

MINIREVIEW *Student activity*

Artificial Intelligence in Infection Control

¹Sossana T. Sadek, ¹Seif A. ElSayed, ¹Seif el dein W. Mohamed, ¹Seif H. Ashour, ¹Selvia S. Youssef, ¹Shady M. Ibrahim, ¹Shrouk A. Abdallah, ¹Shrouk Y. Nabil, ¹Sherif A. Ismail, ¹Shehab A. Mahmoud, ¹Shahd A. Mohamed, ¹Shahd A. Abdelnaby, ¹Shahd T. Mohamed, ¹Shahd H. El Sayed, ¹Shahd R. Nageeb, ²Rasha H. Bassyouni*

¹Medical student, Faculty of Medicine and Surgery, 6th October University

²Medical Microbiology and Immunology Department, Faculty of Medicine, Fayoum University; Medical Microbiology and Immunology Department, Faculty of Medicine and Surgery, 6th October University

ABSTRACT

Key words:

AI, infection control, hand hygiene, environmental cleaning, surveillance, waste management

***Corresponding Author:**

Prof. Dr. Rasha H. Bassyouni
Medical Microbiology and Immunology Department,
Faculty of Medicine, Fayoum University, Medical Microbiology and Immunology Department, Faculty of Medicine and Surgery, 6th October University
Tel. +201223640107
rhb00@fayoum.edu.eg

Artificial intelligence (AI) is used in many fields in medicine to promote disease diagnosis and treatment, optimize meticulous care delivery and also in prevention of healthcare-associated infection (HAIs) as one of the popular proceedings of healthcare in hospitals. In prevention and control of infection, AI surveillance is more powerful and better than traditional surveillance as it is more accurate than the manual methods and it prevents the errors of the human methods to control the infection and it can be used in many applications under the definition of infection control like hand hygiene, waste management, surveillance of healthcare-associated infection and many other applications it is also used in training of healthcare workers to improve their practice. Using service robots in environmental cleaning decreases the risk to develop infection and reduces traditional cleaning/disinfection costs. Also, artificial intelligence (AI) is considered one of the developments in digital technologies data intelligence, and analytics. This minireview will highlight the application of artificial intelligence (AI) in infection control.

INTRODUCTION

Artificial intelligence (AI) is the science of making machines or software do tasks like humans. These tasks include a wide range of applications such as learning, problem solving, perception, reasoning, language understanding, and decision-making. The aim of artificial intelligence is to be able to make decisions, do tasks, judge like humans and make it easier for human to decrease the risk of infection ¹.

Artificial intelligence (AI) can be applied in many fields in medicine offering many solutions by efficiently collect huge amount of data, creating predictive models, extracting crucial insights, promoting disease diagnosis as well as treatment, optimizing meticulous care delivery, guiding and organizing various tasks and workflows ².

Infection Control is the procedures taken to control and lower the risk to develop infection and prevent its spread in the hospital and healthcare places, now we can use artificial intelligence (AI) in infection Control ³. Artificial intelligence is increasing obviously in our daily lives as it is used in many applications beside infection control ranging from computer detection of cancers to mammograms and many other software and hardware applications (In infection control; as reported by the World Health Organization (WHO); artificial

intelligence (AI) offers many applications that can be used to prevent and/or lower the risk of infection for example it can be used in detecting outbreaks and gathering data and producing analytics, this makes the infection control easier for the human beings and it is considered more easier than the traditional ways ⁴.

Importance of Artificial Intelligence in Infection Control:

Artificial intelligence is considered highly important in infection control as it is more accurate than the manual methods and it prevents the errors of the human methods to control the infection and it can be used in many applications under the definition of infection control like hand hygiene, waste management, surveillance of healthcare-associated infection and many other applications ^{1,4}. The aim of this minireview is to discuss the applications used in infection control that are improved by Artificial intelligence.

a. The Role of Artificial intelligence in hand hygiene:

Artificial intelligence (AI) and machine learning applications showcase innovative ways technology can enhance healthcare practices. Improving hand hygiene compliance is crucial for preventing infections in hospitals. The algorithm was trained to detect hand hygiene dispenser use in the images and was found to be

equivalent to human observational checklist in detecting hand hygiene through dispenser use. Another example is reported previously by Fujitsu; the development of the “Actlyzer” hand wash movement recognition technology, this technology demonstrates how machine learning (ML) and artificial intelligence (AI) can contribute to monitoring and enhancing hand hygiene practices. It leverages AI and ML techniques to identify complex hand-washing movements from video data captured by the camera. It also could be used to monitor hand-washing movements and provide feedback to users. These advancements not only assist in compliance but also underscore the potential for technology to provide a significant role in the quality and safety of healthcare services⁵. The integration of depth sensors and AI computer vision by Stanford’s PAC for monitoring compliance of hand hygiene in healthcare settings showcases the innovative use of technology to enhance compliance. It’s impressive how these systems can analyze three-dimensional silhouettes to accurately detect hand hygiene dispenser use, contributing to better infection control. Improving hand hygiene through artificial intelligence (AI) can have a significant impact on reducing hospital-acquired infections. The statistics from the Centers for Disease prevention and Control highlight the prevalence of such infections, making it crucial to enhance preventive measures. Using artificial intelligence (AI) to assess and improve compliance not only addresses the symptoms but also provides valuable data for hospitals to detect and address the root causes of infections more effectively⁶.

b. The Role of Artificial intelligence In Waste management:

All the waste that comes from the hospital should be separated from each other according to the type of waste then transported and stored before final disposal. Artificial intelligence could assist in the automated process of separating waste by using a camera to read the items that goes into the bin and identify them to be separated and can also be used in waste tracking and training by virtual reality to ensure and keep civilians away from the danger of the medical waste by analyzing the data on the volume, type of the waste and the methods to dispose them. Artificial intelligence (AI) also can be integrated with smart bins that measure the variable amount of waste to notify the staff to empty them^{7,8}.

c. The Role of Artificial Intelligence in Surveillance of Healthcare-associated Infections:

Artificial intelligence is important nowadays and has many benefits that can be used in healthcare-associated infections (HAIs) surveillance, as HAIs are one of the popular proceedings that can occur while receiving healthcare in a hospital, and monitoring it can help in its prevention and reduction, since surveillance systems

focus on understanding HAIs risk factors, knowing different pathways of infection transmission, and real-time detection⁹. Artificial intelligence surveillance is more powerful and better than traditional surveillance as it is more accurate, can collect and analyze data from different sources, and saves time, money, and life. Accurately identifying a wide range of acute and chronic health conditions and recognizing emerging viruses can help doctors act earlier before spreading the infection from one patient to another in the hospital and turning into outbreaks or pandemics¹⁰. For example, AI algorithms for surveillance of infection were used in a cohort study and the model discovered correctly 67 of 73 patients with HAIs¹¹. Another study used artificial intelligence (AI) to detect COVID-19 and Community-acquired pneumonia (CAP) depending on pulmonary CT where the study included 4352 chest CT scans from 3322 patients, and in the final dataset 1292 scans were obtained for COVID-19, 1735 for CAP, and 1325 for non-pneumonia abnormalities from the 4352 scans¹².

d. The Role of Artificial intelligence in environmental cleaning and disinfection in hospitals:

Infection control technology has advanced due to the integration of engineering technology and hospital infection management. Service robots are becoming more common in all fields of medicine. By using these service robots, the risk of infection is decreased, and traditional cleaning and disinfection costs are reduced. After determining the necessary disinfectant dose, disinfection spots, important locations, and safety waiting periods, the robot chooses the proper disinfection scheme¹³. For more than a century, ultraviolet (UV) light has been an effective way of disinfecting water, air, and equipment. Within five minutes, the robot that produces UV light in a hospital room can significantly lower the number of bacteria present. There is less need for direct contact between medical and nursing staff because human participation is not required for the disinfection process, which decreases the danger of occupational risks¹⁴.

e. The Role of Artificial Intelligence in Detecting anti-microbial Resistance

Artificial intelligence (AI) can play a crucial role in antimicrobial resistance (AMR) surveillance by enhancing the prediction and identification of AMR in bacteria. Machine learning algorithms can be trained on huge datasets of bacterial genomic information and antibiotic susceptibility data to develop models that can accurately predict which antibiotics will be effective against specific strains of bacteria. Additionally, AI can aid in the discovery of new antimicrobials. By analyzing vast amounts of data, including genetic and chemical information. This can lead to the discovery of many novel compounds that have the potential to combat AMR¹⁵.

CONCLUSIONS

This review reported that artificial intelligence (AI) revolutionizes healthcare by offering precise surveillance and management tools for infection prevention and control. The superiority of artificial intelligence (AI) over traditional methods is evident in its accuracy and power. It can be used in monitoring hand hygiene compliance through advanced observation techniques and also employing service robots for environmental cleaning for risk reduction. Artificial intelligence emerges as a multifaceted solution. Its role in disease detection, exemplified in COVID-19 and pneumonia cases, showcases its pivotal contribution to early diagnosis. The efficiency of AI in collecting and analyzing diverse data sources not only enhances healthcare protocols but also saves crucial time and resources. Addressing antimicrobial resistance, AI presents a new paradigm, complemented by lab testing for discovering novel antimicrobials. In essence, the integration of AI in healthcare signifies a transformative leap, fostering advanced strategies for Infection prevention, waste management, and overall patient well-being.

Acknowledgments

Not applicable

Conflict of interest: All authors report no conflict of interest relevant to this article.

REFERENCES

- Copeland B. Artificial intelligence. Encyclopedia Britannica. 2023. <https://www.britannica.com/technology/artificial-intelligence>
- Basu K, Sinha R, Ong A, Basu T. Artificial Intelligence: How is It Changing Medical Sciences and Its Future?. *Indian J Dermatol*. 2020; 65(5): 365–370.
- Habboush Y, Yarrarapu SNS, Guzman N. Infection Control. [Updated 2023 Sep 4]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK519017/>
- Fitzpatrick F, Doherty A, Lacey G. Using Artificial Intelligence in Infection prevention, *New Technologies and Advances in Infections Prevention*. 2020; 12: 135–144.
- Singh A, Haque A, Fei-Fei L, Milstein A. Artificial intelligence in hand hygiene. *Journal of the American Info Association*. 2020; (27):1316-1320.
- Singh A, Haque A, Alahi A, Yeung S, Guo M, Glassman JR, Beninati W, Platchek T, Fei-Fei L, Milstein A. Automatic detection of hand hygiene using computer vision technology. *J Am Med Inform Assoc*. 2020; 27(8):1316-1320. doi: 10.1093/jamia/ocaa115. PMID: 32712656; PMCID: PMC7481030.
- Božić V. Artificial intelligence (AI) oriented waste management in hospital. *research gate*; 2023:1-5. DOI: 10.13140/RG.2.2.14769.56161
- Luv J, Deng S, Zhang J L. Waste management,. *Biosafety and Health*. 2021; 3 (01): 65.
- Scardoni A, Balzarini F, Signorelli C, Cabitza F, Odone A. Artificial intelligence based tools to control healthcare associated infections. *Journal of Infection and Public Health*. 2020; 13 (8): 1061-1077.
- Anjaria P, Asediya V, Bhavsar P, Pathak A, Desai D, Patil V. Artificial Intelligence in Public Health: Revolutionizing Epidemiological Surveillance for Pandemic Preparedness and Equitable Vaccine Access. *Vaccines (Basel)*. 2023;11(7):1154. doi: 10.3390/vaccines11071154. PMID: 37514970; PMCID: PMC10383160.
- Santos dos RP, Sliva D, Menezes A, Lukasewicz S, Dalmaro CHR, Automated healthcare-associated infection surveillance using an artificial intelligence algorithm, *Journal of Infection Prevention in Practice*, 2021, 3 (3): 100-167.
- Li L, Qin L, Xu Z, Yin Y, Wang X, Kong B, Bai J, Lu Y, Fang Z, Song Q, Cao K, Liu D, Wang G, Xu Q, Fang X, Zhang S, Xia J, Xia J, Using Artificial Intelligence to Detect COVID-19 and Community-acquired Pneumonia Based on Pulmonary CT. *Radiology*. 2020; 296: 65-71.
- Fan Y, Hu Y, Jiang L, Liu Q, Xiong L, Pan J, et al., Intelligent disinfection robots assist medical insitutions in controlling environmental surface disinfection. *Intelligent medicine*. 2021; 1 (1): 19-23.
- Begić A. Application of Service Robots for Disinfection in Medical Institutions. *Advanced Technologies, Systems, and Applications II*. 2017; 28:1056–65. doi: 10.1007/978-3-319-71321-2_89. PMCID: PMC7123593.
- Lau HJ, Lim CH, Foo SC, Tan HS. The role of artificial intelligence in the battle against antimicrobial-resistant bacteria. *Curr Genet*. 2021; 67(3):421-429. doi: 10.1007/s00294-021-01156-5. Epub 2021 Feb 13. PMID: 33585980.