CitiusTech

Transforming the R&D Value-chain:

The Role of AI-ML and Advanced Analytics

Table on contents

Introduction

Research and development (R&D) is an essential component of the pharma industry's business model wherein clinical trials are a necessary mechanism to demonstrate the safety and effectiveness of potential treatments to regulatory agencies across the world. While some diseases like cancer, diabetes, respiratory illnesses, autoimmune disorders, and infectious diseases have been at the core of the pharma innovation engine, COVID-19's emergence and spread have severely disrupted the rapidly evolving healthcare needs and R&D''s operating model. While many several players turned the tide on its head by biopharma companies developed vaccines in record times, some within eight months being minimum, the speed of development speed required an all-hands-ondeck approach may not be sustainable in the long term.

1.1 Pharma's R&D Productivity Problem

Excluding the COVID-19 vaccine scenario, R&D productivity has always been under scrutiny. Typically, new medications take 10-12 years to develop a new and gain FDA approval. According to a Harvard Business Review (HBR) article, pharma investment in R&D swelled from $2 billion in 1980 to $43 billion in 2006 in the U.S., however, in the same period, the number of new drug approvals was almost the same; recent estimates suggest, 2019 investments were $83 billion.

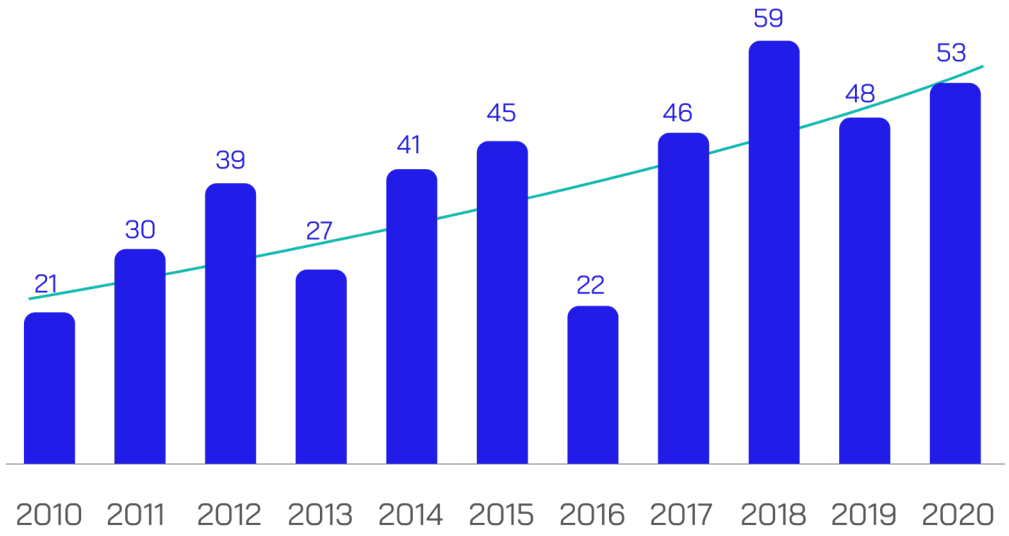


Figure 1: New Drug Approvals by FDA (2010 - 2020)

Compared with other knowledge-based industries like semiconductors, hardware, and software, the R&D spend by the pharma industry as a percentage of revenues is more significant. A comparison of FDA approvals in Figure 1 indicates the number of new drug approvals in recent years.

While a 180% increase in the number of novel drug approvals since 2010 is impressive, large pharma's share of approvals is just 28%, indicating that less than one drug approved per company among the top 25 over a decade.

Factors contributing to low R&D productivity like protocol adherence issues, patient recruitment and retention, execution pace, failure to follow regulatory guidelines, and a failure to meet the primary endpoints. These have been further complicated by the pandemic.

1.2 The Imperative to Improve R&D Productivity

As companies re-prioritize their portfolios, calibrate capabilities, and ensure continued operations, artificial intelligence (AI), machine learning (ML), nd advanced analytics technologies hold great promise to bend the productivity curve dramatically. Successfully building or investing in AI/ML or advanced analytics requires an organizationlevel vision to outline the desired business and clinical outcomes, the intended digital transformation journey, and the tactical approach to use these technologies. Industry trends indicate that many pharma players are asking for innovative choices with digital transformation at the core of their strategy. With Innovation, agility, and lean productivity as are critical of the key business characteristics to any technology or strategy. According to Deep Pharma Intelligence, An example of this trend is renewed interest in AIfocused biotech startups. According to Deep Pharma Intelligence, AI biotech startups attracted $1.9 billion in venture capital in 2020, which is more than the combined total of 2015, 2016, and 20174
.

While startups benefit from agility to experiment, some of the more established pharma companies are looking to push traditional boundaries and disrupt using AI. While goals may vary, common themes include augmenting existing capabilities, automating manual and siloed processes, utilizing existing data assets in new ways, and fostering collaboration. This is the path to building long-term competitive advantages.

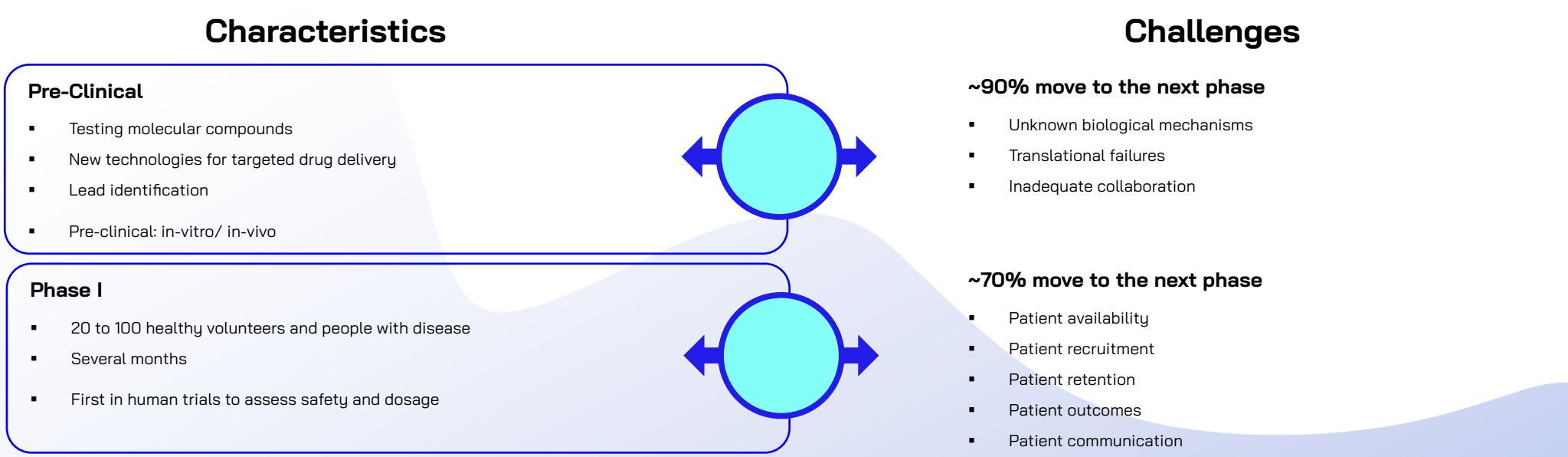
2. R&D Value Chain Challenges

The uncertainty of success throughout the value chain, from preclinical to clinical followed by regulatory approvals, sees pharma products failing in the start or later stages. According to the FDA, for every 100 drugs entering phase I trials, only 20 entered phase III trials, and 12 received FDA approvals[5].

It's worth mentioning that some significant challenges related to patient recruitment, trial logistics, patient monitoring, compliance, and execution speed have been further complicated by COVID19. At the start of the pandemic in April 2020, 80% of clinical trials reported a drop-in patient availability compared to April '2019[6] .According to Mckinsey research, new clinical trial activity in the U.S. fell from ~2,600 in January 20' to 1,200 by midyear. However, activity returned to pre-pandemic levels by July. Yet, clinical trial supplies like raw materials, chemicals, and logistics were significantly impacted by the pandemic.

As pharma companies shift gears from ensuring business continuity at the start of the pandemic to normalizing operations, the overall business and product ecosystem is fluid. Leaders need a holistic approach to leveraging existing resources like ongoing and past clinical trials data, real-world data, observational research, and other sources

Figure 2 presents an overview of the most pressing challenges across the R&D value chain., and Figure 3 illustrates COVID-19's impact on the value chain.



Characteristics

Phase II

- 100-500 with the disease
- 6 month to 2 years
- Efficacy and side-effects are assessed

Phase III

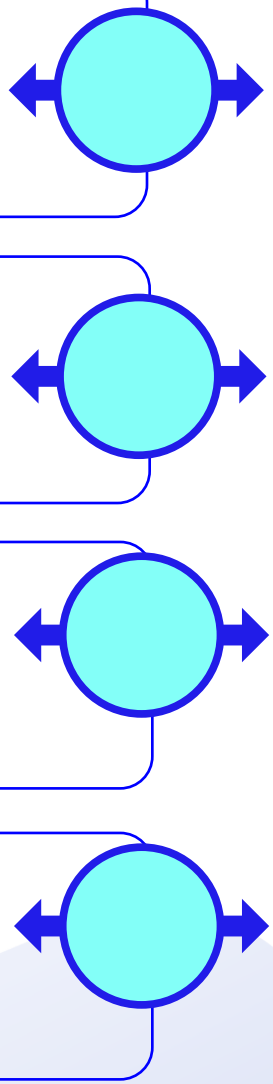
- 500-3000 volunteers with the disease
- 1 to 4 years
- Efficacy and side-effects are assessed

Regulatory

- gulatory
- FDA review for approvals
- 6 months to 1 years for decision
- Grant of NDA approval for marketing

Post Marketing

- Post marketing surveillance
- Real world safety studies
- Off label usage and evidence in new indications



Challenges

~30% move to the next phase

- Treatments risks
- Non-responders
- Complex study
- designs
- Trial Logistics
- Adherence and
- compliance

~25% move to the next phase

- Data accuracy
- Data management
- Treatment risks
- Sponsor-CRO-vendor communication
- Speed of execution

~12% are approved

- Regulatory compliance
- Regulatory oversight
- On-time submissions
- Accuracy of dossiers

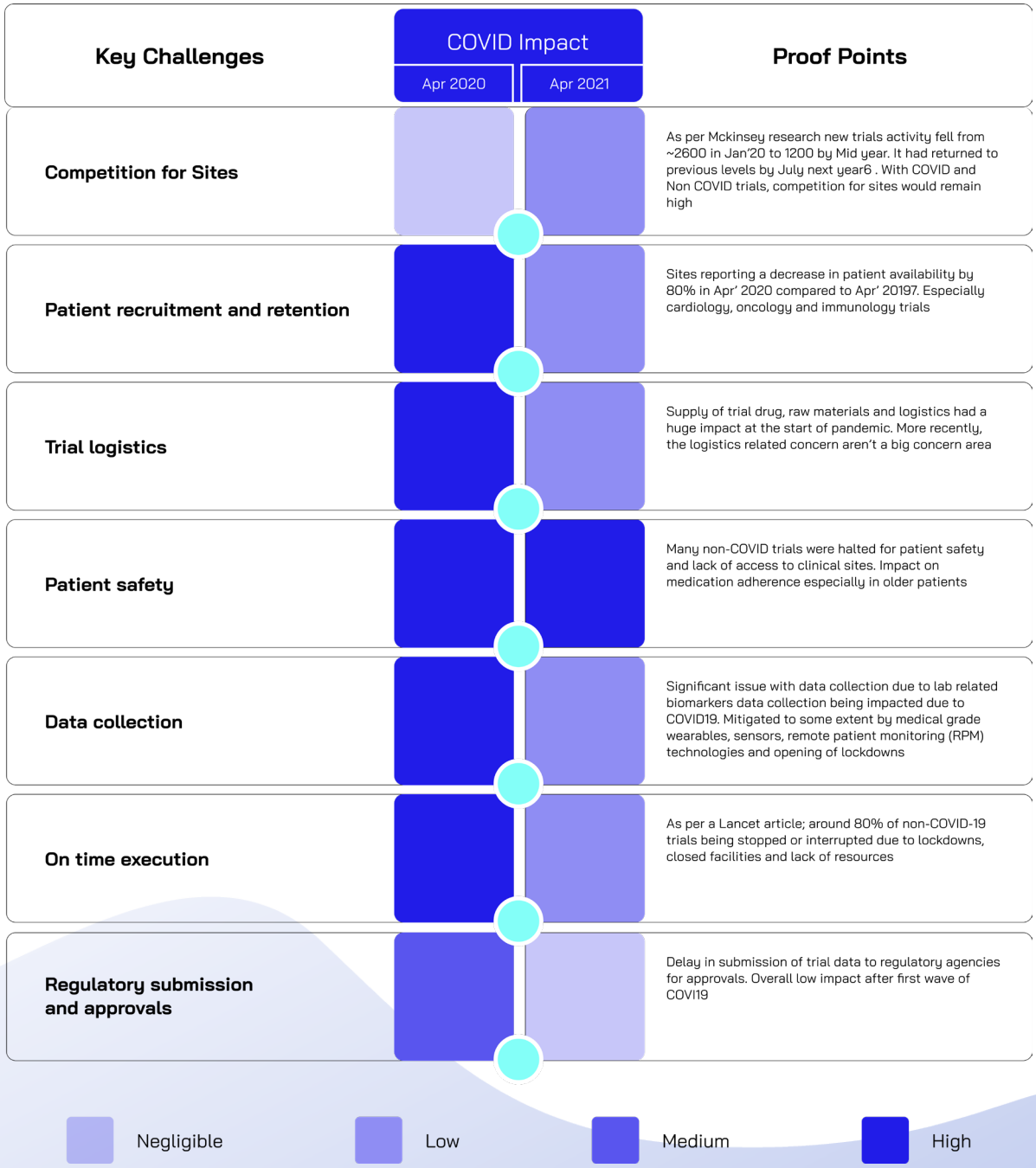
Drug launch

- Measuring real world outcomes
- Patient engagement
- Real world outcomes
- Monitoring safety signals

While data sources can be many and may solve the input part, new-age technologies such as automation, AI-ML, wearables, big data, imaging, and analytics can be leveraged to target specific use-cases with an over-arching goal of reducing the drug development time and costs. Also, helping bring treatments faster to the patients and reduce time to access.

3. AI-ML and Advanced Analytics Boost for R&D Transformation

In a rapidly evolving clinical development scenario, AI and advanced analytics have a role to play throughout the value chain. From target identification, preclinical activities, clinical research, study close-out to dissemination. Companies are modernizing their existing IT infrastructure to align with their digital vision with short-term, medium-term, and long-term roadmaps. R&D leaders should consider an agile approach for securing investment into transformation initiatives, identifying concrete, measurable outcomes in partnership with business, research, data, and technology vendors.



3.1 Essential Digital Data Infrastructure for R&D Transformation

Digital infrastructure that include interoperable systems and machine learning algorithms drive efficiencies across data ingestion, democratization of data assets, and sophisticated analytics. Using the right platform to match business and research objectives is instrumental in capturing the data generated across the continuum of healthcare delivery while making it accessible to internal and external research communities. In this area, a trend that's noteworthy is the use of real-world data (RWD). To achieve greater value from RWD, it's essential to ensure it's connected to targeted and robust tools..

Until recently, the availability of real-world data, and its limited acceptance by regulatory bodies, had led pharma companies to rely almost entirely on clinical trials. Plus, real-world studies were mainly used in during post-approval for value demonstration and postmarketing surveillance.

In the new normal, it's not just pharma companies making considerable investments in this area, but the regulators who are more open to objective evidence. For example, both FDA and Europe Medicines Agency (EMA) have created draft guidance on the use of real-world data.

Companies can create a broader vision using real-world data, which involves using these data-sets at scale on cloud-based platforms. For example, using wearables, apps, and other remote patient monitoring (RPM) technology can monitor patient biomarkers and reduce travel to trial sites.

RWD or real-world evidence (RWE) can deliver higher patient safety outcomes and expedite execution, benefiting patients and sponsors. While RPM is a timely and trending example, there are others that could support pharma modernization, making them AI/ML-ready. In this paper, we are describing two examples being implemented in real-world - vaccine development and use of synthetic control arms for drug approval:

3.1.1 Vaccine development Using AI-ML

One example is an ML model developed by Janssen and MIT data scientists that played a crucial role in developing the Johnson & Johnson vaccine. The event-based ML models were applied to real-world data to track communities with high COVID-19 spread to help identify potential clinical trial sites and recruit patients faster. Figure 4 represents AI/ML and advanced analytics use cases across the drug discovery value chain.

In April 2021, the MIT and Janssen R&D Data Science teams were recognized as the 2021 Innovative Applications in Analytics Award winner by the Institute for Operations Research and the Management Sciences (INFORMS) for their innovative and highly impactful work on COVID-19[8]

.

3.1.2 Synthetic Control Arms for Drug Approvals

While companies are stepping up their efforts, regulators are also supportive of AI/MLdriven solutions, to bring effective treatments to patients faster. New treatments using synthetic control arms as comparators have received approvals. Medidata, a leading healthcare technology company, received approval from FDA for their synthetic control arm (SCA), which is an external control for a phase III registrational trial in recurrent glioblastoma (rGBM). The SCA was built using historical data from more than 22,000 trials data using more than 22,000 clinical studies. Medicenna Therapeutics will use the control arm in the trial for rGBM[9]. The above examples are a few of the real-world use-cases of how companies can experiment with AI/ML and expedite their research effort. Similarly, companies still early in their journey can experiment with few high-impact and easy to execute use-cases. Refer to figure 4 for some AI and advanced analytics use-cases across the R&D value chain, followed by select case-studies.

These examples illustrate how companies can experiment with AI/ML to expedite their research efforts.

Ease of Execution

	Target Identification & Pre-clinical	Protocol & Study Design	Site set-up & Subject Recruitment	Trial Conduct & Treatment Start	Data Management & Statistical Analysis	Reporting, Study clode-out & Dissemination
High	Collaboration platform (industry & academic)	Digital twins of protocol	Patient engagement and reminders	Site performance monitoring	Reduce manual queries	Auto-completion of key sections in clinical study reports
Medium	Target identification & drug repurposing	Protocol design & authoring	Identify patients by mining clinical trials eligibility databases	Identify likely responders for rare disease trials	Flag inconsist ent data	Regulatory Submissions
Low	Connected Labs	Analyze previous trials data to inform study design	Remote patient monitoring by data acquisition from wearables and data management			Risk based quality monitoring (RBQM)

4. AI and Advanced Analytics Case Studies Across the R&D Value Chain

Collaboration platform for Researchers

Challenge

Enabling collaboration among internal and external experts. Exposing structured and unstructured data and drive insights in a therapeutic area

Solution

- Building a collaboration platform capable of ingesting new age data sources like imaging, RWD and genomics
- Role based access control to access, visualize, and analyze data –sets
- In Compliance with regulations like HIPAA and GDPR

Outcomes

- An AI engineered scalable platform allowing end to end project
- workflows and insight sharing
- Technical knowledge sharing at scale
- Platforms capable of creating data challenge events at larger scale for data scientists and researchers. Ex hackathons

Patient recruitment and retention

Challenge

Inefficient and suboptimal patient recruitment techniques leading to 80% of trials failing to meet recruitment timelines

Solution

- Integrate open source platforms like i2b2 with existing systems to improve patient recruitment
- ML models to mine EHRs, EMRs, social media and claims data of consenting patients. Identify, interpret and potential patient characteristics as per inclusion criteria

Outcomes

- Generate area maps and enable direct communication with patients to speed up recruitment process
- Beat competition in reaching out to patients faster
- Reduce overall cost of patient recruitment and scale successful models to multiple trials

Collaboration platform for Researchers

Challenge

The role wearables can play in remote patient monitoring and reduce site visits

Solution

- Developing an IoT enabled and scalable data pipeline to automate data capture from wearables and apps
- Platform to support ingestion, processing and storage of real-time device data
- Viewing device data at clinical trial core labs by physicians

Outcomes

- Remote monitoring saves hassles for patients traveling to trial sites
- Timely interventions to reduce patients dropping out of trials
- Increase patient adherence
- Develop a scalable platform with repeatable trials in different therapeutic areas

Conclusion

In light of the heroic efforts across pharma to create COVID-19 vaccines and other medicines, and despite the turmoil and damage caused by the pandemic, the pharma industry has an opportunity to leverage adoption of RWE, virtual care, and consumerism to establish a competitive stance. Now is the time to adopt and scale AI, machine learning, and to adopt sophisticated data analysis techniques and tools. But, we must be strategic in identifying areas where these technologies can deliver the greatest results. A clearly-defined adoption roadmap will augment existing capabilities, optimize existing data assets, and foster collaboration. While there's no one-size-fits-all approach, it's important for companies to understand the potential impact newer technologies like AI/ML can deliver where it matters. Where else they can start, if not building the infrastructure for the R&D of the future.

CitiusTech
Shaping Healthcare Possibilities

CitiusTech is a global IT services, consulting, and business solutions enterprise 100% focused on the healthcare and life sciences industry. We enable 140+ enterprises to build a human-first ecosystem that is efficient, effective, and equitable with deep domain expertise and next-gen technology.

With over 8,500 healthcare technology professionals worldwide, CitiusTech powers healthcare digital innovation, business transformation and industry-wide convergence through next-generation technologies, solutions, and products.

www.citiustech.com

Shaping Healthcare Possibilities

Authored by:

Shreejit Nair
SVP, Life Sciences CitiusTech

Shobit Saran
Sr. Healthcare Consultant, CitiusTech

To learn more about various CitiusTech solutions, contact us at
sales@citiustech.com