Available online www.ejaet.com

European Journal of Advances in Engineering and Technology, 2024, 11(8):1-3

Research Article ISSN: 2394 - 658X

# Application of Artificial Intelligence in the Pharmaceutical Product Lifecycle: A Shared Perspective Between Leading Health and Regulatory Agencies

**Rohit Singhal**

MS Supply chain management,
HOUSTON, Texas, United States
rohitsinghal@outlook.com

---

**ABSTRACT**

With the proliferation of Artificial Intelligence (AI) and Machine Learning (ML) based applications in various facets of the pharmaceutical life cycle, prominent health and regulatory agencies around the world are looking to establish thought leadership, showcase latest developments and partner with industry stakeholders while emphasizing the need for robust regulations for safe and prosperous AI driven future. This research article aims to understand and summarize the use cases for AI/ML based applications across the pharmaceutical life cycle from a technical and regulatory standpoint as laid out in recent publications by leading health agencies and highlight the main themes addressed along with other technical factors to be considered during the development and deployment of such AI/ML based applications.

**Keywords:** Artificial Intelligence, Machine Learning, FDA, EMA, WHO

---

## INTRODUCTION

Artificial Intelligence and Machine Learning rank high on the technology investment portfolio for life sciences companies with some research even suggesting that 60 percent of the technology investment will be dedicated to this area in the next couple of years [5]. This is evident in multiple recent industry developments such as the advent of AI-generated drugs, AI supported clinical trials and manufacturing operations, automation of routine tasks, and aiding in deviation investigations [6].

It is highly encouraging for AI/ML enthusiasts as well as industry professionals to see that health and regulatory agencies around the world including the Food and Drug Administration (FDA), European Medicines Agency (EMA) and World Health Organization (WHO) have recently come up with discussion papers (see references) to spur a discussion with various stakeholders in the pharmaceuticals/medical products community such as pharmaceutical manufacturers, academia, patient groups, various regulatory authorities, policy makers, AI developers and many more. These papers, albeit different in approach, cover several common themes such as AI/ML current/ future applications, regulatory considerations, data quality and integrity and ethical and social implications. This article aims to summarize some of the important findings of these papers as it applies to the pharmaceuticals industry.

## THE APPROACH

The discussion papers by both FDA and WHO acknowledge the complexity and the possibility of varying interpretations of the definition of AI amongst stakeholders such as drug developers, manufacturers, regulatory agencies, academia and, to this end, generally define Artificial Intelligence as combination of computer science, engineering and statistics that ‘uses algorithms or models to perform tasks and exhibit behaviors such as learning, making decisions, and making predictions’ [1] [4]. FDA also follows the definition laid down by International Medical Device Regulators Forum (IMDRF) when it considers Machine Learning as a subset of AI which involves

implementation of training algorithms on a dataset, learn patterns from the dataset including classification, inference, emulating previous patterns, predictive analysis and eventually apply a 'trained' ML model to a new dataset to produce desirable results [2].

The definition of AI stated by EMA, however, is a bit more simplistic and generic – "systems displaying intelligent behaviour by analysing data and taking actions with some degree of autonomy to achieve specific goals". ML is described as a 'process' through which these systems are developed where models are trained from data without explicit programming [3].

While papers from all three agencies are quite detailed, it appears that FDA's discussion paper does the best to describe the application of AI/ML science to pharmaceutical use cases in general. EMA's reflection paper publication, which followed FDA's publication in timeline, voices a far more conservative tone advocating for a risk management-based approach at every stage. On the other end of the spectrum, WHO's publication is centered solely on areas of regulatory consideration.

## USE CASES ACROSS THE PHARMACEUTICAL PRODUCT LIFECYCLE

The discussion papers go into great depths about the current and potential business use cases for AI/ML with an intention to promote shared learning and collect feedback.

1. Drug Discovery is identified as one of the significant areas of AI/ML application. The early drug development stages of identifying biological targets and establishing disease relationships can employ AI/ML to mine and synthesize large volumes of data from associated scientific publications and other sources. The complex datasets relating to the available genomic, transcriptomic, proteomic, and other data sources from both healthy and diseased subjects are a good candidate for utilization of AI/ML models to process and inform biological target selection.

   From a regulatory perspective, the application of AI in drug discovery may be a low risk setting since impact of non-performance mainly lies on the sponsor.
2. In the domain of compounding screening and design potential AI/ML uses include
   a. Predictive analytics on chemical properties, bioactivity, efficacy and adverse effects of compounds based on their specificity and affinity for a target.
   b. Drug design and repurposing efforts which includes predictive analytics on composition, toxicity and 3D structure of target proteins amongst others.
3. AI/ML application in non-clinical research includes the integration of Pharmacokinetics (PK) and Pharmacodynamics (PD) in a model to ultimately derive drug behavior and effect over time. The importance of the application of Standard Operating Procedures (SOPs) and Good Laboratory Practice (GLP) has also been highlighted at this stage.
4. In the area of clinical research, AI/ML is used for analyzing huge datasets associated with the typical observational and clinical trials, and to inform the design and efficiency of other datasets such as medical claims and decentralized clinical trials.
   a. There is increasing adoption of AI/ML based applications throughout the design and conduct of clinical research including recruitment, selection of trial participants, dose regimen optimization, adherence, retention, site selection and overall clinical trial data management.
   b. EMA is quick to note that such AI/ML models are subject to all guidelines laid down in good clinical practice (GCP). In addition, the model architecture, logs from modelling iterations, validation and testing scripts and data, training datasets, and other associated model characteristics would be considered a part of the trial protocol dossier and thus, must be submitted along with the market authorization dossier or clinical trials application. The reflection paper also highlights the need for risk mitigation related to overfitting the data leakage, the need for early regulatory interaction, and general change management of any model being used for hypothesis testing.
5. Several potential applications for AI/ML have been highlighted during the individual case safety report (ICSR) process in the context of pharmacovigilance as a post marketing safety activity. The ability of AI/ML to detect information from random and complex data sources of adverse events of ISCR such as reports, clinical trials, social media, phone calls, emails and other literature is being explored. This, followed by case validity and prioritization, evaluation (establishing a causal relationship between the drug and adverse event) and final case submission can all have AI/ML involvement to some degree. However, given that generative language models can be error prone, suitable quality review mechanisms need to be in place to ensure factual and syntactical correctness before case submission. Also, the same requirements of a frozen model, data pipeline and other change management protocols may apply.
6. AI/ML is also increasingly integrated to advanced pharmaceutical manufacturing processes and is a prime enabler for the next phase of Industry 4.0. This offers many possibilities including enhanced process control through techniques such as neural networks, efficient inventory management though AI enabled smart monitoring, and root cause identification through trend monitoring, cluster problem areas and

predictive analytics. Model development should follow quality risk management principles while considering patient safety data, data integrity and product quality.

## OTHER TECHNICAL CONSIDERATIONS

All agencies provide several other considerations, both industry agnostic and pharmaceutical industry specific.

In general, AI/ML algorithms can be prone to amplified errors and preexisting bias that typically gets introduced from the underlying data sources. This gives rise to concerns around generalizability and ethical considerations and has led to focused efforts to develop standard AI protocols to address explainability, reliability, privacy, safety and security. Leading organizations such as the International Organization for Standardization (ISO), the Institute of Electrical and Electronics Engineers (IEEE), the International Electrotechnical Commission (IEC) and the National Institute for Standards and Technology (NIST) are working towards AI/ML standards and work products. In the medical devices industry, FDA is partnering with Health Canada, and the UK's Medicines and Healthcare products Regulatory Agency (MHRA) to jointly published 10 guiding principles to inform the development of Good Machine Learning Practices (GMLP) for medical devices that use AI/ML.

Due to proprietary reasons or just the general complexity and the large volume of trainable parameters included in model architectures render them too opaque or too difficult to perceive. Agencies believe that development teams must make efforts to promote development practices that favor model generalizability, robustness, traceable documentation and development logs. The papers also underscore the necessity for rigorous validation of AI/ML models ensuring that they are reliable, replicable, and compliant with frameworks such as Good Manufacturing practices (GMP). During deployment in high-risk use cases, care must be taken to reevaluate model performance when there are changes in the software or hardware stack supporting the model. Early detection of performance degradation may be supported through routine sampling of data for manual classification or the use of externally test datasets. Post deployment, there is need for continuous monitoring and assessment of AI models to ensure ongoing compliance, safety and efficacy.

## CONCLUSION

The rapidly evolving field of AI and ML bears great promise for elevating all stages of the pharmaceutical product lifecycle. Opportunities abound, but agencies strongly believe that efforts should be made in all organizations to reciprocally integrate AI/ML model development and deployment with a human centric, accountable and transparent approach in compliance within the existing legal framework and with true representativeness of data. Agencies will continue to solicit feedback and establish channels of collaboration towards building a foundation for future work in this domain.

## REFERENCES

[1]. "Using artificial intelligence and machine learning in the development of drug and biological products.," FDA, May 2023. https://www.fda.gov/media/167973/download

[2]. Artificial Intelligence Medical Devices (AIMD) Working Group, "Machine Learning-enabled Medical Devices: Key terms and Definitions," 2022. [Online]. Available: https://www.imdrf.org/sites/default/files/2022-05/IMDRF%20AIMD%20WG%20Final%20Document%20N67.pdf

[3]. European Medicines Agency, "Reflection paper on the use of Artificial Intelligence (AI) in the medicinal product lifecycle," report EMA/CHMP/CVMP/83833/2023, Jul. 2023. [Online]. Available: https://www.ema.europa.eu/en/documents/scientific-guideline/draft-reflection-paper-use-artificial-intelligence-ai-medicinal-product-lifecycle_en.pdf

[4]. World Health Organization, "Regulatory considerations on artificial intelligence for health," 2023. [Online]. Available: https://iris.who.int/bitstream/handle/10665/373421/9789240078871-eng.pdf?sequence=1

[5]. Pistoia Alliance, "Lab of the Future Report 2023 - Pistoia Alliance," Pistoia Alliance, Oct. 03, 2023. https://www.pistoiaalliance.org/lab-of-the-future-report-2023/

[6]. European Pharmaceutical review, "Pharma Horizons report on artificial intelligence," Jan. 2024.