WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 8.453
Volume 14, Issue 19, 798-821. Review Article ISSN 2277–7105

A REVIEW ON PHARMACOVIGILANCE

Sahyadri Navade[1]*, Srushti Patil[2], Prof. Nayna Khedekar[3], Dr. Tushar T. Shelke[4]

Genba Sopanrao Moze College of Pharmacy.

Article Received on
17 August 2025,

Revised on 07 Sept. 2025,
Accepted on 27 Sept. 2025

https://doi.org/10.5281/zenodo.17276906

***Corresponding Author**
Sahyadri Navade
Genba Sopanrao Moze
College of Pharmacy.

ABSTRACT

The field of pharmacovigilance is fundamental to safeguarding public health through the systematic process of detecting, assessing, understanding, and preventing adverse drug reactions (ADRs). This review examines the discipline by exploring its historical evolution, contemporary importance, key challenges, and emerging trends, with a specific focus on the Indian healthcare system. The paper outlines established methods for monitoring ADRs and discusses the integral role of clinical trials in enhancing patient safety. In light of an expanding pharmaceutical industry and the increasing complexity of modern treatments, a robust pharmacovigilance system has become indispensable. Ultimately, this review underscores that creating a strong culture of safe medicine use requires collaborative participation from healthcare professionals, regulatory bodies, and patients.

KEYWORDS: Pharmacovigilance, Adverse Drug Reaction, Drug Safety, Clinical Trials, ADR Reporting, Public Health, Drug Monitoring.

INTRODUCTION

When a patient experiences a harmful or unintended effect from a medication used at a normal therapeutic dose, it is defined as an Adverse Drug Reaction (ADR).

While all medications undergo rigorous clinical trials to prove their safety and efficacy before entering the market, these pre-market studies have inherent limitations. Clinical trials are conducted under controlled conditions with strict inclusion and exclusion criteria, often resulting in a selective patient group. Consequently, vulnerable populations such as children, pregnant women, and the elderly are frequently excluded, leaving the drug's effects on these groups largely unknown. Furthermore, variables common in real-world settings—like genetic

diversity, environmental factors, or potential drug-drug interactions—are not always fully assessed in these studies.

This is where the discipline of pharmacovigilance becomes essential. The function of pharmacovigilance as the science of post-market drug monitoring is reflected in its name, which combines the Greek word *Pharmakon* (drug) with the Latin *Vigilare* (to keep watch). In India, formal pharmacovigilance efforts commenced in 1998 with the country's inclusion in the Uppsala Monitoring Centre's global program for tracking adverse events. A key strategy within this field is the use of spontaneous reporting systems, which are vital for collecting real-world data and detecting potential safety risks early.

The core purpose of pharmacovigilance is to safeguard public health by identifying medication-associated risks, continually assessing a drug's benefit-risk profile, and promoting the rational use of medicines. It also seeks to raise public awareness about medication safety through clear communication. Achieving these objectives is not possible in isolation; it depends on a synergistic partnership among government bodies, academic institutions, healthcare professionals, the pharmaceutical industry, and the public to create an effective system for managing medication risks.

2. AIM AND OBJECTIVES

The primary aim of pharmacovigilance is to enhance patient care and promote the safe use of medicines. This overarching goal is supported by several key objectives. A fundamental objective is the early detection of unexpected or severe adverse drug reactions (ADRs), particularly for established medications, as well as identifying even minor reactions to newer drugs. Beyond detection, pharmacovigilance seeks to identify the specific risk factors and underlying mechanisms (e.g., Type A, B, C) that cause these reactions. The discipline also involves quantifying this risk by estimating the incidence, prevalence, and pharmacoeconomic burden of ADRs. Ultimately, these efforts are channeled toward improving patient safety through better medical interventions, specialized clinical training for healthcare professionals, and clear communication with the public to encourage rational medication practices.

Figure 2: Aims of Pharmacovigilance

3. Need For Pharmacovigilance

The necessity for robust pharmacovigilance stems from several interconnected factors, beginning with a fundamental humanitarian concern. The safety data available when a drug first receives marketing approval is inherently incomplete, as pre-clinical studies and controlled clinical trials (Phases I-III) do not fully capture the complexities of real-world use in a diverse general population. Continuous monitoring is therefore crucial to prevent iatrogenic harm, as fatalities resulting from medication are an unacceptable outcome. Beyond direct patient safety, pharmacovigilance delivers significant economic and social benefits by reducing the substantial financial burden that treating ADRs places on healthcare systems. Furthermore, it fosters the rational use of medicines and builds public confidence in the healthcare system. Underpinning all these reasons is a core ethical responsibility: the moral obligation to transparently communicate known risks and ensure that potential harm from medicines is systematically reported and managed.

Growing Need for Pharmacovigilance Systems[19]

The increasing demand for robust pharmacovigilance systems is driven by several factors:

1. **Limitations of Pre-clinical Safety Data**
   - Studies are conducted under highly controlled conditions that do not fully represent real-world use.
   - Small and specific sample sizes may not capture all potential risks.
   - Regulatory and commercial pressures often push for faster drug approvals, which may limit comprehensive safety evaluations.

2. **Changing Pharmaceutical Marketing Strategies**
   - More aggressive promotional practices are being adopted.
   - Drugs are now launched simultaneously in multiple countries, increasing the need for global safety monitoring.

3. **Shifting Preferences Among Stakeholders**
   - Increased reliance on newly developed drugs.
   - Growing use of medicines aimed at improving quality of life rather than just treating illnesses.
   - Movement towards self-administered therapies, requiring careful monitoring of patient safety.

4. **Ease of Access to Medicines and Information**
   - A rising trend of prescription drugs being converted into **over-the-counter (OTC)** products.
   - Widespread availability of drug-related information on the internet, leading to self-medication and potential misuse.

4. Challenges Of Pharmacovigilance

The Pharmacovigilance Programmed of India (PvPI) is an Indian government organization which identifies and responds to drug safety problems. Its activities include receiving reports of adverse drug events and taking necessary action to remedy problems. Administrationϖ Government has a key role in proper functioning of the programmed. In India, the government is the major stake–holder in the implementation of health care. It is through the public sector, the programmed can reach every nook and corner of the country.

Self-Medication: A significant challenge within India is the widespread practice of self-medication, where individuals often bypass proper medical consultation and procure drugs from a pharmacy without a valid prescription. Advertisements by the drug companies and the readily available drug over-the-counter with available pamphlets about the dose, indication, side-effects make the patients to take their own therapeutic decisions, without assistance from doctor or pharmacist.

Health Professional: Lack of continuing medical education about Pharmacovigilance and dearth of drug information led to underreporting of adverse drugs events. Most of the time,

doctors believe that they have to report only if the adverse events has a casual relationship with the products. In our country, due to low ratio of doctor to patient, most of the events are not reported due to lack of time, low motivation, ignorance and lethargy. Traditional Medicinesϖ Traditional drugs are considered safe with few side effects. The processing of natural drugs are not done properly, toxic and essential ingredients are not known most of the time, they are given for long duration and there is lack of knowledge between interaction of herbal drugs with modern medicines.

Generic Drugs: Generic drugs are becoming popular these days and they are considered safe. They are becoming the largest supplier of essential drugs in the country. So, it is utmost responsibility of the pharmaceutical industry to monitor the safety profile of the drugs even though they are considered safe.

Counterfeit drugs: Counterfeit drugs are important and underreported problem, particularly in developing countries. The proliferation of counterfeit drugs leads to negative health outcomes, including increased illness and death, which in turn erodes public trust in both medications and the healthcare system at large. The prevalence of counterfeit drugs appears to be rising and posed a greater challenge for the programmed in India. It has been to be opposed by close cooperation between drug companies, governments, or international organizations concerned with health sector in the developing country like India. Clinical Trial Monitoringϖ India is becoming hub for clinical trial in the 21st century. In most of the clinical trials, adverse drug reactions that happen due to the test drugs are goes unreported and not inform to the regulatory authority due to personal interest or for the fear of litigation. Thus, clinical trials pose a great challenge for Pharmacovigilance.

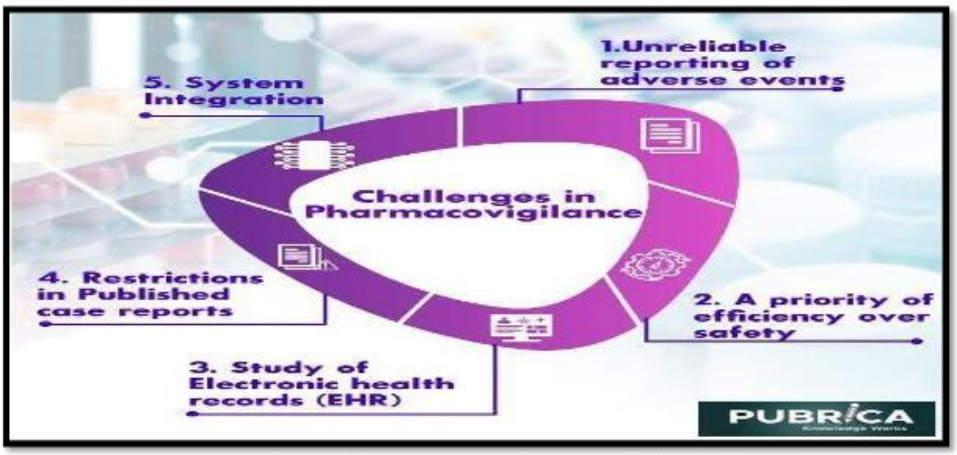

Figure 3: Challenges of Pharmacovigilance

India Challenges of Pharmacovigilance

India is a vast country and there is an excess of drug brands more than 6,000 licensed drug manufacturers and over 60,000 branded formulations. India is the fourth biggest producer of pharmaceuticals in the world and is also rising as a clinical trials hub. Many new drugs are being introduced in the country, so there is an immense need to improve the Pharmacovigilance system to protect the Indian population from potential harm that may be caused by some of the new drugs. In India, a pharmaceutical company holding the marketing license should ensure that they have adequate Pharmacovigilance system in place to ensure the responsibility and liability of their marketed products. When two or more marketed products are identical in all aspects except their trade names, each pharmaceutical company holding a marketing license is obliged to meet the Pharmacovigilance obligations. This includes establishment and maintenance of appropriate Pharmacovigilance system to collect and evaluate information about suspected adverse reactions.[21]

5. Future Of Pharmacovigilance

The future of pharmacovigilance lies in proactive monitoring, integration of digital tools, and patient-centric approaches. Social media platforms and wearable health devices are increasingly being used to collect real-time safety data.[22-24] Personalized medicine will play a key role, tailoring treatments to individual genetic and physiological profiles, but this will also create new safety and labeling challenges. Global harmonization of regulatory standards is crucial to managing risk and ensuring patient privacy across different regions.[25]

The healthcare industry is continuously evolving to improve **drug efficacy** and overall patient outcomes. This evolution is driven by advancements in technology, changing regulatory guidelines, and a growing focus on patient-centered care. As healthcare practices advance, there is a greater need to **redefine how drug safety is monitored and reported**.

Pharmacovigilance has always been a crucial element of the healthcare system, but in recent years, the emphasis on **thorough documentation, safety reviews, and transparency** has grown significantly. Stricter regulatory requirements and heightened public awareness have made drug safety a top priority for both consumers and regulatory authorities. These changes have led to global mandates for **detailed product information** submissions and increased sharing of clinical and safety data.

Understanding the emerging trends shaping the future of pharmacovigilance allows organizations to maintain compliance and ensure efficient performance while adhering to global safety standards.

Figure 4: Trends Shaping the Future of Pharmacovigilance.

1. Shift Toward Proactive Pharmacovigilance[22]

Traditionally, pharmacovigilance systems were reactive, focusing on responding to adverse events after they were reported. This approach is now being replaced by **proactive benefit-risk management systems**, which aim to prevent problems before they escalate.

A purely reactive system can result in serious consequences such as delayed drug approvals, halted clinical trials, product recalls, legal penalties, and significant reputational damage to pharmaceutical companies.

To address these risks, companies are now developing **Risk Management Plans (RMPs)** and **Risk Minimization Action Plans (Risk MAPs)**. These plans are especially crucial for high-risk products, enabling continuous monitoring and management of drug safety throughout the entire **product lifecycle**.

2. Impact of Social Media and Digital Health

The traditional healthcare model, where patients played a passive role in their treatment, is rapidly changing. Today, with the rise of **digital health devices**, mobile health applications, and social media, patients are more engaged and informed than ever before.

Social media, in particular, has become a valuable tool for sharing health-related information and monitoring drug safety. Studies show that:

- Over **40% of consumers** consider information from social media when making health decisions.[23]
- Among individuals aged **18–24 years**, nearly **90% trust health information shared by others on social platforms**.[24]
- Many adults are willing to share their personal health data online:
  - 47% with doctors
  - 43% with hospitals
  - 38% with insurance companies
  - 32% with pharmaceutical companies
  - 30% with other patients.[25]

These statistics highlight the **importance of integrating social media monitoring** into pharmacovigilance systems. By tracking online conversations, companies can detect **early signals of adverse drug reactions**, identify patient concerns, and provide accurate, timely information. This proactive approach not only supports safer drug use but also helps prevent potential legal issues and strengthens public trust.

3. Rise of Personalized Medicine

Personalized medicine is revolutionizing healthcare by tailoring treatments to each individual's unique characteristics, such as genetic makeup, anatomy, and physiology. This approach enhances the **benefit-risk balance**, increasing treatment effectiveness while reducing the likelihood of adverse reactions.

While advancements like regenerative medicine and stem cell therapies bring exciting opportunities, they also introduce new safety challenges. For instance:

- Genetic differences among individuals can lead to **unpredictable drug responses** and interactions.
- Personalized drugs often require **specialized labeling**, as they may only be safe for certain sub-populations or may require varying doses depending on patient characteristics.

Currently, over **100 approved drugs** include genomic biomarker information, such as gene mutations, expression changes, or chromosomal abnormalities, on their labels. Additionally,

when a therapy is paired with a diagnostic test, both must have **aligned and consistent labeling** to ensure accurate patient use.

4. Increasing Global Regulatory Expectations[25]

The global pharmacovigilance landscape is becoming more complex as regulatory authorities enforce **stricter rules and inspection systems**. Pharmaceutical companies must now:

- Comply with **region-specific safety regulations**.
- Interpret and integrate varying legal requirements into their corporate structures.
- Harmonize safety practices across different countries.

To meet these demands, companies must focus on essential components of modern pharmacovigilance, including:

- **Risk Management Plans (RMPs)**
- **Pharmacovigilance System Master Files (PSMFs)**
- **Periodic Safety Update Reports (PSURs)**
- **Periodic Benefit-Risk Evaluation Reports (PBRERs)**
- **Signal management and literature monitoring**
- **Adverse drug reaction (ADR) reporting**
- **Product renewals and quality oversight**

Beyond managing adverse events, **risk management** now encompasses maintaining **product quality**, protecting **patient privacy**, and ensuring **data integrity**. This broader perspective is essential for building a reliable and globally compliant pharmacovigilance framework.

6. Current Trends in Pharmacovigilance

Recent trends emphasize the use of advanced data analytics and big data to enhance ADR detection and monitoring. Outsourcing pharmacovigilance activities to specialized agencies helps reduce costs and improve efficiency. Integration of artificial intelligence and machine learning allows faster signal detection and risk assessment. These developments are aimed at improving compliance, operational efficiency, and patient outcomes.[26]

The rapid advancement in **medical and pharmaceutical sciences** has led to the development of innovative medicines capable of preventing, controlling, and managing various diseases more effectively. While these modern medicines bring significant benefits, **adverse drug reactions (ADRs)** remain a common challenge, especially with newly developed drugs.

Pharmacovigilance has therefore become an **integral part of healthcare systems**, ensuring the safe and rational use of medicines worldwide. It plays a key role in several critical areas of public health management.

Incorporation into National Drug Policies

For most countries, the first step toward ensuring drug safety is the **establishment of regulatory authorities** supported by dedicated pharmacovigilance programs. These bodies are responsible for:

- Monitoring and evaluating ADRs.
- Communicating safety concerns to relevant stakeholders.
- Ensuring that medications used by the public are safe, effective, and of high quality.

Through **post-marketing surveillance**, these regulatory authorities work closely with pharmacovigilance programs to continually assess the benefits and risks of drugs in a real-world population setting, going far beyond just approving a drug for manufacture and sale.[6]

Operational Efficiency through Outsourcing

Maintaining a highly skilled in-house pharmacovigilance team can be expensive and resource-intensive. To address these challenges, many pharmaceutical companies are **outsourcing pharmacovigilance activities** to specialized organizations.

This approach offers several advantages:

- **Reduced fixed costs**, allowing companies to manage resources more effectively.
- **Increased flexibility** in scaling operations based on workload.
- **Improved short- and long-term outcomes** through specialized expertise.

By outsourcing these functions, organizations can achieve better **regulatory compliance**, increase efficiency, and focus on strategic decision-making to improve overall drug safety and monitoring.

Using Data Analytics to Generate Insights

The healthcare sector now produces **large volumes of diverse data**, which can be a valuable resource for pharmacovigilance. By applying advanced **data analytics techniques**, life sciences organizations can:

- Identify patterns and hidden relationships in drug safety data.
- Predict potential risks and detect signals of adverse reactions earlier.

- Gain deeper insights into patient behaviors and preferences.

  Analyzing these complex datasets enables companies to **improve patient safety**, meet regulatory requirements more effectively, and develop proactive strategies for managing drug-related risks.

Big Data for Comprehensive Safety Monitoring

In recent years, the availability of **big data** has transformed the field of pharmacovigilance. These vast datasets include information from various sources, such as:

- **Signal detection** systems for identifying new ADRs.
- Verification and validation of drug or vaccine safety signals.
- **Online platforms and social media**, where patients often report their experiences and concerns.

While big data provides enormous opportunities for enhanced drug safety monitoring, its **complexity** also presents challenges. Efficiently managing, analyzing, and integrating these datasets is essential to harness their full potential.[26]

7. Methods Used in Pharmacovigilance

Pharmacovigilance employs various methods to detect and monitor ADRs. The spontaneous reporting system (SRS) is the most common and cost-effective method, relying on healthcare professionals and patients to report adverse events voluntarily.[27] However, it suffers from underreporting. Prescription Event Monitoring (PEM) collects data from electronic prescription databases, allowing non-interventional observational studies.[28,29] Intensive monitoring systems, like those developed in New Zealand, actively track specific drugs during defined periods.[30,31] Database studies, including the UK General Practice Research Database (GPRD), provide comprehensive patient records for retrospective analysis and signal detection.[32-35]

Pharmacovigilance activities can broadly be divided into three main sectors: **regulatory authorities**, **the pharmaceutical industry**, and **academic institutions**. The primary goal of **regulatory pharmacovigilance** is to ensure that medicines available to the public have a favorable **benefit–risk profile**.

Post-marketing surveillance plays a crucial role in this process, as it helps identify **adverse drug reactions (ADRs)** that may not have been detected during clinical trials. Below are

some of the key methods used for ADR detection, along with their advantages and limitations.

1. Spontaneous Reporting System (SRS)[27]

As a cornerstone of post-marketing surveillance, the Spontaneous Reporting System (SRS) is widely implemented due to its relative simplicity and cost-effectiveness in gathering drug safety data. It relies on the **voluntary reporting** of suspected ADRs by healthcare professionals, including doctors, nurses, pharmacists, and sometimes even patients themselves.

One well-known example is the **Yellow Card System** in the UK, where ADR data is collected electronically through platforms like **ADROIT (Adverse Drug Reaction Online Tracking System)**. Healthcare professionals submit reports containing details about the suspected drug, the patient, and the nature of the reaction. These reports are reviewed by experts to detect patterns that may indicate a **new safety signal**.

Often, a single report is not conclusive; therefore, multiple independent reports are needed to establish a consistent signal.

Advantages of SRS

- Covers the entire population and all marketed medicines.
- Allows continuous monitoring throughout a drug's lifecycle.
- Effective in detecting new, rare, or serious ADRs.
- Easy to establish and relatively low cost.
- Requires minimal labor compared to other methods.

Limitations of SRS

- Significant **underreporting**, as participation is voluntary.
- Difficulty in linking ADRs to a specific drug, especially when reactions are rare or have delayed onset.
- Lack of standardized data due to varied reporting practices.

2. Limitations of Clinical Trial Data[28]

Before a drug is marketed, its safety and efficacy are evaluated through **clinical trials**, typically conducted in three phases.

- **Phase III studies**, often double-blind and randomized, are considered the most rigorous for establishing cause–effect relationships.

However, when it comes to detecting ADRs, clinical trials have several limitations:

- **Small sample sizes**, which make it difficult to detect rare side effects.
- **Short duration**, which may not capture ADRs that appear after long-term use.
- **Selective populations**, as trial participants may not represent the diverse groups in the general population, such as children, elderly individuals, or those with co-morbidities.

As a result, many ADRs only become evident once the drug is introduced to the wider public.

3. Prescription Event Monitoring (PEM)[29]

Prescription Event Monitoring (PEM) is a non-interventional, observational method widely used in the UK. It involves tracking prescriptions issued by **general practitioners (GPs)** to monitor the safety of medicines after they are marketed.

How it works

- Every patient registered with a GP receives prescriptions known as **FP10 forms**.
- These forms are sent to the **Prescription Pricing Authority (PPA)** for reimbursement purposes.
- Copies of these forms are also sent to the **Drug Safety Research Unit (DSRU)** for monitoring.
- The DSRU compiles data for 20,000–30,000 patients for each monitored drug.
- After a year, a **green form questionnaire** is mailed to the GPs to collect information about the patient's experience, including any ADRs.

Key Advantages

- Non-interventional and does not interfere with physicians' prescribing decisions.
- Enables long-term tracking of drug safety in real-world conditions.
- Helps generate and test hypotheses about potential safety concerns.

  This method is highly valuable for detecting safety signals that might otherwise go unnoticed.

4. Intensive Monitoring Systems[30–31]

In the late 1970s and early 1980s, **intensive monitoring systems** were introduced in countries like **New Zealand** (Intensive Medicines Monitoring Programme) and the **UK**.

These systems focus on actively tracking selected drugs for a fixed period.

- Prescription data is used to identify patients taking a specific drug.
- Prescribers are asked to report any adverse events occurring during the monitoring period.
- The data is analyzed to detect new safety signals.

Key Features

- Non-interventional and free from inclusion/exclusion criteria, providing real-world data.
- Capable of identifying **unexpected ADRs**, even those not initially suspected.
- Helps estimate the **incidence rates** of ADRs, allowing risk quantification.
  Unlike clinical trials, this method avoids **selection bias** and reflects actual patient experiences.

5. General Practice Research Database (GPRD)[32–34]

The **General Practice Research Database (GPRD)** is one of the largest computerized databases containing **longitudinal clinical records** from primary care settings in the UK.

Contents of the Database

- Patient demographics (age, sex, etc.)
- Diagnoses and symptoms
- Laboratory test results
- Referrals to specialists
- Prescription data (drug type, dosage, quantity, and route of administration)

Since 1994, the database has been managed by the **UK Department of Health**. Each year, data is collected from approximately **3 million patients**, representing about **5% of the UK population**. This information is used to guide regulatory decision-making and improve drug safety evaluations.

6. Database Studies[35]

Database studies, such as **case–control studies** and **cohort studies**, are essential for testing specific safety hypotheses. These studies rely on **routinely collected and reliable data** from medical records and healthcare systems.

European databases such as the **GPRD** and the **PHARMO Record Linkage System** are frequently used for pharmacoepidemiological research. They enable retrospective analysis of large patient populations to detect patterns and potential drug risks.

7. Detailed Role of GPRD[36]

The GPRD plays a vital role in modern pharmacovigilance by providing a comprehensive view of patient healthcare histories.

Data Collected

- Demographics (age, sex, geographic location).
- Medical diagnoses and outcomes from routine care, hospitalizations, or emergencies.
- Prescriptions, including:
  - Date and strength of the medication.
  - Quantity and dosing instructions.
  - Indication for treatment.
  - Reasons for discontinuation.
- Other health information, such as vaccination records, pregnancy details, smoking habits, height, weight, and laboratory results.

This extensive dataset enables researchers and regulators to:

- Track trends in drug utilization.
- Identify safety concerns.
- Assess the long-term outcomes of therapies in diverse populations.

8. Clinical Trial

Clinical trials evaluate new drugs or treatments for safety and efficacy before market approval. They are divided into phases: Pre-clinical studies are conducted on animals to determine basic pharmacological properties.[36-38] Phase I involves a small group of healthy volunteers to assess safety and dosage levels. Phase II focuses on efficacy and side effect profiling in a larger group of patients. Phase III trials are large-scale studies comparing the new treatment with standard therapies.[39] Finally, Phase IV or post-marketing surveillance monitors long-term effects once the drug is commercially available.

A **clinical trial** is a research study designed to evaluate a **new medical treatment** or a new approach to using an existing treatment. The primary goal is to determine whether the treatment is safe and effective for preventing, diagnosing, or managing a disease.

Before pharmaceutical companies conduct clinical trials in humans, they must first perform **extensive pre-clinical studies** to gather data on the treatment's potential safety and effectiveness.[37]

Pre-Clinical Studies[38]

Pre-clinical studies are the first stage of drug development and involve both *in vitro* (laboratory-based) experiments and *in vivo* (animal-based) trials.

- These studies help determine the drug's **efficacy**, **toxicity**, and **pharmacokinetics** (how the body processes the drug).
- A wide range of dosages are tested to evaluate the potential benefits and risks.
- The information obtained helps researchers decide whether the drug should proceed to human trials.

This stage is critical for identifying potential safety concerns before exposing humans to the drug.

Phases of Clinical Trials

Once a drug successfully passes pre-clinical testing, it moves into **human clinical trials**, which are divided into several phases. Each phase has a specific purpose and methodology.

Phase 0 – Exploratory Trials

Phase 0 trials are small-scale, first-in-human studies introduced under the **U.S. Food and Drug Administration (FDA)** guidelines in 2006.

- They involve administering **very small, sub-therapeutic doses** to a small group of participants (usually 10–15 people).
- The main objective is to gather preliminary data on the drug's **pharmacokinetics (PK)** – how the body absorbs, distributes, metabolizes, and excretes the drug – and **pharmacodynamics (PD)** – how the drug interacts within the body.
- These trials help determine whether it is worthwhile to continue further development.

Phase I – Safety and Dosage Evaluation

Phase I trials are the first stage of testing the drug in humans, typically involving **20–80 healthy volunteers**.

The primary goals are to:

- Assess the drug's **safety and tolerability**.

- Study its **pharmacokinetics** and **pharmacodynamics**.
- Identify safe dosage ranges.

Types of Phase I studies

- **Single Ascending Dose (SAD):** A small group of participants receives a single dose, and they are observed closely to monitor safety and side effects.
- **Multiple Ascending Dose (MAD):** Participants receive multiple doses over a period of time to understand how the drug behaves with repeated administration.

Phase II – Efficacy and Safety in Patients

Once a drug shows acceptable safety in Phase I, it progresses to **Phase II trials**, which involve **20–300 participants**, including both patients and volunteers.

The objectives of Phase II are to:

- Determine **how effective** the drug is in treating the targeted condition.
- Continue safety evaluations on a larger population.

Subdivisions of Phase II

- **Phase IIA:** Focuses on determining the **optimal dose** of the drug.
- **Phase IIB:** Primarily assesses the **drug's efficacy** at the prescribed dose.

Many drug development failures occur during this phase, often because the drug does not work as expected or produces unacceptable side effects. Some trials combine **Phase I and Phase II**, allowing researchers to study both safety and efficacy simultaneously.

***Phase III – Large-Scale Comparative Studies* (39)**

To definitively establish a new drug's efficacy and safety against existing treatments, Phase III trials are conducted. These are extensive, multi-center studies that are randomized and controlled, typically enrolling a large patient population ranging from 300 to over 3,000 individuals.

Purpose

- To confirm the drug's **effectiveness** compared to existing "gold standard" treatments.
- To gather comprehensive data on **safety, benefits, and risks**.

Key Characteristics

- These trials are expensive, complex, and time-consuming.
- They often continue while regulatory review and approval processes are underway.
- Typically, at least **two successful Phase III studies** are required for approval by regulatory authorities such as:
  - **FDA (United States)**
  - **TGA (Australia)**
  - **EMEA/EMA (European Union)**

Because of their size and duration, Phase III trials provide the most reliable evidence for determining whether a drug should be approved for public use.

Phase IV – Post-Marketing Surveillance

Once a drug receives regulatory approval and becomes available to the public, its long-term performance and safety are monitored through Phase IV trials, which constitute a formal process of post-marketing surveillance.

OBJECTIVES

- To continuously monitor the **long-term safety and effectiveness** of the drug.
- To detect **rare or delayed adverse drug reactions (ADRs)** that may not have been identified during earlier trial phases.
- To provide ongoing technical support and safety data to healthcare professionals and regulatory authorities.

These studies are an essential component of **pharmacovigilance**, ensuring that drugs remain safe throughout their lifecycle.

Phase	Group
0	10-15
1	22-80
1A	Single Ascending Dose (SAD)
1B	Multiple Ascending Dose (MAD)
2	20-300
3	300-3000
4	Post Marketing Surveillance Trial

Table 2: Phase & Group

9. Future Prospects of Pharmacovigilance

Future prospects include developing a robust national pharmacovigilance system capable of detecting new ADRs quickly and accurately. Making reporting mandatory, introducing regular inspections, and training healthcare professionals will strengthen the system. Creating a centralized database for clinical trial and post-marketing data will facilitate better signal detection and public health protection.[40]

A **robust pharmacovigilance (PV) system** is essential for detecting new **adverse drug reactions (ADRs)** and implementing the necessary regulatory actions to protect public health. However, until now, limited focus has been placed on generating information that could assist **healthcare professionals** and **patients** in making well-informed decisions about medicine use.

Today, several complex issues challenge the healthcare system, including:

- Increasing **web-based sales** and online drug information,
- **Globalization** and its impact on drug safety regulations,
- Balancing **public health concerns** with **economic growth** of the pharmaceutical industry,
- Safety monitoring of both **established products** and **emerging therapies**,
- Changing **attitudes and perceptions** regarding drug benefits versus risks,
- Managing **outcomes and impacts** related to ADRs.

Given these challenges, it has become **imperative** to spread awareness about pharmacovigilance and ensure effective communication—from **ADR detection (signal generation)** to **risk management**—making it one of the core goals of PV.[27]

Need for Strengthening Pharmacovigilance in India

At present, the **Drug Controller General of India (DCGI)** must take immediate action to:

- Integrate **Good Pharmacovigilance Practices (GPP)** into clinical trials and post-marketing surveillance.
- Ensure **regulatory compliance** and enhance drug safety monitoring.

  An efficient PV system benefits all stakeholders, including **healthcare professionals, regulatory bodies, pharmaceutical companies, and patients**, by ensuring that medicines are used safely and effectively.

Currently, **post-marketing pharmacovigilance** remains a **complex and time-consuming process** for both the pharmaceutical industry and regulatory agencies. To overcome existing challenges and strengthen India's PV system, the following strategies are proposed[40]

Proposed Strategies for a Stronger PV System in India

1. **Develop and Maintain a Robust PV System**
   - Establish a nationwide, integrated pharmacovigilance infrastructure.

2. **Mandatory PV Reporting and Regular Inspections**
   - Make ADR reporting a **legal requirement** for healthcare professionals and pharmaceutical companies.

3. **Stakeholder Collaboration**
   - Conduct **high-level discussions** involving government bodies, pharmaceutical industries, healthcare providers, and patient organizations.

4. **Standardized ADR Reporting System**
   - Create a **single, country-specific ADR reporting form** to be used across all institutions and organizations.

5. **Strengthen the DCGI Office**
   - Employ **trained scientific and medical assessors** dedicated to pharmacovigilance activities.

6. **Centralized Database for Safety Monitoring**
   - Build a **national database** for serious adverse events (SAEs), suspected unexpected serious adverse reactions (SUSARs), and ADRs, enabling **signal detection** and data sharing among stakeholders.

7. **Education and Training**
   - Introduce **pharmacovigilance education** for medical students, pharmacists, nurses, and other healthcare workers.

8. **Comprehensive Drug Database**
   - Maintain a **standardized list of all new drugs and indications** for every pharmaceutical company in India, ensuring consistent post-marketing surveillance.

10. CONCLUSION

In conclusion, pharmacovigilance serves as an indispensable pillar of modern healthcare, crucial for upholding drug safety standards and optimizing patient care in an era of expanding therapeutic options. Despite significant progress, India still faces challenges such as underreporting and lack of awareness. Through integration of technology, regulatory reforms, and active participation of all stakeholders, the pharmacovigilance system can evolve to meet global standards and safeguard public health.

Pharmacovigilance (PV) in India is **continuously growing and evolving**, with ongoing improvements in systems and processes. As the **largest producer of pharmaceuticals** globally and an **emerging hub for clinical trials**, India plays a pivotal role in global drug development and safety monitoring.

The understanding of **adverse drug reactions (ADRs)** can be enhanced through several approaches, including:

- **Database studies**, which allow retrospective analysis of drug safety data,
- **Intensive monitoring systems**, which actively track selected drugs in real-world use, and
- **Spontaneous reporting systems**, which rely on healthcare professionals and patients to report suspected ADRs.

Although India has recently implemented a **well-structured national pharmacovigilance program** under the guidance of the **Central Drugs Standard Control Organization (CDSCO)** and in alignment with **World Health Organization (WHO)** recommendations, achieving the desired level of success remains a challenge.

For the PV system to function effectively, **healthcare professionals, patients, and pharmaceutical companies** must **actively report ADRs** and engage in post-marketing surveillance. Active participation from all stakeholders is vital for improving drug safety and ensuring public health protection.

Clinical Trials and Drug Development

Before any new drug reaches the market, it must undergo a series of rigorous evaluations following the **International Council for Harmonisation (ICH)** and **Good Clinical Practice (GCP)** guidelines.

The drug development process begins with **preclinical studies**, after which the **investigational new drug (IND)** enters **clinical trials**, progressing through **Phases I, II, III, and IV**.

- These phases collectively provide a comprehensive understanding of the drug's **pharmacokinetics** (how the body processes the drug) and **pharmacodynamics** (how the drug acts on the body).
- They also help identify potential **adverse effects**, evaluate both harmful and beneficial outcomes, and ensure **post-marketing surveillance** for long-term safety.

By following these steps, the safety, efficacy, and quality of new medicines can be carefully assessed before widespread use in the general population.

11. REFERENCES

1. Gupta KB, Kumar V, Vishvkarma S, Shandily R. Isoniazid-induced alopecia. Lung India, 2011; 28: 60–61.
2. Mann RD, Andrews EB. Pharmacovigilance. John Wiley and Sons Ltd, Chichester, 2002.
3. Shuka SS et al. Importance of Pharmacovigilance in Indian Pharmaceutical Industry. Asian J Res Pharm Sci., 2012; 2: 04-08.
4. WHO. Pharmacovigilance: ensuring the safe use of medicines. Geneva: WHO, 2004.
5. Mann RD, Andrews EB, eds. Pharmacovigilance. John Wiley & Sons Ltd, Chichester, 2002.
6. Vivek S. Dave, St. John Fisher College, Wegmans School of Pharmacy, Rochester, NY 14618, USA, Tel: 585-385-5297.
7. Shuka SS, Gidwani Bina, Pandey R, Rao SP, Singh V and Vyas Amber, "Importance of Pharmacovigilance in Indian Pharmaceutical Industry", Asian Journal of Research in Pharmaceutical Science, 2012; 2: 04-08.
8. Jadhav Sudhakar and Chakraborthy Guno, "Pharmacovigilance in India: Need of Hour", Journal of Advances in Pharmacy and Healthcare Research (JAPHR), 2011; 1: 01-03.
9. S Amarnath, S Jaikumar, S Basalingappa, M Thulasimani and S Ramaswamy, "Pharmacovigilance for Health Care Professional Students", Research Journal of Pharmaceutical, Biological and Chemical Sciences (RJPBCS), January-March 2013; 4: 1204-1217.
10. Muraraiah Sushma, Rajarathna Kavitha, Sreedhar Divyasree, Basavalingu Deepashri and Jayanthi C.R. "A questionnaire study to assess the knowledge, attitude and practice of

Pharmacovigilance in a pediatric tertiary care centre", Journal of Chemical and Pharmaceutical Research, 2011; 416-422.

11. Kesharwani V, Farooqui MA, Kushwaha N, Singh RK, Jaiswal PK, An overview on pharmacovigilance: a key for drug safety and monitoring, Journal of Drug Delivery and Therapeutics, 2018; 8(5): 130-135.
12. The importance of pharmacovigilance-safety monitoring of medicinal products. Geneva: World Health Organization; 2002. Available at: https://apps.who.int/medicinedocs/pdf/s4893e/s4893 e.pdf. Accessed on 01 July 2020.
13. WHOcc in Uppsala (UMC). Available at: https://www.who.int/medicines/areas/quality_safety/ safety efficacy/PV_fast_facts/en/. Accessed on 01 July 2020.
14. Talbot J, Aronson JK. Stephens' Detection and Evaluation of Adverse Drug Reactions, 6th Edition. Pharmacology & Pharmaceutical Medicine, Wiley Blackwell, 2011; 750.
15. Bates DW, Spell N, Cullen DJ (1997) He costs of adverse drug reactions in hospitalised patients. JAMA, 277: 301-307.
16. Leape LL (1994) Errors in medicine. JAMA, 272: 1851-1857.
17. Bates DW, Collen DJ, laird N (1997) Incidence of adverse drug events and potential adverse drug events in hospitalized patients. JAMA, 277: 307-311.
18. WHO (2004) Pharmacovigilance: ensuring the safe use of medicines, Geneva.
19. Int. J. Pharm. Sci. Rev. Res., May – Jun 2014; 26(2); Article No. 41, Pages: 237-241.
20. Misra A.K et.al Mintage journal of Pharmaceutical & Medical Sciences, 35-36
21. Sumit et al Journal of Drug Delivery & Therapeutics, 2013; 3(4): 237.
22. http://www.adweek.com/socialtimes/files/2012/12/social-media-healthcare.png?red=at
23. http://searchenginewatch.com/sew/news/2169462/-consumers-social-media-health-care-info- survey 3http://Gabi-
24. journal.net/safety-and-toxicity-of-biosimilars-eu-versus-us-regulation.html
25. Inácio, P., Cavaco, A., & Airaksinen, M. (2018). Current trends in Pharmacovigilance: value and gaps of patient reporting. International journal of clinical pharmacy, 40(4): 754-757.
26. Gohil KJ. World Journal of Pharmacy and Pharmaceutical Sciences., Volume 8, Issue 12: 1295-1320.
27. Gross CP, Mallory R, Heiat A et al. (2002) Reporting the recruitment process in clinical trials: who are these patients and how did they get there? Ann Intern Med., 137: 10–16.

28. Layton D, Shakir AW. Prescription even monitoring. IN: Strom BL and Kimmel SE (editors). Pharmacoepidemiology, 5th edition, chapter 20, Copyright © 2012 John Wiley & Sons, Ltd.
29. Mackay FJ (1998) Post-marketing studies: the work of the Drug Safety Research Unit. Drug Saf., 19: 343–353.
30. Mann RD (1998) Prescription-event monitoring–recent progress and future horizons. Br J Clin Pharmacol, 46: 195–201.
31. Wood L1, Martinez C. The general practice research database: role in pharmacovigilance. Drug Saf., 2004; 27(12): 871-81.
32. Rodríguez, LAG and Gutthann SP. Use of the UK General Practice Research Database for Pharmacoepidemiology. Br J Clin Pharmacol, 1998; 45(5): 419–425.
33. Härmark L, van Grootheest AC, Pharmacovigilance: Methods, recent developments and future perspectives Eur J Clin Pharmacol, 2008; 64: 743–752.
34. Strom BL, (Ed) (2005). Pharmacoepidemiology, 4th edn. Wiley, Chichester.
35. Gelfand JM, Margolis DJ, Dattani H (2005) The UK general practice research database. In: Strom BL (Ed) Pharmacoepidemiology, 4th edn. Wiley, Chichester.
36. Kulkarni SK, Hand Book of Experimental Pharmacology, 3rd ed. Vallabh Prakashan New Delhi, 2004; P21.
37. Kesharwani V, Farooqui MA, Kushwaha N, Singh RK, Jaiswal PK, An overview on pharmacovigilance: a key for drug safety and monitoring, Journal of Drug Delivery and Therapeutics, 2018; 8(5): 130-135.
38. S. B. Throat, S. K. Banarjee, D. D. Gaikwad, S. L. Jadhav, R. M. Thorat, International Journal of Pharmaceutical Sciences Review and Research, March – April 2010; 1(2): Article 019.
39. European Commission. Detailed Guidance on the Collection, Verification and Presentation of Adverse Reaction Reports Arising from Clinical Trials on Medicinal Products for Human Use. 2006. Available from: http://ec.europa.eu/health/files/ eudralex/vol-10/21_ susar_rev2_2006_04_11_en.pdf. [Accessed on 2010 Dec 10].
40. Nimesh S, Ashwlayan VD (2018) Pharmacovigilance: An Overview. Int J Pharmacovigil, 3(1): 1-6.