Embracing the Power of Artificial Intelligence in Pharmacy Practice

In a Transformative Era

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June 20, 2025

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Pharmacist Objectives:

1. Briefly define Artificial Intelligence (AI) and formulations of significance.

2. Explain how data is used to build Artificial Intelligence (AI) to design predictive medicine capabilities for drug therapy

3. Discuss Artificial Intelligence (AI) 's role in predicting drug interactions and optimizing Medication Therapy Management, Comprehensive Patient Care plans, and providing Patient Counseling

4. List various Pharmacy Operations workflow utilizing Artificial Intelligence

5. Discuss the regulatory landscape and the need for guidelines to ensure safe and effective Artificial Intelligence (AI) implementation.

6. Discuss emerging trends and future directions in Artificial Intelligence (AI) technology for pharmacy practice.

Pharmacy Technician Objectives:

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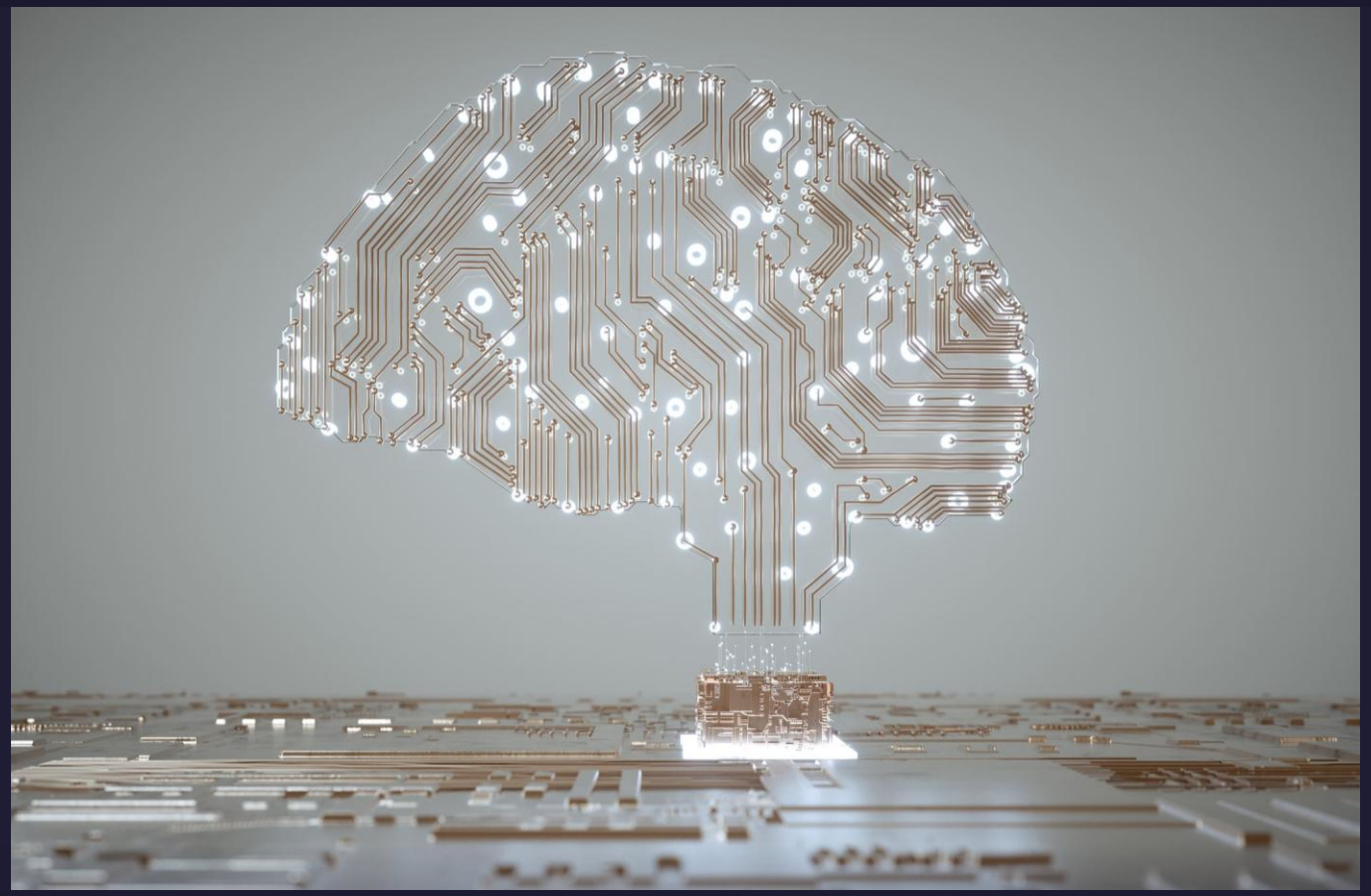
- 4. List various Pharmacy Operations workflow utilizing Artificial Intelligence
- 5. Discuss the regulatory landscape and the need for guidelines to ensure safe and effective AI implementation.
- 6. Discuss emerging trends and future directions in AI technology for pharmacy practice.

Rate your AI in Healthcare knowledge on a scale of 1 (low) to 5 (high)

_____

“ AI does what I tell it to do...”
(scene from Shuri’s Lab- Black Panther 2018)

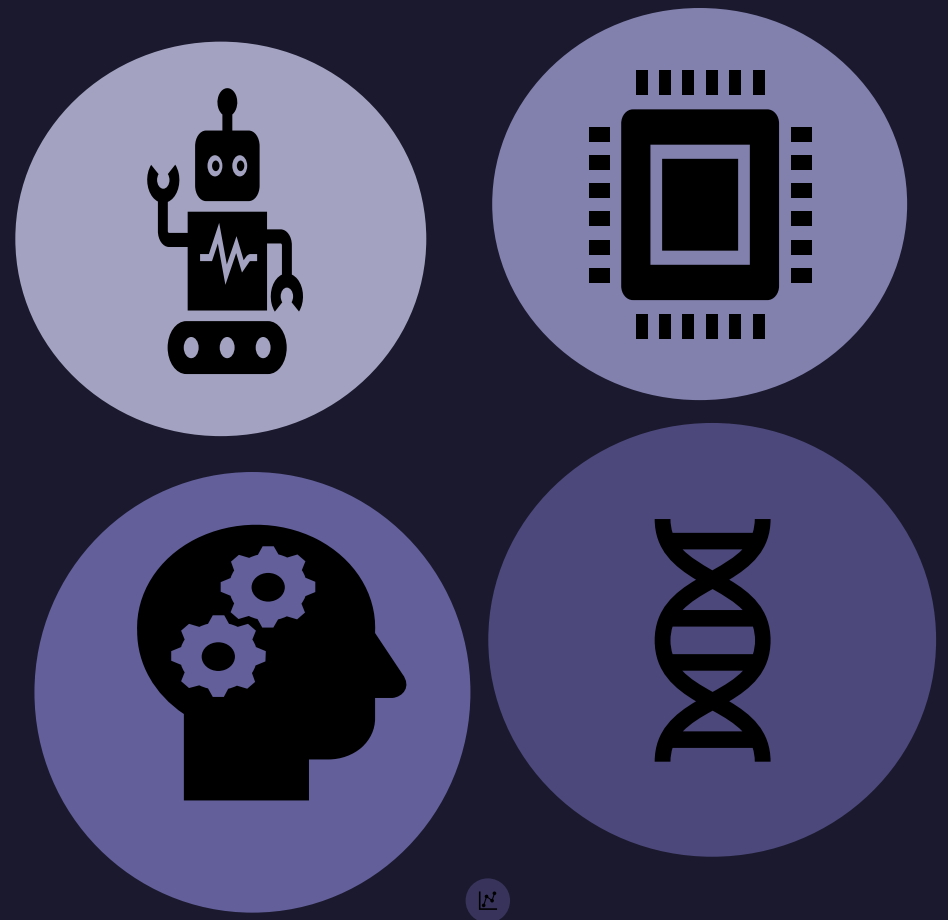
Concept Definitions and Principles of Artificial Intelligence



Artificial Intelligence is the simulation of Human Intelligence

- AI simulates human intelligence, allowing machines to think, learn, and make decisions autonomously.
- Machine learning enables computers to learn from data and improve their performance over time without being explicitly programmed.
- Natural language processing (NLP) allows machines to understand and respond to human language, enhancing human-computer interaction.
- Neural networks are algorithms modeled after the human brain, crucial for pattern recognition and data-driven decision-making in AI.

AI (Artificial Intelligence) terminology and utilizations



Learning Machine Learning (ML) Machine

- Learning is a subset of AI that involves the development of algorithms
  - *Algorithms are set of instructions that a computer follows to perform a specific task, such as learning from data, identifying patterns, or making decisions*

Deep Learning (DL)

- Deep learning is a type of machine learning that uses neural networks with many layers (hence "deep") to analyze complex data.

Natural Language Processing (NLP)-

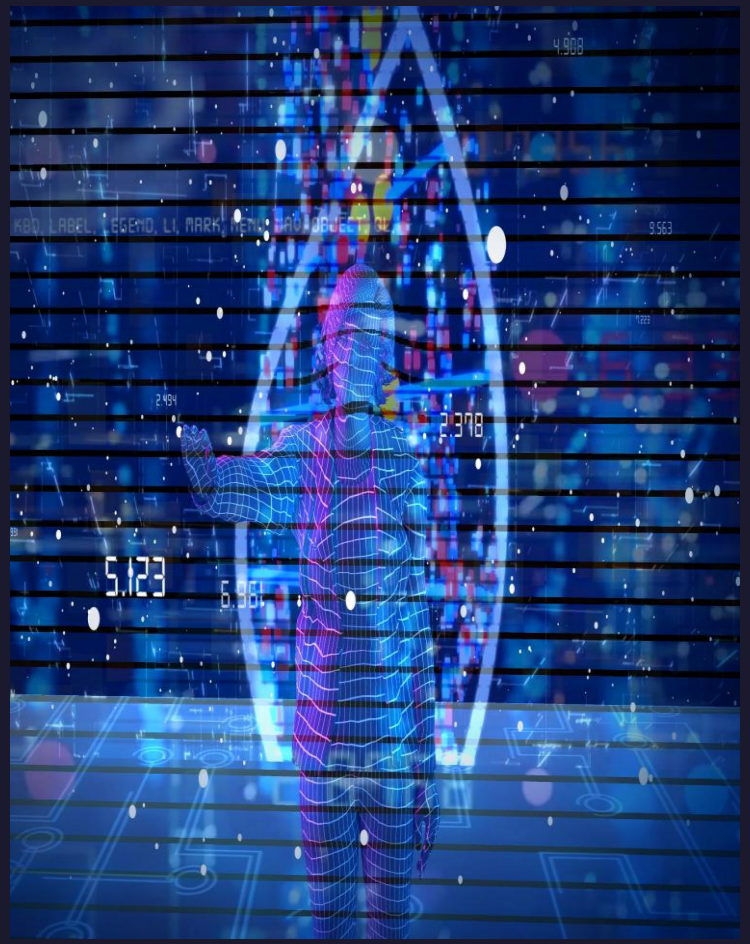
- NLP is a branch of AI focused on the interaction between computers and human language

Predictive Analytic

- Predictive analytics involves using historical data to make predictions about future events.
- In healthcare, it is used to anticipate patient deterioration, optimize resource allocation, and improve patient outcomes.

AI and Predictive medicine capabilities for drug therapy

Drug Discovery and Development

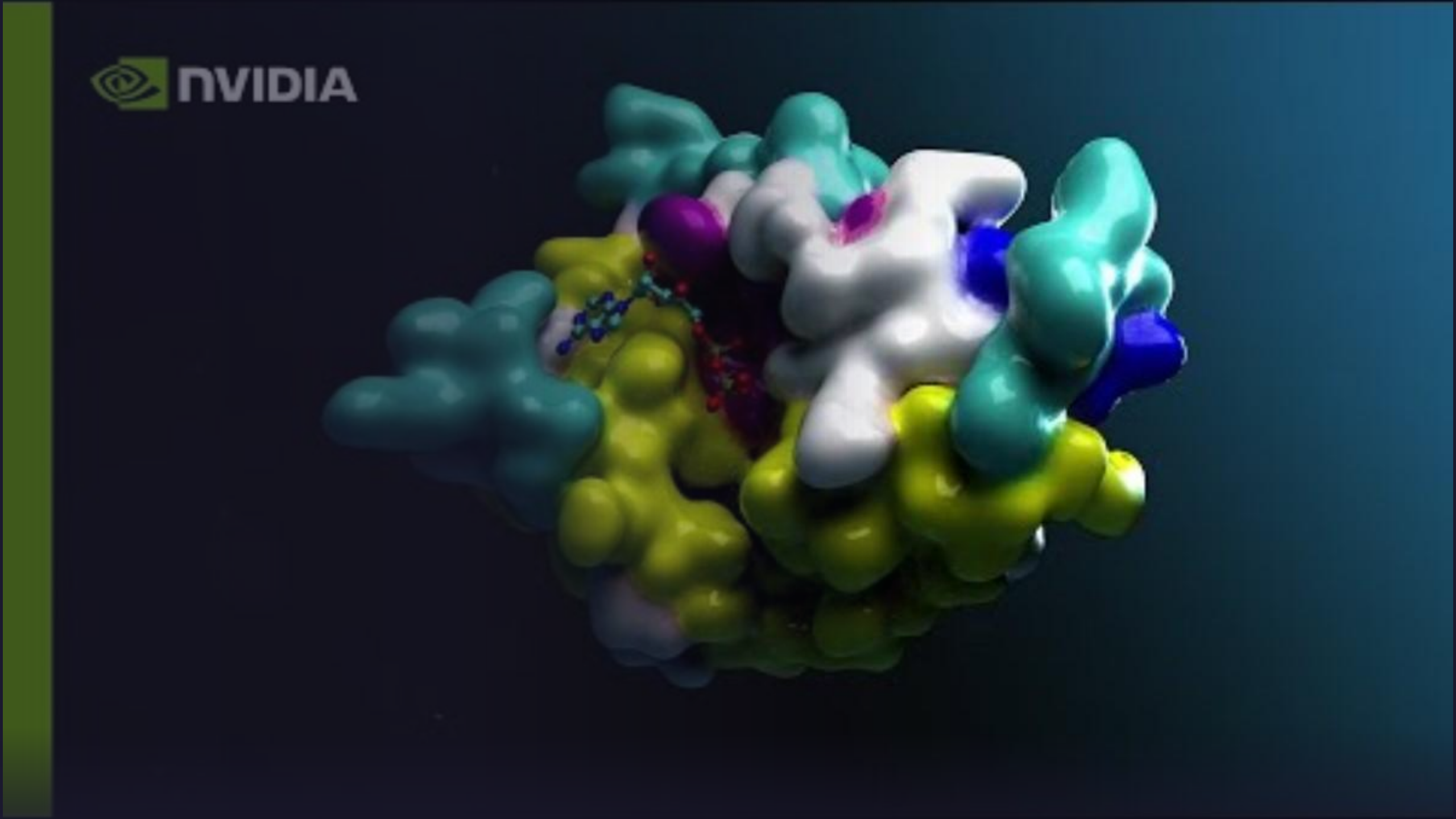


AI in Drug Discovery

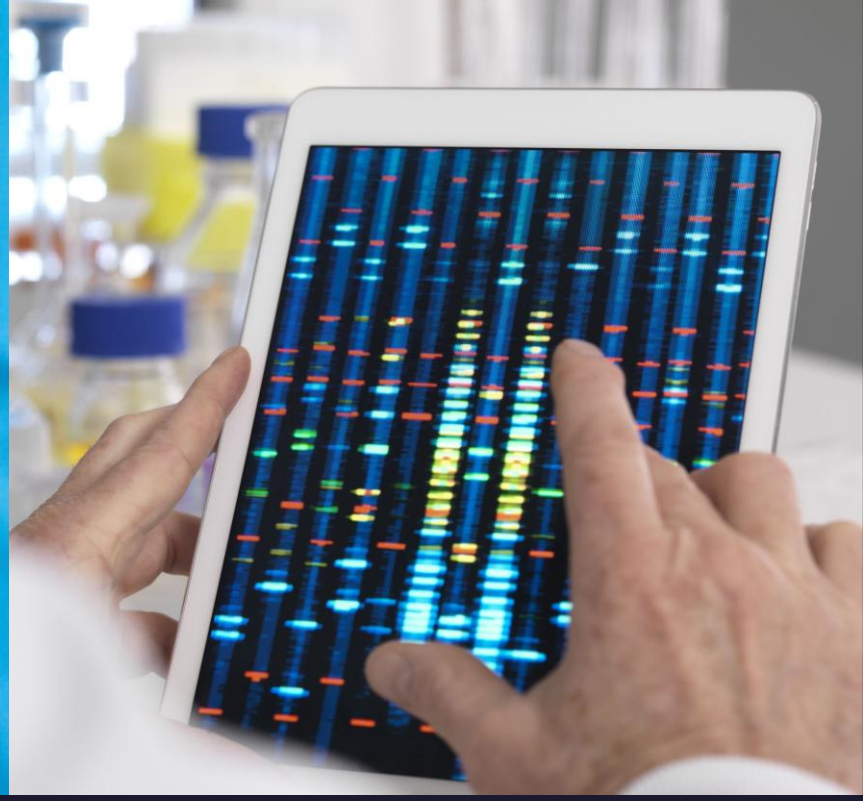
- Analyzing large datasets to identify promising drug compounds.
- Predict drug interactions effectively, minimizing potential side effects and enhancing drug efficacy.
- Streamlines the clinical trial process by optimizing participant selection and monitoring, leading to faster results.

AI enhancement of Clinical Trials

- Patient Recruitment: Identify qualifying patients for clinical trials, improving recruitment
- Trial Design: Refine eligibility criteria and supports decisions about target patient populations which shortens trial durations.
- Patient Engagement: AI-enabled digital health technologies enhance patient engagement and retention.
- Safety Prediction: Predictive AI models can anticipate safety concerns, aiding in risk management during trials. Use of virtual aids for patient reporting
- Drug Discovery: AI assists in the early stages of drug discovery, identifying suitable disease targets and new molecule designs.


NVIDIA





AI Systems in Pharmacy Practice

AI-Driven Clinical Decision Support

Artificial Intelligence (AI) 's role in predicting

- Drug Therapy Optimizing
- Drug interactions
- Medication Therapy Management
- Comprehensive Patient Care plans
- Patient Counseling

Medication Management and Dispensing

AI Assistance in Pharmacy

Provide pharmacists with accurate information for medication dispensing, enhancing the efficiency of pharmacy operations.

Monitoring Drug Interactions

Help monitor drug interactions, ensuring patient safety and minimizing the risk of harmful side effects.

Supporting Therapy Adherence

Support patient adherence to therapy by providing reminders and tracking medication schedules, leading to better health outcomes.

What AI does in application with MTM:

AI-powered systems use various methods, including text messages, mobile apps, and wearable devices, to remind patients to take their medications.

For example, AI-driven chatbots are becoming an innovative solution – these bots provide personalized reminders and answer questions about side effects or treatment plans, thereby improving adherence through patient empowerment.

One notable application is machine learning-based pattern recognition, which identifies adherence trends and helps predict non-compliance before it becomes an issue.

These predictive models allow healthcare professionals to adjust interventions proactively, ensuring patients are more likely to stay on track with their medication.

www.hhmglobal.com/knowledge-bank/techno-trends/how-ai-is-revolutionizing-medication-management

Precision Medicine- Precision medicine

- The customization of healthcare treatments based on individual characteristics, including genetics, lifestyle, and environment
- AI analyzes patterns in health data, AI can predict the likelihood of disease development, allowing healthcare providers to recommend preventive measures tailored to the individual's risk factors.

Precision Medicine and Personalized Treatment

Role of AI in Medicine

Analyzing patient data, improving the accuracy of diagnosis and treatment plans.

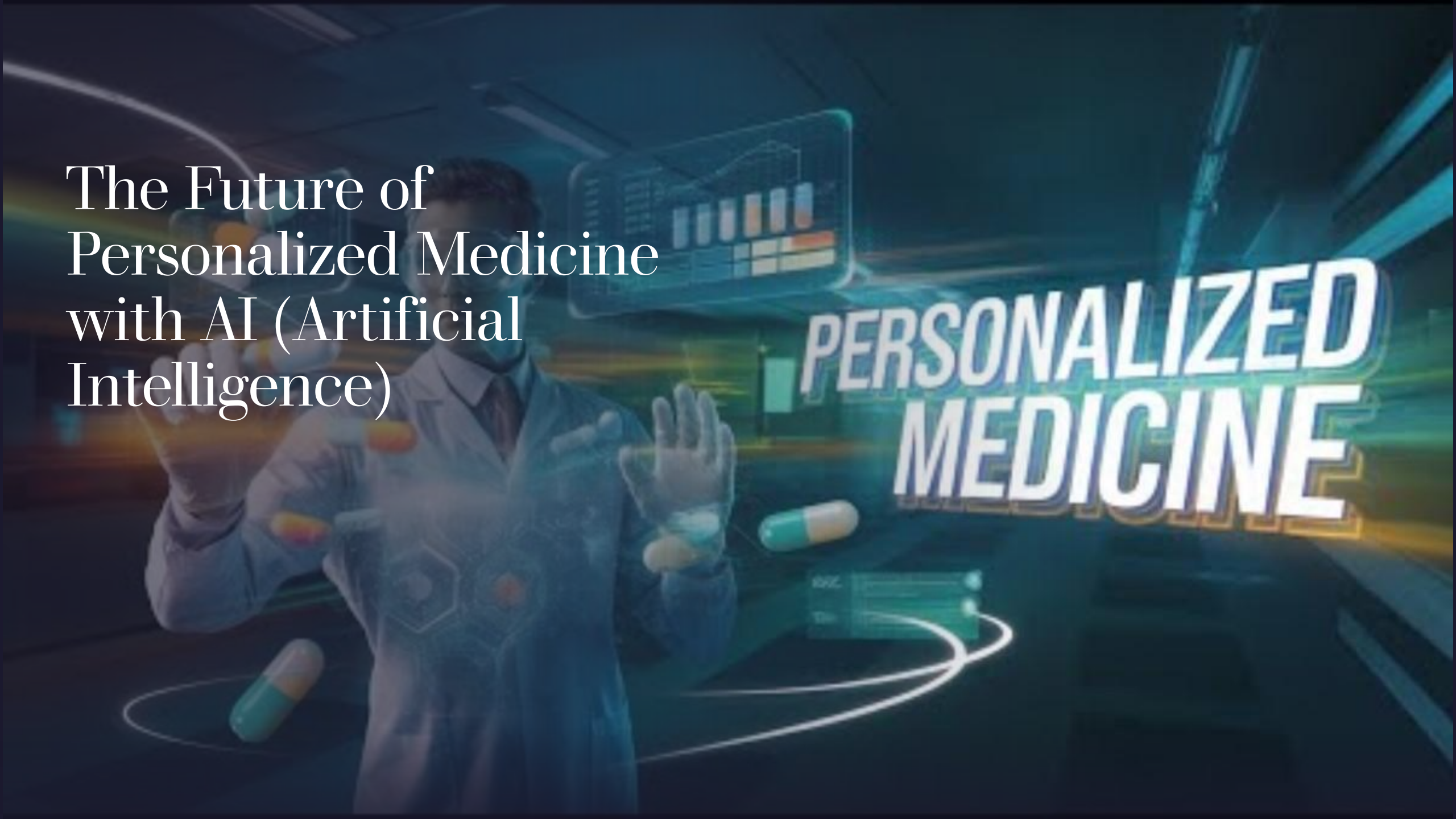
Tailored Treatments

Treatments can be customized based on genetic and lifestyle factors, improving patient outcomes.

Improving Treatment Effectiveness

By focusing on individual patient profiles, therapies become more effective and minimize adverse reactions.

The Future of Personalized Medicine with AI (Artificial Intelligence)



Brain Break

Take 10 – Stretch & Reset

How is AI being applied in software applications:

AI is used for analyzing machine learning to imitate the cognitive tasks of individuals

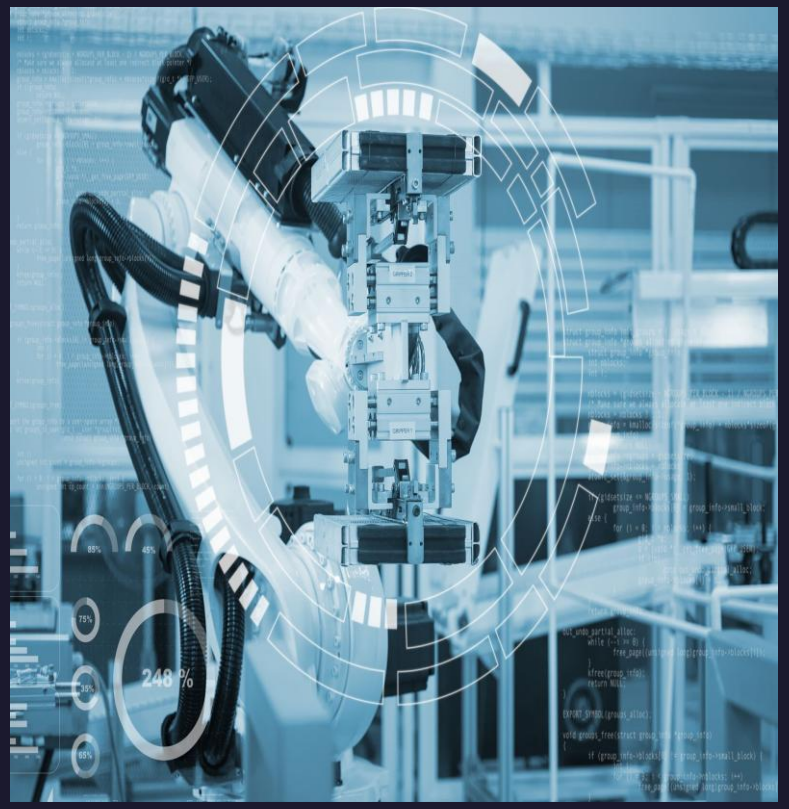
AI technology is exercised to perform more accurate analyses as well as to attain useful interpretation

https://pmc.ncbi.nlm.nih.gov/articles/PMC9836757

Workflow Efficiency

History and Development of AI in Healthcare and Pharmacy Practice

Key AI Technologies Used in Medicine



Machine learning algorithms help identify patterns in medical data, enhancing diagnosis and treatment planning.

Natural Language Processing

Natural language processing is used to analyze clinical texts, facilitating better understanding of patient records and literature.

Robotic Process Automation

Robotic process automation streamlines administrative tasks, improving efficiency in operations

Evolution of AI Algorithms

- AI in healthcare has transitioned from basic algorithms to systems that learn and make predictions

Applications of AI in Pharmacy Practice

Early Applications in Data Management

- AI in data management, improving the organization and analysis of information for better decision-making.
- In Pharmacy Practice – enhancing efficiency, safety, and patient care through data analysis simulating cognitive decisions of human though utilizing massive data resources in accelerated time

Progression of performance in practice:

Patient & Prescription Information → Clinical Resource integrations → EMR – Electronic Medical Records → HMS – Health Management Systems

Clinical Management Systems

AI - Integrates ALL previous models into a mass database to provide – Assessments, Predictive Models, Outcomes, Treatments and more

Real-Time Data Analysis and Predictive Analytics

Anticipating Patient Needs

Real-time data analysis allows healthcare providers to anticipate patient needs effectively, leading to proactive care.

Optimizing Treatment Plans

Predictive analytics helps in optimizing treatment plans by using data-driven insights to tailor care for individual patients.

Improving Outcomes

Leveraging AI algorithms significantly improves patient outcomes through informed decision-making and timely interventions.

Enhancing Patient Safety and Outcomes

Improving Adherence to Prescribed Therapies

Medication Reminders

Timely reminders for patients to take their medications, improving adherence rates significantly.

Personalized Engagement

Personalized strategies based on their unique needs and preferences, fostering a supportive treatment environment.

Follow-Up Plans

Follow-up plans facilitated by AI ensure that patients receive support and guidance to stick to their treatment regimens.

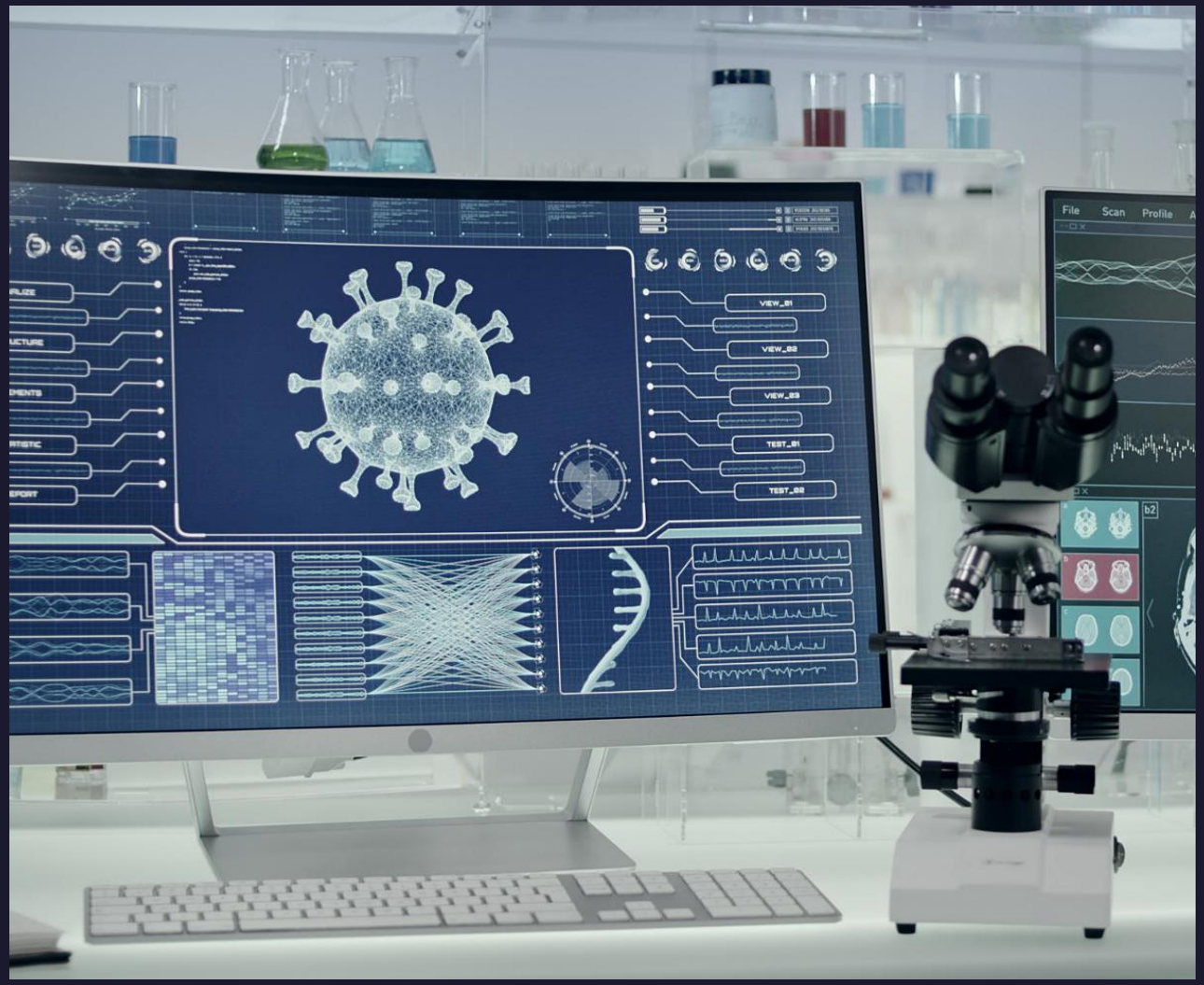
AI in Diagnosing and Monitoring Patient Conditions

Enhanced Diagnostics

Improved diagnostics by recognizing patterns in vast amounts of medical data, **Ongoing Patient Monitoring**

AI supports continuous monitoring of patient conditions yielding timely interventions

AI detects anomalies, healthcare professionals can intervene in a timely manner, improving patient outcomes significantly.



Integration with Electronic Health Records (EHRs)

Streamlined Patient Access

Integrating AI with EHRs allows healthcare providers to quickly access

Enhanced Clinical Workflows

The integration of AI enhances clinical workflows by automating routine tasks

Decision Support Tools

Integrated into EHR systems provides real-time assistance to healthcare providers during patient care.

Monitoring Adverse Drug Reactions

Real-Time Analysis

AI technology can analyze data in real time, identifying patterns of adverse drug reactions as they occur.

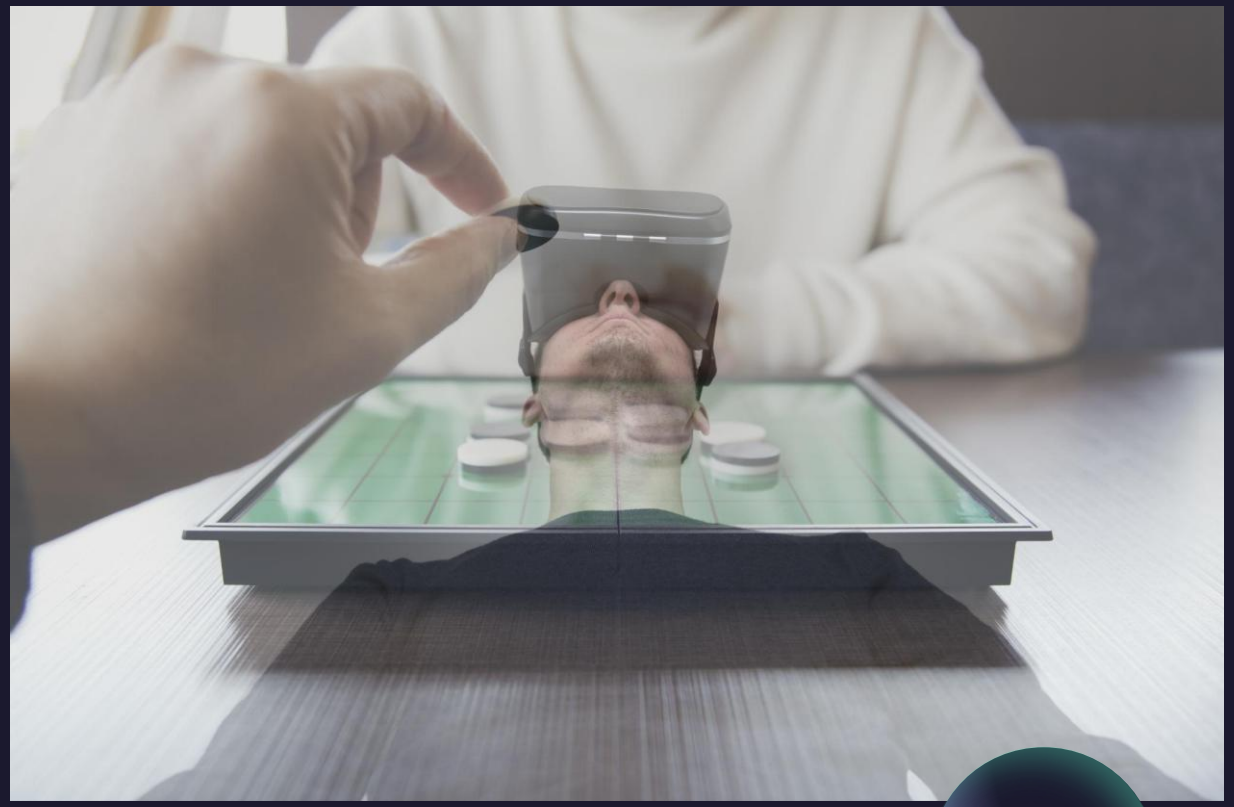
Rapid Response

Quick identification of adverse reactions allows for immediate adjustments in treatment, improving patient outcomes.

Enhanced Patient Safety

By monitoring adverse reactions effectively, AI plays a crucial role in enhancing overall patient safety.

Reducing Medication Errors



Accurate Medication Dispensing

AI systems enhance the accuracy of medication dispensing, minimizing the risk of human errors in pharmacies and healthcare settings.

Dosage Verification

AI tools verify dosages to ensure patients receive the correct amount of medication, reducing the chance of overdoses or underdoses.

Flagging Drug Interactions

By analyzing medication combinations, AI systems flag potential drug interactions before they can adversely affect patients.

Inventory Management

AI-driven inventory management systems enable pharmacies to maintain optimal stock levels, reducing waste and ensuring the availability of essential medications. These systems forecast demand, track inventory, and automate reordering processes.

Forecasting the impact of artificial intelligence on clinical pharmacy practice

JACCP: Journal of American College of Clinical Pharmacy; Feb. 2025

Antibiotic Stewardship

Disease Management

Deprescribing

Personal Health Assistants – via Chat Box technology

- https://accpjournals.onlinelibrary.wiley.com/doi/epdf/10.1002/jac5.70004

AI in Telepharmacy and Remote Patient Care

Revolutionizing Patient Care

AI technologies are transforming how pharmacists deliver care- remote consultations-improving patient access.

Enhanced Access to Care

Tele-pharmacy - AI enhances accessibility for patients in remote areas-medications and consultations.

AI Integration in Pharmacy

AI in Tele-pharmacy streamlines medication management and patient monitoring, improving healthcare delivery

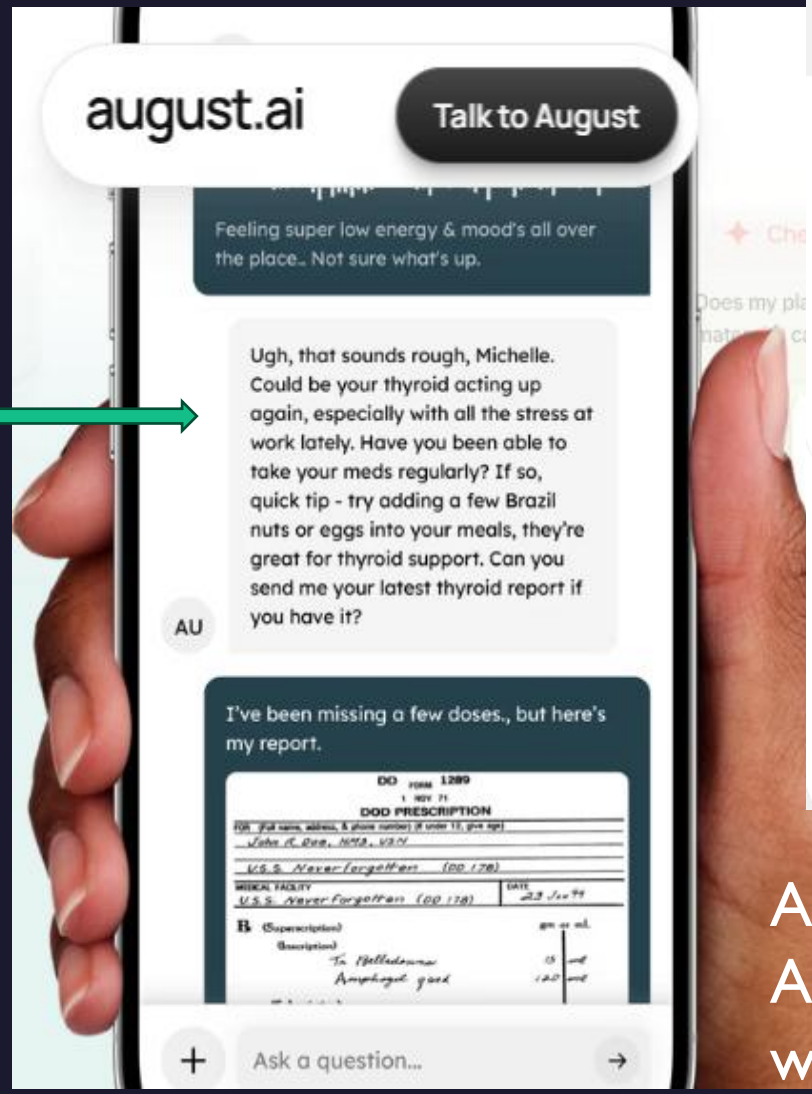
Emerging AI Technologies in Pharmacy Practice

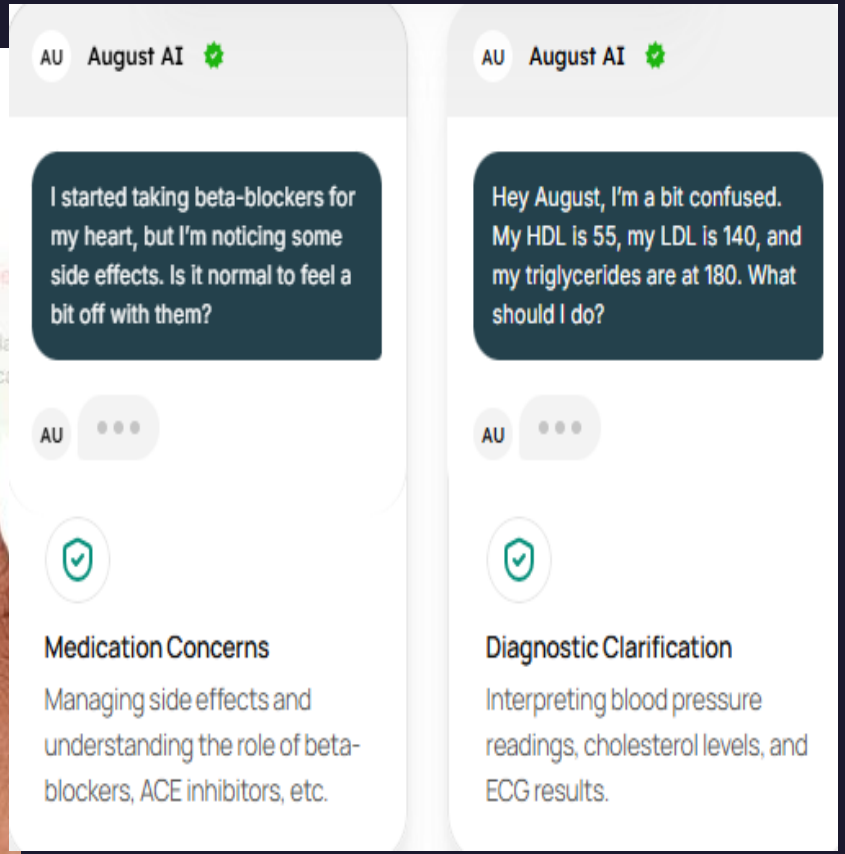
Augmented reality is being used for patient education, allowing them to visualize medication information and instructions in an interactive way.

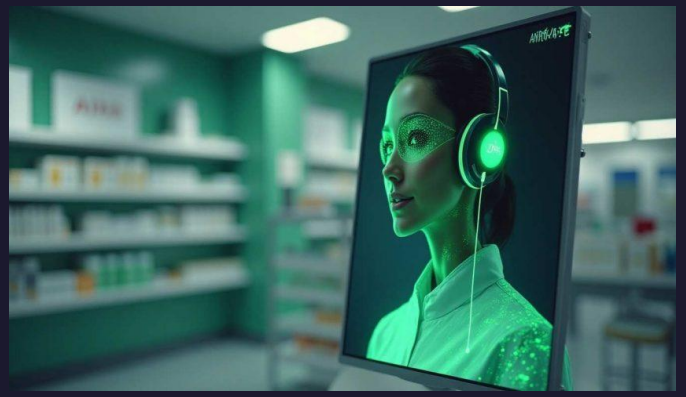
Robotic dispensing systems are improving the efficiency of pharmacy operations by automating the medication dispensing process.

The integration of AI technologies in pharmacy practice aims to enhance patient experiences through improved accuracy and personalized services.

AI Pharm Chat Box Technology Products







August.AI – Personal Health Assistant
www.meetaugust.ai/#features

www.pharmbotai.com
(Summer 2025 release)

Future Trends and Innovations

Automated Dispensing Systems with AI integration:

Increase efficiency

Decrease error

Increase productivity

Improve Inventory Management

Reduces waste

Decrease human labor

Optimization of workflow

Software Capabilities with AI interface

Order Scan-RX Reivew

Med Profile review

Dosing Review

Drug Interactions

Therapeutic Safety-Conditions

Billing and Dispensing Capabilities

Insurance submission

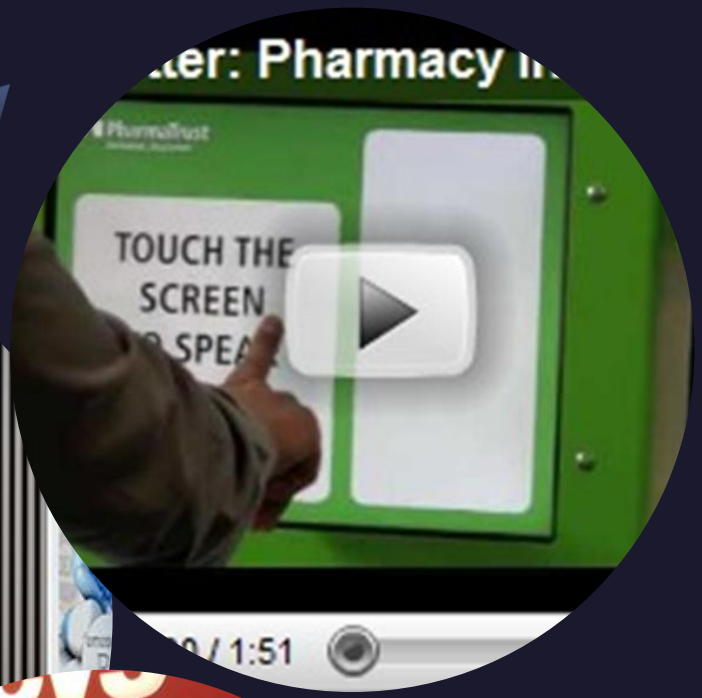
Accuracy in Processing

Labeling

Packaging

Dispense

www.dailymail.co.uk/health/article-1288434/Medicine-vending-machine-dispenses-prescriptions-pharmacist-launched.html



Population demands for Wearables and AI developments:

Due to the increase in life expectancy and the aging of the global population, the demand for telemedicine and remote monitoring will continue to rise. The share of the population aged 60 years and over will increase from 1 billion in 2020 to 1.4 billion in 2030, and is projected to double to 2.1 billion by 2050 (Ma et al., 2023).

- https://pdf.sciencedirectassets.com/778772

AI types utilized in development and integration with Wearable Devices

AI Applications:

- General AI- Artificial Intelligence
- Deep learning
- Machine learning
- Explainable AI (XAI)
- Natural language processing (NLP)

How AI is utilized in development of Wearables

- The latest models incorporate algorithmic designs that employ machine learning and deep learning architectures to teach the models how to identify patterns and make predictions
- (Missing Doses — Therapeutic Responses - Dosing change …)

International Journal of Information Management Data Insights 4 (2024) 100294

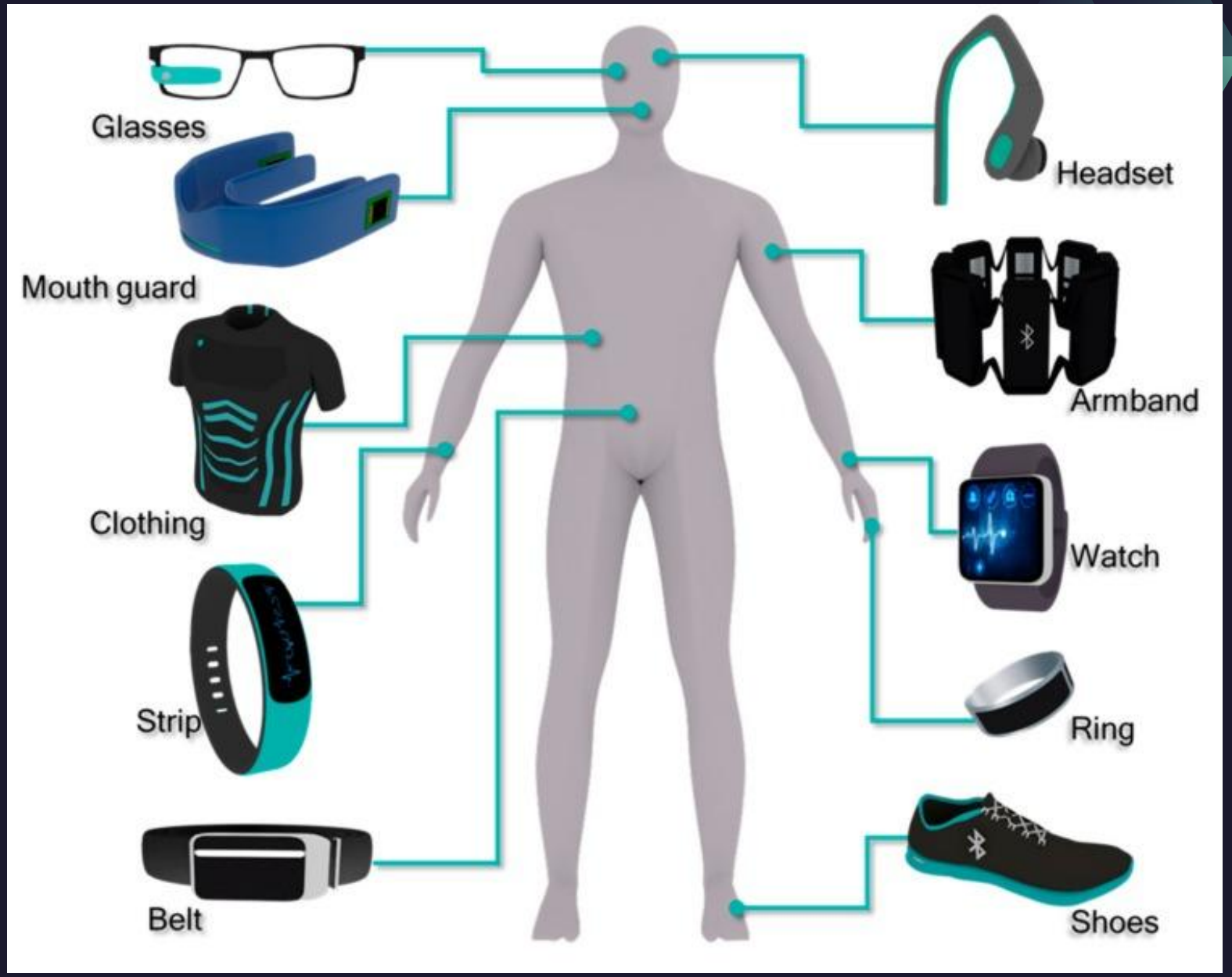
The Emergence of AI-Based Wearable Sensors for Digital Health Technology

- Lower medical costs
- Quick access to patient health data ability to operate and transmit data in harsh environments
- Storage at room temperature, non-invasive implementation,
- Disease pre-diagnosis and immediate therapy.
- New area of personalized health monitoring
- Accurately measuring physical states and biochemical signals.

Examples of Wearable Technology and AI integrations

- RESPIRATORY RATE MONITORS
- PEDOMETERS, FALL-PREDICTION DEVICES,
- HOSPITAL-ACQUIRED PRESSURE INJURY PREVENTION MONITORS,
- SEIZURE DETECTION DEVICES,
- HEART RATE MONITORS
- INSULIN THERAPY SENSORS, AND WEARABLE
- CARDIOVERTER DEFIBRILLATORS

Wearable devices for Monitoring , Analyzing, and Regulating



Lower medical costs

Quality-adjusted life years (QALYs) is a recognized measure that quantifies the benefit of a health intervention by considering both the quantity and quality of life. Despite its extensive use in health economics, there is a dearth of comprehensive reviews exploring the cost-benefit of wearables in health care through a QALY lens.

MAYO CLINIC PROCEEDINGS: DIGITAL HEALTH

Additional benefits of Wearable Medical Devices and capabilities:

- Providing virtual environments
- Reducing the burden on hospital and
- Expands clinical services in a virtual realm

Challenges:

- In managing the large amounts of data generated by these technologies and integrating them into existing electronic health records (EHRs)

Challenges and Ethical Considerations

Regulatory Guidance for CDS & Non-Device CDS (Clinical Decision Software)

Section 520 (o) (1) (E) of the FD&C Act excludes certain software functions from the definition of device. To be excluded, the software functions must meet all of the following 4 criteria:

1. Not intended to acquire, process, or analyze a medical image or a signal from an vitro diagnostic device or a pattern or signal from a signal acquisition system.

2. Intended for the purpose of displaying, analyzing, or printing medical information about a patient or other medical information.

3. Intended for the purpose of supporting or providing recommendations to a health care professional about prevention, diagnosis, or treatment of a disease or condition.

4. Intended for the purpose of enabling such health care professional to independently review the basis for such recommendations that such software presents so that it is not the intent that such health care professional rely primarily on any of such recommendations to make a clinical diagnosis or treatment decision regarding an individual patient.

FDA Law Blog+3

Bias and Fairness in AI Algorithms

Understanding AI Bias

AI algorithms can exhibit bias, potentially leading to unequal outcomes in decision-making processes across various applications.

Importance of Diverse Datasets

Utilizing diverse datasets is crucial to mitigate bias and ensure that AI algorithms produce fair treatment outcomes for all individuals.

Continuous Monitoring

Ongoing monitoring of AI systems is essential to detect and address any biases that may emerge over time, ensuring fairness.

Data Privacy and Security

Importance of Data Privacy

Data privacy is crucial when AI systems manage sensitive patient information, impacting patient trust and safety.

Regulatory Compliance

Compliance with data protection regulations is essential to avoid legal repercussions and to protect patient information.

Robust Security Protections

Implementing strong security measures is necessary to safeguard sensitive data and maintain user trust in AI systems.

Regulatory and Legal Challenges

Accountability in AI

The use of AI in pharmacy necessitates clear guidelines on accountability to ensure proper management of technologies.

Compliance Challenges

AI integration must comply with existing healthcare laws, which can be complex and evolving, posing challenges for practitioners.

Legal Responsibility

Defining legal responsibility in the context of AI use in pharmacies is essential to address potential liabilities and risks.

Limited Regulation of AI Software & The Cures Act

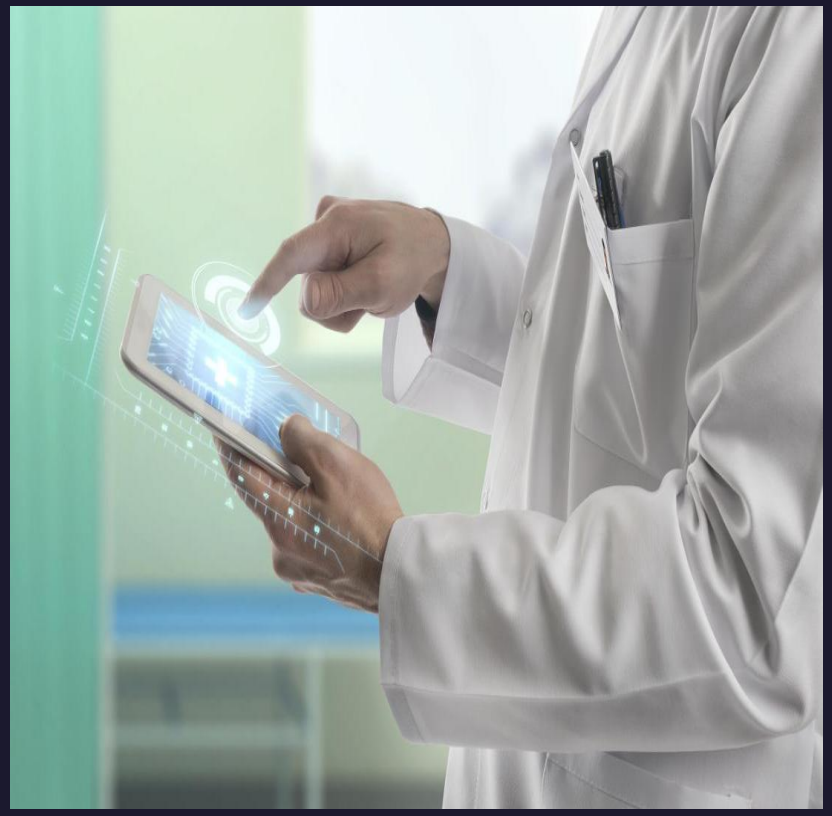
- The 21st Century Cures Act, Congress made clear that many types of software fall outside the FDA's authority, including software for personal wellness functions, health care administrative functions, and providing clinical information or recommendations (not from image processing) that health care professionals will not rely primarily on. The FDA has also expressed an intention to deprioritize some types of low-risk clinical software in exercising its enforcement authority.

- Although the FDA can require warnings and instructions for use of a product, given the complexity and variation in clinical workflows, its oversight will never approach the level of governance needed to ensure safe and effective deployment of AI.

March 2025 article

jamanetwork.com/journals/jama/fullarticle/2831831

Potential Impacts on the Pharmacy Workforce



Changing Workforce Landscape

The integration of AI in pharmacy will significantly change the roles and responsibilities of pharmacists, impacting their daily tasks.

New Skills Required

Pharmacists will need to acquire new skills to effectively collaborate with AI systems and improve patient care.

Training Programs

Educational institutions must develop training programs focused on AI integration to equip pharmacists for future challenges.

Projection of AI impact on Health Care:

Pharmacist are still needed although AI has the ability to scan data swiftly and apply Large Language Model to provide clinical summaries, prediction, develop care plans and essentially apply data from multiple sources in seconds or minutes.

AI can scan 13yrs of data references to provide a response in seconds. The verification will be responsibility of __(?)___

Education and Training for Professionals (Pharmacists & Pharmacy Technicians)

- AI – Basics General
- Certificate courses in Healthcare AI
- AI Pharmacy Courses
- Continuing Education
- Information Technology in Healthcare / Healthcare Informatics
- Pharmacy Residencies Programs
- Data Science Courses and Management with AI logistics

Conclusion

Enhanced Efficiency

AI systems streamline pharmacy operations, reducing wait times and improving the overall efficiency of patient care delivery.

Improved Safety

The integration of AI in pharmacy practice enhances medication safety by minimizing errors in prescriptions and dosage calculations.

Personalized Patient Care

AI enables personalized treatment plans by analyzing patient data, leading to better health outcomes and patient satisfaction.

Embracing Innovations

Addressing the challenges of AI adoption in pharmacy is crucial for leveraging its full potential for healthcare providers and patients.


Deloitte.com

Knowledge Review:

Question:

Artificial Intelligence is the utilization of a or software system which simulates human intelligence through data analytics in Natural Language processing, Neural Networks, Machine learning and other technological response capabilities to render decisions, patterns, information, or projections

A. True

B. False

Knowledge Review:

Question:

Artificial Intelligence (AI) is used to design predictive medicine software, drug development and clinical trials increasing accuracy, safety and efficiency.

A. True

B. False

Knowledge Review:

Question:

Artificial Intelligence software applications can assist in predicting drug interactions, optimize Medication Therapy Management, Comprehensive Patient Care plans, and provide Patient Counseling.

A. True

B. False

Knowledge Review:

Question:

Pharmacy Operations utilizing Artificial Intelligence workflow with Automation, Clinical Decisions, Inventory Management and for Labor efficiency.

A. True

B. False

Knowledge Review:

Question:

The current regulatory landscape provides guidelines for AI systems and Non-Device applications to ensure safety and is regulated by the FDA.

A. True

B. False

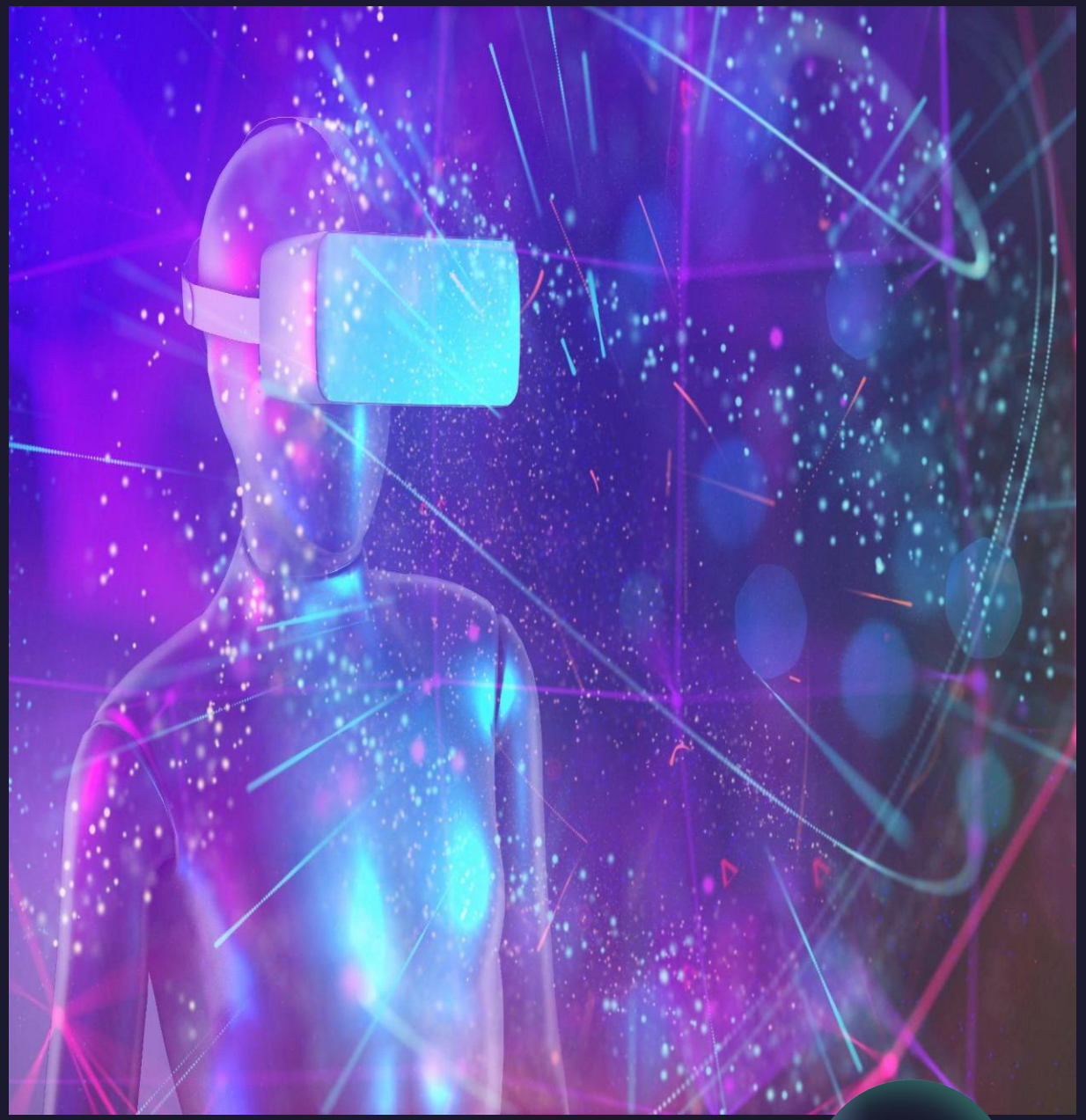
Knowledge Review:

Question:

Emerging trends and future directions in Artificial Intelligence (AI) technology eliminate pharmacy practice.

A. True

B. False



Rate your AI knowledge on a scale of 1 to 5 (highest)

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Sources- References:

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- https://jamanetwork.com/journals/jama/fullarticle/2831831
- www.Deloitte.com ; Pharmacy of the Future

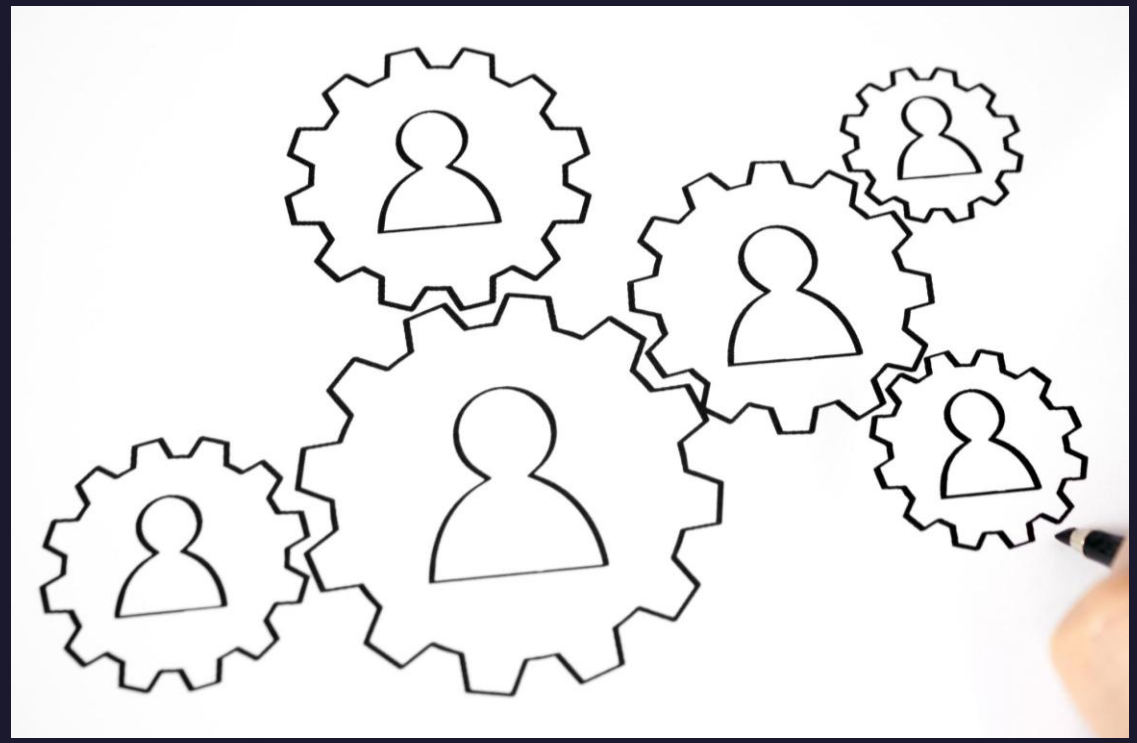
Thank You for Your Attention

Appreciation

Your interest in this presentation on AI is greatly appreciated. . I truly value your engagement and participation.

Staying Informed

I hope the information provided has been insightful and beneficial, contributing to your understanding of AI.



Suspicious Job Offers:

- Introduction of Job via Email or Text Message
- Request you to complete and interview via Teams or WhatApp contact
- Interactive Pre-test of skills test via On-line
- Express At-Home supplies/materials will be shipped to your home
- Request your desired Rate and submit via other personal information via email/text
    - How many of you have received Text Job Offers? Remote Jobs?
- Caller sounds as if there in a mass call center? Audience Experience share

Discover how scammers are exploiting remote hiring—and what you can do about it.

Hello Audrey, (Job Scam article by Kevin Mero @ JobRx – May 2025)

In a rapidly evolving digital landscape, the traditional hiring process faces unprecedented challenges. Recent investigations by leading tech and security experts highlight an alarming rise in AI-driven job scams targeting both employers and job seekers. Leveraging sophisticated artificial intelligence tools, fraudsters are manipulating remote hiring practices to infiltrate companies, steal sensitive information, and exploit job seekers desperate for employment.