International Journal of Pharmaceutical Research and Applications
Volume 9, Issue 2 Mar-Apr 2024, pp: 560-565 www.ijprajournal.com ISSN: 2249-7781

# Artificial Technology in Pharmacovigilance

Deepesh Chouhan

Submitted: 16-03-2024 Accepted: 30-03-2024

Pharmacovigilance is the science and activities related to detecting, evaluating, understanding and preventing adverse effects or problems related to another drug. Artificial Intelligence (AI) and other advanced technologies are being increasingly integrated into pharmacovigilance processes to increase efficiency, accuracy and overall effectiveness. Here are some of the ways in which artificial technology is being used in pharmacovigilance:

**AUTOMATED SIGNAL DETECTION**: AI algorithms can analyze large datasets, including electronic health records, social media, and other sources, to identify potential signals of adverse drug reactions (ADRs). These algorithms can recognize patterns and associations that may not be easily apparent with traditional methods.

**DATA MINING AND TEXT ANALYSIS**: Natural language processing (NLP) and machine learning algorithms can extract valuable information from unstructured text data, such as medical literature, social media, and patient records. This helps identify potential safety concerns and trends related to specific drugs.

**PREDICTIVE ANALYTICS**: AI can be used for predictive modeling to anticipate potential security issues before they become widespread. By analyzing historical data and patterns, AI algorithms can predict which drugs may be more likely to cause adverse reactions, enabling proactive risk management.

**AUTOMATION OF CASE PROCESSING**: AI technologies can automate the initial processing of adverse event reports, extracting relevant information and classifying incidents. This speeds up the reporting and evaluation process, resulting in faster response times.

**SIGNAL TRIAGE**: AI systems can help prioritize signals by analyzing available data and assigning risk levels. This helps pharmacovigilance professionals to focus on the most important matters first.

**RISK ASSESSMENT AND BENEFIT-RISK ANALYSIS**: AI can contribute to a more comprehensive assessment of the benefit-risk profile of medicines. By integrating diverse data sources, it helps assess the overall impact of a drug on patient safety and treatment efficacy.

**ENHANCED DATA QUALITY AND STANDARDIZATION**: AI tools can help maintain data quality and ensure standardization in adverse event reporting. This is important for efficient analysis and comparison of security data across different sources.

**EARLY DETECTION OF EMERGING SECURITY ISSUES**: AI can facilitate early detection of emerging security issues by continuously monitoring real-world data. This allows quick response to potential security concerns.

**PATIENT ENGAGEMENT AND FEEDBACK ANALYSIS**: Social media monitoring and analysis of patient forums can provide insight into patient-reported outcomes and experiences, contributing to a more patient-centric approach in pharmacovigilance.

**CONTINUOUS MONITORING**: AI enables continuous monitoring of security data in real-time, ensuring that any emerging security signals can be identified immediately.

However, it is important to note that the implementation of AI in pharmacovigilance comes with challenges, including the need for data privacy, regulatory considerations, and the need for ongoing validation and improvement of AI algorithms. Collaboration between regulatory agencies, pharmaceutical companies, and technology providers is essential to harness the full potential of artificial technology in pharmacovigilance while ensuring patient safety.

## LITERATURE REVIEW

1. Liang L(#)(1), Hu J(#)(2), Sun G(#)(3), Hong N(4), Wu G(4), He Y(4), Li Y(1), Hao T(1), Liu L(5), Gong M(6).Artificial Intelligence-Based Pharmacovigilance in the Setting of Limited Resources. Drug Saf. 2022 May;45(5):511-519. doi: 10.1007/s40264-022-01170-7. Epub 2022 May 17.

In the face of rapidly advancing artificial intelligence (AI) technologies, it is important to leverage data-driven automated methods to enhance pharmacovigilance in healthcare. This is

particularly relevant given the electronic storage of vast data related to pharmacovigilance. However, successful implementation of AI in pharmacovigilance faces challenges, especially in resource-limited settings. This review identifies four key challenges: the need for a robust database, inadequate human resources, limitations in AI technology, and inadequate government support. The analysis suggests that addressing these challenges could significantly enhance the pharmacovigilance framework in such settings. (Source: Please provide a citation of the original text).

2. Kompa B(1)(2), Hakim JB(3), Palepu A(3), Kompa KG(4), Smith M(5), Bain PA(6), Woloszynek S(7), Painter JL(8), Bate A(9)(10)(11), Beam AL(12)(13)(14). Artificial Intelligence Based on Machine Learning in Pharmacovigilance: A Scoping Review. Drug Saf. 2022 May;45(5):477-491. doi: 10.1007/s40264-022-01176-1. Epub 2022 May 17.

In a scoping review examining the impact of artificial intelligence (AI) based on machine learning in pharmacovigilance, researchers aim to understand its current use, distinguish differences from other areas, and identify opportunities for improvement. The study spanning from 2000 to September 2021 and encompassing 393 papers after screening 7744 abstracts found that 53% of studies focused on detecting security signals using traditional statistical methods. Of the studies that employed the latest machine learning techniques, 61% used off-the-shelf methods with minor modifications, while only 10% reflected current best practices and trends in machine learning. Temporal analysis has indicated increasing use of new methods such as deep learning in recent years. Despite these trends, the research concludes that the impact of AI on pharmacovigilance is still evolving, with only a limited number of studies adopting current best practices, although there are signs of changing trends.

3. Bhardwaj K(1), Alam R(1), Pandeya A(2), Sharma PK(1). Artificial Intelligence in Pharmacovigilance and COVID-19. Curr Drug Saf. 2023;18(1):5-14. doi: 10.2174/1574886317666220405115548.

The history of pharmacovigilance dates back 169 years to the death of Hannah Greiner. The thalidomide incident in 1961 marked a watershed moment, leading to systematic and regulated adverse drug reaction reporting. Focused on continued monitoring of marketed medicines for public health protection. Signal detection became the primary goal, with spontaneous reporting systems becoming widely used despite limitations such as under-reporting. The World Health Organization established the Uppsala Monitoring Center in 1978, which operated databases such as VisiFlow and VisiBase. Computational methods such as Bayesian frameworks and E-synthesis combined with social media have enhanced signal detection. India initiated a national pharmacovigilance program in 2005 by amending Schedule Y of the Drug and Cosmetic Act. Collaboration of information technology and pharmaceutical companies can leverage artificial intelligence for pharmacovigilance, an area that gained momentum after 2017, improving the quality and accuracy of information.

4. Ndagije HB(1), Walusimbi D(1), Atuhaire J(1), Ampaire S(1). Drug safety in Africa: a review of systems and resources for pharmacovigilance. Expert Opin Drug Saf. 2023 Jul-Dec;22(10):891-895. doi: 10.1080/14740338.2023.2251375. Epub 2023 Sep 7.

Pharmacovigilance in Africa has made progress, with 50 out of 54 countries participating in the WHO program for drug monitoring. Challenges include weak regulation, limited resources, and policy variations. This expert opinion, based on extensive experience, suggests solutions to implement pharmacovigilance in resource-limited settings, focusing on reporting, monitoring, available resources and the use of artificial intelligence. A literature search in June 2023 revealed diverse maturity levels in the pharmacovigilance capacity of African countries. Some have robust systems, but most lack fully functional systems. Collaboration through regional blocs could enhance joint pharmacovigilance efforts, and adoption of artificial intelligence is expected to drive sustainable practices.

5. Hauben M(1), Hartford CG(2). Artificial Intelligence in Pharmacovigilance: Scoping Points to Consider. Clin Ther. 2021 Feb;43(2):372-379. doi: 10.1016/j.clinthera.2020.12.014. Epub 2021 Jan 18.

Artificial Intelligence (AI) is playing a growing role in pharmacovigilance (PV), a multidisciplinary field. This article highlights understanding the scope of AI in pharmacovigilance (AIPV), with an aim to clarify the rules, methods, functions and data sets underlying AIPV applications. The text explores the main considerations for defining the scope of AIPV and proposes a possible working definition.

6. Kassekert R(1), Grabowski N(2), Lorenz D(3), Schaffer C(4), Kempf D(5), Roy

P(6)(7), Kjoersvik O(8), Saldana G(9), ElShal S(10). Industry Perspective on Artificial Intelligence/Machine Learning in Pharmacovigilance. Drug Saf. 2022 May;45(5):439-448. doi: 10.1007/s40264-022-01164-5. Epub 2022 May 17.

Transcelerate's report on surveys for 2019-2021 shows that member companies have adopted intelligent automation in pharmacovigilance, particularly in individual case safety reports (ICSR) processing. Robotic process automation focused on rule-based automation such as lookup and workflow, progressing from planning to implementation. Companies express continued interest in technologies such as machine learning and artificial intelligence for more humane data interpretation and decision making. Challenges include obtaining suitable training data for ML models and the need for harmonized regulatory guidance in implementing intelligent automation solutions.

7. Schmider J(1), Kumar K(2), LaForest C(3), Swankoski B(4), Naim K(5), Caubel PM(6). Innovation in Pharmacovigilance: Use of Artificial Intelligence in Adverse Event Case Processing. Clin Pharmacol Ther. 2019 Apr;105(4):954-961. doi: 10.1002/cpt.1255. Epub 2018 Dec 11.

A pilot study tested the feasibility of automating pharmaceutical safety case processing through artificial intelligence and robotic process automation. The results confirmed the feasibility of using AI to extract information from adverse event reports and evaluate case validity. The study also showed that security database data fields can serve as an alternative to annotating source documents directly, saving time and costs. The evaluation methodology used identified the most suitable vendor for further exploration in the search phase.

8. Yearb Med Inform. 2020 Aug;29(1):203-207. doi: 10.1055/s-0040-1702007. Epub 2020
Aug 21.Clinical Research Informatics.Daniel C(1)(2), Kalra D(3); Section Editors for the IMIA Yearbook Section on Clinical Research Informatics.

This study aims to summarize notable contributions to Clinical Research Informatics (CRI) and identify the best papers from 2019. A bibliographic search was conducted on PubMed using MeSH descriptors and free-text terms on CRI. The double-blind review and subsequent peer-review process resulted in the selection of the three best papers. The first paper discusses homomorphic encryption for federated analysis of real-world data with enhanced data security compliance. The second paper presents evidence from a large real-world data study on hypertension treatment using federated data networks. The third paper discusses the migration of the FDA Adverse Event Reporting System database to the OMOP common data model, enabling seamless reporting system and joint analysis of electronic health record data for pharmacovigilance. The focus in CRI is on real-world evidence generation, particularly the re-use of electronic health record data. Advances in phenotyping, data integration, semantic interoperability, and data quality assessment are making real-world data more accessible and reusable. High-quality datasets play a vital role in large observational studies, transforming clinical trials, and developing personalized care through artificial intelligence algorithms. Ongoing research areas include security, privacy, ethical and regulatory issues, and data governance.

9. Clin Ther. 2018 May;40(5):790-797. doi: 10.1016/j.clinthera.2018.02.013. Epub 2018 Mar 28.Pharmacovigilance in Crisis: Drug Safety at a Crossroads.Price J(1).

Pharmacovigilance (PV) faces unprecedented challenges due to changes in the pharmaceutical industry, the complex global regulatory environment, and the unpredictable consequences of cost-cutting measures. Demand for PV professionals exceeds talent availability, creating potential risks for companies. This situation motivates discussion on corporate and industry-level strategies to automate PV operations, collaboration with regulatory agencies, and adoption of new technologies such as artificial intelligence and machine learning. These approaches are intended to streamline regulatory compliance efforts, freeing up resources to focus on the primary mission of PV as an important public health activity, and reinvesting in new drug development.

10. OMICS. 2019 Mar;23(3):134-137. doi: 10.1089/omi.2019.0020. Epub 2019 Mar 1.Panvigilance: Integrating Biomarkers in Clinical Trials for Systems Pharmacovigilance.Şardaş S(1), Kendirci A(1).

The field of drug safety and pharmacovigilance is evolving with the inclusion of biomarkers and artificial intelligence. A recent concept called panvigilance advocates proactive testing of new drug candidates on panels of patients or healthy volunteers identified by biomarkers located at the edges of the population in terms of variability. The goal of panvigilance is to provide upper and lower bound estimates for drug performance under conditions that mimic the edges

of a population, thereby facilitating better extrapolation of pharmacovigilance signals to individuals between those edges. The three-pronged goals of panvigilance include understanding full population-scale variability, predicting pharmacovigilance signals at a global scale through biomarker knowledge, and integrating signals across stakeholders. Panvigilance is seen as a complement to pharmacovigilance, providing added value to global clinical trials and introducing a systems approach to risk governance in medicinal product development.

11. Therapie. 2023 Jan-Feb;78(1):115-129. doi: 10.1016/j.therap.2022.11.003. Epub 2022 Nov 25.

Quelle place pour l'automatisation intelligente et l'intelligence artificielle pour préserver et renforcer l'expertise en vigilance devant l'augmentation des déclarations ?

Pariente A(1), Micallef J(2), Lahouegue A(3), Molimard M(4), Auffret M(5), Chouchana L(6), Denis B(7), Faillie JL(8), Grandvuillemin A(9), Letinier L(10), Pierron E(11), Pons C(12), Pujade I(10), Rubino H(13), Salvo F(4). (13)Pfizer, Inc, 235, East 42nd Street, NYC, NY, 10007 New York, USA.

12. Front Pharmacol. 2021 Jan 14;11:568659. doi: 10.3389/fphar.2020.568659. eCollection 2020.

Artificial Intelligence in Pharmacoepidemiology: A Systematic Review. Part 2-Comparison of the Performance of Artificial Intelligence and Traditional Pharmacoepidemiological Techniques.Sessa M(1), Liang D(1), Khan AR(1)(2), Kulahci M(2)(3), Andersen M(1).

The objective of the study was to assess the performance of artificial intelligence (AI) compared to traditional pharmacoepidemiological methods. A search of Ovid Medline from 01/1950 to 05/2019 yielded 72 original articles and five reviews. Of these, 19 studies (26.4%) compared AI techniques with traditional methods. Comparisons focused on a variety of objectives, including dose prediction (31.8%), clinical response (29.5%), adverse drug reactions (20.5%), propensity score (9.1%), at-risk sub-populations (4.5% ), predicting drug consumption. (2.3%), and drug-related hospital stays (2.3%). In 50% of comparisons, AI outperformed traditional methods, with random forests (63.6%) and artificial neural networks (60.0%) being the most successful techniques. The findings highlighted that only a small portion of articles made such comparisons, and not all AI techniques were evaluated in a pharmacoepidemiological context. Nonetheless, the AI showed better performance in half of the comparisons.

13. Cureus. 2023 Aug 30;15(8):e44359. doi: 10.7759/cureus.44359. eCollection 2023 Aug.

Artificial Intelligence and Machine Learning in Pharmacological Research: Bridging the Gap Between Data and Drug Discovery.Singh S(1), Kumar R(1), Payra S(1), Singh SK(1).

Artificial Intelligence (AI) has revolutionized pharmaceutical research by leveraging machine learning, deep learning, and natural language processing. These technologies enhance drug discovery, development, and precision medicine by analyzing comprehensive biomedical data to identify potential drug targets, predict efficacy, and optimize lead compounds. AI applications in pharmaceutical research include target identification, drug repurposing, virtual screening, de novo drug design, toxicity prediction, and personalized medicine. The technology improves patient selection, trial design and real-time data analysis in clinical trials, enhancing safety and efficacy outcomes. Post-marketing surveillance uses AI to monitor adverse events, detect drug interactions, and support pharmacovigilance. Machine learning models enable accurate predictions and informed decisions, accelerating drug discovery, while deep learning, particularly convolutional neural networks, excel in image analysis for biomarker identification and drug formulation optimization. Natural language processing aids in mining scientific literature for valuable insights. However, ethical considerations arise in AI adoption, which require attention to data privacy, security, algorithm bias, transparency, informed consent, and human oversight. Responsible AI deployment mandates strong frameworks and regulations. The future of AI in pharmacological research is promising, with integration with emerging technologies such as genomics, proteomics and metabolomics for personalized medicine and targeted therapies. Collaboration between academia, industry, and regulatory bodies is critical to ethically apply AI in drug discovery. Continued research, development and comprehensive training programs will empower professionals to fully harness the potential of AI, leading to improved patient outcomes and innovative medicinal interventions.

14. Drug Saf. 2023 Apr;46(4):433. doi: 10.1007/s40264-023-01273-9.Correction to:

Artificial Intelligence Based on Machine Learning in Pharmacovigilance: A Scoping Review.

Kompa B(1)(2), Hakim JB(3), Palepu A(3), Kompa KG(4), Smith M(5), Bain PA(6), Woloszynek S(7), Painter JL(8), Bate A(9)(10)(11), Beam AL(12)(13)(14).

15. JMIR Public Health Surveill. 2022 May 27;8(5):e32543. doi: 10.2196/32543.

Artificial Intelligence-Enabled Social Media Analysis for Pharmacovigilance of COVID-19 Vaccinations in the United Kingdom: Observational Study.

Hussain Z(#)(1)(2), Sheikh Z(#)(1), Tahir A(3), Dashtipour K(4), Gogate M(4), Sheikh A(5), Hussain A(4).

The aim of the study was to evaluate AEFI-related discussions on social media regarding COVID-19 vaccines in the United Kingdom. Analyzing more than 121,406 Twitter and Facebook posts from December 2020 to April 2021, the study identified increased mentions of AEFI. Common AEFI topics include appetite, allergies, injection sites, and clots. Rarely reported AEFIs such as Bell palsy and Guillain–Barré syndrome were discussed. Public sentiment toward the vaccines and manufacturers was mostly positive (58%), with 22% negative and 19% neutral sentiment. The sentiment trend remained relatively stable, influenced by political and regulatory announcements. The study shows that social media analysis complements traditional sources for pharmacovigilance.

16. Drug Saf. 2021 Mar;44(3):261-272. doi: 10.1007/s40264-020-01030-2. Epub 2021 Feb 1.

Validating Intelligent Automation Systems in Pharmacovigilance: Insights from Good Manufacturing Practices.

Huysentruyt K(1), Kjoersvik O(2), Dobracki P(3), Savage E(4), Mishalov E(5), Cherry M(6), Leonard E(7), Taylor R(8), Patel B(9), Abatemarco D(7).

Pharmacovigilance involves monitoring medicinal product effects to identify and assess potential adverse reactions, implementing timely risk reduction measures. Intelligent automation technologies, particularly artificial intelligence (AI), promise to enhance pharmacovigilance by automating routine tasks and resource allocation. However, existing validation guidelines should be expanded to verify the fitness of intelligent automation systems, with tailored activities for documenting evidence. Three categories of intelligent automation systems are proposed, each requiring a unique verification approach. This framework is based on good automated manufacturing practices, offering a risk-based approach to AI stable systems. It empowers pharmacovigilance professionals to lead technology implementation, ensuring consideration for system creation, implementation, validation and maintenance. Their role becomes critical in bridging the gap between business operations and technological advancements for inspection readiness and global regulatory compliance.

17. Br J Clin Pharmacol. 2023 Oct 16. doi: 10.1111/bcp.15930. Online ahead of print.

Artificial intelligence and machine learning for clinical pharmacology.

Ryan DK(1), Maclean RH(1)(2), Balston A(3), Scourfield A(1), Shah AD(1)(2)(4), Ross J(1).

AI will significantly impact clinical pharmacology, impacting drug discovery, clinical trials, personalized medicine, pharmacogenomics, pharmacovigilance, and clinical toxicology. The rapid advancements in AI within healthcare require clinical pharmacologists to understand its implementation. To ensure safe and equitable outcomes, rigorous evaluation of AI tools is critical. This review introduces clinical pharmacologists to AI, including current applications, model development, and issues of evaluation and deployment. The goal is to empower clinical pharmacologists to safely and effectively lead the integration of AI into health care.

18. Ther Adv Drug Saf. 2021 Feb 10;12:2042098620985991. doi: 10.1177/2042098620985991. eCollection 2021.

Pharmacovigilance and the digital world in Italy: presentation of the results of a national survey.

Stagi L(1), Bocchi I(2), Bianco S(3), Sirizzotti G(4), Bernardini D(5), Calderazzo V(6), Pirisino G(7), Grisoni I(8), Romano S(9).

Digital transformation has facilitated information sharing in pharmacovigilance and health care products. The Pharmacovigilance Working Group "Ernesto Mantegna" conducted a survey among Italian healthcare/pharmaceutical companies to explore the role of pharmacovigilance in digital activities. Using computer-assisted web interviewing (CAWI) technology, 93 members participated, revealing ongoing digital activities with uncertainties in areas such as the inclusion of pharmacovigilance teams and governance tools for digital projects. The study emphasizes the need for updated regulations, suggesting that scientific societies such as SIMEF and PharmIndustry could

International Journal of Pharmaceutical Research and Applications
Volume 9, Issue 2 Mar-Apr 2024, pp: 560-565 www.ijprajournal.com ISSN: 2249-7781

contribute to developing guidance in coordination with authorities to standardize the approach among pharmaceutical companies.

**PHARMACOVIGILANCE FROM SOCIAL MEDIA**: An improved random subspace method for identifying adverse drug events.

Liu J(1), Wang G(2).

OBJECTIVE: Recent advances in Web 2.0 technologies have seen significant strides towards utilizing patient-generated content for pharmacovigilance. Social media-based pharmacovigilance has great potential to augment current efforts and provide regulatory authorities with valuable decision aids. Among various pharmacovigilance activities, identifying adverse drug events (ADEs) is very important for patient safety. However, in health-related discussion forums, ADEs may confound with drug indications and beneficial effects, etc. Therefore, the focus of this study is to develop a strategy to identify ADEs from other semantic types, and meanwhile to determine the drug that an ADE is associated with.

MATERIALS AND METHODS: In this study, two groups of features, i.e., shallow linguistic features and semantic features, are explored. Moreover, motivated and inspired by the characteristics of explored two feature categories for social media-based ADE identification, an improved random subspace method, called Stratified Sampling-based Random Subspace (SSRS), is proposed. Unlike conventional random subspace method that applies random sampling for subspace selection, SSRS adopts stratified sampling-based subspace selection strategy.

RESULTS: A case study on heart disease discussion forums is performed to evaluate the effectiveness of the SSRS method. Experimental results reveal that the proposed SSRS method significantly outperforms other compared ensemble methods and existing approaches for ADE identification.

## DISCUSSION AND CONCLUSION:

Our proposed method is easy to implement since it is based on two feature sets that can be naturally derived, and therefore, can omit artificial stratum generation efforts. Moreover, SSRS has great potential of being applied to deal with other high-dimensional problems that can represent original data from two different aspects.