AI Leapfrogging Pharma Industry

A perspective by

Abhay Shukla

Senior Director, Advanced Analytics Solutions
Optum | UnitedHealth Group

AI is no-more an Alien / AI is already in-action

moderna

Moderna Therapeutics used ML technologies to expedite mRNA sequencing for COVID-19 treatment:

- By embracing advanced analytics early on, alongside its focus on mRNA-based therapeutics, **Moderna leveraged ML technology to speed up development of Covid vaccine mRNA-1273**
- This was ready to initiate Phase 1 clinical trials in a **record-breaking time 42 days** following COVID-19 sequencing

Sumitomo Dainippon Pharma

Reduction in preclinical development to less than **12 months from 4 to 5 year**

- A new drug candidate, DSP-1181, created using Exscientia Centaur Chemist **Artificial Intelligence platform**.
- The drug was developed together with Sumitomo Dainippon Pharma for the treatment of obsessive-compulsive disorder.

Increase patient engagement and participation rates using wearable patch

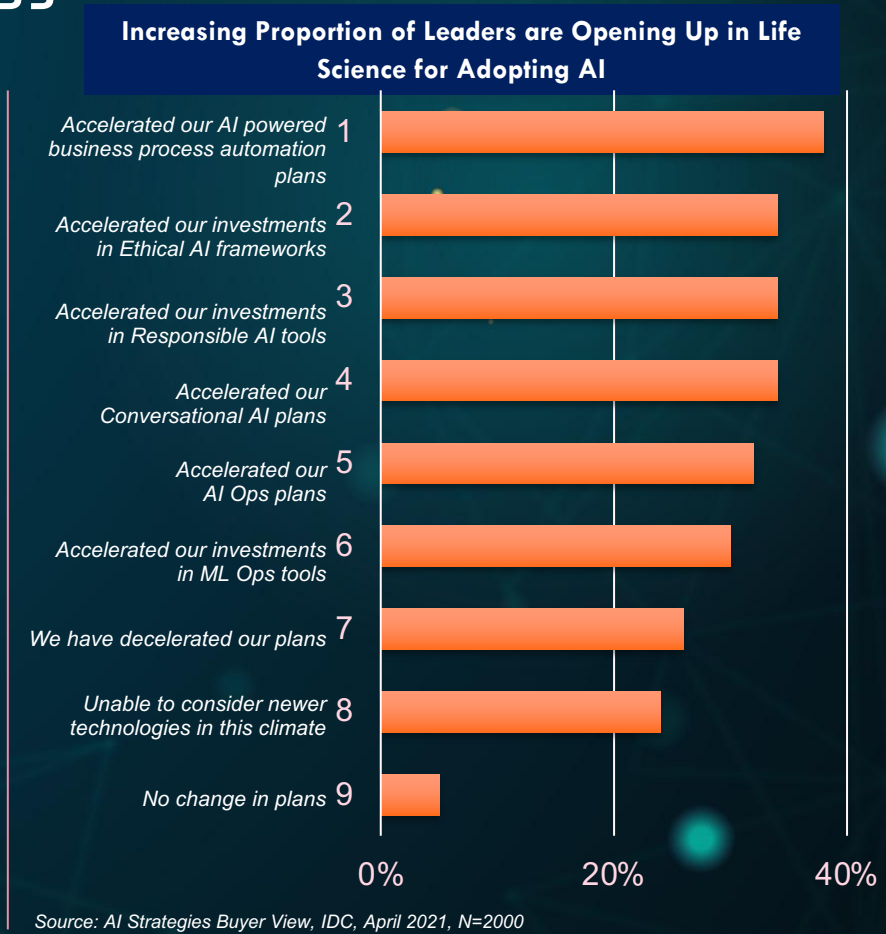
SANOFI

- Sanofi – Mentalab: Mentalab combines a wearable patch that can **measure electrocardiogram bio signals continuously.**
- The patch can be applied by patients directly, and worn throughout their daily activities, while **data is transmitted and analyzed seamlessly.**

AI is transforming All Business

AI Investments:

- A 40% projected growth from 2017 to 2024 indicates that AI will likely revolutionize the pharmaceutical and medical sectors.
- By 2024, AI investments in silico drug discovery will double to fuel growth of genomics and precision medicine to bring vital vaccines and medicines to patients faster.
- Investment in AI for real-world evidence by life sciences companies will double by 2025, driven by health data interoperability initiatives and platforms.
- By 2026, the increased adoption of medication adherence apps, smart IoT–based solutions, and connected drug delivery systems will reduce treatment compliance gaps in clinical trials by one-third



Pharma is all Ready for AI Enablement

With Goals of Pharma Industry, Startups and Pharma Partnership is all geared for rapid AI transformation

Top Pharma Company Partnerships or Acquisitions within AI Space				
Pharma Company	**AI Driven Companies**			
Roche Diagnostics	Owkin	GNS Healthcare	Flatiron	Synapse
Johnson & Johnson	Benevolent AJ	Winter Light		
NOVARTIS	IBM Watson	MIT	Intel	Quantum Black
Pfizer	IBM Watson	MIT	XtaIPS	
MERCK	Atomwise	Numerate		
SANOFI	Berg	Exscientia	Recursion	
AstraZeneca	Berg			
gsk GlaxoSmithKline	Berg	Exscientia	Cloud Pharmaceuticals	Insillico Medicine
abbvie	Atomwise	AiCure		
Bristol Myers Squibb	Path AI			

Development | Target Discovery | Drug Discovery

AI Role in Pharma Value Chain

	Drug Discovery	Pre-Clinical Trials	Clinical Development/Trial	Regulatory	Drug Adherence
Business	• New drug design • Validate & optimize drug • Understand disease mechanisms • Repurpose existing drug	• Design pre-clinical trial • Run pre-clinical trial for suitability • Establish biomarkers	• Feasibility assessment – Clinical trial eligibility, protocol design • Patient stratification • Site/investigator selection • Operational data management • Patient Recruitment • Patient Retention, Minimize Dropouts	• Record Keeping • Auto. Review and Approval • Automated Schedule, Reminder • Automated Reporting • Detection of Trend	• Real world evidence • Guideline Development • Provider Marketing • Adherence Measurement • Drug Supply Chain
Activities	ML, NLP, DL, Reasoning	ML, NLP, DL, Reasoning, HMI	ML, NLP, DL,OCR Reasoning, Voice/speech recognition, HMI	ML, NLP, DL,OCR Reasoning	ML, NLP, DL
	Pharmacopeias, EMR, Omics, Medical Literature, Social Media etc.	Medical Literature, Public Databases (FDA, NLM etc.), Preclinical trials & animal study registries, etc.	Clinical trial databases, Trial Announcements, EMR, Medical Literature, Social Media, Patient Registries, Wearable's data, Speech/Voice data, Image data, Videos etc.	Clinical Trial Database, Public Data, CAPA data, Social Media etc.	iOT, Pharmacy Data, Supply Chain Ops, Prescription Data

Effective Trial Planning	Improved site/investigator selection	Targeted Patient Recruitment	Lower Patient Dropout	Lower Protocol Amendment	Faster Time to Market	Better Clinical Outcomes	Better Patient Satisfaction	Optimized Cost	Higher Adherence	RWE Clinical Guideline

discovery

Drug discovery time reduced from 4-5 years to mere 8 months for solid tumors

Examples of AI tools used in drug discovery

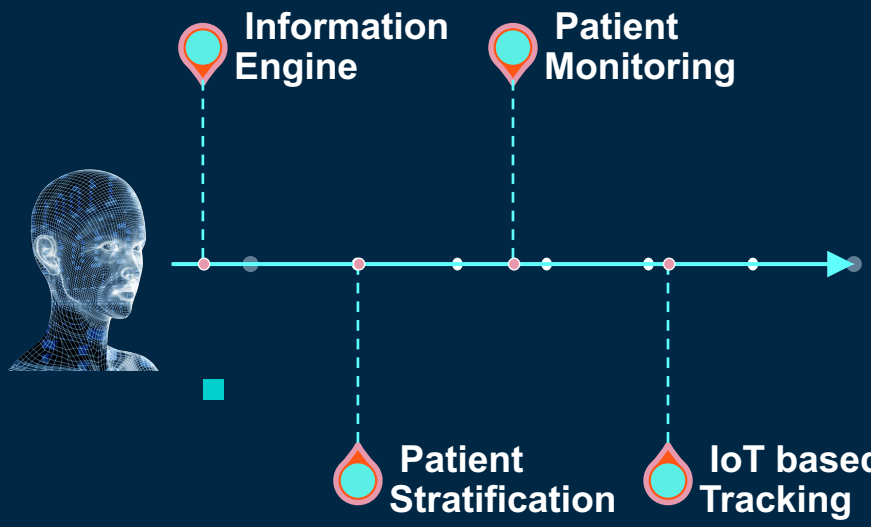
- DeepNeuralNetQSAR – for Detection of the Molecular Activity of Compounds
- PotentialNet - Uses CNNs to Predict Binding Affinity of ligands
- Hit Dexter - ML technique to Predict Biochemical Assays
- Neural graph fingerprint - Helps to Predict Properties of Novel Molecules

AI solutions for drug discovery accounted for about 30% of the total AI and Big Data analytics market for the pharmaceutical industry

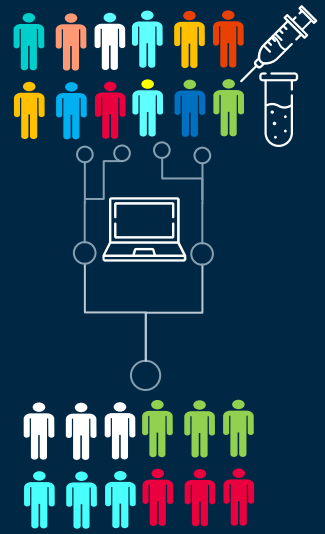
- **AI in Drug design**
- **AI in Polypharmacology**
- **AI in Chemical Synthesis**
- **AI in Drug Repurposing**
- **AI in Drug Screening**

AI in Clinical Trial

Drug Discovery → Pre-Clinical Trials → Clinical Development/Trial → Regulatory → Drug Adherence



AI–enabled Clinical Trial Enrichment Strategies



Reduced Population Heterogeneity

- Biomarker verification to reduce variability and increase study power

Prognostic Enrichment

- Selecting patients more likely to have measurable clinical end-points

Predictive Enrichment

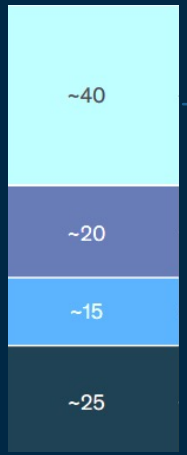
- Identifying patients more likely to respond to the treatment

ML and DL methods can be applied to mine, analyze, and interpret multiple data sources, including EHR, medical imaging, and ‘Omics’ data

Open-source web tool, called DQueST- filter out 60–80% of trials that the user was not eligible for, with an accuracy of a little more than 60%.

More to explore Clinical data using AI

Factors that contribute to health outcomes, %



Social determinants of health

Health behaviors

Clinical Care

Non-modifiable factors (genetics)

Avg. amount of data generated over a person's lifetime

1,100 terabytes (volume, variety, velocity, veracity)

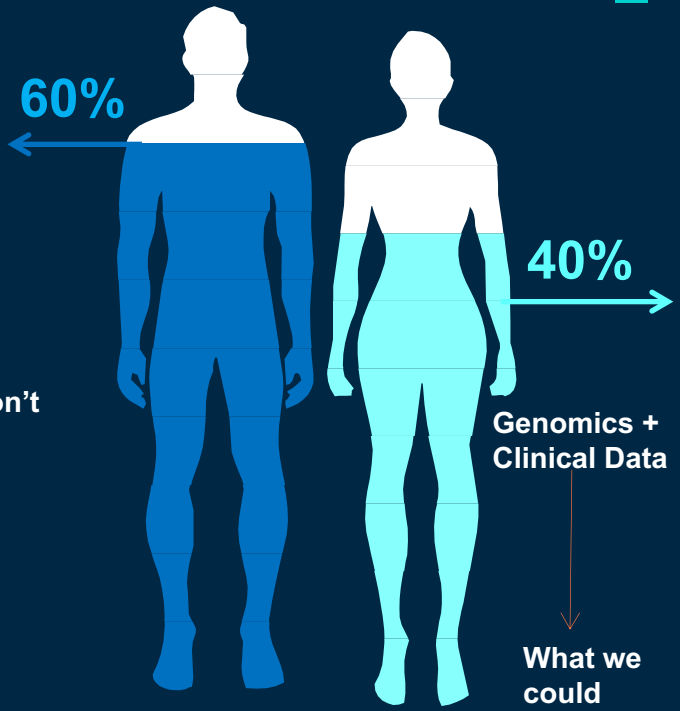
0.4 terabytes (clinical data)

6 terabytes

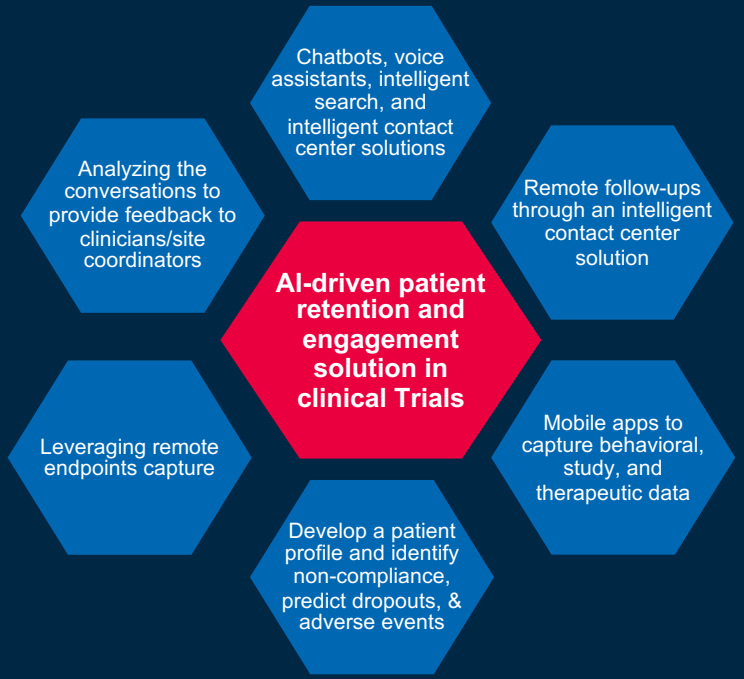
Source: Bureau of Labor Statistics; Robert Wood Johnson Foundation; IBM Watson (Latts L. *The age of big data and the power of Watson.* European Medicines Agency presentation. Updated April 1, 2017); McKinsey analysis

Exogenous Data

What we don't know



Patient Engagement through AI



Products and Solutions

Catalia Health

- **Mabu social robo** - Mabu is provided to trial participants so that they can more easily follow their study-related activities and surveys
- **Mabu platform** organizes all aspects of the patient protocol with reminders for medications, appointments, lab visits, telemedicine, and evaluations
- Secure, browser-based dashboard allows the trial team to access and coordinate key information in near real time
- **Pfizer** has collaborated Catalia Health for Mabu Wellness Coach

IQVIA

- Transform relationship with patients through a SaaS-based platform built to serve both patients and the life sciences industry
- IQVIA Orchestrated Patient Engagement (OPE) enables pharmaceutical companies to improve communication and orchestration with the audience that matters most—the patient
- IQVIA has partnered with Belong to deliver patient engagement via a configurable, personalized SaaS based solution, Orchestrated Patient Engagement (OPE)

AI & ML – Impact on Patient Adherence

Chatbots: Conversational AI focused on medication adherence can build a personalized patient profile and engage them to help stay on track

Smart pills: These pills include ingestible bio-sensors that are embedded into the medicine, which, when consumed, send a signal to the patient and HCP on smart phone; **Example:** FDA approved Abilify MyCite in Nov 2017

Wrist band sensors: The unique motion of taking the drug out of its packaging and consuming it can be tracked

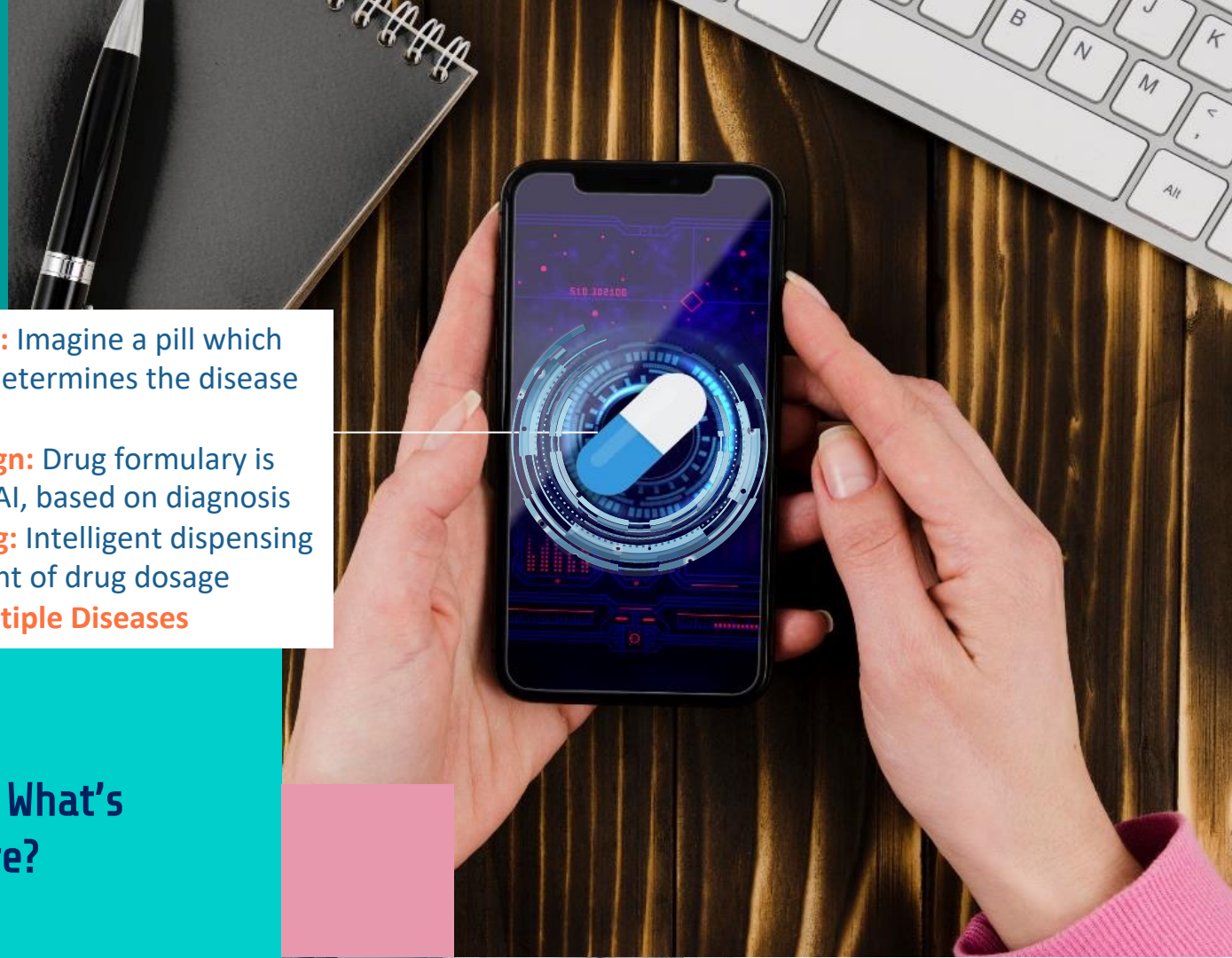
Gamification: Game-based apps aim to instill a behavior change in patients by rewarding them upon continued adherence mainly for chronic diseases

Apps: There are multiple apps currently available on Apple (iOS) and Android OS to aid in improving patient adherence; **Examples** include Groove Health, AiCure, Medisafe, etc.

Smart packaging: There are pill dispensers available in which users can enter dosage and timing for medication and sync the device with the app on their smartphone; **Example:** Fellow Smart Pillbox, CleverCap

Magic Pill

- ✓ **Self Diagnostics:** Imagine a pill which diagnoses and determines the disease on its own
- ✓ **Auto Drug Design:** Drug formulary is designed using AI, based on diagnosis
- ✓ **Auto Dispensing:** Intelligent dispensing the exact amount of drug dosage
- ✓ **One Pill for Multiple Diseases**



Future of AI

What do you think? What's hidden in the Future?

Data Science Reshaping Pharma R&D

Abhay Shukla

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