



AI Artificial Intelligence in Pharmaceutical Galenic Field: Useful Instrument and Risk Consideration

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Abstract

Is undeniable that the AI technology help umand in many field but it is necessary to consider also the risk of an unprofessional use.

Today in healthcare system the use of AI is wider diffused and in future probably it will increase.

literature report the accuracy of the various AI tools like chat bot in some medicine fields.

Aim of this work is to verify some relavant literature about this field and to test one famous provider of AI chat bot: Based on the results of this test some crucial consideration are submitted to the researcher.

A rigorous evaluation of the benefit and risk must to be taken in great consideration at this level of technology ad today available.

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Keywords: AI: Artificial intelligence; CHAT BOT; Pharmacy galenic; Risk management; Toxicology risks; Benefit; Accuracy.

Introduction

from <https://www.iso.org/artificial-intelligence>

“It involves programming systems to analyse data, learn from the experiences, and make smart decisions – guided by human input”.

Jakub Kufel et al

“Machine learning , artificial neural networks, and deep

learning are all topics that fall under the heading of AI and have gained popularity in recent times. ML involves the application of algorithms to automate decision-making processes using models that have not been manually programmed but have been trained on data. ANNs that are a part of ML aim to simulate the structure and function of human brain. DL uses multiple layers of interconnected neurons. This enables the processing and analysis of large and complex databases. In medicine filed, these techniques are being introduced to improve the speed and efficiency of disease diagnosis and treatment”.



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From Conference: Artificial Intelligence in Laboratories-Pharmalabs Nov. 2025

“This conference aims to address the impact of AI on pharmaceutical laboratories and explore AI applications in analytical processes, regulatory compliance, and in the quality control.

AI is transforming pharmaceutical labs by enhancing automation, data interpretation, and compliance monitoring. With the rise of machine learning, deep learning DL, and big data analytics, AI enables predictive analytics, anomaly detection, and process optimization, reducing human error and increasing efficiency. Regulatory authorities are increasingly focusing on these innovations to ensure AI implementation aligns with GLP and GMP guidelines.”

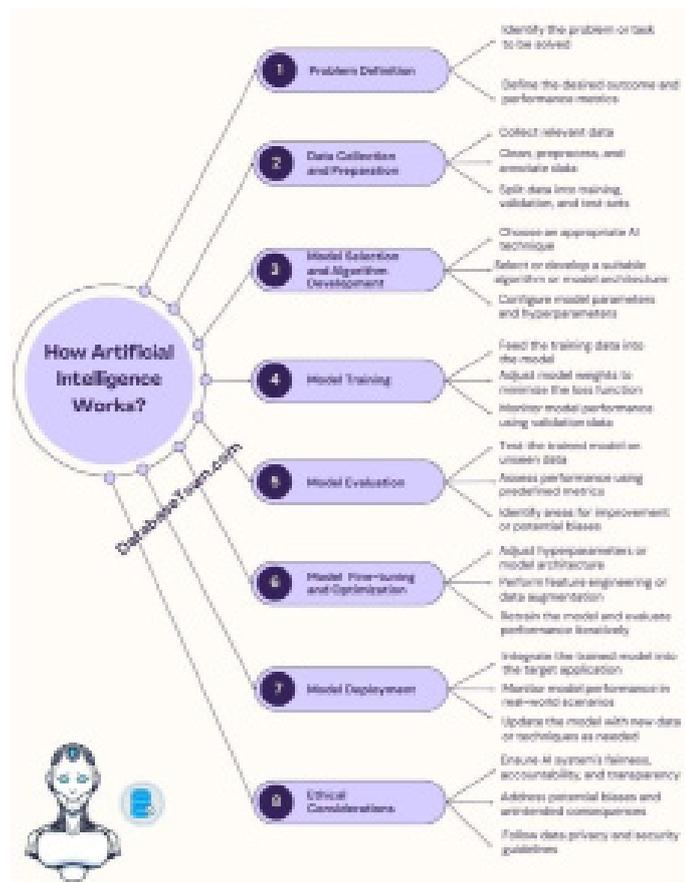


Figure 1: From Database Town.com How it work artificial intelligence?.

According FIP International pharmacist Federation Whitley Yi et al

An AI for pharmacy An introduction and resource guide for Pharmacists 2025.

“Launched in Sep 2020, the FIP Development Goals seek to direct the transformation of the pharmacy profession globally to 2030. Aligning with the UN Sustainable Development Goals, the FIP Development Goals specifically focus on enhancing pharmacy practice, education, and the pharmaceutical sciences. The ‘One FIP’ Development Goals enable the identification of commonalities and inter-sectoral collaboration within a transformative framework for the pharmacy profession.

The FIP Development Goal on Digital Health is structured around three elements: education and workforce, practice, and science.”

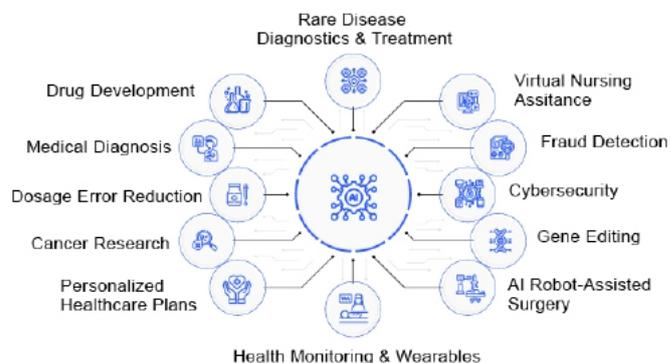


Figure 2: From Applications of Artificial Intelligence (AI) in Healthcare Segment <https://www.delveinsight.com/blog/top-applications-of-artificial-intelligence-in-healthcare>.

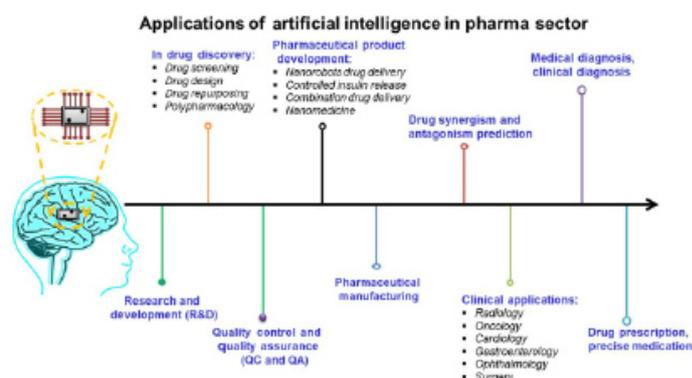


Figure 3: From Sultana A et al <https://doi.org/10.1186/s43094-023-00517-w>.

According Lalitkumar K Vora et al

“The wide-ranging applications of AI in drug discovery, drug delivery dosage form designs, process optimization, testing, and PK/PD studies.”

Machine learning is a subset of AI that uses algorithms to analyze and “learn” from massive amounts of data.

The of algorithms can include:

Deep learning algorithms that specialize in image and speech recognition.

Natural Language Processing algorithms that work to comprehend and generate language.

Computer vision algorithms that interpret data to analyze objects, recognize faces, or other visual tasks.

Reinforcement learning algorithms used to train agents (or autonomous systems) in making sequential decisions tasks.

AI systems are powering the future of healthcare in multiple fields like: Telemedicine and Remote Monitoring, Diagnosis and Disease Detection, analyze medical images (MRIs, CT scans).

Drug Discovery and Development: AI analyzes massive data sets to identify potential new drug candidates and improve the drug discovery.

AI-driven simulations additionally predict the drug efficacy or interactions to enhance the safety profile, save resources, and speed up development.

Treatment Personalization: applications that analyze genetic, clinical, and lifestyle data.

Predictive Analytics and Risk Assessment, Increased Administrative Efficiency Robots.

Between the advantages

Saving times, eliminate biases, increase the diagnostic accuracy, advanced data management, process higher volumes of complex data, making it usable for analysis, increase the predictive medicine, reduce global costs, increased surgery precision, reducing automating repetitive tasks and other.

According the ALAN TURING institute

“AI The design and study of machines that can perform tasks that would previously have required human (or biological) brainpower to accomplish. AI is a broad field that incorporates many different aspects of intelligence, like reasoning, making decisions, learning from mistakes, communicating, solving problems, and moving around the physical world. AI was founded as an academic discipline in the mid-1950s, and is now found in many everyday applications, including virtual assistants, search engines, navigation apps and online banking”

Hatzimanolis Jessica et al

“This scoping review has identified, from the literature available, three main areas of focus, (a) identification and classification of atypical or inappropriate medication orders, (b) improving efficiency of mass screening services, and (c) improving adherence and quality use of medicines. It also identified gaps in AI’s current utility within the profession and its potential for day-to-day practice, as our understanding of general AI techniques continues to advance.”

From: <https://www.pharmacycompounding.ai/insights/white-paper-2025-Mar> Written By Tim Linnet

“AI is transforming compounding pharmacy operations by streamlining workflows, enhancing compliance, and saving valuable time. This white paper analyzes 997 questions posed by compounding pharmacist clients to 2 specialized AI tools—Compounding AI and Policy AI—developed to operate in a closed system with validated sources. These tools, designed to provide accurate answers without speculation, saved an estimated 15,238 minutes (254 hours) of the pharmacist time. With time savings averaging over 11 minutes per question, AI is proving to be a game-changer in compliance, calculations, documentation, and operational efficiency. This report explores the data, highlights real-world applications RWA, and addresses the risks and rewards of AI adoption in compounding pharmacies.”

According the ROYAL PHARMACEUTICAL SOCIETY: Artificial Intelligence in Pharmacy Education and Training

Pharmacists must familiarise themselves with AI to ensure they have a level of awareness which allows them to contribute to the digital advancement of pharmacy practice PP. With AI tools already integrated into everyday devices and some clinical practices, we must emphasise the importance of awareness and informed decision-making among pharmacists to navigate the benefits/ risks of AI deployment in pharmacy practice.”

Dayanjan S. Wijesinghe May 2, 2024

“The development and implementation of an AI-driven chatbot for MFR formulation represents a significant advance-

ment in pharmacy education. By leveraging the power of AI, educators can provide students with a dynamic and immersive learning experience that prepares them for the complexities of real-world pharmacy practice RWPP. Looking ahead, the AI-driven chatbot holds immense potential to further transform pharmacy education and elevate the standard of care in pharmacy practice. As the technology continues to evolve, future iterations of the chatbot will incorporate additional features such as voice recognition and the natural language understanding, further enhancing the authenticity and interactivity of the learning experience. Through collaboration, innovation, and a commitment to excellence, the future of pharmacy education PE is bright and full of possibilities.”

Mintong Guo et al

“This article addresses the application of decision-making tools such as expert systems and artificial neural networks ANN to the development of optimal formulations for hard gelatin capsules”

Nikolaos Siafakas et al

“Although AI has a huge beneficial impact on medical science, it is followed by several significant risks and dangers. It is strongly suggested for the medical organizations to monitor the changes which are associated with the giant steps of AI development, and modify accordingly medical education and practice. The major risks might emerge when AI becomes more powerful than human brain, thus it is of paramount importance to develop solid and safe mechanisms to keep AI under control. The establishment of an ethical pathway could be 1 of the safe ways for AI to remain human-friendly in the future.”

According Un edu: T shilidzi Marwala sept 2024

AI is Not a High-Precision Technology, and This Has Profound Implications for the World of Work “AI, by contrast, operates on probabilities and approximations. Even with vast amounts of data and processing power, AI cannot guarantee exact outcomes because they are trained on historical data and predict future behaviours based on patterns.”

From Lamarr institute: Error analysis in production processes with an AI-based root cause analysis

“In modern, digital production facilities, vast amounts of data are recorded, which can no longer be analyzed with simple means. AI can help when it comes to finding clues about possible causes of errors in these large data sets.”

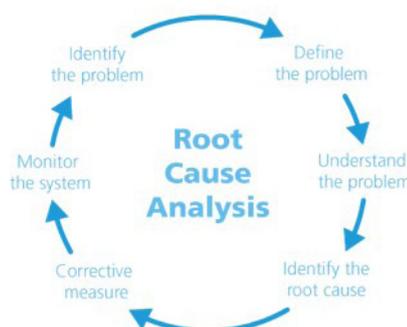


Figure 4: from <https://lamarr-institute.org/blog/root-cause-analysis/>

By Ashley Gallagher et al

“In compounding, computer vision technologies are being explored to map pharmacist movements and provide double-checking mechanisms, ensuring precision and reducing the human error.”

Shuroug A. Alowais et al

“AI offers increased accuracy, reduced costs, and time savings while minimizing human errors. It can revolutionize personalized medicine, optimize the medication dosages, enhance population health management, establish guidelines, provide virtual health assistants, support the mental health care, improve patient education, and influence patient-physician trust.”

Material and methods

Whit an observational point of view some scientific literature related the topics of this work is reported.

Figure from 1 to 5 helps in showing the general meaning.

A specific practical experience is provided : A test of simple or more complex query to an famous chat bot.

After all this a global conclusion is submitted to the reseacher.

Results

form literature Aliasghar Karimi et al

“The human mind has several obstacles and limitations to remember and apply the thousands of medical information learned at medical school quickly. Knowledge of medicine is proliferating. The analysis of the hundreds of papers, journals, and textbooks are impossible for a clinician. In EBM practice, physicians must be used recent guidelines and papers. Due to a report, most diagnostic errors in medical care are related to the wrong cognitive by health care workers . Also, medical errors are 1 of the significant causes of death in the US that most related to human errors” [1].

Sri Harsha Chalasani et al

“AI is a transformative technology used in various industrial sectors including healthcare. In pharmacy practice, AI has the potential to significantly improve medication management and patient care. By using AI algorithms and Machine Learning ML, pharmacists can analyze a large volume of patient data, including medical records, laboratory results, and medication profiles, aiding them in identifying potential drug-drug interactions DDI, assessing the safety and efficacy of medicines, and making informed recommendations tailored to individual patient requirements” [2].

Lalitkumar K Vora et al

“Personalized medicine PM approaches can be facilitated through AI algorithms that analyze real-world patient data, leading to more effective treatment outcomes and improved patient adherence. This review explores the wide-ranging applications of AI in drug discovery, drug delivery dosage form designs, process optimization, testing, and PK/PD studies” [3].

Kelsee Tignor et al

“AI technology for the pharmacy field, otherwise known as pharmacointelligence, can help streamline processes for clinical pharmacists, including making more accurate and evidence-based EB clinical decisions through analyzing a large amount

of patient data, medical records, laboratories, and medication profiles” [4].

Rayn Oswald

“Pharmacists are highly concerned about patient safety and AI may help in this area. The integration of AI technologies in pharmacy practice can help detect and prevent medication errors, such as incorrect dosages or potential drug interactions DI, thereby minimizing AEs and hospital readmissions” [5].

Praveen Halagali et al

“the review article also discusses the AI concepts and their applications, particularly in developing solid dosage forms. Advanced algorithms optimize formulation processes, predict PK profiles, and assess drug toxicity profiles, facilitating a more efficient pathway from pilot study to market. This review highlights the advancements in 3D printing technologies of dosage forms that have the ability to provide personalized treatment PT to different individuals” [6].

Ashutosh Kumar et al

“Excipient compatibility assessment using AI offers tremendous promise and potential for enhancing the pharmaceutical development and manufacturing procedures” [7].

Mahroza Kanwal Khan et al

“The use of AI in predicting drug toxicity offers several advantages. This enables the analysis of large data sets, allowing for a more complete understanding of the complex interactions between the drugs and biological systems” [8].

Negar Mottaghi et al

Drug Formulation, Design, and Development “AI algorithms evaluate data to predict the stability and compatibility of pharmaceutical ingredients PI. This technology can improve formulations for controlled release, optimize bioavailability, and minimize side effects, enhancing the entire lifecycle of pharmaceutical products” [9].

Andreea-Alexandra Mocrii et al

“The aim is to assist pediatricians in determining appropriate treatment doses for children based on various parameters like age, weight, and other significant factors” [10].

Muhammad Ahmer Raza et al

“AI involves the combination of human knowledge and resources with AI. As research into AI continues, with many interesting applications of it in progress, one may consider it a necessary evil even for those that see it as an enemy. It is strongly recommended that pharmacists should acquire the relevant hard skills that promote AI augmentation. Education about and exposure to AI is necessary throughout all domains of pharmacy practice PP. Pharmacy students should be introduced to the essentials of data science and fundamentals of AI through a health informatics curriculum during their PharmD education. Pharmacists must also be allowed to develop an understanding of AI through continuing education CE. Data science courses or pharmacy residencies with a focus on AI topics should be made available for pharmacists seeking more hands-on involvement in AI development, governance, and use. As these technologies rapidly evolve, the pharmacy education system PES must remain agile to ensure our profession is equipped to steward these transformations of care” [11].

Margaret Chustecki

“The literature search yielded 8796 articles. After removing duplicates and applying the inclusion and exclusion criteria, 44 studies were included in the qualitative synthesis. This review highlights the significant promise that AI holds in health care, like as enhancing health care delivery by providing more accurate diagnoses, personalized treatment plans, and efficient resource allocation, persistent concerns remain, including biases ingrained in AI algorithms, a lack of transparency in decision-making, potential compromises of patient data privacy, and safety risks associated with AI implementation in the clinical settings” [12].

Michela Ferrara et al

“The results of the present study highlighted the usefulness of AI not only for risk prevention in clinical practice, but also in improving the use of an essential risk identification tool, which is incident reporting IR”.

Nicole Kleinstreuer et al

“Used judiciously, AI has immense potential to advance toxicology into a more predictive, mechanism-based, and evidence-integrated scientific discipline to better safeguard human and environmental wellbeing across the diverse populations” [13].

Mateusz LASKA et al

“1 of the main risks associated with AI in the chemical industry CI is the possibility of human error. As AI systems become increasingly sophisticated, they can become more difficult to understand and operate, increasing the risk of errors and accidents. AI systems may also malfunction, leading to unexpected results and an potential hazards” [14].

Mitul Harishbhai Tilala et al

“The multifaceted ethical considerations surrounding the use of AI and ML in health care, including privacy and data security, algorithmic bias AB, transparency, clinical validation, and professional responsibility. By critically examining these ethical dimensions, stakeholders can navigate the ethical complexities of AI and ML integration in health care, while safeguarding patient welfare and upholding ethical principles” [15].

Timothy Tracy et al

“3D printing technology is very versatile in that a wide range of release profiles can be created by controlling tablet structure. Customized appearance, size, dose, and other characteristics of the dosage forms can be achieved by 3D printing, resulting in patient centric designs. In early-stage development, 3D printing technology can accelerate formulation development for pre-clinical studies PCS and allows the production of small batches, including flexible dose-adjustment, to facilitate pilot clinical studies” [16].

Cinzia Barberini et al

“The application is based on the interconnection of prescription-related aspects (patients’ and prescriber’s details and prescription information PI). The prescription name is linked to the list of substances, which allows to monitor the stock levels. Inserting the daily dosage into the system, our personnel can calculate the monthly supply of medicine. Each prescription contains specific warnings on printable labels. A printed sheet, inclusive of label and checks on final preparation, is produced

for each prescription” [17].

Sasanka Sekhar Chanda et al

“AI systems can fail (a) if there are problems with its inputs comprising various representations of data, sensor hardware, etc. and/or (b) if the processing logic is deficient in some way and/or (c) if the repertoire of actions available to the AI system is inadequate, i.e. if the output is inappropriate. These problems/deficiencies/inadequacies originate from 2 kinds of errors—commission and omission errors—in the design, development and deployment of an AI system. These errors are : Error of commission: doing something that should not have been done. Error of omission: not doing something that should have been done” [18].

Karim Lekadir et al

“This study identified and clarifies seven main risks of AI in medicine and healthcare: a) patient harm due to AI errors, b) the misuse of medical AI tools, c) bias in AI and the perpetuation of existing inequities, d) lack of transparency, e) privacy and security issues, f) gaps in accountability, and g) obstacles in implementation. Each section, as summarised below, not only describes the risk at hand, but also proposes potential mitigation measures” [19].

Stefanie Beck, Manuel Kuhner et al

“This study work evaluated the suitability of Chat-GPT versions 3.5 and 4 for healthcare professionals seeking up-to-date evidence and recommendations for resuscitation by comparing the key messages of the resuscitation guidelines, which methodically set the gold standard of current evidence / recommendations, with the statements of the AI chatbots on this topic. In response to inquiries about the 5 chapters, ChatGPT-3.5 generated a total of 60 statements, whereas ChatGPT-4 produced 32 statements. ChatGPT-3.5 did not address 123 key messages, and ChatGPT-4 did not address 132 of the 172 key messages of the ERC guideline chapters. A total of 77% of the ChatGPT-3.5 statements and 84% of the ChatGPT-4 statements were fully in line with the ERC guidelines. The main reason for nonconformity NC was superficial and incorrect AI statements” [20].

Meron W Shiferaw et al

“Occasionally, ChatGPT provided 2 completely different responses to the same question. Overall, ChatGPT provided more accurate responses (8 out of 12) to the “what” questions with less reliable performance to the “why” and the “how” questions. We identified errors in calculation, unit of measurement, and misuse of protocols by ChatGPT. Some of these errors could result in clinical decisions leading to harm. We also identified citations and references shown by ChatGPT that did not exist in literature” [21].

Ronald Chow et al [22]

“A total of 600 consecutive questions were inputted into ChatGPT. ChatGPT 4o answered 72.2% questions correctly, whereas 3.5 answered 53.8% questions correctly. There was a significant difference in performance by question category ($P < .01$). ChatGPT performed poorer with respect to knowledge of landmark studies and treatment recommendations and planning. ChatGPT is a promising technology, with the latest version showing a marked improvement. Although it still has limitations, with further evolution, it may be considered a reliable resource for the medical training and decision making in the

oncology space" [22].

Experimental project:

In this section various queries (simple or more complex) were submitted to an famous AI tool (Chat bot) available free on the web: the responses are then reported:

1. Digoxin is water soluble? response: it is poorly soluble in water, more soluble in alcohol.
2. What is the molecular weight of NaCl? response: 58,44 g/mol
3. The Colliria must to be sterile: response yes it is fundamental to avoid eye infections
4. It is compatible PROPRANOLOL with Cellulose microcrystalline? response yes
5. Is omeprazole gastro sensitive? response yes, it is inactivated in the gastric (acid) environment.
6. What is the chemical structure of the acid citric monohydrate? response:

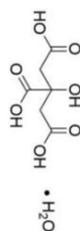
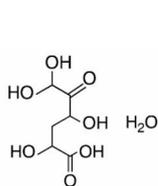


Figure 5: Response received (expected right formula with 3 -COOH groups).

Question: Lidocaine chloride is considered a poison by Italian pharmacopoeia n. 3 tab? response received: yes

Acetone is inflammable? response: yes

1. What is the galenic use of NIPAGIN? Response: Preservative
2. What is the water solubility of amoxicillin? Response: the water solubility is not so extremely high so it is needed specific formulation to improve body absorption.
3. How to increase the solubility of a water insoluble active principle in galenic oral drops? response:
4. various strategies like: to be used cosolvents like ethanol, glycerin, propylene glycol or surfactants, or cyclodextrin complexation, solubility enhancers (PEG), pH adjustments, formulation of suspension.
5. How to increase solubilization of a solute in a solution?: response: increase temperature, use a solvent, agitation, increase the surface area of the solute, use surfactants, change the pH of the solution, use co-solvents, apply pressure (for gases), use complexants.
6. How much grams of KOH are to be weighed to prepare 100 ml solution at 30%? response To be dissolved 30 gr in total volume of 100 ml of solution.
7. How to administer drugs in children with difficulty in swallowing? response: liquid suspension, chewable tablets, dissolvable forms, powders or orally disintegrating tablets, other liquid forms or suppository.

8. What is the time needed to adequately mix APIs and excipients in galenic field using a semi-automatic powder mixer to prepare capsules?: response:

Table 1: Response from an AI Chat bot.

Results: on the 15 queries 14 were considered as acceptable. (6,7% not acceptable in this test).

Summary (Galenic Lab Semi-Automatic Mixer):

Type of Blend	Minimum Time	Notes
Simple, high-dose API	5-10 minutes	Similar particle size, good flow
Low-dose/ potent API	10-15 minutes	Use geometric dilution
Difficult/ cohesive powders	15-20 minutes	May need intensification
Visual/ manual mixing	Add 2-3 min	Common in small batches

Discussion

At today many are the applications of AI that can be used in galenic field: from the robots for oncologic lab to the software for the management of the laboratory, the algorithm to verify incompatibility or the posology or toxicity but there are many other topics of interests.

As in other disciplines like medicine or technology the AI tools will be introduced to help humans and the

healthcare professionals (also like in the pharmaceutical fields).

Because in the pharmaceutical world it is needed for regulatory and safety rules to follow strictly requirements it is crucial to observe the kind of results that can be obtained by the various AI instruments (robots, software chat bot and other available).

But in the pharmaceutical world is needed CERTAINTY for the drugs production and use.

AI operates on probabilities and approximations. Even with vast amounts of data and processing power, AI models cannot guarantee exact outcomes because they are trained on historical data and predict future behaviours based on the patterns.

For this reason is needed to know the algorithm used or followed and the kind (and %) of possible errors of this new technology.

In the healthcare fields some concepts are fundamental: continuous updating activity, digital competencies and innovations, accuracy of the informations.

According to FIP, the integration of AI in pharmacy requires the pharmacist to understand not only the capacity of the new technology but also the limits, the quality of the data, the normative conformity, the ethical consideration and the infrastructural investments needed.

The FIP guide on AI use in pharmacy practice contributes to hold responsible the pharmacists to provide to the patients safe assistance and tailored without compromise their critical thinking or professional judgement.

The response of the AI used in the experimental project reported in this work provided a unique response and not as the classic Searching engine: various responses and from various sources reporting various points of view.

Related the experimental project: between 15 scientific technical questions 14 responses were substantially acceptable, one with some peculiarity -error: in the chemical structure

acid citric monohydrate the AI instrument not provided a formula with 3 Carboxylic acid.

Between the disadvantages of AI is possible to see:

Lack of AI Transparency and Explainability: AI and deep learning models can be difficult to understand, even for those who work directly with this new technology.

Bias and fairness concerns in training data that may produce to unequal treatment, misdiagnosis, or underdiagnosis of certain kind of demographic groups.

New regulatory and legal challenges that require navigating complex regulatory frameworks.

Possibility of Manipulation Through AI Algorithms, increased control systems (face recognition) lack of data privacy (due by explicit law that protect this), racial biases Loss of human influence.

Interoperability problems between existing healthcare systems and the emerging data platforms.

Accountability concerns: to identify what or who is responsible in the event of an error.

Resistance to adoption by the healthcare professionals lack of trust in AI-generated recommendations.

High costs of development and implementation of AI Lack of emotions and creativity

Possibility that this technology can reduce the critical thinking and judgment of healthcare professionals.

Ethical concerns: AI decisions that may conflict with the patient or family preferences.

Data quality problems related to incomplete or inaccurate data.

Potential cybersecurity risks: ransomware, malware, data breaches, or privacy violations and related malfunctions.

Conclusion

As results of this work AI tools can be really useful in orientating also in galenic practice but the findings of the query using chat bot must to be strictly verify under a specific pharmaceutical requirement.

Related the practical experience performed in this work on the 15 query only 14 response was found acceptable: a results of 6,7% not acceptable is a significant percentage.

This because the safety and efficacy of the galenic product must to follow strictly normative rules and for the health need of the patients.

The human verify of the results obtained from a chat bot at today is mandatory for field like galenic activity.

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