30]. Epidemic surveillance has been greatly enhanced by the quick identification and analysis of trends in epidemiological data. AI systems can identify new epidemics, monitor the spread of illnesses, and identify possible hotspots by processing and analyzing real-time data from several origin, including medical records, and environmental detector. During infectious disease emergencies, this proactive approach helps containment and mitigation efforts by enabling prompt intervention measures. Essentially, artificial intelligence in microbial diagnosis and epidemic monitoring plays a critical role in protecting public health globally in addition to improving healthcare by optimizing treatment approaches [31].

CONCLUSIONS

The methods for diagnosing microbial infectious diseases have evolved from serological techniques to advanced molecular approaches [32,33]. Today, AI has become a powerful tool applicable across all fields of life. AI-driven predictive analytics can improve the accuracy, efficiency, and cost-effectiveness of clinical laboratory testing and disease detection. As AI is incorporated, the method for diagnosing microorganisms is changing. It makes it possible to identify pathogens quickly and accurately, identify antibiotic resistance early, and develop better diagnostic methods. AI is also crucial for drug research, outbreak detection, early disease diagnosis, and individualized treatment. Consequently, there have been significant improvements in healthcare results and public health benefits. But as AI becomes more prevalent in medical decision-making, ethical concerns like patient privacy, algorithmic biases, data security, transparency, accessibility, and human oversight must be addressed. Further improvements in illness prevention and treatment are now acceptable due to the development of AI in microbiological detection, which also ensures ethical and equitable healthcare practices.

REFERENCES

1. Kandilci M, Yakıcı G, Kayar MB. Artificial Intelligence and Microbiology. Experimental and Applied Medical Science. 2024;5(2):119 – 128. doi:10.46871/eams.1458704. DOI
2. Oh J, Makar M, Fusco C et al. A generalizable, data-driven approach to predict daily risk of Clostridium difficile infection at two large academic health centers. Infect. Control Hosp. Epidemiol. 2018;39:425–433. doi: 10.1017/ice.2018.16. DOI
3. Tilton CS, Johnson SW. Development of a risk prediction model for hospital-onset Clostridium difficile infection in patients receiving systemic antibiotics. Am. J. Infect. Control. 2019;47:280-284. doi: 10.1016/j.ajic.2018.08.021. DOI
4. Miller MB, Atrzadeh F, Burnham C-AD et al. Clinical utility of advanced microbiology testing tools. J Clin Microbiol. 2019;57(9):10-11282. doi:10.1128/JCM.00495-19. DOI
5. Salazar BM, Balczewski EA, Ung CY, Zhu S. Neuroblastoma, a paradigm for big data science in pediatric oncology. Int J Mol Sci. 2016;18(1):37. doi:10.3390/ijms18010037. DOI
6. Hamet P, Tremblay J. Artificial intelligence in medicine. Metabolism. 2017;69:S36-S40. doi:10.1016/j.metabol.2017.01.011. DOI
7. Abdi J, Al-Hindawi A, Ng T, Vizcaychipi MP. Scoping review on the use of socially assistive robot technology in elderly care. BMJ Open. 2018;8(2):e018815. doi:10.1136/bmjopen-2017-018815. DOI
8. Jartarkar SR. Artificial intelligence: Its role in dermatopathology. Indian J Dermatol Venereol Leprol. 2023;89(4): 549-552. doi: 10.25259/IJDVL_725_2021. DOI
9. Franco-Duarte R, Cernáková L, Kadam S et al. Advances in chemical and biological methods to identify microorganisms – From past to present. Microorganisms. 2019;7(5):130. doi: 10.3390/microorganisms7050130. DOI
10. Uddin TM, Chakraborty AJ, Khusro A et al. Antibiotic resistance in microbes: History, mechanisms, therapeutic strategies and future prospects. J. Infect. Public Health. 2021;14:1750-1766. doi: 10.1016/j.jiph.2021.10.020. DOI
11. Agbehadji IE, Awuzie BO, Ngowi AB, Millham RC. Review of big data analytics, artificial intelligence and nature-inspired computing models towards accurate detection of COVID-19 pandemic cases and contact tracing. Int. J. Environ. Res. Public Health. 2020;17:5330. doi:10.3390/ijerph17155330. DOI
12. Rabaan AA, Alhumaid S, Al Mutair A et al. Application of artificial intelligence in combating high antimicrobial resistance rates. Antibiotics. 2022;11:784. doi:10.3390/antibiotics11060784. DOI
13. Hamet P, Tremblay J. Artificial Intelligence in Medicine. Metab. Clin. Exp. 2017;69:S36–S40. doi: 10.1016/j.metabol.2017.01.011. DOI
14. Krishnan G, Singh S, Pathania M et al. Artificial Intelligence in Clinical Medicine: Catalyzing a Sustainable Global Healthcare Paradigm. Front. Artif. Intell. 2023;6:1227091. doi:10.3389/frai.2023.1227091. DOI
15. Beam AL, Kohane IS. Big Data and Machine Learning in Health Care. JAMA. 2018;319:1317-1318. doi: 10.1001/jama.2017.18391. DOI
16. Yang W, Olson DR, Shaman J. Forecasting Influenza Outbreaks in Boroughs and Neighborhoods of New York City. PLoS Comput. Biol. 2016;12:e1005201. doi:10.1371/journal.pcbi.1005201. DOI
17. Liu JYH, Rudd JA. Predicting drug adverse effects using a new Gastro-Intestinal Pacemaker Activity Drug Database (GIPADD). Sci Rep. 2023;13(1):6935. doi:10.1038/s41598-023-33655-5. DOI
18. Subramanian M, Wojtusciszyn A, Favre L et al. Precision medicine in the era of artificial intelligence: implications in chronic disease management. J Transl Med. 2020;18(1):472. doi:10.1186/s12967-020-02658-5. DOI

19. Gerke S, Minssen T, Cohen G. Ethical and legal challenges of artificial intelligence-driven healthcare. Artif Intell Healthc. 2020, pp.295–336. doi:10.1016/b978-0-12-818438-7.00012-5. DOI
20. Cohen IG, Mello MM. HIPAA and protecting health information in the 21st Century. JAMA. 2018;320(3):231. doi:10.1001/jama.2018.5630. DOI
21. Yuan B, Li J. The policy effect of the General Data Protection Regulation (GDPR) on the digital public health sector in the European Union: an empirical investigation. Int J Environ Res Public Health. 2019;16(6):1070. doi:10.3390/ijerph16061070. DOI
22. Alotaibi S, Mehmood R, Katib I et al. A Big Data Analytics Tool for Healthcare symptoms and Diseases Detection using Twitter, Apache Spark, and machine learning. Appl Sci. 2020;10:1398. doi:10.3390/ app10041398. DOI
23. Al-Mistarehi A-HM, Mijwil M, Filali Y et al. Artificial Intelligence Solutions for Health 4.0: Overcoming Challenges and Surveying Applications. MJAIH. 2023. doi: 10.58496/MJAIH/2023/003. DOI
24. Radanliev P, De Roure D. Epistemological and bibliometric analysis of Ethics and Shared responsibility—health policy and IoT Systems. Sustainability. 2021;13(15):8355. doi: 10.3390/su13158355. DOI
25. Radanliev P, De Roure D, Ani U, Carvalho G. The ethics of shared Covid-19 risks: an epistemological framework for ethical health technology assessment of risk in vaccine supply chain infrastructures. Health Technol (Berl). 2021;11(5):1083–91. doi: 10.1007/s12553-021-00565-3. DOI
26. Ransbotham S, Candelon F, Kiron D et al. The Cultural Benefits of Artificial Intelligence in the Enterprise. MIT Sloan Management Review and Boston Consulting Group. 2021. https://sloanreview.mit.edu/projects/the-cultural-benefits-of-artificial-intelligence-in-the-enterprise/ [Accessed 12 December 2024]
27. Rigby MJ. Ethical Dimensions of Using Artificial Intelligence in Health Care. AMA Journal of Ethics. 2019;21(2):121-124. doi: 10.1001/amajethics.2019.121. DOI
28. Rutala WA, Weber DJ. Best practices for disinfection of noncritical environmental surfaces and equipment in health care facilities: A bundle approach. American Journal of Infection Control. 2019;47:A96–A105. doi: 10.1016/j.ajic.2019.01.014. DOI
29. Bohr A, Memarzadeh K. The rise of artificial intelligence in healthcare applications. Artificial Intelligence in Healthcare. Elsevier, Amsterdam, the Netherlands. 2020. doi:10.1016/B978-0-12-818438-7.00002-2. DOI
30. Vora LK, Gholap AD, Jetha K et al. Artificial intelligence in pharmaceutical technology and drug delivery design. Pharmaceutics. 2023;15:1916. doi: 10.3390/pharmaceutics15071916. DOI
31. Agrebi S, Larbi A. Use of artificial intelligence in infectious diseases. Artificial Intelligence in Precision Health. Elsevier, Amsterdam, the Netherlands. 2020. doi: 10.1016/B978-0-12-817133-2.00018-5. DOI

CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Laith Abbas Al-Huseini
Warith Al-Anbiyaa University
Karbala, Baghdad Road, Karbala, Iraq
e-mail: nisreen.ja@uowa.edu.iq

ORCID AND CONTRIBUTIONSHIP

Laith Abbas Al-Huseini: 0000-0002-5170-1865 A F
Nisreen Jawad Kadhim: 0000-0002-7255-8383 B D
Mohammed Salih Mahdi: 0000-0003-4825-6892 D
Raed H. Ogaili: 0000-0001-7092-4936 D E
Orooba Al-hammood: 0000-0002-1534-3546 B F

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

RECEIVED: 02.12.2024
ACCEPTED: 06.01.2025