



Short communication

Realizing the potential of AI in pharmacy practice: Barriers and pathways to adoption

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HIGHLIGHTS

- AI can simplify pharma processes, boost productivity, accelerate drug development. But costs, regulations, trust issues persist.
- Large amounts of health data generated, but analyzing "big data" remains challenging. AI and statistics can help extract insights.
- Barriers like security concerns, high costs, job loss fears, lack of human connection hinder AI adoption. Privacy regulations also a hurdle.
- Updating medical education, stakeholder engagement, R&D investments could facilitate AI adoption. Developing privacy-preserving machine learning also key.
- AI applications like managing chronic diseases, improving prescription accuracy, enhancing doctor-patient relationships can improve care. But human oversight still critical.

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ABSTRACT

Artificial intelligence (AI) has immense potential to revolutionize pharmacy operations by simplifying procedures, improving efficiency, and expediting pharmaceutical research. Nevertheless, obstacles such as steep expenses, absence of faith in AI, worries about unemployment, threats to privacy, and the incapacity to substitute human decision-making have impeded acceptance. This text discusses the future of AI in the field of pharmacy, obstacles that are preventing its usage, and methods to make its integration easier. The expansion of large data in healthcare offers chances for AI to obtain understanding, but examining and implementing information still presents difficulties. Significant obstacles such as costly implementation, safety concerns, restrictions on data exchange by regulations, and absence of interpersonal interaction need to be resolved. Methods to facilitate acceptance involve upgrading medical instruction to center around AI, involving interested parties, allocating resources for research and development, creating safeguarded machine learning methods, and carefully incorporating AI to enhance, rather than replace, pharmacy personnel. Although additional effort is required to establish confidence in AI and address genuine worries, specific actions can tap into AI's capacity to enhance effectiveness, lower expenses, expedite drug exploration, and improve healthcare for patients. Responsible and moral adoption requires tackling obstacles through cooperation among interested parties and gradual incorporation centered on enhancing human workforce, rather than substituting them.

1. Introduction

If given appropriate equipment, pharmacy may become not just places to fill prescriptions—they can become health care clinics.¹

Pharmacologists significantly contribute to healthcare, with local chemists becoming more involved. Issues are resolved by suggesting drugs without prescriptions, allowing chemical professionals to feel at ease in their roles.² (see [Tables 1 and 2](#))

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Table 1
Barriers to AI adoption in pharmacy.

Reference	Barrier	Details
(Cabitza, Rasoini, & Gensini, 2017)	Lack of trust in capabilities for patient-level decisions	Concerns that current AI approaches cannot be trusted for individual patient treatment decisions
(Rahurkar et al, 2015; Robbins, 2019)	Privacy and security concerns due to potential for data theft and misuse	Healthcare data is vulnerable to breaches. Need regulations to protect privacy.
(Panesar, 2019)	Regulations around patient privacy hindering implementation	Specific regulations needed for gathering and sharing patient data with AI systems
(Vu et al, 2019)	Potential for cyberattacks on AI systems	AI systems susceptible to malicious attacks. Security collaborations needed.
(Mahdavi et al, 2019; Yang & Yang, 2019; Jiang et al, 2017)	Concerns about job loss due to automation	AI may replace human workers, especially for routine tasks. But cannot replace human judgment.
(Davenport & Kalakota, 2019; Panesar, 2019)	High costs of implementation and maintenance	AI systems require major upfront investment and ongoing costs for updates.
(Loh, 2018; Liew, 2018)	AI lacks empathy and human connection	AI does not have human skills like empathy. Can enhance but not replace provider relationships.

Table 2
Approaches to address adoption challenges.

Approach	Details	Reference
Updating medical education to focus on AI concepts rather than just instruments	Prepare healthcare workers to use AI systems effectively	(Panesar, 2019)
Engaging employees and citizens in proper AI deployment	Get stakeholder input to build trust and facilitate adoption	(Davenport & Kalakota, 2019)
Investing in R&D and maintenance for complex AI systems	Allocate resources for ongoing AI development and upgrades	(Panesar, 2019; Jiang et al, 2017)
Developing privacy-preserving machine learning methods	Research new techniques to protect data security and privacy	(Powles & Hodson, 2017; Payne, 2019; Zhang et al, 2020; Mir et al, 2020; Yang et al, 2019)
Using AI to improve disease management and prescription accuracy	Apply AI to enhance patient care and outcomes	(Panesar, 2019)

To identify compound medical cases successfully, AI can be quickly applied in medical facilities to improve pharmaceutical formulation and treatment of patients by efficiently addressing complicated medical risks. With the growing size of medical data, the sector is leading the way in statistical analysis, making it challenging to gather, evaluate, and apply information for drug development and addressing complex diseases.³

Big data refers to volumes of records which are too huge to handle with normal programmed or web-based systems. It exceeds the range of computing, retrieval, and data analysis that is typically employed.⁴ Many healthcare institutions worldwide access vast amounts of information gathered from individuals with illnesses, which is growing in size daily.^{5,6} Large-scale data(Fig. 1) on illnesses provides information but

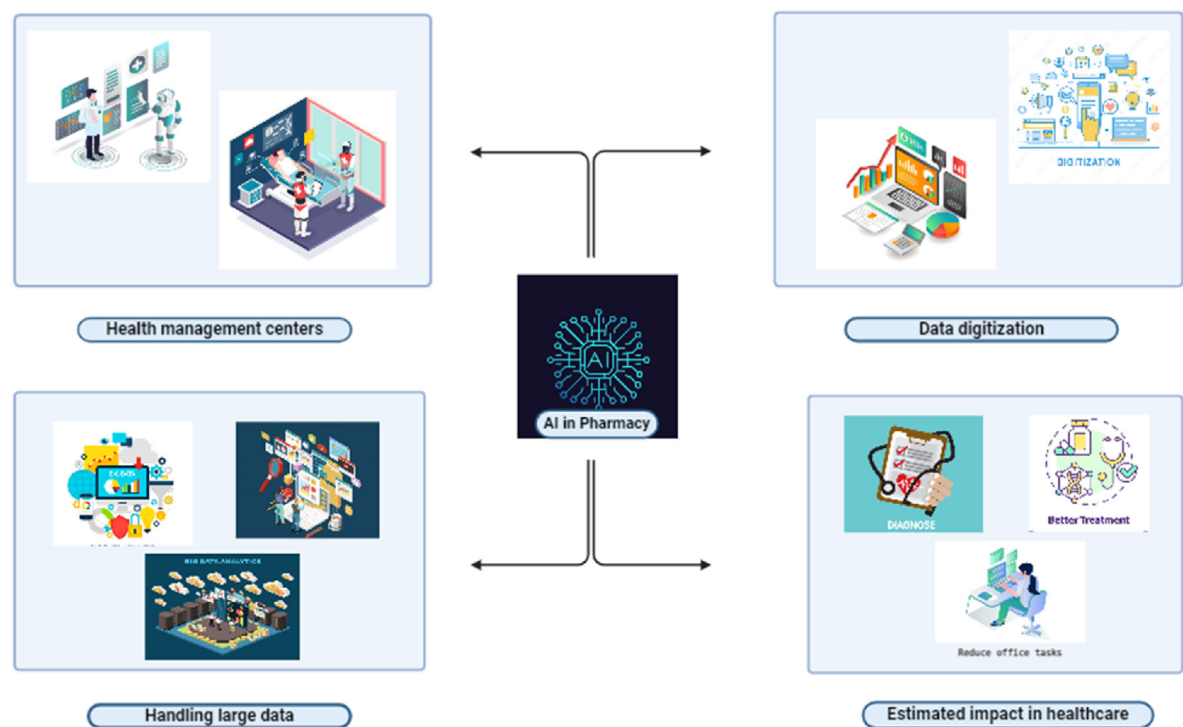


Fig. 1. Potential of AI in pharmacy practice.

does not offer a cure. Statistical methods and quantitative AI aid in understanding anthropology, but healthcare organizations face challenges in analyzing vast data. Multiple tools are used for data creation and decision-making.^{6,7}

Integrating AI into pharmaceutical practice offers benefits such as simplifying processes and increasing productivity. However, obstacles need to be overcome through financing assistance and comprehensive instructional packages. Emphasizing the incremental value of AI systems in pharmacies can alleviate apprehensions and demonstrate the potential for improved medical treatment and results.⁸ Pharmacies have access to numerous substances for treating various ailments, but lack resources. AI can help shorten the development period for new drugs, reducing expenses, improving profits, and potentially lowering consumer prices by reducing the time required for drug growth.⁹

AI in healthcare is a promising development that could revolutionize disease treatment and human welfare. It could improve diagnosis, reduce office tasks, and improve treatment accuracy, while also aiding elderly individuals in their independent lives.¹⁰ This article emphasizes on different landscape of AI in pharmacy practice.

2. Barriers to AI adoption in pharmacy

Artificial intelligence is expected to significantly impact healthcare in the future, but defining its capabilities for patient-level decisions remains challenging. Current approaches fail to boost trust, ensure human decision accuracy, or support AI suggestions in therapeutic settings. Medical professionals have to exercise caution when using AI systems and urge authorities to ensure safety and provide justifications before implementing AI in medical settings.¹¹

Healthcare information security is highly vulnerable to criminal activity, insurance scams, and healthcare fraud. Thieves can use stolen data to acquire medicines or services, negatively impacting medical advancements, undermining consumer trust, and exposing medical professionals to financial and legal losses.¹² Modern technology in healthcare raises privacy and security concerns, necessitating collaboration between government officials, medical professionals, and creators to establish data protection principles and AI-specific regulations.¹³

Regulations for patient privacy in pharmacy are hindering the implementation of emerging artificial intelligence due to the need for specific rules for gathering, archiving, and disseminating personal information.⁸ Counterproductive cyberattacks pose a significant threat to AI systems, involving hardware and software issues. Efficient after-market inspection is crucial for healthcare product security, and collaboration between physicians, medical organizations, and AI engineers is essential for collecting medical information.¹⁴

The rise of AI technology in workplaces raises concerns about potential loss of manual labor, as machines can perform routine tasks faster, leading to job schedule adjustments and potential loss of employment in computational operations and expensive human occupations.¹⁵ People are concerned about AI's potential to replace medical jobs, but this view is based on a misreading of AI's potential. AI's potential to replace medical workers is contingent on its ability to adapt to unpredictable and human-factored medical treatments, rather than relying on algorithms.^{16,17}

Medical costs are increasing, necessitating the need for AI-based services. The aging population in industrialized nations is increasing, leading to costly treatment for elderly patients. Skilled nurses are scarce, and emerging nations and the impoverished lack quality care. AI integration in computer programs and medical research can reduce healthcare costs and improve quality of life.¹⁸ It has the potential to significantly reduce unnecessary and costly work, particularly in harsh weather-prone areas.¹⁹

AI can aid physicians in making better decisions, especially in cases of healthcare incompetence, due to its methodical nature and role-playing nature, unlike human decisions, which are often faster than human ones.²⁰ AI can provide accurate information but lacks empathy and

personal connection in medical encounters. Medical providers should ensure AI usage doesn't disrupt their relationship with patients, as it can enhance knowledge, support choices, and improve interaction while preserving trust and relationship for quality treatment.²¹

3. Addressing adoption challenges

Learning AI can enhance current standards in medical academy, shifting focus from basic instrument operation to fundamental concepts. This prepares learners for innovative instruments and outdated systems, ensuring they can apply the basics effectively.²² Medical executives emphasize the importance of engaging employees and citizens in the proper deployment of AI technology. They emphasize the need for worker participation and meeting their requirements to minimize potential mistrust and ensure the necessary shift in the implementation of AI.²³

Machine learning deployment requires significant financial investment due to complex machinery creations, maintenance, and frequent operating system upgrades, as well as extensive research and development for intelligent systems.²⁴ Implementing intelligent medical technologies incurs significant costs, including repair, computing, software, installation, and maintenance, while many remain in testing and require substantial funding for updates and maintenance.²⁵

On the other hand, DeepMind Inc's case highlights the need for proper safety measures in public-private collaborations, despite potential patient infractions current privacy legislation. Artificial Intelligence presents a unique challenge due to its potential misuse of authority and its continuous use of vast personal information.^{26,27} The privacy-preserving machine learning (PPML) approaches are application-dependent and designed for specific computer training processes. As machine learning is still in its infancy, researchers need to develop advanced data protection techniques for these new algorithms. Despite being widely used, PPML methods face high processing control and interaction expenses, making homomorphic security costly in research. The solution to this problem involves implementing distributed/parallel processes and providing methods that focus on the most crucial data. Major businesses like Amazon, Google, and Facebook use various protections for private data, but ensuring user's file's security remains challenging.^{28–31}

AI can aid pharmacologists in managing long-term diseases like high blood pressure, diabetes, and heart problems by tracking medical records and identifying problems quickly. This can reduce hospitalization risks, improve medical results, and save costs. AI's potential applications in the pharmaceutical sector could significantly change healthcare in the future. AI can also enhance medicine delivery security and reliability by tracking dosage compliance and providing personalized drug suggestions, reducing prescription errors, and allowing chemists to focus on patient treatment and counseling.³²

4. Conclusion

The incorporation of artificial intelligence in the field of pharmacy brings forth a plethora of possibilities and obstacles. Artificial intelligence (AI) technology offers the potential to streamline tasks and boost operational effectiveness, yet it also presents several obstacles in terms of adopting, implementing, and enhancing its capabilities. With the necessary monetary backing and extensive learning and preparation endeavors, these hurdles can be overcome. Furthermore, it is vital to emphasize the benefits and extra worth provided by AI systems in the pharmaceutical field, easing apprehensions and showcasing the potential for improved patient care and results.

Data availability

This review article did not generate or analyze any primary data. The findings are based solely on the authors' expert analysis and synthesis of secondary data from previously published literature available in the

public domain. The referenced works constituting the evidence base for this review are properly cited within the manuscript text. Any additional information required to support the conclusions of this review is available from the corresponding author upon reasonable request.

Declaration of competing interest

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CRediT authorship contribution statement

Md Ismail Ahamed Fahim: Data curation, Writing – review & editing. **Tamanna Shahrin Tonny:** Investigation, Resources, Software. **Abdullah Al Noman:** Conceptualization, Supervision, Writing – original draft.

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