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Letter to Editor

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Recent and Future Applications of Artificial Intelligence in HIV Management

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LETTER TO EDITOR

Dear Editor,

Artificial Intelligence (AI) has opened new avenues in healthcare in recent years [1-4], improving the experiences of both physicians and patients [5]. AI can be applied in different areas, leading to a reduction in the time needed for the diagnosis and increased diagnostic accuracy. AI assists in medical treatment through surgical support, perioperative care, and rehabilitation. Moreover, AI can be applied in drug development, medical management, education, and research [6]. By using machine learning, large-scale biological datasets can be analyzed to improve early detection, personalized treatment, and accelerate vaccine production [7,8]. Like other fields, AI has been applied extensively in Human Immunodeficiency Virus (HIV) prevention, diagnosis, monitoring, and treatment. This letter aims to provide current evidence on recent and future applications of AI in HIV management.

Current applications of AI in HIV

HIV prevention

Machine learning, AI, and Chatbots can be applied to HIV prevention [9]. Different programs using AI-based tools and other technologies have been developed to prevent HIV. These applications deliver prevention messaging, encourage self-testing, and provide reliable information from professional medical resources [10]. AI also supports behavior change and psychosocial support. The Tough Talks virtual reality program helps young men who have sex with men practice and HIV serostatus disclosure in simulated settings, to promote protective behaviors. Chatbots offer anonymous, tailored conversations providing sexual health education and can potentially support decisions about preexposure prophylaxis use and adherence [9-11].

HIV diagnosis

Studies showed that AI can improve the HIV self-test through image analysis, increasing result sensitivity. In Roche et al., [12] study, AI identified four HIV infections that were missed by pharmacy experts.

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Similarly, Turbe et al., [13] trained an AI algorithm on 11,374 rapid HIV tests, achieving 97.8% sensitivity-outperforming human interpretation. AI analyzes Electronic Health Records, imaging, and laboratory data, which helps to detect HIV-related complications earlier and more precisely.

HIV monitoring

By the use of machine learning, the HIV viral load can be detected more accurately [14], and high-risk patients can be recognized more effectively [15]. AI-trained models can predict the risk of HIV and other sexually transmitted infections by the use of demographic and sexual behavior data [16]. Moreover, AI can help patient adherence monitoring by AI-powered apps and wearable devices that follow antiretroviral therapy (ART) adherence to improve patient compliance [17].

HIV treatment

Different AI techniques have led to advances in HIV treatments. By analyzing datasets, researchers identified a unique HIV-1 protease ligand not belonging to traditional inhibitor classes [18]. Also, AI tools have been developed to predict drug-drug interactions (DDIs), which helps the drug screening process, and contributes to safer clinical development strategies [19]. AI methodologies enable more precise and individualized treatment by translating complex datasets into clinically actionable insights [17]. Predictive models can forecast treatment outcomes, such as patient response to ART, based on patient history [17]. Additionally, AI-driven interventions improve adherence and compliance by providing medication reminders, educational support, and real-time guidance [20,21].

Future applications of AI in HIV

The future trend of AI is moving toward more comprehensive, adaptive, and human-like systems. Such improvements enhance clinical decision support, improve doctor–patient communication, and optimize healthcare data management [22]. Generative AI models can provide decision-making support, which can be comparable to decisions made by human experts [23]. The combination of machine learning, generative AI, and digital health innovations will allow more precise, timely, and personalized prevention, diagnosis, and treatment strategies [24]. AI-powered predictive modeling could integrate epidemiological, demographic, and mobility data to forecast HIV outbreak patterns in near real-time, guiding targeted prevention strategies for high-risk communities. However, realizing these advancements will require strong collaboration between healthcare providers, researchers, developers, and end-users [9].

Ethical challenges of AI applications in HIV management

Although research in the use of AI in HIV research has greatly increased, significant ethical and technical challenges remain. There is limited available data from HIV patients – largely due to privacy concerns – leading to incomplete or biased training of AI models [25]. The highly sensitive nature of HIV status raises serious issues regarding confidentiality and informed consent. Another ethical issue is about the responsibility of the decisions and recommendations made by AI. It should be a balance between human clinicians and AI in making critical decisions [26]. Finally, ensuring equitable access to AI-driven tools is essential to narrow the gap between high-income and middle- and low-income countries. Addressing these challenges will require transparent governance frameworks, regulatory oversight, and engagement of patients, communities, and healthcare providers in AI system development [27].

In conclusion, AI holds great potential for transforming HIV prevention, diagnosis, monitoring, and treatment by enabling more precise, timely, and personalized healthcare. However, realizing its full potential will require addressing significant ethical, technical, and infrastructural challenges. With thoughtful development and implementation, AI can play a pivotal role in advancing toward the ultimate goal of decreasing the HIV incidence.

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