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# IMPACT OF ARTIFICIAL INTELLIGENCE ON THE DEVELOPMENT OF THE PHARMACEUTICAL INDUSTRY WITH THE IMPLICATIONS OF IPR

**Ms. Sushree Devashrita**
Research Scholar, Vivekananda Global University

**Dr. Shilpa Rao Rastogi**
Associate Professor, Vivekananda Global University

**Dr. Sonia Dutt Sharma**
Associate Professor, Vivekananda Global University

**Abstract**
This paper explores the transformative impact of Artificial Intelligence (AI) in the pharmaceutical industry and its implications for Intellectual Property Rights (IPR). It highlights the key contributions of AI across drug discovery, clinical trials, and personalized medicine, revolutionizing these critical aspects of pharmaceutical research. AI accelerates drug discovery, streamlines clinical trials, and personalizes treatments, offering the potential for faster, more cost-effective and patient-centric healthcare solutions.
However, alongside these advancements, the paper underscores the multifaceted challenges posed by AI in the realm of IPR. It delves into the intricacies of patentability for AI-generated inventions and addresses issues of data ownership, privacy, and ethical considerations. The paper emphasizes the urgent need for adaptations in IPR laws and regulations to align with the evolving landscape of AI-driven innovation in pharmaceuticals, striking a balance between protecting intellectual property and fostering collaboration and ethical use of AI technologies for the betterment of healthcare worldwide.
**Keywords:** Artificial Intelligence (AI), Intellectual Property Rights (IPR), pharmaceutical industry, healthcare.

## 1. Introduction

The pharmaceutical industry plays a pivotal role in global healthcare by researching, developing, and manufacturing drugs and therapies to improve human health. It's a multifaceted sector encompassing drug discovery, clinical trials, regulatory approvals, and drug production. With a continuous need for innovation, the industry is highly research-intensive and capital-intensive. In recent years, Artificial Intelligence (AI) has appeared as a transformative strength within healthcare and the pharmaceutical sector (Kulkov, 2021). AI leverages machine learning algorithms and data analytics to expedite drug discovery, enhance clinical trial efficiency and optimize drug repurposing. Its ability to analyze vast datasets and predict potential drug candidates has accelerated research processes, reduced costs, and brought promising therapies to market faster. As AI continues to gain prominence, its impact on pharmaceutical development is becoming increasingly significant, revolutionizing how drugs

are researched, developed, and delivered to patients (Cai et al., 2018). This transformation is not only reshaping the industry but also raising critical questions about Intellectual Property Rights (IPR) and their implications in both India and the USA.

Below are the research question and objectives of this research paper:

**Research Question:**

"What is the influence of Artificial Intelligence (AI) on the pharmaceutical industry's development, and how does Intellectual Property Rights (IPR) affect this transformation in India and USA?"

**Objectives:**

- To examine the current applications of AI in pharmaceutical research and development processes, including drug discovery, clinical trials, and drug repurposing by comparing pharmaceutical industry of India and USA.
- To analyze the impact of AI-driven advancements on the speed, efficiency, and cost-effectiveness of pharmaceutical innovation by comparing pharmaceutical industry of India and USA.
- To investigate the legal and ethical challenges posed by AI-generated inventions and data-driven drug development, with a focus on IPR issues such as patentability, ownership, and licensing in India and USA.
- To assess the strategies and approaches adopted by pharmaceutical companies to protect their intellectual property rights in the context of AI-driven innovations and to explore the implications of these strategies for competition and collaboration within the industry.

## 2. Literature Review

### Historical context of AI in pharmaceuticals

The integration of Artificial Intelligence (AI) into pharmaceuticals represents a remarkable evolution in the industry's history. The roots of this integration can be traced back to the early 2000s when computational approaches began to gain traction in drug discovery (Thakur et al., 2020). Initially, these methods focused on molecular modeling and simulating chemical interactions, aiding in the identification of potential drug candidates (Vora et al., 2023). However, the true breakthrough came with the initiation of deep learning and machine learning techniques, which significantly expanded AI's capabilities in pharmaceutical research.

Around the mid-2010s, AI-powered algorithms started to excel in data analysis, enabling the processing of vast volumes of biological and clinical data. This development coincided with the growth of genomics, proteomics, and electronic health records, providing a wealth of information for AI systems to leverage (Bajorath et al., 2020). Consequently, AI-powered platforms began to demonstrate their potential in target identification, biomarker discovery, and even predicting patient responses to specific treatments. These advancements marked a turning point, ushering in a new era of drug discovery and development, where AI became an indispensable tool for pharmaceutical companies striving to expedite the delivery of innovative therapies to patients while minimizing costs and risks (Bhattamisra et al., 2023). Today, AI's historical context in pharmaceuticals serves as a testament to the industry's commitment to harnessing cutting-edge technology to address complex medical challenges.

Impact of AI in drug discovery, development, and healthcare

The impact of Artificial Intelligence (AI) in drug discovery, development, and healthcare has been nothing short of revolutionary. AI technologies have transformed these domains by significantly accelerating processes, reducing costs, improving efficiency, and enhancing the quality of patient care (Shaheen, 2021). Here, we delve into the multifaceted influence of AI across these critical areas:

Drug Discovery: AI has breathed new life into the drug discovery process. Traditionally, identifying potential drug candidates was a laborious and time-consuming task. AI, powered by machine learning algorithms, has revolutionized this phase by analyzing vast datasets and predicting potential drug candidates with remarkable accuracy (Paul et al., 2021). AI-driven drug discovery leverages computational methods to identify molecules that have the desired therapeutic properties. These algorithms can analyze biological data, understand complex molecular interactions, and predict how different compounds will behave within the human body. This not only expedites the identification of promising drug candidates but also reduces the number of failed experiments, saving both time and resources (Mak and Pichika, 2019). Furthermore, AI is adept at identifying drug repurposing opportunities – finding new therapeutic uses for existing drugs. This approach not only saves years of development time but also reduce costs significantly. By repurposing existing drugs, pharmaceutical companies can quickly bring effective treatments to market, benefiting patients worldwide.

Clinical Trials: AI has had a profound impact on clinical trials, which are critical for evaluating the safety and efficacy of new drugs. AI can streamline various aspects of the clinical trial process, from patient recruitment to data analysis.

- Patient Recruitment: Identifying and enrolling suitable participants for clinical trials can be a lengthy process. AI algorithms can analyze patient data from electronic health records and identify potential candidates, matching them with specific trial criteria (Manne and Kantheli, 2021). This not only accelerates recruitment but also ensures that trials are conducted with a diverse and representative patient pool.
- Predictive Analytics: AI can predict patient outcomes and potential adverse events during clinical trials. By analyzing data in real time, it can provide early warnings of potential issues, allowing researchers to adjust trial protocols as needed (Bender and Cortes-Ciriano, 2021). This enhances patient safety and trial efficiency.
- Data Management: Clinical trials generate enormous amounts of data. AI tools can efficiently manage and analyze this data, extracting valuable insights and speeding up the decision-making process (Manne and Kantheli, 2021). This can lead to faster trial completion and the ability to bring life-saving drugs to market sooner.

**Healthcare: In healthcare, AI has been transformative across multiple dimensions:**

- Diagnosis and Risk Prediction: AI-driven diagnostic tools can analyze medical images, such as X-rays and MRIs, with exceptional accuracy. These tools can help identify diseases and conditions at an earlier stage, improving patient outcomes. AI can also predict patient risks, enabling proactive interventions to prevent adverse health events.
- Personalized Medicine: AI enables the development of personalized treatment plans based on a patient's genetic makeup and medical history (Arora et al., 2021). By analyzing vast amounts of patient data, AI can recommend the most effective therapies, reducing the trial-and-error approach to treatment and minimizing side effects.

- Drug Management: AI is used to optimize medication management. It can help healthcare providers ensure that patients adhere to prescribed medications, reducing medication errors and hospital readmissions.
- Healthcare Operations: AI plays a significant role in healthcare operations by optimizing resource allocation, predicting patient admission rates, and improving hospital efficiency. This can lead to cost savings and better patient care.

**Relationship between AI and IPR in the pharmaceutical sector**

The relationship between AI and IPR in the pharmaceutical sector is complex and evolving. AI-driven innovations in drug discovery and development have raised critical questions surrounding IPR, including patentability, ownership, and licensing.

Firstly, the issue of patentability is central. AI-generated inventions challenge traditional notions of inventorship. In many jurisdictions, patent laws require that an invention be created by a human. However, AI systems are increasingly playing a creative role in identifying novel drug candidates and optimizing molecular structures. This blurs the line between human innovation and AI-driven discovery, leading to debates about whether AI-generated inventions should be eligible for patent protection and, if so, who should be considered the inventor (Modic et al., 2019). Resolving these questions is essential to providing pharmaceutical companies with the incentives and protections needed to invest in AI research.

Secondly, ownership and licensing agreements are critical in the context of AI in pharmaceuticals. When AI systems are employed by pharmaceutical companies, questions arise about who owns the data generated by AI and who has the right to use and license it. Additionally, AI may involve the use of external datasets, which could have their IPR considerations. Companies must navigate complex legal frameworks to establish clear ownership and licensing agreements, which are pivotal for collaborations, partnerships, and the sharing of data and AI models within the industry. Balancing the need for collaboration and innovation with protecting IPR rights is an ongoing challenge in the pharmaceutical sector's AI-driven landscape (Chowdhury et al., 2019). Overall, the evolving relationship between AI and IPR in pharmaceuticals highlights the need for legal and regulatory frameworks to adapt to the rapidly changing technological landscape while fostering innovation, collaboration, and the protection of intellectual property.

## 3. Methodology

For this research on the implications of Intellectual Property Rights (IPR) in the context of AI in pharmaceuticals, a comprehensive data collection and analysis approach using secondary sources has been employed (Snyder, 2019). The primary sources of data include academic papers, industry reports, and case studies from reputable sources.

**Data Collection:**

- Academic Papers: A systematic review of peer-reviewed academic papers related to AI in pharmaceuticals and IPR has been conducted. This involved searching databases such as PubMed, IEEE Xplore, and academic journal repositories to gather scholarly insights and findings on the subject.
- Industry Reports: Industry reports from pharmaceutical research organizations and consulting firms have been accessed to gain a broader perspective on the current trends, challenges, and opportunities related to AI adoption in the pharmaceutical sector

(Bairagi and Munot, 2019). These reports provide valuable insights into industry-specific IPR issues and practices.

- Case Studies: Real-world case studies of pharmaceutical companies that have integrated AI into their drug discovery and development processes have been examined. These case studies offer practical examples of how IPR considerations are navigated in the pharmaceutical industry.

**Data Analysis:** The collected data has been analyzed through a thematic analysis approach. Key themes related to IPR in the context of AI applications in pharmaceuticals, such as patentability challenges, ownership disputes, licensing strategies, and ethical considerations, have been identified and extracted from the literature (Zhou et al., 2022). These themes are then synthesized and discussed in the research findings to provide a comprehensive understanding of the implications of IPR in the pharmaceutical industry's AI-driven transformation.

## 4. Impact of AI on the Pharmaceutical Industry

AI has made significant strides in transforming the pharmaceutical industry across various stages, from drug discovery to personalized medicine. In drug discovery, AI-driven algorithms have demonstrated their prowess in sifting through massive datasets to identify potential drug candidates. For instance, companies like Atomwise have employed deep learning models to analyze molecular structures and predict their potential as drug candidates (Pareek et al., 2022). This approach has significantly accelerated the drug discovery process, reducing the time and cost traditionally associated with it. According to a report by McKinsey, AI can reduce drug discovery time by up to 30% and cut R&D costs by as much as 25%.

In clinical trials, AI plays a pivotal role in patient recruitment and data analysis. IBM's Watson for Clinical Trial Matching, for instance, uses natural language processing to review medical records and match patients with suitable clinical trials (Paul et al., 2021). This not only expedites the recruitment process but also enhances the chances of finding suitable participants. Furthermore, AI-powered data analytics can identify trends and potential safety issues in real time, ensuring quicker and more informed decision-making during trials. Collectively, these advancements contribute to reduced trial durations and lowered expenses (Martinez-Mayorga et al., 2020). Overall, AI's integration into pharmaceuticals holds the promise of more efficient drug development, shorter clinical trial timelines, and ultimately, more affordable and accessible treatments for patients.

## 5. Intellectual Property Rights in the Pharmaceutical Industry

Intellectual Property Rights (IPR) play a pivotal role in the pharmaceutical industry due to their multifaceted importance.

- Encouraging Innovation: Patents grant pharmaceutical companies exclusive rights to develop and market their inventions, which fosters innovation (Ayati et al., 2020). This exclusivity enables them to recoup the substantial investments required for drug research and development, thereby incentivizing the creation of new medicines.
- Protecting Investment: Copyrights safeguard the extensive research data, clinical trial results, and proprietary information that pharmaceutical companies generate during drug development (Sherwood, 2019). This protection ensures that competitors cannot exploit their investments and results in the industry's continued growth.

- Maintaining Quality Standards: Trade secrets protect manufacturing processes and formulation details, ensuring the quality and consistency of pharmaceutical products. This is crucial for patient safety and regulatory compliance.

**However, IPR in the pharmaceutical sector also faces significant challenges and controversies:**

- Patent Thickets: The proliferation of overlapping patents, often referred to as "patent thickets," can hinder competition and result in higher drug prices (Juarez-Lopez and Schcolnik-Cabrera, 2021). This can stifle innovation as smaller companies may struggle to navigate these complex patent landscapes.
- Ever-greening: Pharmaceutical companies are sometimes accused of extending their market exclusivity by making minor modifications to existing drugs, a practice known as "ever-greening." Critics argue that this delays the availability of cheaper generic alternatives.

Balancing the need for innovation with access to affordable medicines remains a contentious issue in the pharmaceutical industry, making IPR an ongoing subject of debate and regulatory scrutiny.

## 6. Implications of AI on IPR

AI's integration into pharmaceutical research introduces complex implications for Intellectual Property Rights (IPR). One significant challenge is the patentability of AI-generated inventions. In many jurisdictions, patents require human inventors, raising questions about the eligibility of AI-generated discoveries for patent protection (Narayanan et al., 2022). Legal frameworks must adapt to address this novel issue, determining whether AI systems themselves or the humans who create, train, and oversee them should be recognized as inventors.

Another critical consideration involves potential conflicts and legal challenges in AI-generated drug discoveries. These discoveries often involve the use of extensive datasets, some of which may have proprietary or confidential information. Pharmaceutical companies must navigate issues of data ownership, licensing, and privacy (Rosemann and Zhang, 2022). Additionally, disputes may arise over the ownership of AI-generated drug candidates, especially when multiple entities collaborate or contribute to the AI's development and training. Furthermore, ethical concerns surrounding AI-driven inventions and their potential societal impact need to be addressed (Cohen et al., 2020). Regulatory bodies and legal systems must evolve to provide clarity and guidance in this rapidly evolving landscape, ensuring that AI's role in pharmaceutical research aligns with established IPR principles and ethical considerations.

## 7. Case Studies

Case Study 1: Atomwise and Drug Discovery: Atomwise, a San Francisco-based company, employs AI for drug discovery. They used AI to identify potential treatments for Ebola and multiple sclerosis, among other diseases. The IPR implications arise from the patentability of AI-generated compounds. Atomwise's AI system screens existing molecules to discover new drug candidates, raising questions about whether AI can be listed as an inventor on patents (Nagarajan et al., 2019). This case highlights the need for legal clarity regarding AI-generated inventions.

Case Study 2: Exscientia's AI-Discovered Drug: Exscientia, a UK-based company, utilized AI to discover a new drug candidate for the treatment of obsessive-compulsive disorder (OCD).

The IPR concern here is around the ownership of the AI-generated drug candidate. Exscientia's AI algorithms played a crucial role in identifying the compound, raising questions about the division of intellectual property rights between the AI system and the human researchers who oversee it (Hasselgren and Oprea, 2023).

These case studies exemplify how AI is reshaping drug discovery and development, while simultaneously posing IPR challenges related to patentability, ownership, and collaboration within the pharmaceutical industry. Clarifying IPR rules in these contexts is essential to encourage innovation while safeguarding intellectual property rights.

## 8. Challenges and Ethical Considerations

AI-driven research in pharmaceuticals presents ethical dilemmas and potential bias issues.

**Ethical Dilemmas:**

- Data Privacy: AI relies on patient data, raising concerns about informed consent, data anonymization, and ensuring the privacy of individuals (Guan, 2019). Striking a balance between using data for research and protecting patient privacy is an ongoing challenge.
- Bias: AI algorithms can inherit biases present in the data they're trained on. This can lead to disparities in treatment recommendations, impacting patient outcomes (Naik et al., 2022). It's crucial to address bias in AI systems to ensure fairness in healthcare.
- Transparency: AI's complex algorithms can be challenging to interpret, making it difficult to explain decisions to patients and regulators (Beil et al., 2019). Ensuring transparency in AI-driven research is essential for accountability and trust.

**Data Privacy and Security:**

- Data Breaches: Handling sensitive patient data exposes pharmaceutical companies to the risk of data breaches, potentially compromising patient privacy and data security.
- Regulatory Compliance: Adhering to data privacy regulations like GDPR and HIPAA is essential (Briganti and Le Moine, 2020). AI systems must comply with these regulations, adding complexity to research processes.

**Regulatory Compliance:**

Navigating regulatory pathways for AI-driven treatments and therapies can be challenging. Ensuring that AI applications meet FDA and other regulatory standards is crucial to bring innovations to market.

## 9. Future Directions and Recommendations

The future of AI in the pharmaceutical industry holds immense promise but also demands careful consideration of policy and legal frameworks. Firstly, regulatory agencies need to develop clear guidelines for AI-generated inventions, addressing questions about inventorship and patentability. Policymakers should engage with stakeholders to create a legal framework that encourages innovation while preserving the integrity of the intellectual property system (Yang et al., 2019). This may involve recognizing AI systems as "tools" created and operated by humans, clarifying that the AI itself is not an inventor. Additionally, establishing data-sharing standards and promoting transparent AI algorithms will be critical for ethical and fair AI-driven research in the industry.

Furthermore, international collaboration and harmonization of IPR laws related to AI in pharmaceuticals should be a priority. By creating consistent standards across jurisdictions, companies can avoid conflicts and uncertainties in different markets. Policymakers should also

encourage public-private partnerships to develop AI-driven solutions for pressing healthcare challenges, incentivizing companies to share data and collaborate on drug discovery efforts. This will require a delicate balance between protecting IPR and fostering cooperation, ultimately benefiting patients by accelerating the development of life-saving treatments (Mozumder et al., 2023). As the pharmaceutical industry continues to harness AI's potential, proactive policy changes and legal adaptations will be essential to navigate the evolving landscape and ensure that the benefits of AI-driven innovation are realized while upholding ethical and legal standards.

## 10. Conclusion

In conclusion, AI's integration into the pharmaceutical industry holds the promise of transforming drug discovery, clinical trials, and personalized medicine, leading to faster, more cost-effective, and personalized treatments. However, this transformative potential is accompanied by complex Intellectual Property Rights (IPR) challenges, including questions about the patentability of AI-generated inventions and issues of data ownership and privacy. Policymakers must adapt IPR laws and regulations to accommodate AI innovations to fully harness AI's benefits. Clear guidelines on inventorship and patent eligibility for AI-generated inventions are crucial. Moreover, fostering international collaboration and data-sharing standards will facilitate innovation while ensuring ethical and legal compliance. Ultimately, striking the right balance between protecting IPR and promoting innovation will be key to realizing AI's full potential in revolutionizing pharmaceutical research and improving patient care.

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