Pharmacovigilance: Safeguarding Drug Safety from Clinical Trials to Global Healthcare

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***Abstract*— Pharmacovigilance acts like a protective shield for monitoring and evaluating adverse drug reactions (ADRs). It plays a vital role in drug regulation, clinical practice, and public health.As the number of reported ADRs increases, the amount of data to be analyzed also grows, requiring skilled professionals to quickly identify potential drug risks and protect useful medicines from being withdrawn unfairly. The global pharmacovigilance network, coordinated by the Uppsala Monitoring Centre, could benefit from an independent review system to address major drug safety concerns that affect health across countries. Traditionally, pharmacovigilance has focused on identifying unknown or poorly understood adverse drug events, but its importance has expanded with the growth of clinical research worldwide. Today, many pharmacovigilance centers work to ensure drug safety at a global level. However, as we move forward, the field continues to face challenges in improving drug monitoring and safety systems. This review discusses the importance of pharmacovigilance, its global network, benefits, challenges, and its future role in healthcare.**

***Keywords*— Pharmacovigilance, Adverse Effect, Drug Regulation, Safety, Uppsala Monitoring Centre.**

I. INTRODUCTION

Drug safety and pharmacovigilance remains a dynamic clinical and scientific discipline. Pharmacovigilance is defined by WHO as “The science and activities relating to detection, assessment, understanding and prevention of adverse effects or any other drug related problems”. It plays a crucial role in ensuring that patients also do have right to check on the drug and make a decision when it comes to choose a drug for the treatment.

However still it is not a concern and despite all of this techniques we face the severe yet curable adverse effects which further can be the reason or cause of death. As we all know that taking wrong medicines has been a common reason leading to higher mortality rates. In order to prevent more such cases or tragedies and to reduce patient loss and improve public health measures for clinical safety and monitoring drug effects has been a prime study topic. The curated world is looking for new researches but only with the assurance which is finely a great start to considerations. Hence the pharmacovigilance topic has been focused which helps in creating a aware world with a little assurance, collective assistance and evaluation .So far the picture is been clear that pharmcovigilance would lead for the evolution in drug design and will show a potential impact on the implications favoring evolution of science. These days it has been a task to control effectively and hence also seen as a challenge to develop better care systems in global pitch. Web based sales, globalization, sale retention, broader safety concerns, levelled marketing, economic growth are some evolving challenges for developing economic products. Developing or emerging countries worldwide favor certain attitudes and perceptions to benefit and harm outcomes and impact.

1.1 Defination of Pharmacovigilance:

The World Health Organization (WHO) defines pharmacovigilance as:
" The science and activities relating to the detection, assessment, understanding and prevention of adverse effects or any other drug-related problem."(WHO, 2002)
The historical development of word “pharmacovigilance” includes the Greek word pharmakon= ‘drug or medicinal substance’ and the Latin word Vigilare= ‘to keep watch’.
Pharmacovigilance aims to demonstrate drug efficacy by long-term monitoring, ensuring public health and safety, promoting safe and cost-effective drug use, fostering education in pharmacovigilanc, and facilitating effective communication.

1.2 Objective of Pharmacovigilance:

1. To supply accurate and useful information to

patients, healthcare professionals, and regulatory authorities, and to establish systems for collecting, reviewing, and responding to feedback and reports from both patients and medical staff.

2. To improve patient safety and health by ensuring that medicines and all related medical procedures are used safely and responsibly.

3. To evaluate the effectiveness of medicines by studying how well they work — starting from laboratory research, continuing through dispensing in pharmacies, and extending to long-term monitoring for any harmful reactions.

4. To continuously observe, identify, and report serious or significant adverse effects caused by medicines.

5. To safeguard public health by promoting the safe and appropriate use of drugs.

6. To assess the benefits, risks, efficacy, and potential harm of medicines in order to ensure their safe, effective, rational, and cost-effiective.

1.3 Components of Pharmacovigilance:

Pharmacovigilance activities involve collecting, analyzing, and interpreting drug-safety information to identify and prevent adverse drug reactions. Data can be gathered directly from healthcare settings or through structured monitoring programs. Real-time collection systems help detect safety issues early, allowing faster regulatory and clinical action. However, traditional, more detailed laboratory and clinical evaluation methods remain essential, especially for confirming findings or meeting regulatory standards. Modern drug-safety systems use automated tools and digital databases to record and track adverse events. Older systems mainly relied on manual reporting and basic clinical observations, whereas current technologies integrate electronic health records, patient-reporting platforms, and artificial-intelligence-based monitoring to detect adverse reactions, medication errors, and safety signals more efficiently. Remote reporting systems and electronic communication technologies are especially useful in areas with limited medical access, enabling timely data sharing and improving global safety surveillance. Most safety studies combine routine reporting systems with advanced monitoring tools and follow international guidelines such as WHO, FDA, and EMA standards.

1.4 Constitution and Objectives of the Pharmacovigilance Programme of India (PvPI):

The Government of India established the Pharmacovigilance Programme of India (PvPI) on July 14, 2010 to promote safe use of medicines and protect public health. The All India Institute of Medical Sciences (AIIMS), New Delhi was designated as the National Coordination Centre (NCC) for this program. Initially, 22 Adverse Drug Reaction (ADR) Monitoring Centres were set up across India, including AIIMS, to collect and analyze drug-safety data. PvPI functions as a specialized national system that continuously monitors the safety of medicines and medical products used in the country. It focuses on detecting, assessing, understanding, preventing, and managing adverse drug reactions (ADRs) and other drug-related problems.

1.5 Objectives:

1. To establish a nationwide system for reporting patient safety issues.

2. To detect and evaluate new adverse drug reaction (ADR) signals from reported cases.

3. To review the benefit–risk profile of medicines in the market.

4. To generate reliable, evidence-based data on medicine safety.

5. To assist regulatory authorities in making informed decisions on drug use.

6. To share safety-related information with stakeholders to reduce risks.

7. To develop as a national centre of excellence in pharmacovigilance.

8. To collaborate with national centres for information exchange and data handling.

9. To offer training and consultancy support to pharmacovigilance centres worldwide.

1.6 CLINICAL RESEARCH:

Clinical research, also known as medical research, involves studies conducted on human participants to assess the effectiveness and safety of drugs, medical procedures, or devices used in diagnosis, treatment, or prevention of diseases. It also explores disease-related factors such as symptoms, causes, and mechanisms. A clinical trial is a structured study designed to determine how safe and effective a drug or device is for a specific condition. These trials are carried out in several stages: Phase 0 (micro-dosing studies), Phase 1, Phase 2, Phase 3, and Phase 4. Phases 0 and 2 are considered exploratory, Phase 1 is non-therapeutic, Phase 3 is confirmatory, and Phase 4 involves post-marketing surveillance. Phase 0, previously performed in animals, is now conducted in humans to assess dose tolerability and pharmacokinetics before proceeding to Phase 1 studies with healthy volunteers.

- Phase I - Safety & Dosage

Purpose: To test if the drug is safe and determine the appropriate dose range.
Participants: 20–100 healthy volunteers (or sometimes patients).
Focus: Evaluate safety, tolerability, and pharmacokinetics (how the drug moves in the body) Identify side effects.
Duration: Several months.
Success rate: About 70% move to Phase II.

- Phase II - Efficacy & Side Effects

Purpose: To see if the drug works for a specific disease or condition.
Participants: 100–300 patients with the targeted condition.
Focus: Test efficacy (does it work?),Continue monitoring safety and short-term side effects.
Duration: Several months to 2 years
Success rate: Around 33% move to Phase III.

- Phase III - Confirmation & Comparison

Purpose: To confirm effectiveness, monitor side effects, and compare with standard treatments.
Participants: 1,000–3,000 patients (large-scale).
Focus: Collect comprehensive data on safety and efficacy Support regulatory approval (e.g., FDA, CDSCO).
Duration: 1–4 years.
Success rate: About 25–30% move to Phase IV.
Regulatory review –Submit to NDA /Biological license application.

- Phase IV – Post-Marketing Surveillance

Purpose: To monitor long-term safety and real-world effectiveness after the drug is approved.
Participants: Thousands of patients using the drug under normal conditions.
Focus: Detect rare or long-term side effects, Study use in special populations (children, elderly, etc.),Evaluate cost-effectiveness and quality of life impact.
Duration: Ongoing after approval.

1.7 DCGI:

DCGI stands for Drugs Controller General of India. The DCGI is the head of the Central Drugs Standard Control Organization (CDSCO), which is a department under the Government of India. The DCGI is in charge of giving approval for certain types of medicines to be sold and used in India.
DCGI is the head of the Central Drugs Standard Control Organization (CDSCO) and the chief regulatory authority for drugs and clinical trials in India.

1.8 Key responsibilities:

DCGI operates under the Ministry of Health and Family Welfare and is responsible for:

1. Drug Approval: Approves new drugs and clinical trial protocols in India.
   Ensures drugs meet safety, efficacy, and quality standards.

2. Clinical Trial Regulation: Grants permissions to conduct clinical trials in India (Phase I–IV).Oversees Good Clinical Practice (GCP) compliance. Protects rights, safety, and well-being of clinical trial participants.

3. Import and Manufacture Licensing: Authorizes the import of drugs and medical devices.

4. Pharmacovigilance: Oversees post-marketing surveillance of adverse drug reactions (ADRs). Coordinates with Pharmacovigilance Programmeof India (PvPI).

5. Regulation of Biologicals and Vaccines
   Approves: Vaccines, Blood products,

Biotechnological drugs

6. Harmonization with International Standards
   Collaborates with: WHO, US FDA, EMA, etc.
   Promotes alignment with global drug regulatory frameworks.

1.9 Legal Authority:

DCGI works under: Drugs and Cosmetics Act, 1940
Drugs and Cosmetics Rules, 1945
New Drugs and Clinical Trials Rules, 2019

Location: Head Office of CDSCO:FDA Bhawan, Kotla Road, New Delhi – 110002, India

1.10 Functions of DCGI:

1. The Drugs Controller General of India (DCGI) has many important jobs to make sure medicines and medical products in India are safe and effective.
2. DCGI gives licenses to make and sell certain types of drugs in India, like blood products, IV fluids, vaccines, and sera.
3. DCGI sets the rules and quality standards for how drugs should be made, sold, imported, and distributed.
4. DCGI helps create and update official reference samples used to check the quality of medicines.
5. DCGI trains drug testing experts from state labs and other places. It also tests cosmetics that are collected for surveys by CDSCO.
6. DCGI is the main authority for giving licenses for medical devices. It manages and coordinates the approval of different type of devices.

1.11 CDSCO Central Drugs Standard Control Organization is the national regulatory authority for drugs and medical devices in India:

1.12 Functions:

1. Approval of new drugs
2. Clinical trial oversight
3. Import & export regulation
4. Quality control & standards
5. Licensing authority
6. Pharmacovigilance (Drug safety monitoring)
7. Medical devices regulation
8. Coordination with state drug control authorities
9. Control of banned & restricted drugs

1,13 Recent Changes in CDSCO Functions:

1. Revi1sed guidance for zonal, sub-zonal, and port offices
2. New coordination division
3. Export NOC for unapproved/banned/new drugs
4. Biological products & IVD (In-Vitro Diagnostic) devices
5. Port monitoring enhancements
6. Policy on vaccine approval

1.14 Types of Regulatory Applications:

1. Investigational New Drug
2. New Drug Application
3. Abbreviated New Drug Application

1. Investigational New Drug:
Under current federal law, a drug must be approved for marketing before it can be shipped between states. However, if a company (called a sponsor) wants to send an experimental drug to doctors or researchers in different states for testing, they need special permission. This permission is called an Investigational New Drug (IND) application. By submitting an IND to the FDA, the sponsor asks for an exception to the rule so they can legally ship the drug for clinical trials.

2. New Drug Application:
When a drug company thinks it has enough proof that a new drug is safe and works well, it sends a request to the FDA called a New Drug Application (NDA). This request includes detailed information like how the drug is made, how it works in the body, test results, and data analysis. If the FDA approves the NDA, the company is allowed to sell the drug in the U.S. Each NDA gets a special number so the FDA can keep track of it.

Once the FDA receives an NDA, the agency has 60 days to determine whether the submission is complete enough to be accepted for full review. If essential studies or required documentation are missing, the FDA may choose not to file the application. Under the Prescription Drug User Fee Act (PDUFA), the FDA's Center for Drug Evaluation and Research (CDER) aims to finish the review and issue a decision on 90% of standard NDAs within 10 months of submission. For priority-review drugs, the goal is to complete the review within six months. According to estimates from the

Tufts Center for the Study of Drug Development, only about 20% of drugs that begin clinical trials ultimately receive FDA approval.

2. Abbreviated New Drug Application:

An Abbreviated New Drug Application (ANDA) is a request to the FDA to approve a generic version of a brand-name drug. It's called "abbreviated" because it doesn't need to include animal or human testing to show the drug is safe and effective. Instead, the company must prove that their generic drug works the same way as the original. If the FDA approves the ANDA, the company can make and sell the generic drug, offering a safe, effective, and cheaper option for patients.

II. CONCLUSION

Pharmacovigilance is a vital component of modern healthcare, ensuring the safety and effectiveness of medicines throughout their life cycle. By systematically detecting, assessing, and preventing adverse drug reactions, pharmacovigilance protects patients and supports informed regulatory decisions. Global initiatives led by the World Health Organization and national programs such as the Pharmacovigilance Programme of India (PvPI) have strengthened drug safety monitoring and public health protection.

Despite advancements in technology and regulatory frameworks, challenges such as under-reporting, data management, and global coordination remain. Addressing these issues through improved reporting systems, education, and international collaboration …