From COVID to AI in Telepharmacy

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Speaker Disclosure

Your speaker for this session is:

Christopher B. Sullivan, PhD

Statement of Disclosure:

I have no vested interest or affiliation with any corporate organization offering financial support of grant money for this continuing education program.

Additionally, I have no vested interest or any affiliation with any organization whose philosophy could potentially bias this presentation.

Learning Objectives for This Session

- Explain the basic applications of telepharmacy technology as they exist today
- Recognize the innovations in telepharmacy services due to the COVID-19 pandemic
- Describe the use of AI in pharmacy that expanded rapidly during and after the COVID-19 pandemic
- Identify the basic features of Narrow AI, which can learn from data and make predictions based on the data, and Generative AI, which can create new formulations from existing data
- Discuss future telepharmacy opportunities and challenges created by AI

Pre-Presentation Questions

Baseline Question 1

The total number of retail pharmacies in the USA have declined since 2018.

A. Yes

B. No

C. Don’t know

Baseline Question 2

The greatest reduction of retail pharmacies in the USA occurred in which area?

A. Rural areas
B. Rural Micropolitan areas
C. Suburban areas
D. Metropolitan areas

Baseline Question 3

Telepharmacy is a form of telehealth.

A. Yes
B. No
C. Don’t know

Baseline Question 4

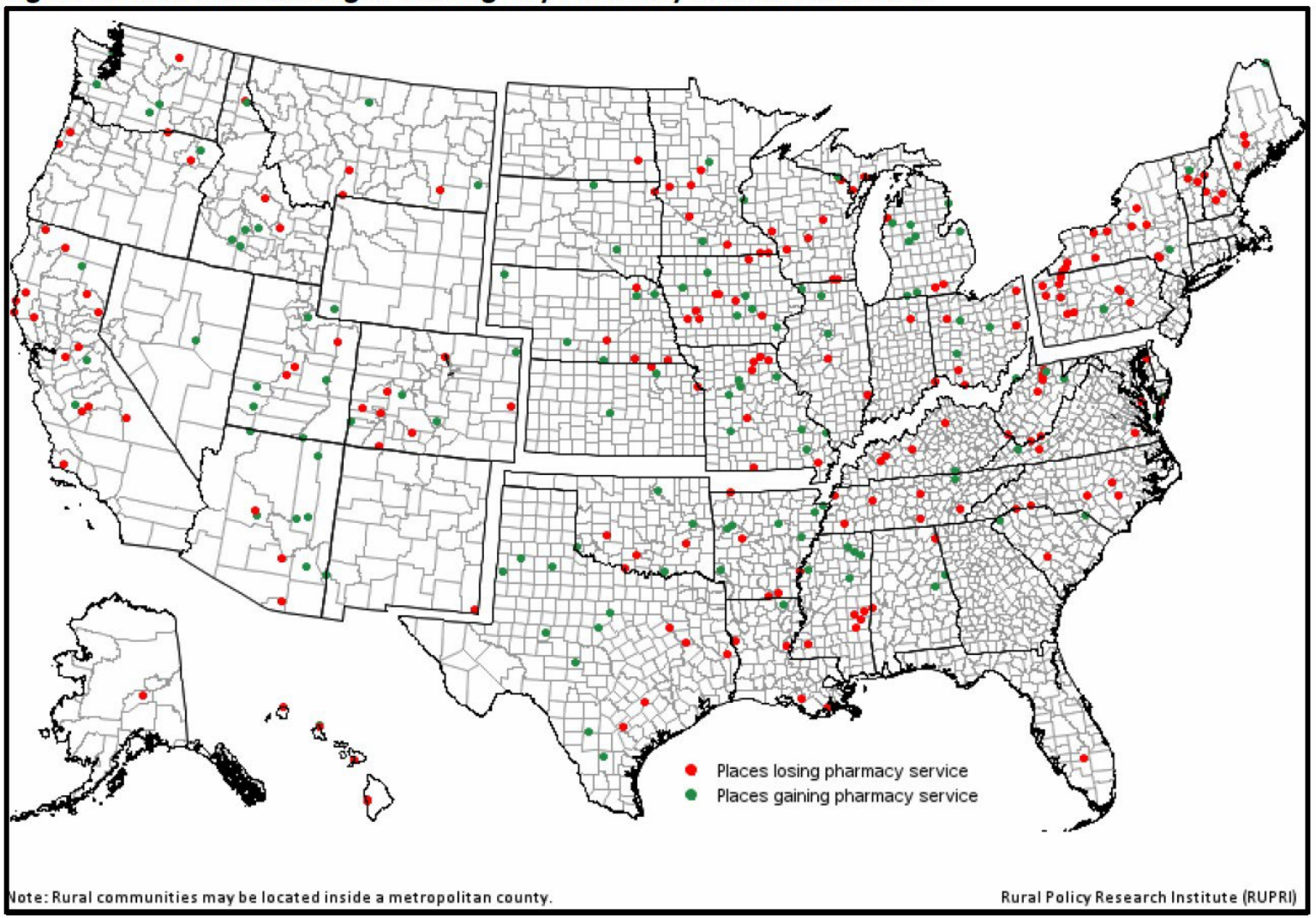
The Florida Board of Pharmacy regulates Telepharmacy in Florida.

A. Yes
B. No
C. Don’t know

Telepharmacy as a Mitigation Strategy to Address the Scarcity of Rural Pharmacies

Pharmacies Closing in Rural Areas

Figure 1. Rural Places Losing or Gaining Any Pharmacy Service: 2018-2023



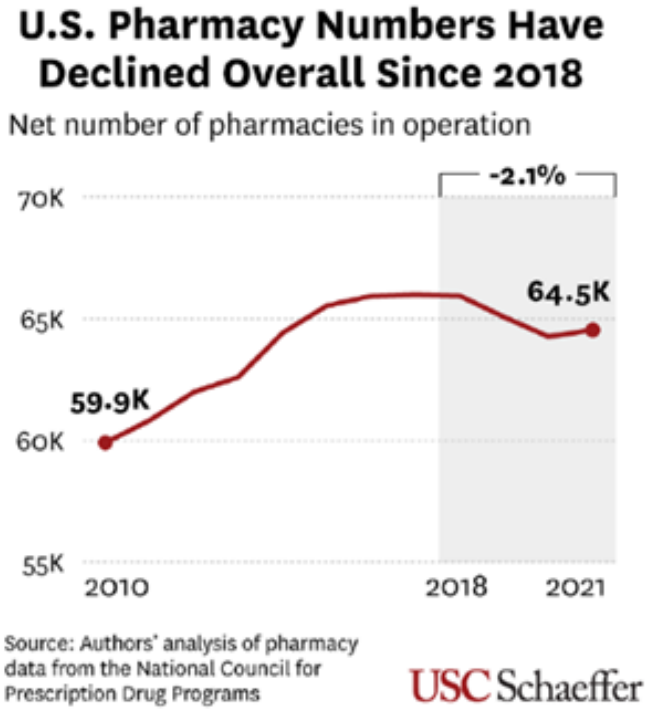
Nationwide Decline in Retail Pharmacies

Between 2018 and 2023, the number of retail pharmacies in the U.S. declined by 3.9 percent.

- Rural areas by -5.9 percent
- Urban areas by -3.4 percent.

Starting in 2018, large pharmacy chains began to merge -- and shut down stores deemed not profitable

- Between 2019 and 2021, the number of pharmacies declined in 41 of 50 states



Rural Pharmacy Challenges

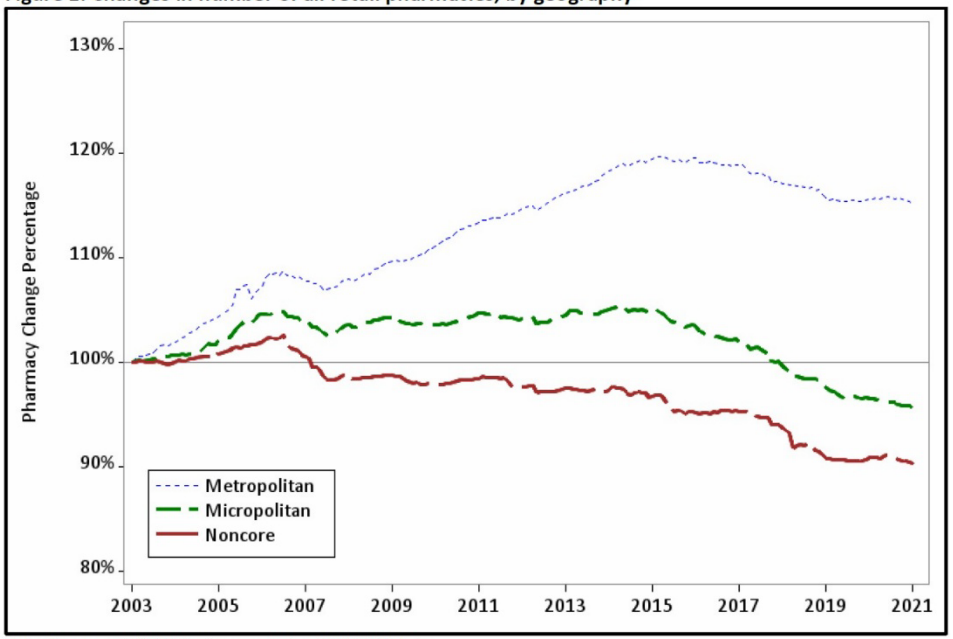
Half of the pharmacies in rural areas are independent

- They are often the only healthcare source in rural areas
- They experienced higher rates of closure than pharmacies in cities

Change in retail pharmacies between 2003 and 2021:

- Noncore Rural areas declined by 9.8%
- Rural Micropolitan areas declined by 4.4%
- Metropolitan areas increased by 15.1%

Figure 1. Changes in number of all retail pharmacies, by geography



Data Source: RUPRI Center analysis of NCPDP data

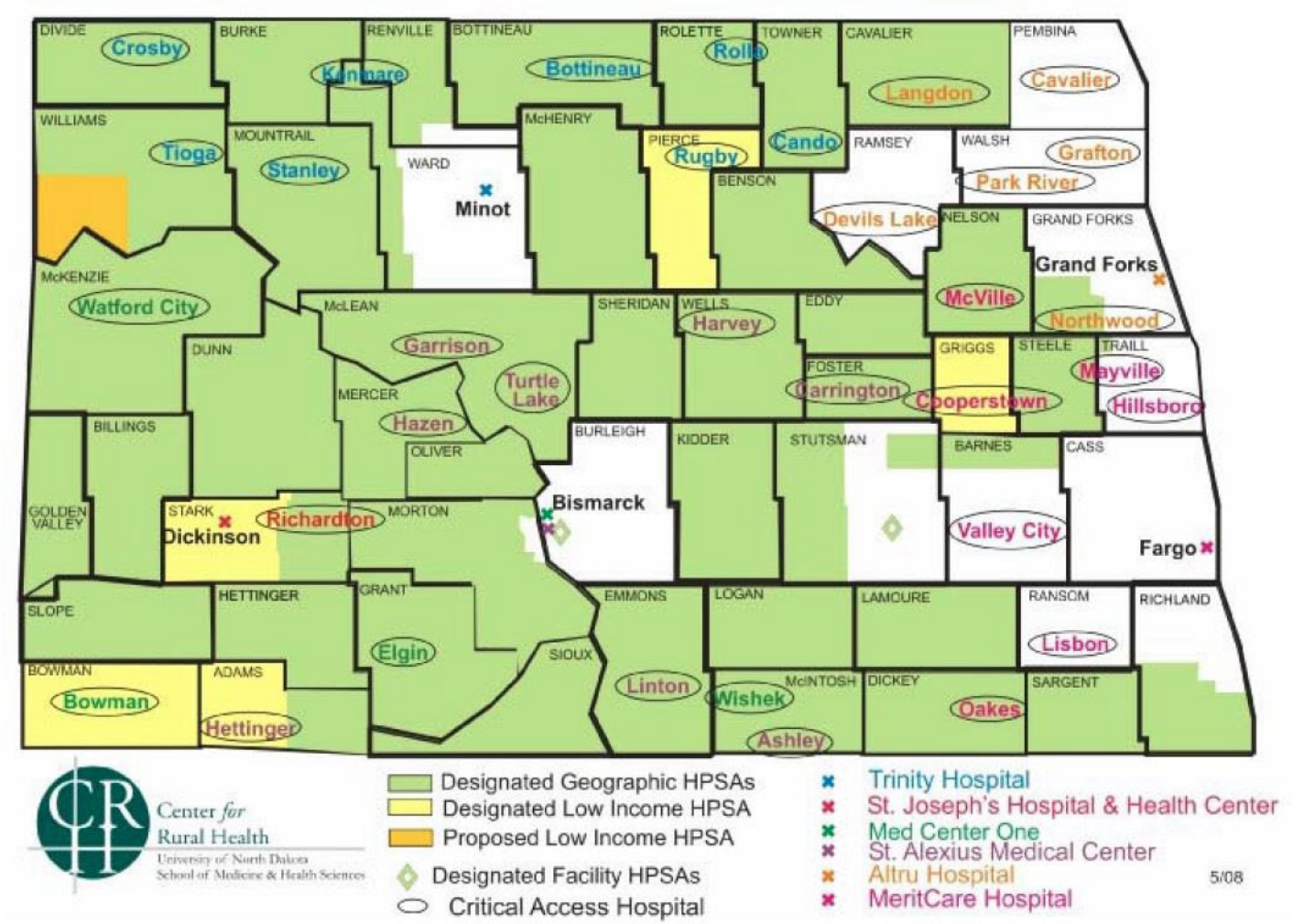
Telepharmacy as a Mitigation Strategy

National Association of Boards of Pharmacy

"Practice of Telepharmacy" means the provision of Pharmacist Care Services by registered Pharmacies and Pharmacists located within US jurisdictions through the use of telecommunications or other technologies to patients or their agents at distances that are located within US jurisdictions.

ND Telepharmacy Project – Rural Need

Exhibit 2. North Dakota Health Professional Shortage Areas, Critical Access Hospitals, and Network Affiliates



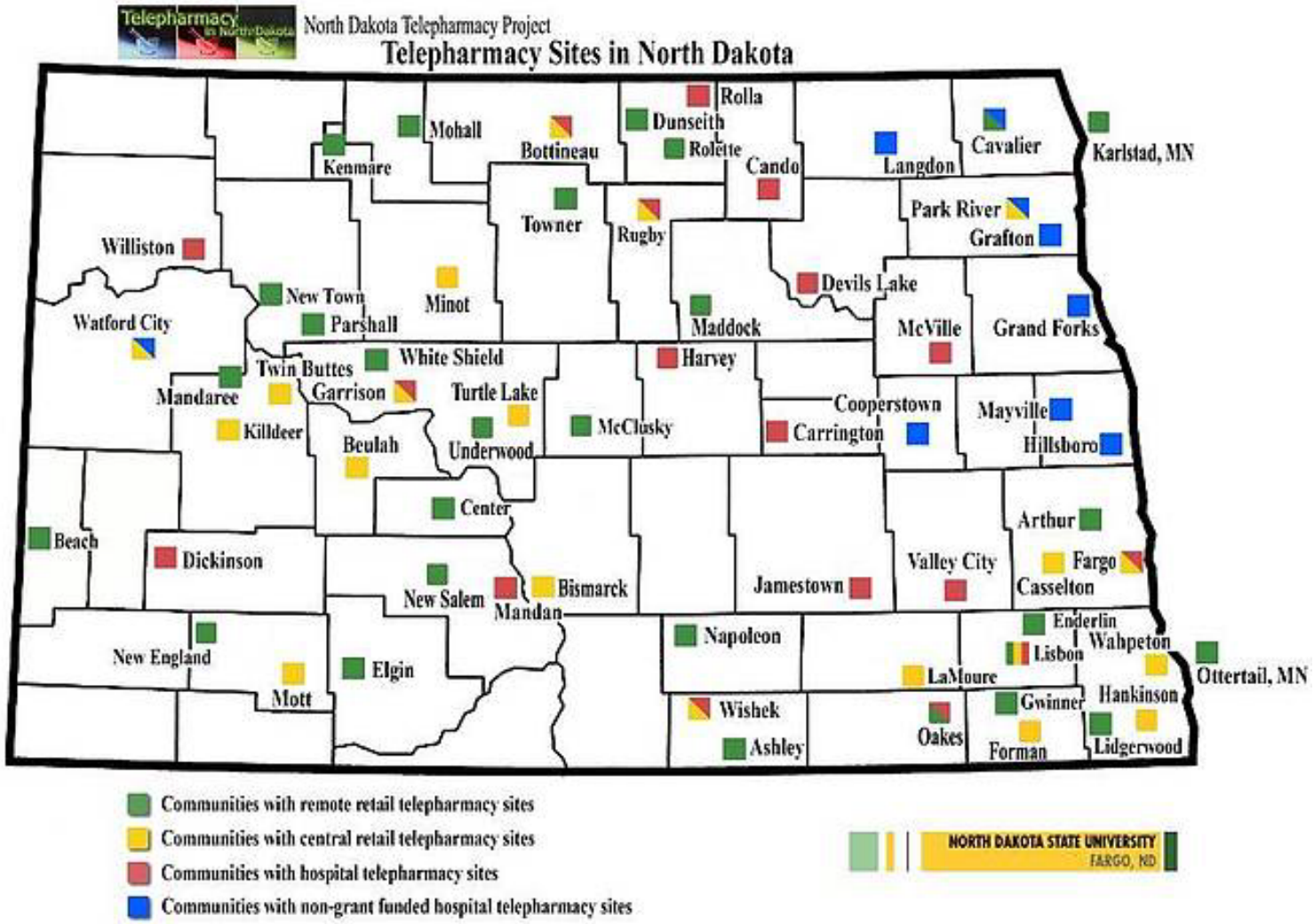
North Dakota Telepharmacy Project

Telepharmacy is working well in North Dakota, restoring pharmacy services for many remote rural communities.

- Telepharmacy services produce the same quality as the traditional mode of delivery
- They also provide some value-added features that are not found in traditional pharmacy practice

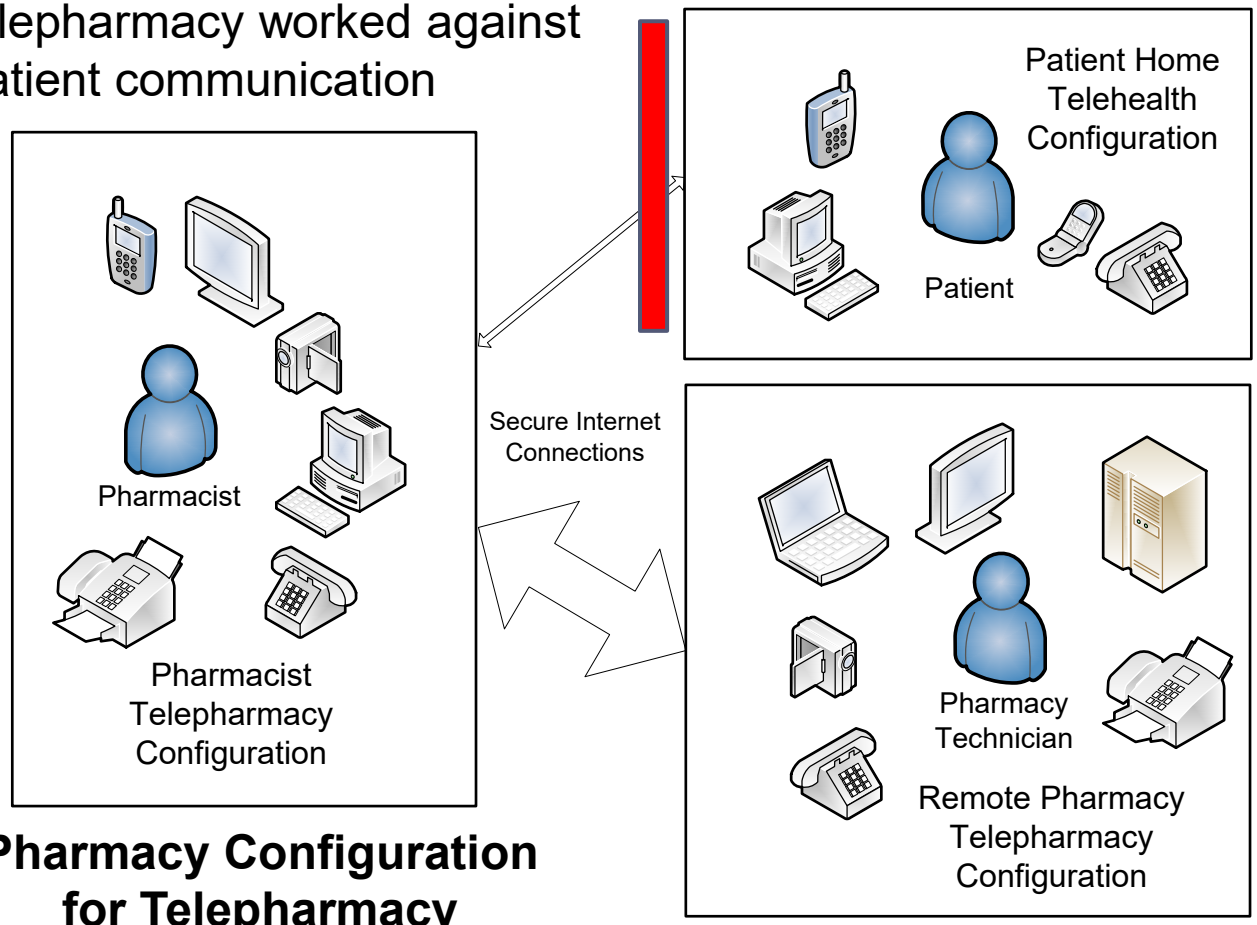
ND Telepharmacy Project Partners

Remote telepharmacy locations in North Dakota



Telepharmacy Model pre-COVID

"Incident to" requirement for telepharmacy worked against patient communication



Pharmacy Configuration for Telepharmacy

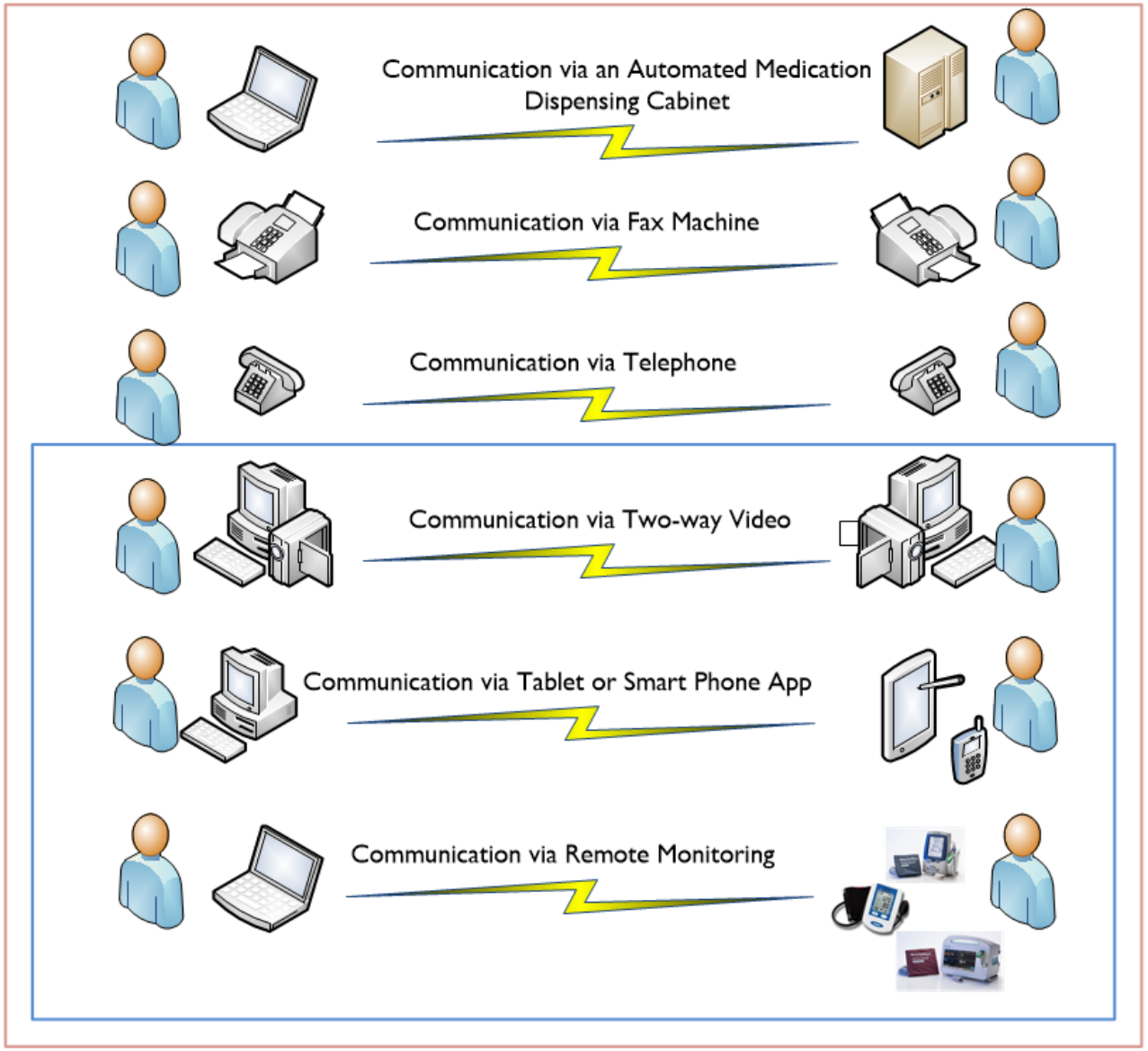
CMS Rule for Reimbursing Pharmacists

Pharmacists are not included as practitioners who can bill for Medicare services but must bill through a physician or clinic.

"Pharmacists may "**incident to**" provide services under the supervision of a billing, if payment for the services is not made under the Medicare Part D benefit."

According to CMS, direct supervision by the physician would be allowed through real-time audio and video technology – essentially through telehealth channels, as telepharmacy was practiced at that time.

Technical Scope of Telepharmacy vs Telehealth



HIPAA Security Rule

§ 164.312 Technical safeguards

Transmission security:

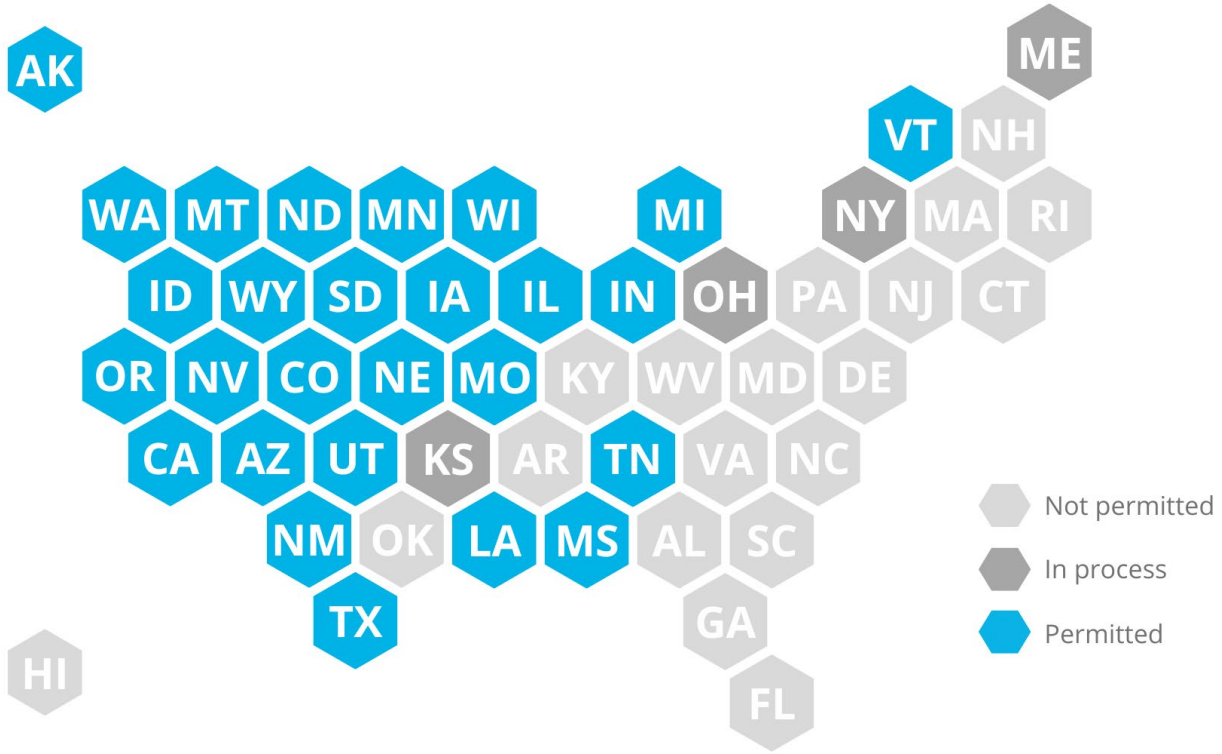
- Implement technical security measures to prevent unauthorized access to Electronic Protected Health Information (ePHI) transmitted over an electronic communications network.

- Under the HIPAA Omnibus Rule, ePHI that is **not encrypted** is considered “Unsecure” and liable for penalties if breached
- **Encrypted** ePHI is “Secure” and not liable for penalties if breached

States Regulating Telepharmacy

Over half the country permits telepharmacy at some level

- Twenty-two states have not implemented telepharmacy regulations or have policies that limit the practice.



Telepharmacy Services During COVID

How COVID-19 Interfered with Pharmacies

COVID Restricted Physical Access to Pharmacies

- Pharmacies faced lockdown-related closures
- Patients avoided in-person visits due to infection fears

Increased Pressure on Pharmacists for COVID Services

- Pharmacists were put into frontline roles, engaging in COVID-19 testing, vaccination and triage

Increased Demand on Healthcare Workforce

- Community pharmacists had to handle consults via telehealth platforms

How COVID-19 Interfered with Pharmacies

Supply Chain and Medication Shortages

COVID-19 disrupted global pharmaceutical supply chains Pharmacies struggled to fill prescriptions timely.

- The surge in demand for specific drugs created backlogs
- Lockdowns in manufacturing countries halted production
- Pharmacists had to find alternatives while managing inventory and navigating price fluctuations.
- Hospital pharmacies employed AI and automated inventory systems to predict and manage stockouts effectively

How COVID-19 Interfered with Pharmacies

Hospital pharmacies in the United States introduced AI-assisted inventory platforms OrbitalRX and Micromedex to proactively manage drug shortages

- OrbitalRX is designed to unify supply chain and clinical utilization to manage drug shortages

- IBM Micromedex is one of the largest online reference databases for medication information.
- It covers medication therapy management, disease and condition management, toxicology, alternative medicine and patient education

Consultations via Telehealth

COVID made in-person consultation unsafe, so pharmacists turned to telehealth platforms

- Pharmacists used platforms like Zoom, Google Meet, and WhatsApp to communicate with patients

These platforms were not compliant with HIPAA so issues of privacy and patient consent became major obstacles.

The HHS Office for Civil Rights ruled a "good faith" use of telehealth would not violate the HIPAA Security Rule

- This opened the door for telehealth platforms

Platforms Approved for Telehealth

The HHS Office for Civil Rights approved platforms using encryption, between an individual and another person.

- Apple FaceTime
- Facebook Messenger video chat
- Google Hangouts video
- Whatsapp video chat
- Zoom
- Skype

Products such as TikTok, Facebook Live, Twitch, or public chat rooms were unacceptable because they are designed to be open to the public

FAMU Telehealth Outreach During COVID

Virtual consultation and medication counseling during COVID

Pharmacists used telecommunication platforms like Zoom, Google Meet, and WhatsApp to conduct patient counseling and medication education.

The FAMU College of Pharmacy, working with a Federally Qualified Health Center in Pensacola, FL, introduced a telehealth solution

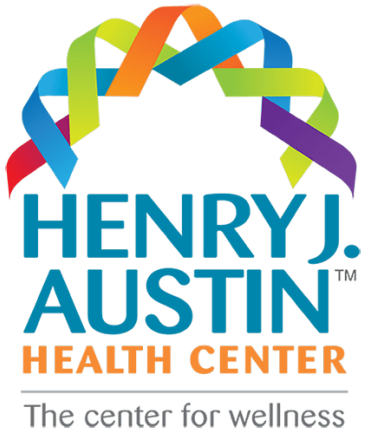
Student pharmacists worked with pharmacists at the FQHC to assist them interviewing patients and providing medication-related help via telehealth.

The student pharmacists helped formulate care plans and make recommendations to health care providers via Zoom.

Medication Reconciliation via Telehealth

Remote medication order review and reconciliation during COVID

COVID-19 increased the need for remote medication order review and reconciliation using electronic health and secure communication tools.



Pharmacists at the Henry J. Austin Health Center in Trenton, NJ, provided the majority of their clinical services during COVID using telehealth channels

- Pharmacists could prescribe and order labs via telehealth
- Pharmacists used phone and video consultations

Chronic Disease Management via Telehealth

COVID disrupted routine chronic care, making telehealth platforms vital to monitor patients' drug regimens remotely.

- In many remote care models, pharmacists helped adjust regimens for COVID-infected patients

Rocking Horse Community Health Center

Pharmacists providing chronic care management at the Rocking Horse Community Center in Springfield, OH, used telehealth throughout COVID

- Patients enjoyed the ability to join visits from their own home

Chat Room Break

Let’s stop here and see if there are any questions in the chat box

How is Artificial Intelligence Defined?

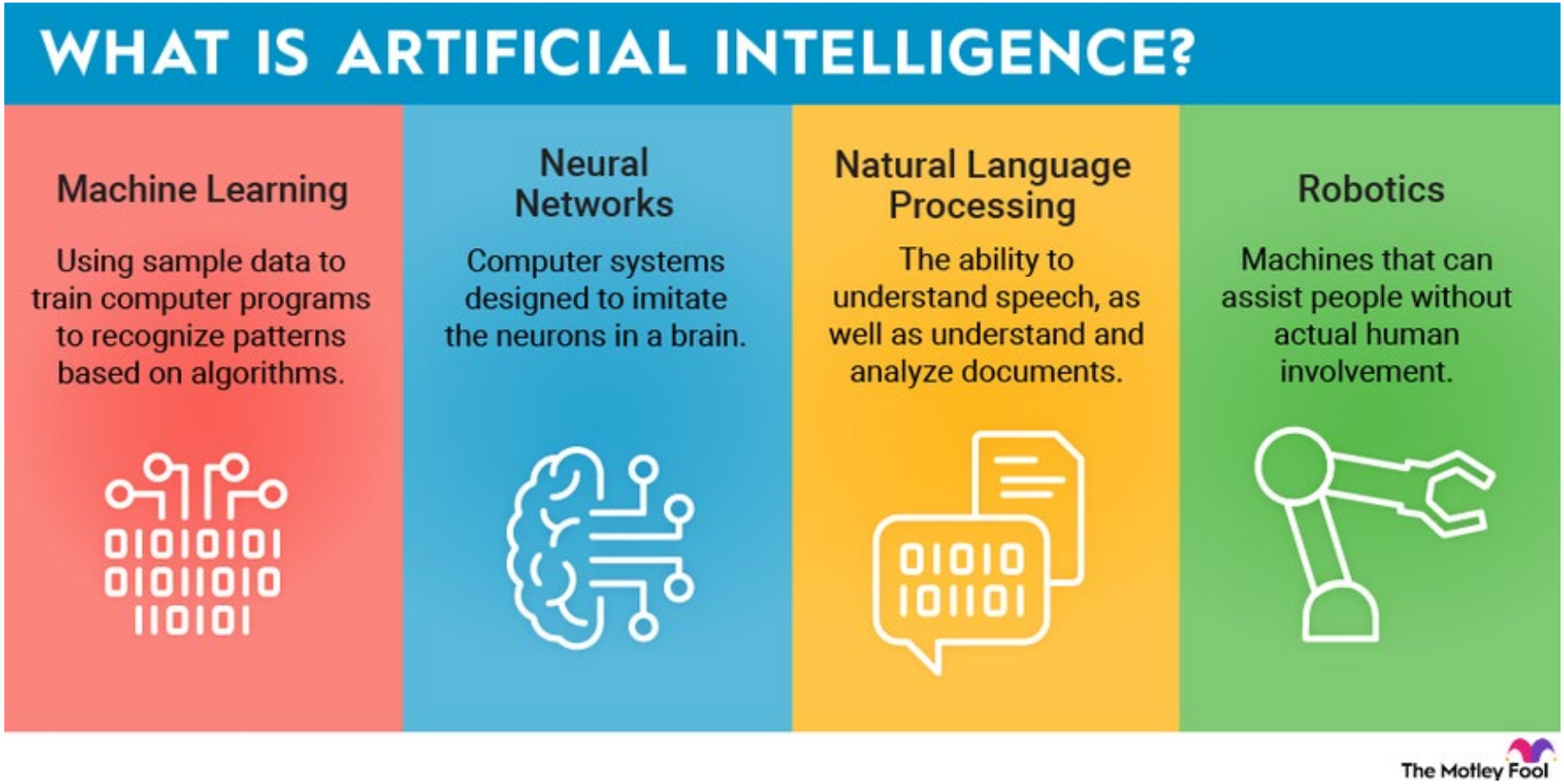
IBM: AI is technology that enables computers and machines to simulate human learning, comprehension, problem solving, decision making and creativity

Google: AI is concerned with building computers and machines that can reason, learn, and act in such a way that would normally require human intelligence

NASA: AI refers to computer systems that can perform complex tasks normally done by human-reasoning, decision making, creating, etc.

NIST: A machine-based system that can, for a given set of human-defined objectives, make predictions, recommendations, or decisions influencing real or virtual environments.

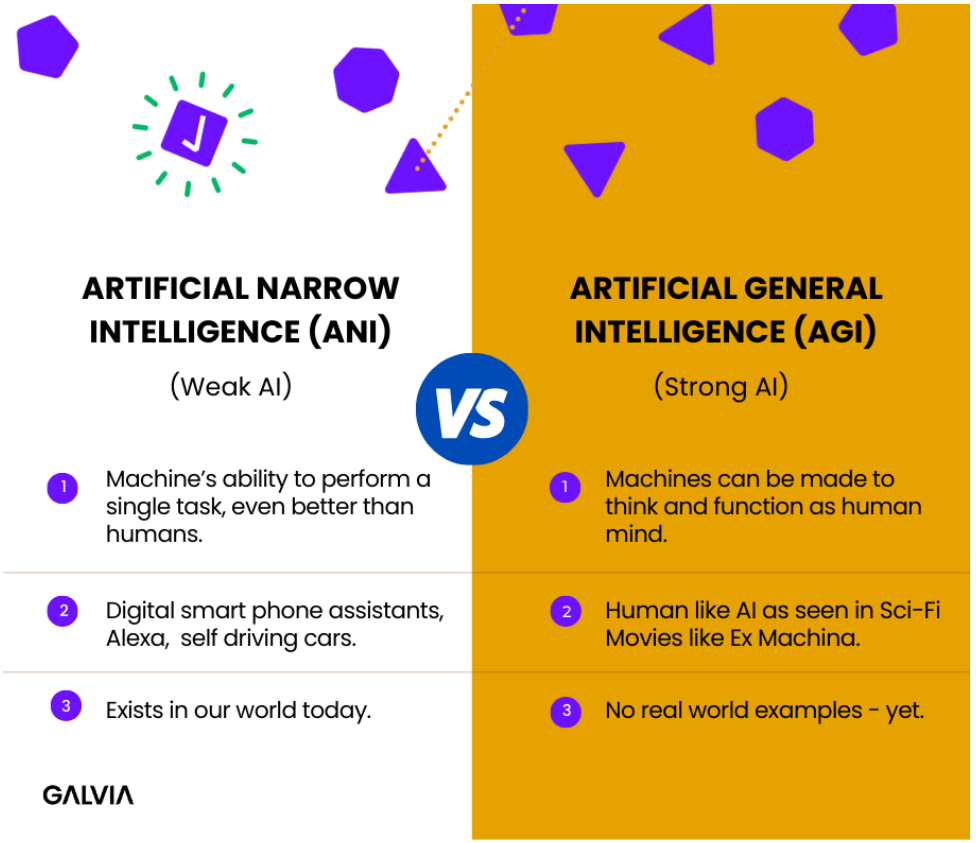
Features of Artificial Intelligence



Narrow AI versus General AI

Narrow AI systems are designed and trained to perform a particular function and excel at it

General AI systems can understand, learn and perform intellectual tasks like humans but are currently still theoretical

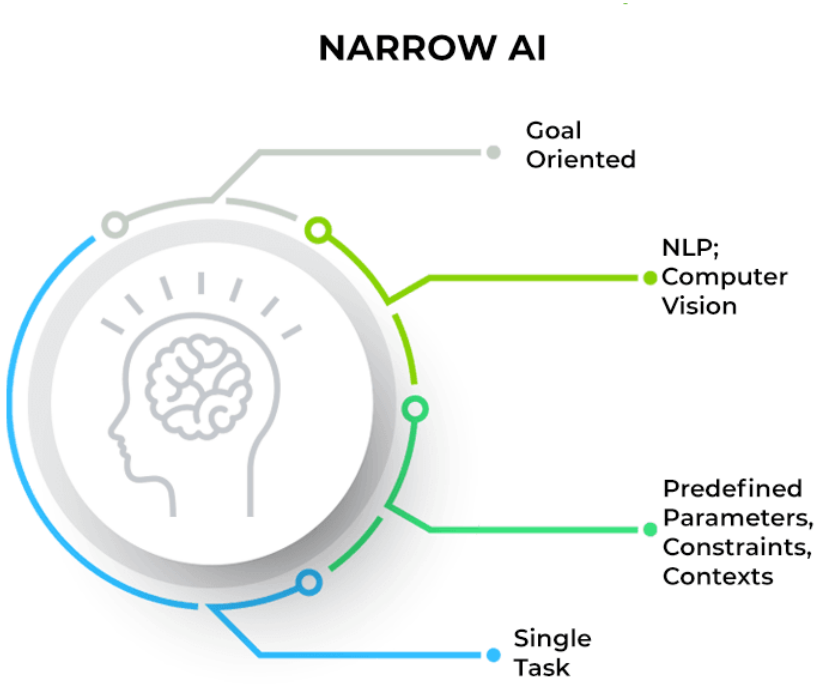


General AI is not yet a reality, so this talk will focus on Narrow AI features relevant to telepharmacy

Narrow AI Described

Narrow AI systems are designed to perform a specific or limited set tasks

- They operate in predefined boundaries
- Optimized to deliver high performance such as solving well-defined problems within a specific domain



Narrow AI systems are extensively trained

- With large datasets
- Using sophisticated algorithms

Machine Learning in AI

Machine Learning allows AI systems to learn patterns from data and make predictions without being explicitly programmed.

ML models improve performance as they are exposed to more data over time using several methods:

- Supervised learning (with labeled data),
- Unsupervised learning (discovering structure)
- Reinforcement learning (trial-and-error optimization)

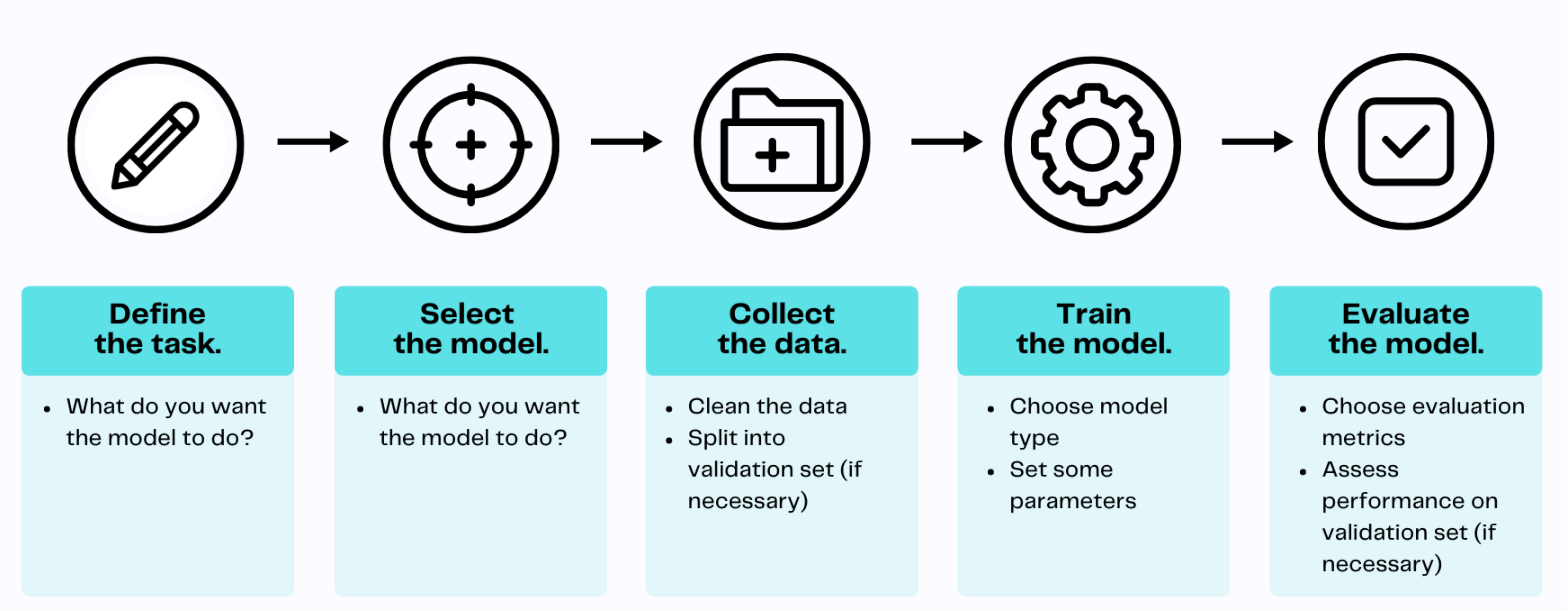
Machine Learning uses **algorithms** like decision trees, support vector machines, and neural networks.

- ML adapts over time, making it useful for predicting outcomes and detecting anomalies

Machine Learning Process Model

Machine learning is an iterative and evolving process

- Focus of interest is centered on the model training step
- Most time is spent on the data collection and cleaning step
- Its adaptability and scalability make it central to AI systems



Machine Learning Pharmacy Example

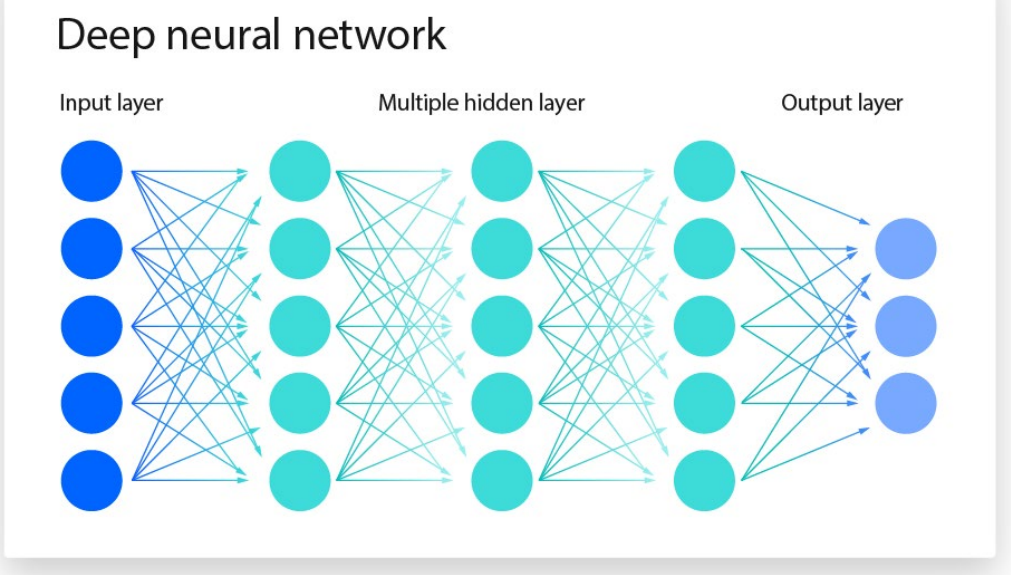
Machine Learning algorithms help pharmacists analyze large volumes of patient data from labs and EHRs

- Identify potential drug-drug interactions
- Assess the safety and efficacy of medicines
- Optimize inventory management by forecasting demand

ML offers promising solutions for predicting and managing adverse drug events

- Can identify patterns linking drugs to specific side effects
- Can analyze diverse information sources to uncover hidden relationships between medications and adverse events.

Neural Networks in AI

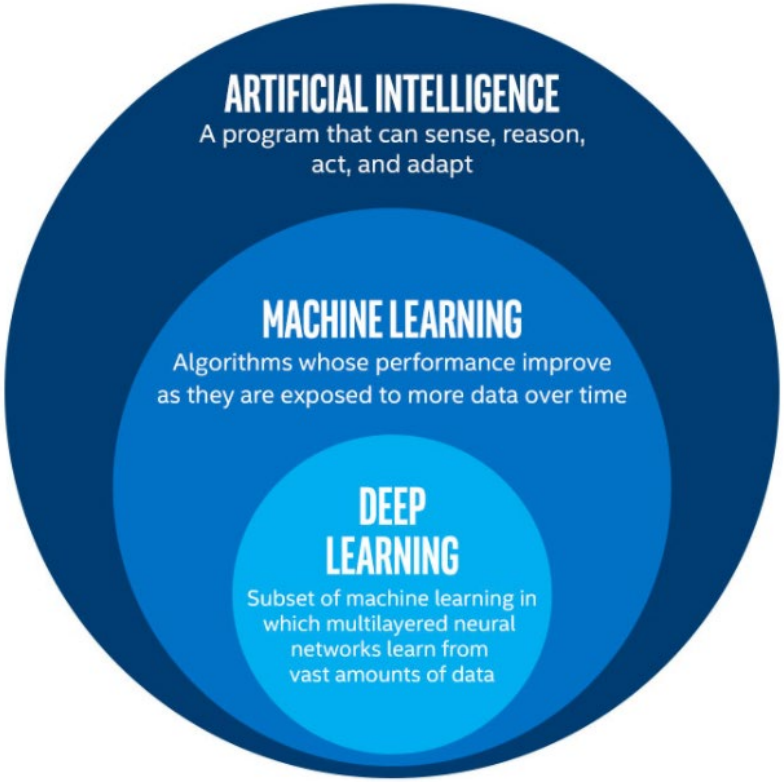


A neural network is an ML model using processes that mimic the way biological neurons work to identify data, weigh options and arrive at conclusions.

Neural networks consist of layers - an input layer, one or more hidden layers, and an output layer.

- When output of any node is above a threshold value, that node is activated and sends data to the next layer

Deep Learning in AI



Deep Learning is a specialized subset of machine learning using neural networks with multiple layers (deep neural nets)

Deep learning models assess raw data and extract relevant output for -

- Image-based diagnostics
- Voice recognition
- Automated note transcription

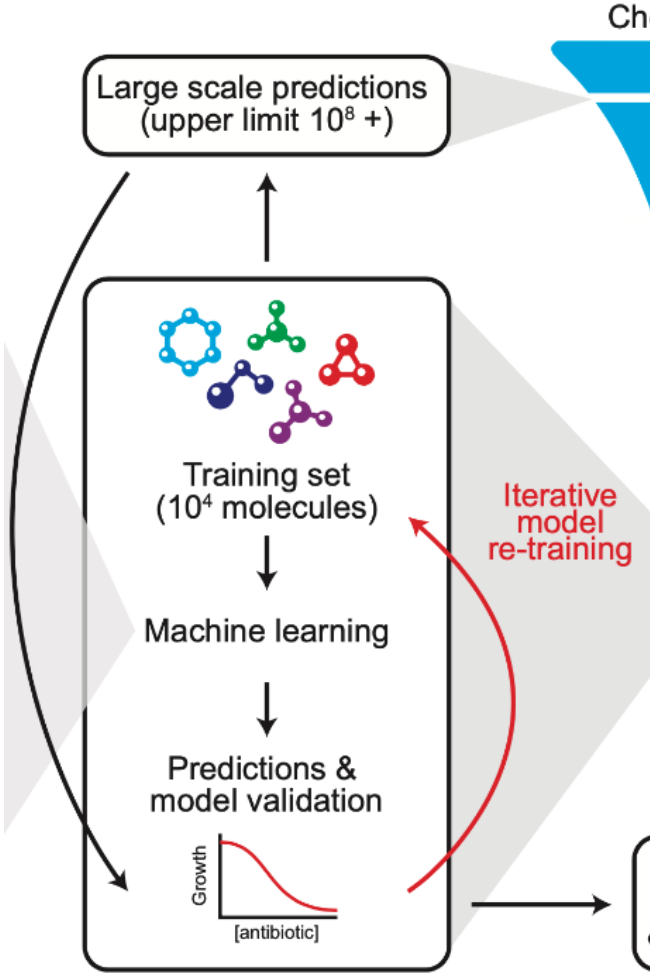
Deep Learning Pharmacy Example

In pharmacy, AI Deep Learning is increasingly used for

- Drug discovery
- Molecular modeling
- Adverse effect prediction

DL algorithms evaluate millions of molecular structures to predict -

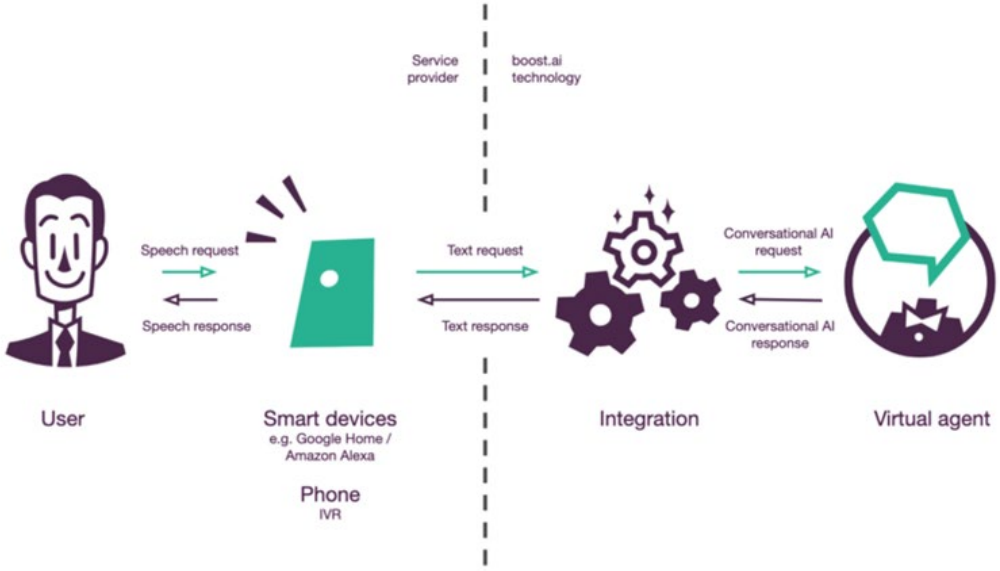
- Therapeutic potential
- Side effects
- Toxicology



AI in Speech Recognition

AI chatbots and conversational assistants convert spoken language into text. They are designed to –

- Understand natural language
- Interpret user queries and provide relevant responses
- Perform specific tasks



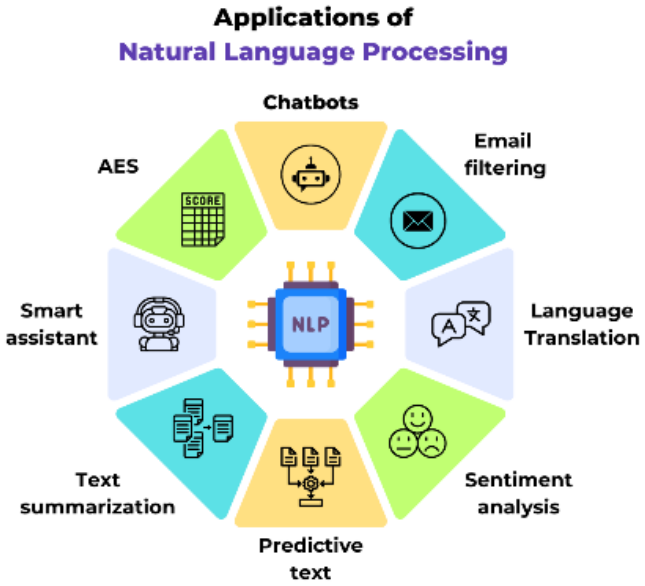
Voice-enabled virtual assistants in telepharmacy enable hands-free interaction and better accessibility for patients

Natural Language Processing

Natural Language Processing uses machine learning to enable computers understand and communicate with human language

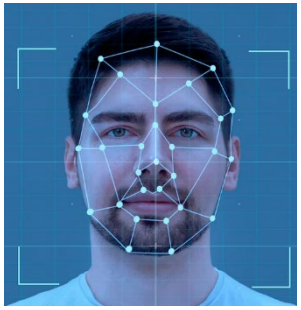
- Apple's Siri, Google's Alexa and Microsoft's Cortana

NLP has enabled the era of Generative AI, from employing large language models (LLMs) to image generation models



NLP combines the power of computational linguistics together with machine learning algorithms and deep learning

Computer Vision & Image Recognition



AI algorithms are used in face and image recognition systems to analyze and identify objects in images or videos

- Consider your cell phone's face recognition capability

Machine Learning utilizes neural network models and deep learning techniques to analyze imaging data for identify clinically significant diagnostic images

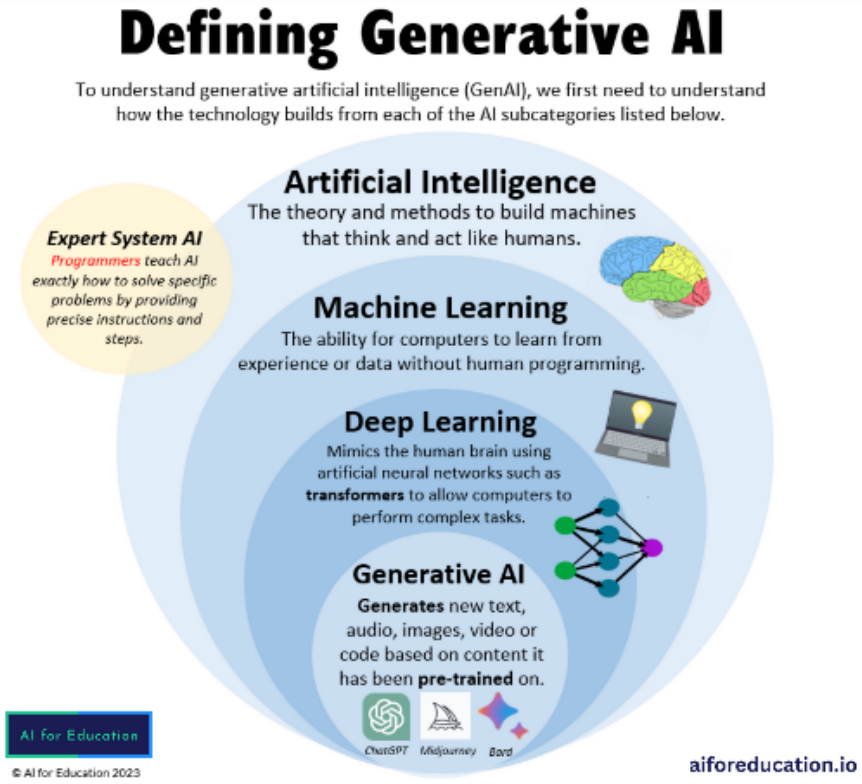
- Cancer-related diagnoses
- Histology slides
- Counting and verifying pill labels

Machine Learning is being integrated with Natural Language Processing to explore unstructured data in databases, medical records, lab reports and doctor's notes

Generative AI

Generative AI (GenAI) creates original content such as text, images, video, audio or software code in response to a user's prompt or request.

GenAI relies on *deep learning* algorithms to simulate the learning and decision-making processes of the human brain



GenAI can understand natural language requests or questions and respond with relevant new content

Chat Room Break

Let’s stop here and see if there are any questions in the chat box

Telehealth in Pharmacies Today

Photo taken while picking up medications

AI in Drug Discovery

AI algorithms have played a pivotal role in AI for drug discovery transforming the drug discovery pipeline by predicting the molecular interactions of potential compounds

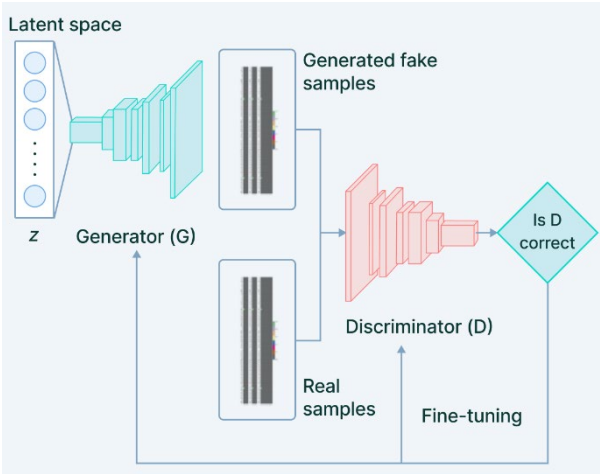
- Using deep learning to screen millions of compounds
- Molecular modeling by evaluating billions of molecules quickly to identify optimal ones for synthesis or testing
- Enabling pharmacogenomics and personalized medicine
- Generating optimized molecular structures while matching specific pharmacological and safety profiles

Traditional drug development takes years, but AI accelerates this process using simulation and predictive modeling

AI in Drug Discovery

Generative Adversarial Networks in Drug Development

AI algorithms harness deep learning models and Generative Adversarial Networks to generate new data samples using two neural networks –



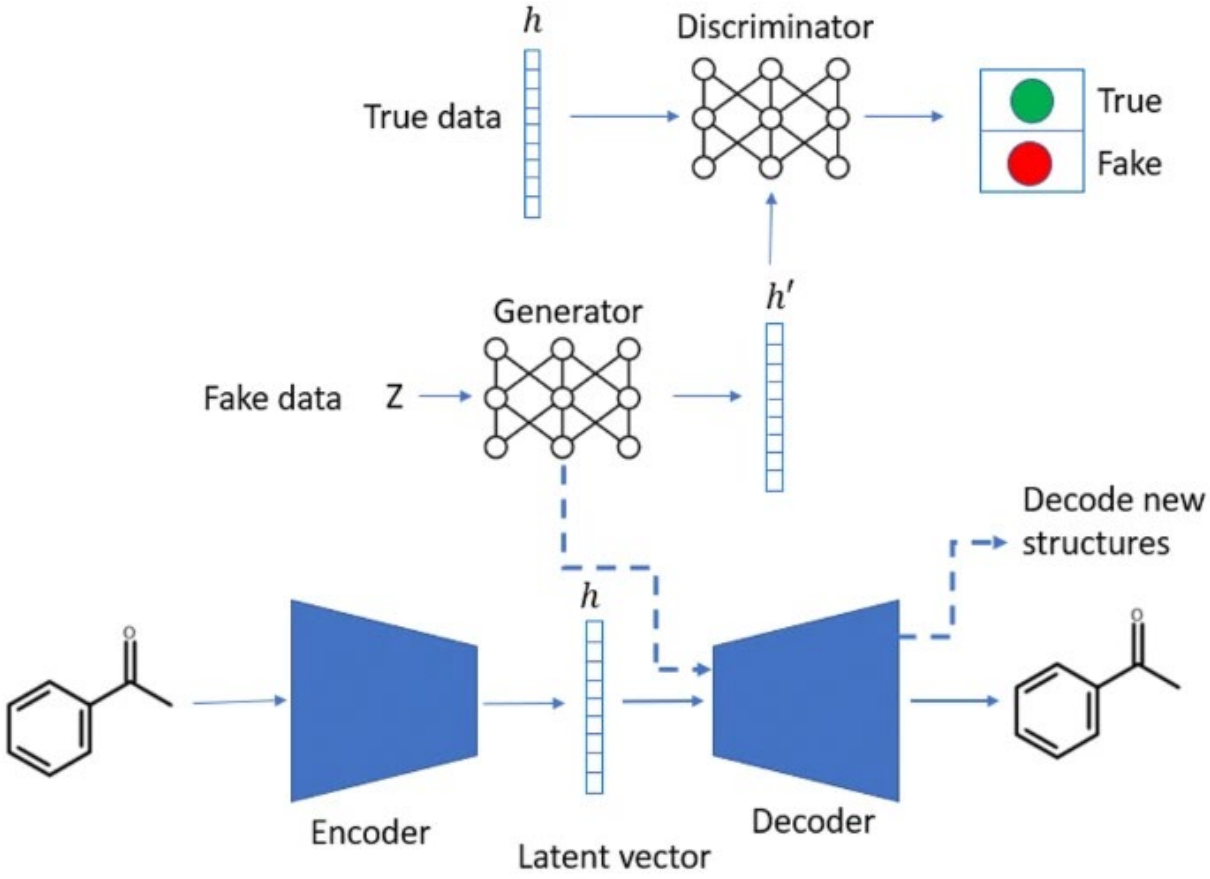
- A **generator** creates new molecular structures that mimic existing compounds with desirable properties
- A **discriminator** evaluates the samples and differentiates the real data from the training set and the fake data created by the generator

This process continues until the generator produces samples that the discriminator can no longer reliably distinguish fake data from real data

Generative Adversarial Network Example

During training, the generator neural network keeps improving its ability to create realistic samples

The discriminator neural network becomes more skilled at detecting fakes



AI Software for Drug Development

AI Software	Key Features
Chemistry42	An AI-driven platform that designs novel molecules for drug discovery using deep learning and reinforcement learning. It generates potential chemical compounds with desired pharmacological properties.
AtomNet (Atomwise)	A deep learning-based structure-based drug design tool that analyzes 3D structures of proteins and predicts molecule-target interactions. Predicts drug-target binding using protein structures.
PandaOmics (Insilico Medicine)	A multinomics AI platform that identifies disease targets using gene expression, epigenetics, and literature mining. It supports hypothesis generation in early research stages.
BioXcel AI Therapeutics Engine	Uses AI to repurpose existing drugs for new indications and designs optimized clinical trial protocols. Machine learning on real-world data and EHRs, drug repurposing and clinical trial optimization.
DeepChem	Provides tools for molecular machine learning, enabling researchers to build custom AI models for cheminformatics and pharmacology.

AI in Pharmacy Inventory Management

AI helps telepharmacy operations manage inventory by predicting medication demand, tracking purchasing trends, automating restocking, preventing shortages or overstocking

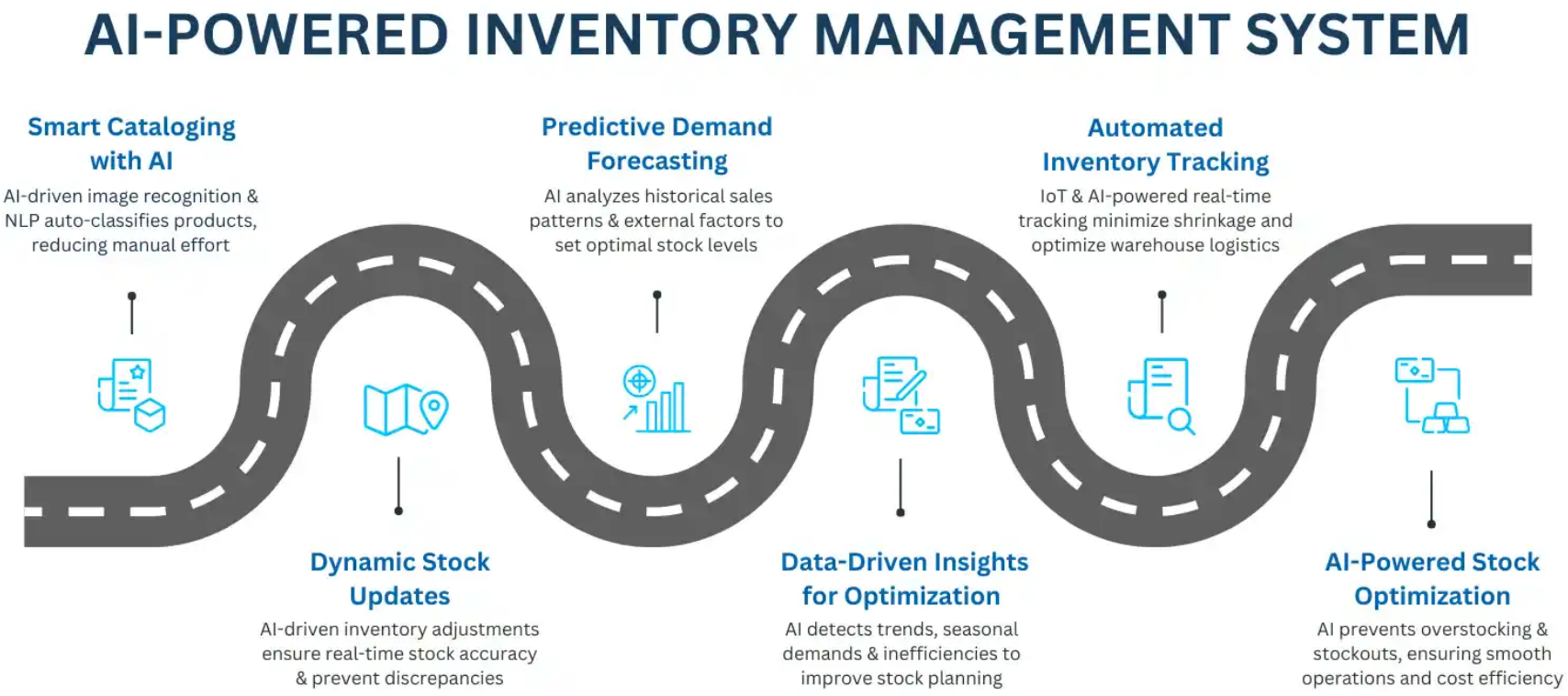
- Machine Learning models optimize inventory management by forecasting demand based on seasonal and geographic trends
- This ensures medications are stocked according to need, improving efficiency and patient care outcomes

AI in medical record management enables the automatic organization, extraction and utilization of patient data

- Deep learning models identify relevant clinical information from unstructured notes
- AI also ensures compliance with data handling standards in pharmacy systems

AI in Pharmacy Inventory Management

AI-based analytics tools combine data analysis, machine learning, and predictive analysis to automate supplier management in inventory management



AI Telepharmacy in Clinical Decision Support

Pharmacists play a crucial role in patient-centered care for people with chronic conditions

- AI Telepharmacy can enhance their ability to provide personalized interventions

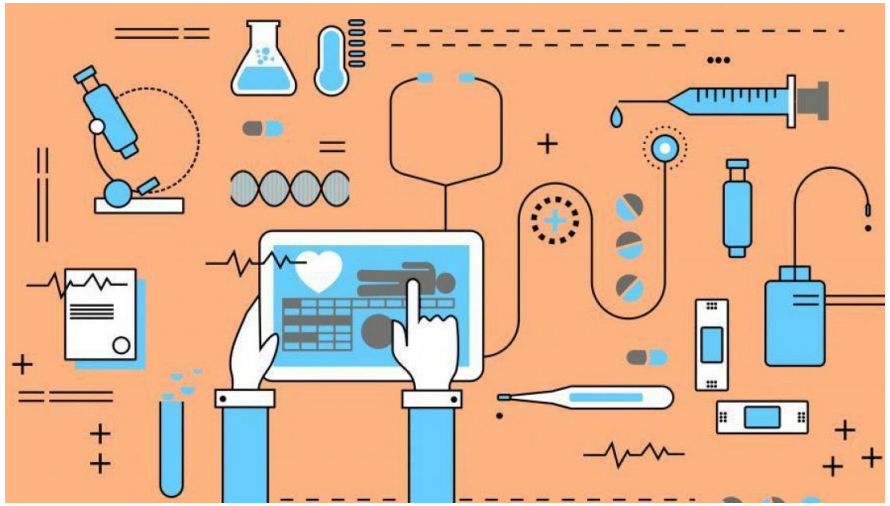
Pharmacists are trained in educating patients to address underlying risks and medication regimen management

- AI-driven Clinical Decision Support Systems analyze patient data, manage chronic diseases and promote adherence to treatment

Telepharmacy services augmented by Machine Learning and AI provide communication channels using AI Telepharmacy chatbots and virtual assistants for chronic diseases requiring continuous monitoring

AI for Medication Therapy Management

AI enhances Medication Therapy Management by helping pharmacists assess drug therapy problems and manage polypharmacy



- AI can examine medication histories, lab values, and patient demographics to optimize therapy plans
- MTM programs powered by AI support more efficient, data-driven pharmacist consultations
- AI tools can be personalized to specific patient populations and conditions

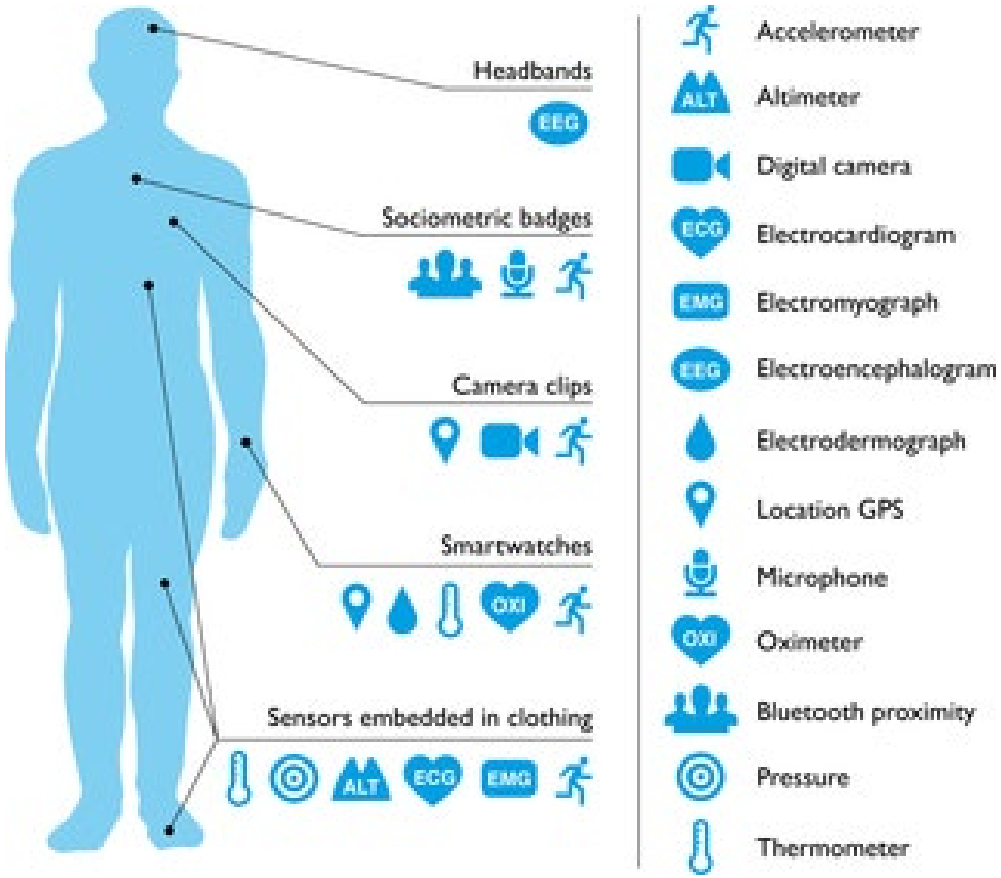
MTM systems improve health outcomes and reduce costs in chronic care settings

AI Telepharmacy in Medication Therapy Management

Telepharmacy enables remote monitoring of patients' medication regimens

Through telemonitoring, pharmacists can

- Track adherence
- Manage adverse events
- Detect drug interactions
- Evaluate therapeutic progress in real time



AI in Telepharmacy

AI-assisted Telepharmacy enables virtual patient education, counseling on medication use and side effects using video or messaging platforms

- Chatbots and virtual assistants help patients with drug information, in understanding medications, symptom triage, and behavior coaching.
- Remote monitoring of medication adherence, side effects and therapy outcomes for chronic disease
- Image recognition software verifies pill authenticity and identity

These tools greatly improve access to pharmacy services

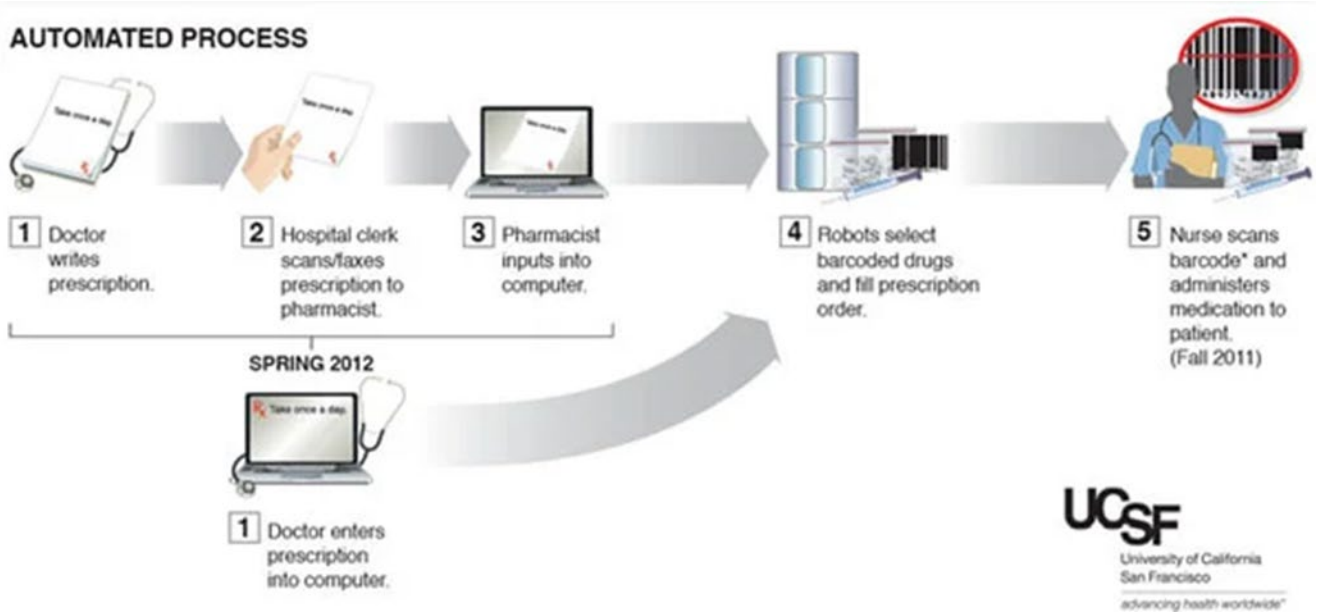
AI Applications in Telepharmacy

Application Area	AI-NLP Feature
Chatbot Interaction	Conversational AI for Q&A, refills, reminders
Virtual Medication Education	Voice assistants for counseling and education
Clinical Documentation	Automated EMR note generation from dialogue
Sentiment & Behavioral Analysis	Detect mood/tone to adapt patient interactions
Multilingual Communication	Translation, speech-to-text, culturally adaptive phrasing

Robotics in Telepharmacy

Robotic dispensing integrates AI with robotic systems for automated medication dispensing and inventory handling

At the University of California San Francisco School of Pharmacy, robots run on embedded AI algorithms for visual inspection, medication scheduling and barcode validation.



Chat Room Break

Let’s stop here and see if there are any questions in the chat box

Digital Integration with AI Telepharmacy

Telepharmacy will become deeply intertwined with AI and digital tools in the future. Expect it to transform both clinical and operational workflows in many areas -

- Prescription verification
- Inventory forecasting
- Medication safety checks
- Personalized interventions
- Predictive analytics
- Smart decision-support systems
- AI-driven engagement with chronic disease and polypharmacy patients.

The Future of AI Telepharmacy

Four areas of telepharmacy will most likely merge with AI platforms -

- **Drug therapy monitoring** - Will include real-time adherence tracking, biometric monitoring, and AI-supported alerts for adverse events
- **Patient education** - Will be enhanced with chatbots, mobile apps and video-based learning tools
- **Clinical care coordination** - Will flag drug interactions, or dosing errors using EHR-integrated algorithms that connect pharmacists, physicians and nurses in unified platforms
- **Remote dispensing** - Will be optimized through AI to reach patients at homes, clinics, or partner pharmacies

AI Telepharmacy in Drug Therapy Monitoring

Telepharmacy enables remote monitoring of medication adherence, side effects, and therapy outcomes—especially in chronic disease patients.

- AI tools track adherence and send alerts to patients and providers
- Predictive analytics detect nonadherence patterns and risk of complications

AI enables pharmacists to make data-informed decisions without direct contact, improving outcomes in remote populations

- AI can detect missed doses and provide personalized coaching to improve compliance.
- AI can analyze behavioral data and intervene with reminders, enhancing adherence in chronic disease management.

AI Telepharmacy in Patient Education

Telepharmacy enables virtual patient education, counseling on medication use, and managing side effects via video or messaging platforms available through phone or tablet or computer

- Chatbots and virtual assistants conduct conversations with patients to answer questions, explain prescriptions, remind them of doses, and collect symptom updates
- AI tailors educational content based on patient conditions and behavior

Natural Language Processing enables voice-based systems and virtual assistants to educate patients about medication usage, side effects, and disease-related information.

- Converts written medication instructions into speech
- Allows patients to speak questions and receive real-time answers
- Supports multiple languages and literacy levels

AI Telepharmacy in Remote Dispensing

AI Telepharmacy will help pharmacists verify and approve prescriptions remotely and oversee medication dispensing in rural or spoke sites.

- Image recognition verifies pill authenticity and identity, reducing errors in prescription filling
- AI guarantees the total traceability of the dispensing process
- AI flags discrepancies or wrong medications and enhances accuracy in remote telepharmacy settings without a pharmacist on-site.
- It reduces travels, time and resource use, and facilitates

With increasing demand for healthcare services in rural and remote areas, AI Telepharmacy offers a solution to medication management challenges and improving therapeutic outcomes

AI Telepharmacy in Clinical Care Coordination

NLP tools in telepharmacy platforms will convert verbal consultations into structured pharmacy notes

- Pharmacists can use AI to interpret lab results, monitor health indicators, and recommend changes in therapy
- AI extracts key data from text concerning symptoms, medications, side effects and summarizes patient interactions for review

Pharmacists can provide virtual consultations to adjust therapies, counsel patients, and coordinate care for chronic illnesses

- AI suggests dose modifications based on predictive risk stratification
- Monitors long-term patient outcomes and alerts clinicians to deterioration
- Provides remote verification of best possible medication histories

Telepharmacy AI Enhancements

Telepharmacy Application	AI Feature
Drug Therapy Monitoring	AI adherence tracking and risk alerts. Track missed doses, alerts caregivers.
Image-Based Verification & Dispensing	Image recognition pill validation. Verify pills using AI and computer video.
Patient Counseling & Education	Chatbots, content personalization.
Medication Reconciliation	AI-CDSS flagging interactions, contraindications. Suggest optimal meds based on patient profiles.
Inventory Management	Demand forecasting and automated stock control. Predict demand and prevent stock shortages.
Chronic Care Follow-Up	Predictive analytics for dose adjustments. AI chatbots can provide 24/7 patient support and education.
Clinical Risk Management	Identify high-risk patients for intervention, proactive alerts. Flag interactions, contraindications, dosing issues.
Rural Access	Automated scheduling, refill reminders, consultation and education.

AI Telepharmacy Integrating Digital Health Ecosystems

AI-enhanced telepharmacy will integrate with broader digital health platforms to facilitate multidisciplinary collaboration between pharmacists, nurses, and physicians

- AI will support remote consultations, synchronized with hospital systems, patient portals, and wearables.
- Data from EMRs, smart pill bottles, and biometric sensors will be aggregated and analyzed to guide care plans.

Post-Presentation Questions

Post Presentation Question 1

Hospital pharmacies in the USA introduced AI during COVID to manage drug inventories.

A. Yes
B. No
C. Don’t Know

Post Presentation Question 2

Most AI applications today run within the constraints of Narrow AI.

A. Yes

B. No

C. Don’t Know

Post Presentation Question 3

The major use of AI in pharmacy today is for drug discovery and development.

A. Yes
B. No
C. Don’t Know

Post Presentation Question 4

The merger of AI with Telepharmacy will change the responsibilities of pharmacists in the future.Reimbursement for services.

A. Yes
B. No
C. Don’t Know

Thank you for your attention.

Questions?

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This presentation, with notes, is available at:

www.imageresearch.com/telepharmacy

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