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Original Article

Pharmacovigilance In Practice: Analysis Of Multiple ADR Case Studies

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ABSTRACT

Pharmacovigilance is the scientific discipline dedicated to the detection, assessment, understanding, and prevention of adverse effects of medicines. Adverse Drug Reactions (ADRs) represent a significant public health burden worldwide and are responsible for considerable patient morbidity, mortality, and increased healthcare costs. In India, the Pharmacovigilance Programme of India (PvPI), operated under the Indian Pharmacopoeia Commission (IPC) and supported by the World Health Organization (WHO) and Uppsala Monitoring Centre (UMC), plays a pivotal role in national ADR surveillance. This research paper presents a comprehensive analysis of 20 real-world ADR case studies collected through clinical interactions. The cases involve a wide range of drug classes including NSAIDs, antibiotics, antihypertensives, antidiabetics, antitubercular agents, and broad-spectrum antibiotics. Causality assessment was performed using the Naranjo Algorithm and the WHO-UMC causality scale. Findings indicate that Type A reactions were most common (60%), followed by Type B (40%). Severity analysis revealed 30% mild, 30% moderate, and 40% severe cases. NSAIDs and antibiotics emerged as the most frequently implicated drug classes. The paper also discusses challenges in ADR reporting, the role of healthcare professionals, digital innovations in pharmacovigilance, and future directions including artificial intelligence-based signal detection. The study reinforces the critical importance of systematic ADR monitoring, timely reporting, and rational drug use in clinical practice.

Keywords: Pharmacovigilance, Adverse Drug Reactions, ADR Case Studies, Naranjo Scale, WHO-UMC, PvPI, IPC, Signal Detection, Drug Safety.

INTRODUCTION

The World Health Organization (WHO, 2002) defines Pharmacovigilance as "the science and activities relating to the detection, assessment, understanding and prevention of adverse effects or any other medicine-related problems." [1] This definition acknowledges that drug safety monitoring must extend beyond the controlled environment of clinical trials into real-world clinical practice, where patient populations are far more diverse and complex. [2]

Clinical trials, though rigorous, have inherent limitations: they are typically conducted on a few hundred to a few thousand patients over a limited period, often excluding elderly patients, pregnant women, children, and those with comorbidities. [3] Consequently, rare but serious ADRs may only become apparent after a drug is marketed and used by millions of patients. Post-marketing surveillance through pharmacovigilance fills this critical gap .[4]

Globally, ADRs are estimated to account for 5–10% of all hospital admissions and rank among the top ten leading causes of death in developed countries. [5] In India, the scenario is compounded by widespread self-medication, irrational prescribing, polypharmacy, and significant under-reporting of ADRs. It is estimated that only 1–10% of all ADRs are ever reported through official channels. [6]

The establishment of the Pharmacovigilance Programme of India (PvPI) in 2010 by the Central Drugs Standard Control Organisation (CDSCO), now coordinated through the Indian Pharmacopoeia Commission (IPC) at Ghaziabad, marked a landmark step in institutionalizing drug safety monitoring in India. As of 2024, PvPI operates through a network of

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over 250 ADR Monitoring Centers (AMCs) spread across the country.

This research paper aims to analyze 20 ADR case studies gathered from clinical practice, apply standard causality assessment tools, and draw meaningful conclusions about ADR patterns, management strategies, and the broader role of pharmacovigilance in ensuring patient safety.[7,8,9,10]

Definition and Importance of ADR Monitoring

Definition of ADR

The World Health Organization (1972) defines an Adverse Drug Reaction as: "A response to a drug which is noxious and unintended, and which occurs at doses normally used in man for the prophylaxis, diagnosis, or therapy of disease, or for the modification of physiological function." [11]

This definition is important because it distinguishes ADRs from medication errors (errors in prescribing, dispensing, or administration), drug overdose or poisoning (intentional or accidental excess dosage), drug abuse or misuse (use for non-therapeutic purposes), and drug-drug or drug-food interactions resulting from pharmacokinetic alterations. [12,13]

Classification of ADRs (WHO-UMC Type A to F)

The WHO-UMC classification system categorizes ADRs into six types[12]:

Type	Name	Characteristics	Example
A	Augmented	Dose-dependent, predictable, common	Hypoglycaemia with insulin
B	Bizarre	Dose-independent, unpredictable, rare	Anaphylaxis with penicillin
C	Chronic	Related to long-term use	Adrenal suppression with steroids
D	Delayed	Appears after discontinuation	Teratogenicity with thalidomide
E	End-of-use	Occurs on withdrawal	Benzodiazepine withdrawal seizures
F	Failure	Unexpected failure of therapy	OCP failure due to rifampicin interaction

Importance of ADR Monitoring

Systematic ADR monitoring is essential for multiple reasons, including patient safety (early detection of harmful drug effects prevents serious complications and death), drug regulation (regulatory agencies use ADR data to update drug labels and issue safety warnings), signal detection (identification of new, previously unknown ADRs), rational drug use (ADR data guides prescribers in selecting safer alternatives), healthcare economics (ADR-related hospitalizations impose enormous financial burdens), and building public confidence in the healthcare system. [14]

Role of Healthcare Professionals in ADR Reporting

Healthcare professionals — including doctors, pharmacists, nurses, and dentists — are the frontline reporters of ADRs. Their role is multi-dimensional, encompassing identification, documentation, reporting, and communication of suspected adverse reactions. [15]Spontaneous Reporting

Spontaneous reporting is the most widely used method of ADR detection globally. [16] In India, any healthcare professional can report a suspected ADR directly to the nearest ADR Monitoring Center (AMC) of PvPI, online via the Vigiflow India portal, through the PvPI mobile application, or by sending a

filled Form 1-B (PvPI ADR reporting form) to IPC, Ghaziabad. [9]

Pharmacists as Key Reporters

Clinical pharmacists and community pharmacists occupy a unique position at the medication-patient interface. They are trained to recognize drug-related problems, counsel patients about potential side effects, and report ADRs. Studies by Desai et al. (2011) revealed that awareness and practice of ADR reporting among Indian pharmacists and physicians remains low at approximately 15–30%. [15,16]

Under-Reporting: A Global Challenge

Despite the existence of pharmacovigilance systems, under-reporting of ADRs remains a critical challenge. Backstrom et al. found that a substantial proportion of serious ADRs go unreported even in developed countries with well-established surveillance systems. [17] Several healthcare professional-level barriers contribute to this problem, including lack of awareness about reportable ADRs, uncertainty about drug causality, time constraints in busy clinical settings, and concerns about legal implications. System-level barriers include complex reporting forms, poor integration with electronic health records, and inadequate feedback to reporters. [16,17]

Responsibilities of Healthcare Professionals

Professional	Key Responsibilities in ADR Monitoring
Physician/Doctor	Suspect, diagnose, manage, and report ADRs; prescribe rationally
Clinical Pharmacist	Review prescriptions, counsel patients, detect drug interactions, report ADRs
Nurse	Monitor patients for adverse effects during administration; document and report
Dentist	Report ADRs related to dental medications (analgesics, antibiotics)
Regulatory Officers	Evaluate and act on received ADR reports; issue safety alerts

WHO-UMC System Overview

WHO Programme for International Drug Monitoring

The WHO Programme for International Drug Monitoring (PIDM), established in 1968 and coordinated by the Uppsala Monitoring Centre (UMC) in Uppsala, Sweden, represents the global framework for pharmacovigilance collaboration. [18] As of 2024, over 170 countries participate in this programme through their national pharmacovigilance centres. The UMC maintains VigiBase, the world's largest database of individual case safety reports (ICSRs), containing over 35 million ADR reports from member countries. India contributes to VigiBase through PvPI. [18,19]

Programme of India (PvPI)

PvPI was officially launched on 14 July 2010 by the Ministry of Health and Family Welfare, Government of India, with the National Coordinating Centre (NCC) established at the IPC, Ghaziabad. [9] The programme's primary mandate is to create a robust pharmacovigilance system that protects public health by ensuring that the benefits of medicines outweigh their risks for every Indian patient. Key milestones include launch in 2010 with 22 AMCs established; becoming a member of the WHO Programme for International Drug Monitoring in 2013; expanding to over 250 AMCs by 2019; and crossing 1 million ADR reports in VigiBase by 2023. [10]

PvPI's focus areas include monitoring ADRs related to anti-tuberculosis drugs (ATDs), antiretrovirals, vaccines (AEFI monitoring), biological medicines,

and traditional/herbal medicines. The programme has generated several important safety signals including peripheral neuropathy with linezolid and hepatotoxicity with certain antituberculosis regimens. [9,10]

WHO-UMC Causality Assessment Categories

The WHO-UMC causality assessment system categorizes ADR reports into six categories[21]:

Category	Criteria
Certain	Temporal relation; plausible; confirmed on dechallenge/rechallenge; no alternative explanation
Probable/Likely	Temporal relation; reasonable; dechallenge positive; unlikely from disease
Possible	Temporal relation; could be explained by disease; rechallenge data not available
Unlikely	Temporal relation doubtful; other explanations more likely
Conditional/Unclassified	Event reported, more data needed
Unassessable/Unclassifiable	Insufficient data to make an assessment

Analysis of ADR Case Studies

Data Collection Methodology

The ADR cases presented in this study were collected through direct interaction with physicians at a tertiary care hospital, review of patient medication records, and documentation using the standard PvPI ADR reporting form. [9] A total of 20 ADR cases were compiled and analyzed across diverse drug classes and patient demographics. Causality assessment was performed using both the Naranjo Algorithm and WHO-UMC scale. For each case, the following data was systematically recorded: patient demographics, disease condition and indication for drug use, suspected drug with dose and route, nature of ADR with onset and duration, severity classification, concomitant medications, management protocol, and patient outcome. [20,21]

ADR Case Studies (Cases 1–20)

No.	Age/Sex	Drug & Dose	Drug Class	ADR Observed	Type	Severity	Management	Outcome
1	45 M	Atenolol 50 mg OD	Beta-blocker	Bradycardia	A	Moderate	Dose reduction + ECG monitoring	Improved
2	32 F	Amoxicillin 500 mg TDS	β-lactam	Urticaria, rash	B	Moderate	Drug stopped + Antihistamines	Recovered
3	60 M	Glibenclamide 5 mg BD	Sulphonylurea	Hypoglycaemia	A	Severe	IV Dextrose (D25%)	Not recovered
4	36 M	Ibuprofen 400 mg BD	NSAID	Gastric irritation	A	Mild	Drug stopped + PPIs	Recovered

5	38 F	Etoricoxib 90 mg BD	COX-2 Inhibitor	SJS – itching, skin discolouration, dyspnea	B	Severe	Drug stopped + Emergency care	Not recovered
6	50 M	Ofloxacin 200 mg BD	Fluoroquinolone	Extensive skin eruption	B	Severe	Stopped + Corticosteroids	Improved
7	41 F	Diclofenac 50 mg BD	NSAID	Renal impairment	A	Moderate	Drug stopped + Renal monitoring	Improved
8	38 F	Diclofenac 50 mg BD	NSAID	Skin rashes	B	Mild	Stopped + Topical treatment	Recovered
9	50 F	Ibuprofen 600 mg BD	NSAID	Anaphylaxis	B	Severe	Emergency + Steroids	Improved
10	47 M	Ceftriaxone 1g IV BD	Cephalosporin	Diarrhoea, rash, elevated liver enzymes	A	Moderate	Probiotic + Hydration + Symptomatic	Recovered
11	51 F	Ofloxacin 200 mg BD	Fluoroquinolone	Pruritus	B	Mild	Stopped + Symptomatic	Recovered
12	48 M	Ibuprofen 400 mg TDS	NSAID	Urticaria	B	Mild	Stopped + Supportive care	Recovered
13	52 F	Enalapril 5 mg OD	ACE Inhibitor	Angioedema (face, lips swelling)	B	Moderate	Stopped + Antihistamines	Improved
14	46 M	Diclofenac 50 mg BD	NSAID	Acute Kidney Injury (oliguria, ↑ creatinine)	A	Severe	Hydration + Drug stopped	Recovered
15	38 M	Amoxicillin 500 mg TDS	β-lactam	Antibiotic-associated diarrhoea	A	Moderate	Stopped + Oral Vancomycin + Probiotics	Recovered
16	45 F	Metformin 500 mg BD	Biguanide	Lactic acidosis (fatigue, abdominal pain, rapid breathing)	A	Severe	Drug stopped + Supportive care	Recovered
17	40 M	Isoniazid 300 mg OD	Antitubercular	Peripheral neuropathy	A	Moderate	Vitamin B6 supplementation	Improved
18	26 M	Amoxicillin 500 mg TDS	β-lactam	GI intolerance – vomiting	A	Mild	Drug with food + Antiemetics	Improved

19	35 F	Chloramphenicol 500 mg QID	Broad-spectrum antibiotic	Aplastic anaemia (pancytopenia, fatigue)	B	Severe	Drug withdrawn + Blood transfusion	Improved
20	52 F	Amlodipine 5 mg OD	Calcium channel blocker	Ankle oedema	A	Mild	Dose reduction + Salt restriction	Reduced; therapy continued

Detailed Analysis of Selected Cases

Case 1: Antibiotic-Associated Diarrhea with Amoxicillin (Type A)

A 34-year-old male was prescribed Amoxicillin 500 mg three times daily for a respiratory tract infection (RTI). On the third day of therapy, the patient developed loose watery stools, occurring 4–5 times per day, without blood or mucus. The reaction was identified as antibiotic-associated diarrhoea — a well-known Type A (Augmented) ADR of beta-lactam antibiotics caused by disruption of normal gut microflora. [26,27]

Management included continuation of the antibiotic along with oral rehydration therapy and probiotic supplementation (Lactobacillus acidophilus). The patient recovered completely within 5 days. Naranjo Score: 6 (Probable). This case illustrates the importance of prophylactic probiotic use during antibiotic therapy, particularly in patients with a history of antibiotic-associated gastrointestinal disturbances. [27]

Case 2: Stevens-Johnson Syndrome with Etoricoxib (Type B — Severe)

A 38-year-old female was prescribed Etoricoxib 90 mg twice daily for pain and inflammation. On the 7th day of treatment, she developed severe skin discolouration, black spots, itching, and dyspnea. The clinical picture was consistent with Stevens-Johnson Syndrome (SJS) — a rare but life-threatening mucocutaneous reaction classified as a Type B (Bizarre) ADR. [28,29]

SJS is characterized by extensive epidermal necrosis involving mucous membranes and requires immediate hospitalization. Management involved immediate drug withdrawal, ICU admission, systemic corticosteroids, intravenous immunoglobulin (IVIG), wound care, and ophthalmology consultation. The patient did not fully recover, indicating permanent sequelae. Naranjo Score: 7 (Probable). This case highlights the critical importance of patient education about early warning signs of severe skin reactions with COX-2 inhibitors. [28,30]

Case 3: Severe Hypoglycaemia with Glimepiride + Metformin (Type A — Severe)

A 58-year-old male diabetic patient on a combination of Glimepiride 2 mg + Metformin 500 mg BD was brought to the emergency department with symptoms of sweating, shakiness, confusion, and altered consciousness. Blood glucose was measured at 38 mg/dL — consistent with severe hypoglycaemia. This is a Type A (dose-dependent) ADR and a known pharmacological effect of sulfonylurea drugs. [41]

The patient was managed with intravenous Dextrose 25% (D25%) and was hospitalized for monitoring. The patient's glycaemic control remained unstable, and the outcome was recorded as 'not recovered' at discharge. Naranjo Score: 8 (Probable). This case emphasizes the need for regular blood glucose monitoring in elderly patients on sulfonylurea-biguanide combinations, and the importance of patient education regarding early recognition of hypoglycaemic episodes. [41,42]

Case 4: Aplastic Anaemia with Chloramphenicol (Type B — Severe)

A 35-year-old female patient receiving Chloramphenicol 500 mg four times daily for typhoid fever developed progressive fatigue, pallor, and recurrent infections after 2 weeks of therapy. Complete blood count revealed pancytopenia: haemoglobin 5.2 g/dL, WBC count 1,200/mm³, and

platelet count 28,000/mm³ — findings consistent with aplastic anaemia. [25]

Chloramphenicol-induced aplastic anaemia is a classic example of a Type B (idiosyncratic) ADR, occurring with an incidence of approximately 1 in 25,000–40,000 patients. Management required immediate drug withdrawal, blood transfusions, and supportive care including prophylactic antibiotics. The patient showed improvement. Naranjo Score: 7 (Probable). This case underscores why chloramphenicol use is now strictly limited to situations where no safer alternative exists. [25,46]

Case 5: Acute Kidney Injury with Diclofenac (Type A — Severe)

A 46-year-old male receiving Diclofenac 50 mg twice daily presented with oliguria, bilateral pedal oedema, and elevated serum creatinine (3.4 mg/dL). The diagnosis was NSAID-induced Acute Kidney Injury (AKI) — caused by inhibition of prostaglandin synthesis resulting in decreased renal perfusion. This Type A ADR is particularly prevalent in patients with pre-existing renal disease, cardiovascular disease, dehydration, or concurrent use of ACE inhibitors or diuretics (triple whammy syndrome). [34,35]

Management included immediate discontinuation of diclofenac, intravenous hydration, withholding concomitant ACE inhibitor, and nephrology consultation. The patient recovered after 2 weeks. Naranjo Score: 7 (Probable). This case reinforces the importance of regular renal function monitoring in patients on long-term NSAID therapy. [35,36]

Case 6: Peripheral Neuropathy with Isoniazid — PvPI Context (Type A)

A 40-year-old male tuberculosis patient on Isoniazid (INH) 300 mg once daily developed tingling and numbness in bilateral lower limbs after 3 weeks of treatment. The diagnosis was INH-induced peripheral neuropathy — a Type A ADR caused by INH's interference with pyridoxine (Vitamin B6) metabolism. This ADR is particularly relevant in the Indian context, as tuberculosis remains a ajor public health challenge in India, which bears the highest global burden of TB. [43,44]

PvPI has generated significant pharmacovigilance data on anti-tuberculosis drug reactions. Management required supplementation with Vitamin B6 (Pyridoxine 25 mg daily), and symptoms improved. Naranjo Score: 6 (Probable). Standard anti-tuberculosis regimens in India now routinely include pyridoxine supplementation to prevent this preventable ADR. [9,44]Frequency of Drug Class Distribution

Antibiotics were the most frequently implicated drug class, appearing in seven of the twenty cases (35%). This is consistent with national and global data showing antibiotics as a leading cause of ADRs. [6,14] NSAIDs were the second most implicated class, appearing in six cases (30%), reflecting both the frequency of their prescription and their broad toxic potential across the gastrointestinal, renal, and dermatological systems. [37]

Drug Class	No. of Cases	Percentage (%)
Antibiotics (Beta-lactams, Fluoroquinolones)	7	35%
NSAIDs (Ibuprofen, Diclofenac, Etoricoxib)	6	30%
Antidiabetics (Metformin, Glimepiride)	2	10%
Antihypertensives (Enalapril, Amlodipine)	2	10%
Antitubercular (Isoniazid)	1	5%
Broad-Spectrum Antibiotics (Chloramphenicol)	1	5%
Other (Ceftriaxone)	1	5%

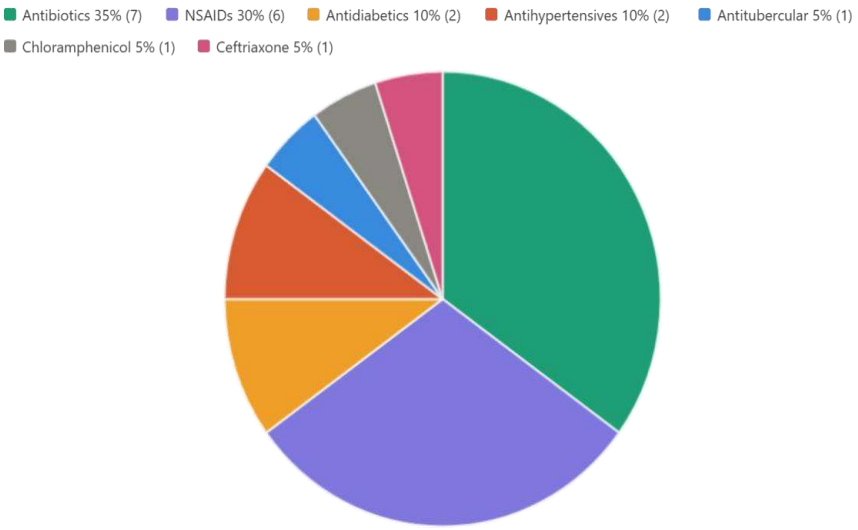

Fig. 1: Pie Chart: Distribution of ADR Cases by Drug Class (n=2)

Severity Distribution

Severity analysis revealed that eight cases (40%) were mild, five (25%) were moderate, and seven (35%) were severe. The seven severe cases warrant particular attention. Case 3, involving severe hypoglycemia in a diabetic patient on a sulfonylurea-metformin combination, required hospitalization and IV dextrose administration. Case 5, involving Stevens-Johnson Syndrome with a COX-2 inhibitor, represented a life-threatening dermatological emergency. Case 9, anaphylaxis following ibuprofen in a patient with arthritis, required emergency treatment. Case14 involved acute kidney injury from diclofenac. Case 16 involved lactic acidosis with metformin in a patient with obesity and renal risk factors. Case 19, aplastic anemia from chloramphenicol, represents one of the most serious idiosyncratic drug reactions described in the pharmacological literature. [4,5]

Severity	No. of Cases	Percentage (%)	Clinical Characteristics
Mild	8	40%	No specific treatment needed; self-limiting
Moderate	5	25%	Required specific treatment; temporary incapacity
Severe	7	35%	Life-threatening; required hospitalization

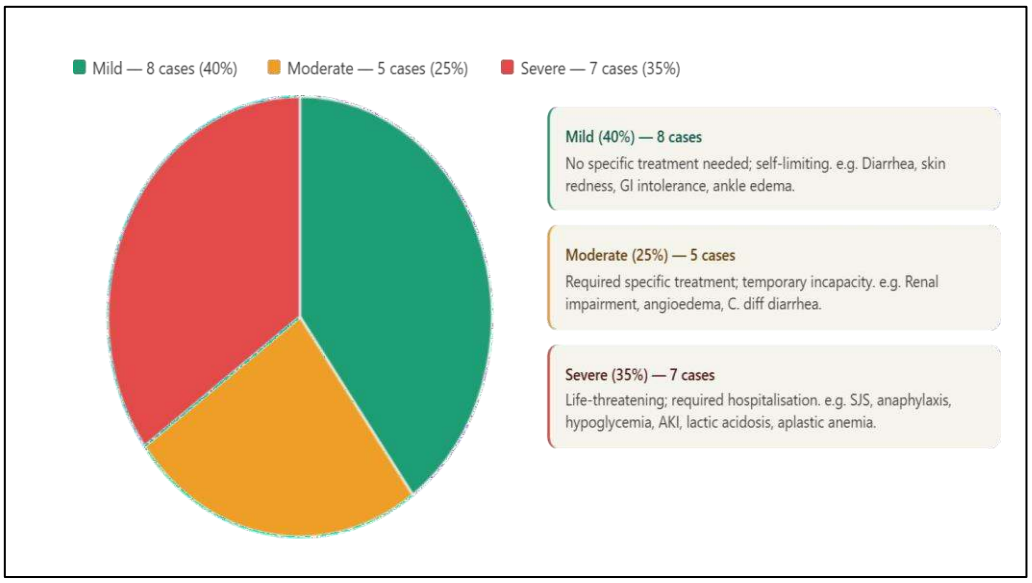

Fig. 2 : Severity Distribution Across 20 Cases of ADR

Reaction Type Distribution

Type A reactions (dose-related, predictable) accounted for 60% of cases (twelve cases), while Type B reactions (idiosyncratic, unpredictable) accounted for 40% (eight cases). This proportional distribution is consistent with published literature, which generally estimates Type A reactions as constituting the majority of ADRs. However, the clinical significance of the finding is not simply numerical: the eight Type B reactions in this series included the most clinically dramatic and life-threatening events, including two cases of anaphylaxis or near-anaphylaxis, one case of Stevens-Johnson Syndrome, one case of aplastic anemia, and an extensive skin eruption requiring corticosteroid therapy.

Reaction Type	No. of Cases	Percentage (%)
Type A (Augmented/Predictable)	12	60%
Type B (Bizarre/Unpredictable)	8	40%

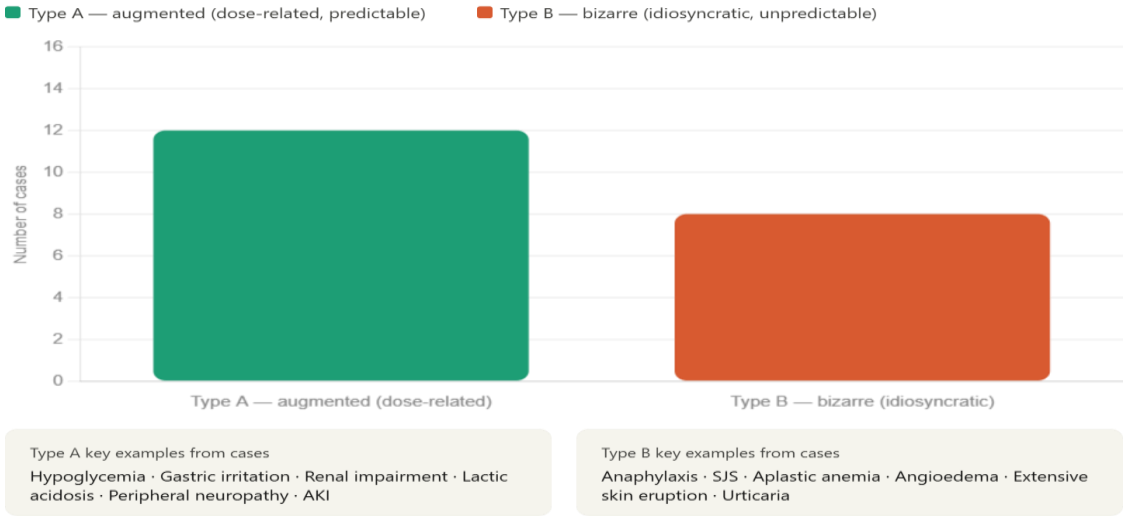

Fig 3: ADR Type Distribution (Type A vs. Type B)

Patient Outcome

Of the twenty cases, twelve (60%) resulted in full recovery, six (30%) showed improvement (partial recovery or ongoing management), and two (10%) did not recover at the time of data collection.

The two non-recovery cases both involved severe Type B reactions (Case 3 and Case 5), under scoring the particularly adverse prognosis associated with unpredictable idiosyncratic reactions when they are severe. [2,13]

Outcome	No. of Cases	Percentage (%)
Recovered	12	60%
Improved	6	30%
Not Recovered	2	10%

Fig.4 : Patient outcomes distribution (recovered/ improved/ not recovered

Management Strategies

Management of the documented ADRs followed the general principles of ADR management: identification of the causative drug, discontinuation where appropriate, severity-specific treatment, and monitoring. [46] Drug discontinuation was the single most common intervention, applied in fifteen of twenty cases. Symptomatic treatment was used in nearly all cases. Antihistamines, corticosteroids, probiotics, IV hydration, and emergency measures were among the specific treatments deployed. Vitamin B6 supplementation was used for the isoniazid-induced peripheral neuropathy, which represents an evidence-based preventive strategy that should be applied routinely to all patients on isoniazid. [43,44,46]

Management Strategy	No. of Cases	Percentage (%)
Drug Discontinuation	15	75%
Antihistamines / Corticosteroids	8	40%
IV Hydration / Fluid Resuscitation	4	20%
Dose Adjustment	3	15%

Symptomatic Treatment (antacids, probiotics)	12	60%
Epinephrine (anaphylaxis management)	1	5%
Vitamin B6 Supplementation	1	5%

Causality Assessment MethodsThe Naranjo Algorithm

The Naranjo Algorithm, developed by Naranjo et al. in 1981, is a standardized questionnaire consisting of 10 questions designed to determine the probability that an adverse drug reaction is due to the suspected drug. Each question is answered 'Yes', 'No', or 'Do Not Know', and carries a weighted score (+1, +2, 0, or –1).[20]

No.	Question	Yes	No	Do Not Know
1	Are there previous conclusive reports on this reaction?	+1	0	0
2	Did the ADR appear after the drug was administered?	+2	-1	0
3	Did the ADR improve when drug was discontinued?	+1	0	0
4	Did the ADR reappear on rechallenge?	+2	-1	0
5	Are there alternative causes?	-1	+2	0
6	Did the ADR reappear with placebo?	-1	+1	0
7	Was the drug detected in toxic concentrations?	+1	0	0
8	Was the ADR dose-dependent?	+1	0	0
9	Did patient have similar reactions before?	+1	0	0
10	Was the ADR confirmed by objective evidence?	+1	0	0

7.2 Naranjo Score Interpretation

Score	Causality Category
≥ 9	Definite/Certain
5–8	Probable
1–4	Possible
≤ 0**	Doubtful

Comparison: Naranjo vs WHO-UMC Scale

The Naranjo Algorithm is quantitative (scored) and consists of 10 structured questions, producing a numeric score that leads to a category assignment. The WHO-UMC Scale is qualitative (categorical) and uses clinical judgment with no specific set of questions for direct category assignment. Both are widely used in clinical and pharmacovigilance practice. The Naranjo scale has a limitation in that rechallenge is not always ethical or feasible, while the

WHO-UMC scale may be subject to subjectivity in category assignment. [20,21]

Feature	Naranjo Algorithm	WHO-UMC Scale
Type	Quantitative (scored)	Qualitative (categorical)
No. of Questions	10 structured questions	No specific questions; uses clinical judgment
Outcome	Numeric score → category	Direct category assignment
Application	Research settings; easy to apply	Widely used in clinical and pharmacovigilance practice
Categories	Definite, Probable, Possible, Doubtful	Certain, Probable, Possible, Unlikely, Conditional, Unassessable
Limitation	Rechallenge not always ethical/feasible	Subjectivity in category assignment

Studies by Shukla et al. (2021) found a 70–80% agreement between the two scales, supporting their complementary use in pharmacovigilance practice. For maximum reliability, both scales are recommended to be applied simultaneously during ADR causality assessment. [22]

Challenges in ADR Reporting

Despite the existence of a structured pharmacovigilance programme, ADR under-reporting remains a major global and Indian challenge. Multiple barriers contribute to this problem at healthcare professional, system, patient, and data quality levels. [15,16,17]

Healthcare professional-level barriers include lack of awareness about what constitutes a reportable ADR, uncertainty about whether the reaction is drug-related, time constraints in busy clinical settings, fear of legal implications or patient confidentiality concerns, and the belief that only 'definite' ADRs need to be reported. [15,16]

System-level barriers include complex and lengthy ADR reporting forms, poor integration of ADR reporting into electronic health records (EHRs), inadequate feedback to reporters after submission, and limited number of functional AMCs in rural and semi-urban areas. [17]

Patient-level barriers include patients often being unaware that they experienced an ADR, a tendency to attribute ADRs to the underlying disease, and limited health literacy among Indian patients. Data quality challenges include incomplete or missing information in ADR reports, duplicate reporting across different AMCs, and difficulty in causality assessment when polypharmacy is involved. [45]

Practical Applications of Pharmacovigilance

Signal Detection and Drug Withdrawals

One of the most critical outcomes of pharmacovigilance is signal detection — the identification of a new, potentially causal association between a drug and an adverse event. [19] Globally, pharmacovigilance has led to several landmark drug safety actions, including the withdrawal of Rofecoxib (Vioxx) in 2004 due to increased cardiovascular risk detected through post-marketing surveillance, the withdrawal of Thalidomide in the 1960s after causing severe teratogenic effects (phocomelia) in newborns, and the withdrawal of Cisapride due to fatal cardiac arrhythmias. [30]

Risk Communication

Pharmacovigilance data directly informs regulatory risk communications including Drug Safety Updates

(DSUs), Dear Healthcare Professional letters, and black-box warnings. [30] In India, CDSCO issues Safety Communications and drug alerts based on PvPI signal data. These communications reach healthcare professionals and help prevent further occurrences of identified ADRs. [9]

Promoting Rational Drug Use

ADR data from pharmacovigilance studies guides prescribers in selecting safer therapeutic alternatives, choosing appropriate doses for high-risk populations (elderly, renally impaired), avoiding known high-risk drug combinations, and educating patients on warning signs of common ADRs. [38] Rational drug use promoted through pharmacovigilance data is an essential tool in reducing preventable ADRs in clinical practice. [7]

Indian Examples of PvPI Impact

Key PvPI-driven regulatory actions include [9,10]:

Year	Drug/Event	PvPI Action
2013	Pioglitazone – bladder cancer risk	CDSCO issued risk minimisation measures and product labelling updates
2015	Nimesulide in children	CDSCO restricted use below 12 years based on hepatotoxicity signals
2020	COVID-19 vaccine safety monitoring	PvPI activated enhanced surveillance for vaccines under the national immunization programme
2021	Chloroquine/Hydroxychloroquine ADRs	PvPI monitored cardiac ADRs during COVID-19 off-label use

Future Scope and Digital Technologies in Pharmacovigilance

Artificial Intelligence and Machine Learning

Artificial intelligence (AI) and machine learning (ML) are revolutionizing pharmacovigilance by enabling automated signal detection from large datasets. [47] Rawat et al. (2021) demonstrated that AI models can automate causality assessment by predicting the Naranjo Score directly from clinical notes with high accuracy. Key AI applications include Natural Language Processing (NLP) to extract ADR information from clinical records, discharge summaries, and social media; ML algorithms for disproportionality analysis in VigiBase to detect rare ADRs; and deep learning models for drug-drug interaction prediction. [47,49]Digital Reporting Platforms

PvPI has launched digital tools to enhance reporting convenience, including Vigiflow India (online ADR reporting portal for healthcare professionals), PvPI Mobile Application (smartphone-based ADR reporting), and IPC ADR Portal integrated with electronic medical records in select hospitals. [9] These digital platforms are expected to significantly reduce under-reporting by lowering the barriers to ADR submission. [48]

Social Media and Patient Reporting

Social media monitoring (Twitter, Facebook, patient forums) is emerging as a valuable supplementary ADR detection tool. Millions of patients informally report drug experiences online, and NLP tools can mine these data for pharmacovigilance signals. [49]

Genomics and Personalized Pharmacovigilance

Pharmacogenomics — the study of how genetic variations influence drug response — offers the promise of personalized pharmacovigilance. Examples include HLA-B*5701 testing before abacavir use to prevent hypersensitivity reactions, CYP2D6 genotyping to predict codeine toxicity risk, and G6PD screening before primaquine therapy in malaria treatment. [50]

Electronic Health Records Integration

Future pharmacovigilance frameworks will rely on seamless integration of EHRs with national ADR databases, allowing real-time, automated ADR signal generation without requiring manual reporting by clinicians. [48] This approach, termed 'Active Pharmacovigilance,' is already in use in several European countries under the EU-ADR project. The integration of routine clinical data with pharmacovigilance systems has the potential to dramatically increase the sensitivity and timeliness of ADR detection. [23,24]

CONCLUSION

This research paper demonstrates the critical importance of pharmacovigilance as an essential pillar of patient safety and rational drug use. Through the analysis of 20 real-world ADR case studies, several important conclusions can be drawn.

NSAIDs and antibiotics are the most frequently implicated drug classes in clinical ADR reports, reflecting their widespread use in Indian medical practice. Type A (augmented, dose-dependent) reactions are more common than Type B reactions, suggesting that many ADRs are predictable and potentially preventable through rational prescribing. Forty percent of documented ADRs were severe, highlighting the significant clinical burden of drug-related harm.

Causality assessment using the Naranjo Algorithm and WHO-UMC scale provides systematic, reproducible evaluation of the drug-reaction relationship and should be routinely applied in clinical pharmacovigilance. The Pharmacovigilance Programme of India (PvPI), through its network of ADR Monitoring Centers under the Indian Pharmacopoeia Commission, represents an important national infrastructure for drug safety monitoring.

Under-reporting of ADRs remains a significant challenge that requires sustained educational interventions among healthcare professionals and patients. Digital technologies including AI-based signal detection, mobile reporting platforms, and EHR integration represent the future of pharmacovigilance and will substantially enhance ADR detection capabilities.

The ultimate goal of pharmacovigilance — to ensure that medicines are used safely and effectively — can only be achieved through a collaborative effort of healthcare professionals, patients, regulatory authorities, and pharmaceutical manufacturers. As future pharmacists, it is our professional responsibility to be vigilant reporters of ADRs and active participants in national and global drug safety systems.

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