

IMPACT OF ARTIFICIAL INTELLIGENCE AND SOCIAL MEDIA IN PHARMACOVIGILANCE

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ABSTRACT

Artificial intelligence (AI) and social science media integration is transforming pharmacovigilance in the age of customized medication. This review examines the use of AI in pharmacovigilance, such as the identification of adverse drug reactions, real-time tracking as well as customized medical care. Furthermore, the function of Social science media in risk assessment, data gathering, and patient involvement We look at communication. The article talks about the advantages and difficulties in integrating social science media with AI in pharmacovigilance, and outlines potential avenues for further study and growth. Using these tools, pharmacovigilance can be improved, and in the age of customized medical care. By improving the identification, evaluation, and avoidance of adverse drug reactions (ADRs), artificial intelligence (AI) is transforming pharmacovigilance (PV). This review looks at

how artificial intelligence (AI) technologies, such as machine learning (ML), natural language processing (NLP), and big data analytics, address current problems in pharmacovigilance (PV), such as underreporting, massive data volumes, and inefficient data processing. By automating data collection, real-time adverse event detection, and risk prediction, AI enhances drug safety through proactive risk management. AI's role in PV is developing quickly, offering more effective and precise drug safety monitoring despite obstacles in data quality, model interpretability, and regulatory compliance. The article's brief synopsis discusses how pharmacovigilance (PV) is being transformed by artificial

intelligence (AI) through improved drug-related adverse event detection, analysis, and prediction. This review emphasizes how AI improves drug safety by increasing productivity, reducing human error, and facilitating real-time analysis of large datasets from various sources.

KEYWORDS: PV(Pharmacovigilance), AI(artificial intelligence), signal detection, predictive analytics, natural language processing (NLP), Drug interaction, Adverse effect.

INTRODUCTION

Personalized medicine has revolutionized the pharmaceutical environment, requiring creative methods for pharmacovigilance. Synthetic Social science media and artificial intelligence (AI) have appeared as potential instruments for improving pharmacovigilance. This review investigates the possibilities of social science media and AI to improve unfavorable risk, patient involvement, and drug reaction detection pharmacovigilance communication. Machine learning applications of artificial intelligence algorithms and past knowledge to generate forecasts.

There has been a recent desire to incorporate more AI in pharmacovigilance of goods currently available on the market and medications in growth. Keeping an eye on and assessing the security of pharmaceutical products are the main focus of Pharmacovigilance is an essential component of medical care systems worldwide. Its significance to the public health is derived from its capacity to identify and evaluate adverse drug reactions in addition to ensuring the overall efficacy and safety of medications.

Historically, pharmacovigilance has relied on clinical knowledge, manual assessment, and post-analysis of mortem data from clinical trials, epidemiological studies, and individual case reports. However, the scalability, efficiency, and susceptibility to biases and human error of these methods were limited. AI-driven automation, which employs machine learning models, natural language processing (NLP), and complex algorithms to swiftly and efficiently assess vast quantities of real-world data sources, has revolutionized pharmacovigilance. Social media posts, adverse event reports, medical literature, electronic health records, and correlations and anomalies that may indicate new safety issues or unfavorable reactions can all be examined by AI systems. Additionally, AI-driven automation can make inferences using natural language processing (NLP). The term "pharmacovigilance" describes the identification, evaluation, tracking, and avoidance of negative drug reactions. It is a crucial

component of healthcare and scientific research, and it is crucial for keeping an eye on the efficacy and safety of medications. Since its inception in the 20th century, pharmacovigilance has expanded quickly. Pharmacovigilance was being carried out in a number of nations by the end of the 20th century. Pharmacovigilance is now widely used worldwide and subject to a number of laws. These rules are enforced to safeguard the public's health and are primarily responsible for ensuring the quality and safety of pharmaceuticals. The adverse drug reaction (ADR) is a core component of pharmacovigilance. The definition of an adverse drug reaction (ADR) is "an appreciably harmful or unpleasant reaction resulting from an intervention related to the use of a medicinal product."

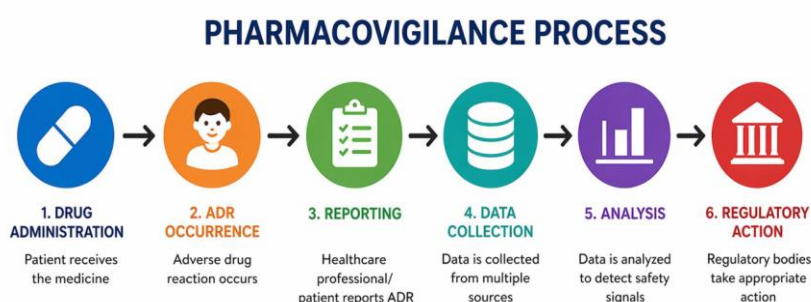


Figure 1: basic pharma covigilance process.

By hiding the actual frequency and type of adverse drug reactions (ADRs), underreporting in pharmacovigilance systems the science centered on medication safety has a substantial negative influence on patient safety. The ability to identify safety signals and make well-informed public health decisions is impacted by the startlingly high median underreporting rate of approximately 94%. Patient safety may be jeopardized if drug-related risks are not promptly identified as a result of this underreporting with the development of artificial intelligence, pharmacovigilance has seen tremendous progress.

(AI) and large data. The conventional approaches to drug safety monitoring and adverse drug reaction (ADR) detection are facing challenges as the amount and complexity of healthcare data increase. AI and machine learning (ML) technologies, such as deep learning and natural language processing (NLP), present viable ways to improve and automate pharmacovigilance procedures. These technological advancements are transforming our understanding of drug safety and increasing the effectiveness and proactivity of pharmacovigilance. However, in order to clearly identify the current constraints and direct future developments in the field, it is imperative that we take a step back and critically assess the major developments and

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- 1. AI-Powered Social Media Data Analysis:** Social media sites are now important sources of up-to-date health information. Patients frequently discuss their medication experiences, side effects, and treatment results. Adverse drug reactions (ADRs) and new safety signals can be found by using AI to mine social media sites like Reddit, Twitter, and specialty health forums. Natural language processing (NLP) and other AI models are capable of parsing unstructured text to extract useful information from patient reports, including the identification of side effects that were previously unknown.
- 2. Pharmacovigilance in Real Time:** AI algorithms, particularly machine learning models, can be used to analyze large amounts of real-time data from social media and other sources (for example, medical records and clinical trials). This enables continuous monitoring of drug safety across populations, allowing for the early detection of potential risks. For example, if multiple users report the same ADR on social media, AI can flag it as a potential safety concern for further investigation.
- 3. Targeted Monitoring and Personalized Healthcare:** Treatments in personalized medicine are customized based on a patient's genetic profile, lifestyle, and surroundings. AI can evaluate the effectiveness and safety of particular treatments for various patient subgroups by combining genomic data, drug response data, and social media reports. By tracking how people with specific genetic markers or conditions react to treatments, pharmacovigilance initiatives can be more focused.

- 4. Enhancing Drug Safety Monitoring:** By integrating social media with AI data, pharmacovigilance systems can take a more proactive approach. AI can assist in spotting signs of adverse drug reactions (ADRs) before they are formally reported through conventional channels like regulatory agencies or healthcare providers. By distinguishing between authentic ADR reports and anecdotal or irrelevant posts, it can also eliminate false positives. Pharmacovigilance systems can become more proactive by integrating AI with social media data. AI can assist in spotting signs of adverse drug reactions (ADRs) before they are formally reported through conventional channels like regulatory agencies or healthcare providers. By distinguishing between authentic ADR reports and anecdotal or irrelevant posts, it can also eliminate false positives.
- 5. Decision Support and Reporting Automation:** AI can automate the reporting of adverse events by collecting relevant data from social media posts, electronic health records (EHR), and clinical databases. This automated system can then determine which cases require further investigation or intervention. For example, when a significant number of posts identify a potential adverse drug reaction related to a specific drug, the system can alert pharmacovigilance teams, who can then review the situation and take appropriate regulatory action.
- 6. Customer Engagement and Awareness:** Social media platforms are not only data sources, but also tools for consumer engagement. Pharmacovigilance efforts can use social media to inform patients about potential drug risks and encourage them to report adverse events. Chatbots and virtual assistants powered by artificial intelligence can assist patients in understanding medication side effects and navigating reporting mechanisms.
- 7. Integration of Traditional Databases:** While AI and social media provide novel methods for detecting and analyzing ADRs, they should be integrated with traditional pharmacovigilance databases such as the FDA's Adverse Event Reporting System (FAERS) and Europe's Eudra Vigilance system. AI can cross-reference new social media signals with existing data in these databases, confirming trends and improving risk assessment accuracy.
- 8. Privacy and Ethical Issues:** Maintaining patient privacy and following ethical standards is one of the main obstacles to using social media data for pharmacovigilance. All models need to be built to extract valuable insights while safeguarding sensitive data.

WHAT IS PHARMACOVIGILANCE?

The science and activities pertaining to the identification, evaluation, comprehension, and avoidance of side effects or other drug-related issues are known as pharmacovigilance. It seeks to increase patient safety and guarantee the most efficient and secure use of medications and vaccines. Pharmacovigilance is the process of keeping an eye on the safety of pharmaceutical products after they are put on the market, collecting and evaluating data from clinical trials, patients, and healthcare professionals, and identifying any possible risks related to their use. Making regulatory decisions, directing the appropriate use of pharmaceuticals, and ultimately safeguarding public health are all aided by this field. The relevant scientific field is pharmacovigilance (PV) with the identification, evaluation, recognizing and avoiding adverse drug reactions (ADRs) and other drug-related issues. Its main goal is to guarantee that medications continue to be safe and effective throughout their entire lifecycle, from clinical trials and development to widespread use in the real world. Over time, PV's purview has grown to include biologics, vaccines, medical devices, herbal products, and traditional pharmaceuticals.

Traditionally dependent on voluntary reporting systems like post-marketing surveillance, clinical trial data, and spontaneous ADR reports, pharmacovigilance systems have encountered a number of difficulties. The efficiency and efficacy of PV processes have frequently been hampered by manual data collection and analysis, underreporting of ADRs, and delayed signal detection. Traditional pharmacovigilance systems are finding it difficult to keep up with the growing amount of data produced in the healthcare industry, including real-world data (RWD) from wearable technology, social media, and electronic health records (EHRs).

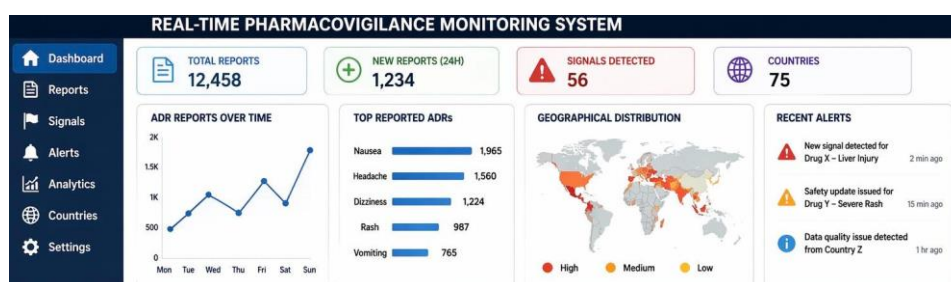


Figure 2: Real-Time Pharmacovigilance Monitoring System.

GOALS AND AIM

- 1. Boost Monitoring of Drug Safety:** AI can be used to analyze social media data and identify adverse drug reactions (ADRs) and other safety concerns in real time.
- 2. Improve the Identification of Early Signals:** Finding potential safety signals and trends in drug responses across various populations is quicker than with traditional reporting systems.
- 3. Personalized Risk Assessment:** Utilize AI-driven insights to customize pharmacovigilance tactics according to medical, genetic, and unique patient characteristics.
- 4. Increase Public Engagement:** Encourage patients to report adverse drug reactions (ADRs) and share their medication experiences on social media platforms to enhance data collection.
- 5. Enhance Regulatory Choice-Making:** Give AI-powered analytics to pharmaceutical companies and regulatory bodies so they can make better risk-benefit evaluations.
- 6. Reduce Underreporting of ADRs:** Utilize patient-generated health data on social media to address the shortcomings of traditional pharmacovigilance systems.
- 7. Facilitate Global Drug Surveillance:** Analyze multilingual and region-specific social media conversations to keep an eye on drug safety globally.

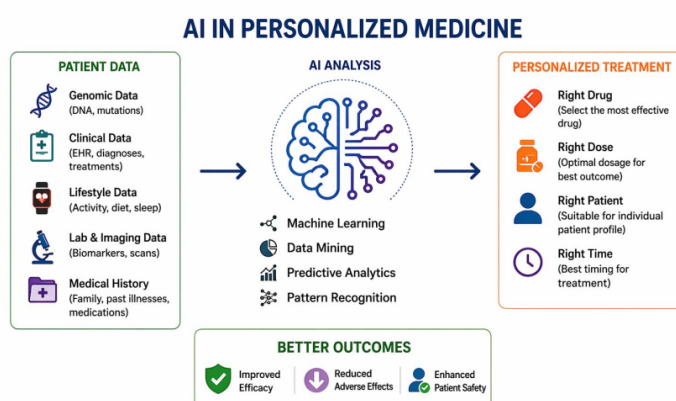


Figure 3: Ai In Personalize Medicine.

NEED FOR AI AND SOCIAL MEDIA IN PHARMACOVIGILANCE

- 1. Early Adverse Drug Reaction (ADR) Detection:** Clinical trials and post-marketing surveillance, which can be sluggish, are the foundation of traditional pharmacovigilance. Early ADR detection is made possible by social media's real-time patient-reported outcomes.
- 2. Availability of Large-Scale Patient Information:** On social media sites like Facebook, Reddit, Twitter, and health forums, millions of people share their experiences with drugs. AI is capable of processing unstructured data from these sources to find patterns in medication safety.
- 3. Customized Medication Safety Observation:** Patients' responses to medications vary depending on their lifestyle, age, and genetics. Social media data can be analyzed by AI to identify population-specific ADRs and improve individualized treatment.
- 4. Reducing ADR Underreporting:** Due to ignorance or the difficulty of formal reporting, many negative effects go unreported. Monitoring social media offers passive pharmacovigilance, recording adverse drug reactions that could otherwise be overlooked.
- 5. Improving Decision-Making in Regulation:** Social media-driven insights can help regulatory agencies (FDA, EMA) issue safety alerts and update labels more quickly.
- 6. Enhance Signal Detection:** Large datasets can be swiftly analyzed by AI to find possible safety signals, saving time and effort compared to manual analysis.
- 7. Improved Reporting of Adverse Events:** By automating the reporting process, AI-powered tools can lower errors and enhance report quality.
- 8. Analytical Prediction:** AI can forecast possible safety problems by analyzing past data, allowing for proactive steps to stop unfavorable outcomes.
- 9. Customized Healthcare:** AI can assist in customizing pharmacovigilance for each patient, taking into consideration their distinct lifestyle choices, medical histories, and genetic profiles.

- 10. Real-time Information Gathering:** Real-time data on unfavorable events can be obtained from social media platforms, allowing for faster detection and reaction.
- 11. Involvement of Patients:** Social media can encourage patient participation and adverse event reporting, offering insightful information for pharmacovigilance.
- 12. Communication of Risk:** Patients, medical professionals, and the general public can all receive safety information via social media.
- 13. Analysis of Sentiment:** Social media analytics can be used to track public opinion and worries about pharmaceuticals, allowing for the proactive resolution of possible safety concerns.

ROLE OF AI AND SOCIAL MEDIA IN PHARMACOVIGILANCE

- 1. Artificial Intelligence in Pharmacovigilance:** By offering sophisticated tools for data collection, analysis, and decision-making, artificial intelligence (AI) technologies, such as machine learning (ML) and natural language processing (NLP), can improve pharmacovigilance.
- 2. Among the ways AI helps are:** Predictive Analytics for Drug Safety: To detect possible adverse drug reactions (ADRs) before they spread widely, artificial intelligence (AI) can examine enormous volumes of healthcare data, such as electronic health records (EHRs), clinical trial data, and post-marketing surveillance.
- 3. Social Media in Pharmacovigilance:** Social media and other social science media platforms, internet discussion boards, and additional public health channels of communication offer real-time, crowdsourced data that can make a substantial contribution to pharmacovigilance.
- 4. Adverse Event Reporting in Real Time:** Social media sites like Facebook, Twitter, and patient-specific forums frequently see people talking about their experiences with drugs, including adverse reactions. Although not always rigorous from a scientific standpoint, this information can act as a warning system for identifying ADRs. These platforms can be monitored by AI tools for pertinent discussions, spot trends, and warn regulatory agencies or medical specialists of possible issues with safety.

5. **Public Attitude and Perception of Risk:** Social media gives information about public opinion and sentiment. in relation to drugs. Through online analysis conversations, medical organizations and pharmaceutical businesses are better able to comprehend how patients feel regarding a specific medication, including their worries regarding adverse effects or effectiveness. This data is useful to modify safety or improve communication tactics cautions.
6. **The Combination of AI and Social Media:** AI and social science media can work in tandem to improve pharmacovigilance. Improved Data Gathering: AI is capable of instantly analyzing data from social media sites to spot warning signs of negative drug reactions. AI can create a more comprehensive safety profile for medications by merging this with structured data from clinical trials and EHRs.
7. **Better Decision-Making:** By incorporating real-world data from social media, AI models can help pharmaceutical companies and healthcare providers make better decisions regarding drug safety while also making sure that patient-specific factors are taken into consideration. AI and social media data can both yield personalized medical insights. While social media data provides a more comprehensive understanding of patient experiences and outcomes, AI can use genetic and health data to predict individual drug responses. In the age of personalized medicine, they offer a more comprehensive approach to pharmacovigilance.

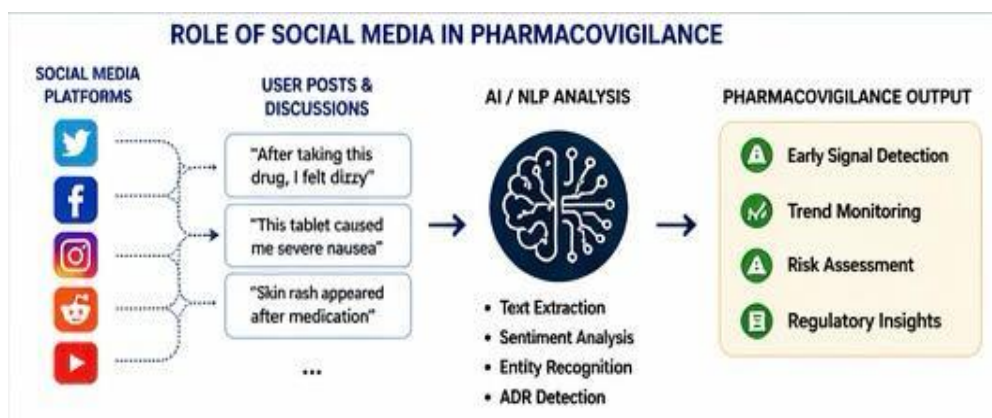


Figure 4: role of social media in pharmacovigilance.

Essential characteristics

1. Data Analysis and Integration

AI systems can process and evaluate a variety of patient datasets, including genomics, proteomics, and clinical records, to give each patient a customized treatment based on their genetic composition, lifestyle choices, and disease features.

2. Monitoring in Real Time

AI-powered in order to identify subtle indicators of adverse events and forecast possible safety issues with previously unheard-of accuracy, pharmacovigilance systems continuously monitor enormous streams of real-world evidence, such as social media and electronic health records.

3. Machine for Signal Analysis

By finding patterns and correlations in massive datasets, machine learning models can improve the efficiency of pharmacovigilance procedures and detect the safety of signals.

4. Patient-Centric Approaches

By capturing patient experiences and viewpoints that might not be reported through conventional channels, social media data enables a more patient-centric approach to pharmacovigilance.

5. Regulatory Considerations

Establishing high-quality databases, guaranteeing adequate human resources, and securing government support are all obstacles that must be overcome for the integration of AI in pharmacovigilance, especially in environments with limited resources.

ADVANTAGES

- 1. Early Identification of Adverse Drug Reactions (ADRs):** Compared to conventional reporting systems, AI algorithms are able to identify possible ADRs earlier by processing enormous volumes of data from social media platforms. For example, research on the Levothyrox case in France has shown how successful AI-based methods are at identifying safety signals from social networks.
- 2. Customized Safety for Patients Assessment:** AI identifies clusters of adverse events that may indicate syndromes linked to particular medications, enabling a more customized approach to patient safety. In the end, this helps healthcare professionals make well-informed decisions by enabling the prediction and prevention of ADRs through real-world data-based predictive models.

3. **Complete Safety Monitoring:** AI-powered wearable technology, social media, electronic health records, and patient-reported outcomes are just a few of the real-world evidence streams that pharmacovigilance systems can continuously monitor. This thorough monitoring improves the ability to identify vulnerable patient populations, detect subtle adverse event signals, and predict possible safety issues with previously unheard-of accuracy.
4. **Enhanced Accuracy and Efficiency:** The AI's automation capabilities simplify pharmacovigilance procedures, decreasing manual workloads and reducing human error. This results in more accurate and efficient drug safety monitoring.
5. **Better Safety Monitoring:** By integrating AI and social media, safety monitoring can be improved and adverse events can be detected and responded to more quickly.
6. **Increased Patient Involvement:** By facilitating patient involvement and adverse event reporting, integration can offer insightful information for pharmacovigilance.
7. **More Effective Risk Communication:** By utilizing social media platforms to share safety information with patients, medical professionals, and the general public, integration can facilitate more effective risk communication.
8. **Personalized Pharmacovigilance:** Integration can assist in customizing pharmacovigilance for each patient, accounting for their distinct lifestyle choices, medical histories, and genetic profiles.



Figure 5 Benefits Of Ai In Pharmacovigilance.

APPLICATIONS

1. ADR using Natural Language Processing (NLP) Identification: Unstructured text data from social media can be analyzed by AI models, especially those that use natural language processing (NLP), to extract pertinent information about ADRs.

For instance, studies have demonstrated that AI-based methods can successfully identify possible pharmaceutical safety signals by examining comments and reviews left by patients on social media.

2. Predictive Modeling for Risk Assessment: AI makes it possible to create predictive models that evaluate the possible dangers connected to drug use. These models assist healthcare providers in making well-informed decisions about patient safety by estimating possible risks through the analysis of real-world data.

3. Integration with Telehealth Services: By raising the standard of pharmacovigilance, AI can improve telehealth procedures. AI techniques, for example, can be used to examine data gathered through telehealth services, thereby enhancing the monitoring of patient safety and medication effects in real-time.

4. Adverse Event Detection and Reporting: Faster reporting and analysis are made possible by AI-powered social media monitoring, which can promptly detect adverse event reports.

5. Patient Support and Engagement: Social media platforms can help patients who are having negative experiences by offering resources and support.

6. Pharmacogenomics and personalized medicine: AI can forecast possible side effects by analyzing genetic information and medical histories allowing for individualized pharmacovigilance.

7. Real-time Safety Monitoring: AI-powered social media monitoring can offer real-time safety monitoring, allowing for the prompt identification and handling of unfavorable incidents.

8. Risk Mitigation and Communication: By disseminating safety information to patients, medical professionals, and the general public via social media, possible risks can be reduced.

- 9. Sentiment Analysis and Public Perception:** Social media analytics can track public opinion and worries about drugs, allowing for preventative actions to deal with possible safety hazards.
- 10. Predictive analytics and modeling:** AI is capable of analyzing sizable datasets to forecast possible safety concerns, allowing for preventative actions to avert unfavorable outcomes.



Figure 6: Applications of Ai In Drug Safety.

FUTURE SCOPE

- 1. Increased Use of Machine Learning and AI:** Broad use of AI and machine learning algorithms in pharmacovigilance to enhance the identification, reporting, and analysis of adverse events.
- 2. Electronic Health Record Integration (EHRs):** AI-powered integration pharmacovigilance systems with EHRs to enhance data analysis, completeness, and accuracy.
- 3. Extension to Orphan Drugs and Rare Diseases:** Application of AI-powered pharmacovigilance to orphan medications and rare diseases, where reporting adverse events is essential and data is limited.
- 4. Creation of Customized Pharmacovigilance Models:** Development of customized pharmacovigilance models that consider medical histories, genetic profiles, and unique patient characteristics. Enhanced Attention to Patient-Reported Results incorporating patient-reported outcomes (PROs) into pharmacovigilance systems to enhance the identification, reporting, and analysis of adverse events.

5. **Organic Processing of Languages (NLP) Developments:** NLP algorithms have been improved to better analyze and comprehend adverse event reports from EHRs, social media, and other sources.
6. **Enhanced Utilization of Real-World Data (RWD):** Increasing use of RWD, including social media data, to enhance adverse event detection and guide pharmacovigilance decisions.
7. **Development of Hybrid AI Models:** To enhance pharmacovigilance decision-making, hybrid AI models are developed by fusing traditional rule-based systems with machine learning algorithms.
8. **Resolving Data Quality and Standardization Issues:** Resolving issues with data quality, interoperability, and standardization to guarantee smooth integration of AI-driven systems for pharmacovigilance.
9. **Providing Explainability and Transparency:** To promote trust and understanding among stakeholders, including patients, healthcare providers, and regulatory bodies, transparent and comprehensible AI models are being developed.
10. **Promoting Cooperation and Information Exchange:** Promoting cooperation and information exchange among interested parties in order to progress the creation and application of AI-powered pharmacovigilance systems.
11. **Defines Research Objectives:** A well-defined scope aids in defining the research objectives, guaranteeing that the study remains pertinent and focused.
12. **Identifies Important Stakeholders:** Knowing the scope makes it easier to identify important stakeholders, such as patients, medical professionals, regulatory bodies, and pharmaceutical firms.
13. **Relevance and Impact:** A well-defined scope guarantees that the study is pertinent and has a major influence on pharmacovigilance procedures.
14. **Growing Acceptance of AI-Powered Pharmacovigilance:** AI-powered pharmacovigilance is widely used systems in regulatory bodies, healthcare institutions, and pharmaceutical companies.

- 15. Extension to Orphan Drugs and Rare Illnesses:** Use of AI-powered pharmacovigilance for orphan medications and rare diseases, where adverse event reporting is essential and data is limited.
- 16. Creation of Customized Pharmacovigilance Frameworks:** Development of customized pharmacovigilance models that consider genetic profiles, medical histories, and unique patient characteristics.
- 17. Electronic Health Record (EHR) Integration:** Including AI-powered EHR-based pharmacovigilance systems to enhance data analysis, completeness, and accuracy.
- 18. Enhanced Attention to Patient-Reported Results:** incorporating patient-reported outcomes (PROs) into pharmacovigilance systems to enhance the reporting, analysis, and detection of adverse events.
- 19. Trend Development of Hybrid AI Models:** The development of hybrid AI models that enhance pharmacovigilance decision-making by fusing conventional rule-based systems with machine learning algorithms.
- 20. Broad Acceptance of AI-Powered Pharmacovigilance in Low-Resource Environments:** The application of AI-driven pharmacovigilance in low-resource environments, where access to medical care and pharmacovigilance knowledge is restricted.

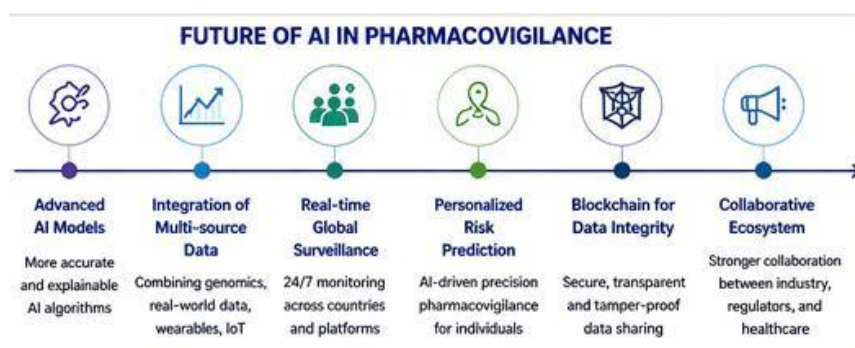


Figure 7: Future of Ai In Pharmacovigilance.

CONCLUSION

By utilizing the vast amount of real-time patient experiences shared online, integrating artificial intelligence (AI) with social media monitoring offers a potent tool for greatly

improving pharmacovigilance in the era of personalized medicine. This allows for faster detection of adverse events, improved safety signal identification, and a more patient-centric approach to drug safety monitoring, ultimately leading to better treatment decisions and improved patient outcomes. In the age of personalized medicine, the combination of social media and artificial intelligence (AI) has the potential to completely transform pharmacovigilance. Pharmacovigilance can be improved by utilizing social media data and AI-powered analytics, allowing for faster adverse event detection and response. The applications, advantages, and future directions of AI-powered pharmacovigilance are highlighted in this review, which also emphasizes the necessity of greater adoption, cooperation, and innovation in this area.

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