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Signal to Safety: Unpacking the Pharmacovigilance Program of India (PVPI)

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Abstract

The Pharmacovigilance Programme of India (PVPI), established in 2010, has become a cornerstone of India's public health strategy for drug safety. This review critically examines PVPI's evolution, organizational structure, reporting mechanisms, and signal detection processes. Key achievements include a dramatic increase in Individual Case Safety Reports (ICSRs), the expansion of the AMC network, digital innovations such as the ADR PVPI app, and recognition as a WHO Collaborating Centre. PVPI's regulatory interventions, such as label changes for carbamazepine-induced Stevens–Johnson Syndrome, demonstrate its impact on patient safety. However, persistent challenges remain: underreporting (especially from the private sector), data quality concerns, limited surveillance of traditional medicines and biologics, funding constraints, and state-level disparities. Comparative analysis with US and EU pharmacovigilance systems highlights the need for mandatory reporting, harmonized data standards, and robust risk management frameworks. Future directions include expanding AMC coverage, mandating ADR reporting in the private sector, integrating pharmacovigilance into all health curricula, leveraging AI-driven analytics, and broadening surveillance to cover traditional medicines, biologics, and counterfeit drugs. Strengthening international collaboration and securing sustainable funding are also essential. As India moves toward universal health coverage, a robust and integrated pharmacovigilance system is vital to ensure that the benefits of medicines consistently outweigh their risks for every citizen.

Keywords: Pharmacovigilance; India; Drug Safety; PVPI; Adverse Drug Reactions; Public Health

1. Introduction

1.1. Importance of Pharmacovigilance

Pharmacovigilance (PV) is a vital scientific discipline encompassing activities focused on detecting, assessing, understanding, and preventing adverse effects or any other drug-related problems [1]. It plays an indispensable role in safeguarding patient safety and public health, especially in a nation as vast and diverse as India, with its complex healthcare system [2]. As the global pharmaceutical industry continues to expand and new medicinal products are constantly introduced, robust post-marketing surveillance becomes essential. This is because unforeseen side effects might not become apparent during the more controlled and limited environment of pre-market clinical trials [3]. Continuous monitoring is crucial to ensure a drug's benefits continue to outweigh its risks throughout its entire lifecycle in the real world [3].

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1.2. Necessity and Establishment of PVPI

India's formal involvement in drug safety monitoring began with its participation in the World Health Organization (WHO) Programme for International Drug Monitoring (PIDM) in 1997 [1][4]. However, these initial efforts were often disjointed and lacked central coordination, which limited their effectiveness. For instance, out of six regional centers initially established in 1997, only two (Mumbai and New Delhi) remained active, leading to poor spontaneous reporting of adverse drug reactions (ADRs) [1][5].

Subsequent attempts to build a stronger system also faced hurdles. A National Pharmacovigilance Programme (NPVP) was launched in November 2004 with five years of annual funding from the World Bank, aiming to boost ADR reporting [1][6]. While it collected a significant amount of ADR data, the program struggled with sustainability, partly because it operated as a time-limited project without consistent regulatory support or clear leadership [2]. As a result, the World Bank funding ended in mid-2009, and the program was temporarily suspended [1][6].

Recognizing the critical need for a robust, centralized, and sustainable national system, the Central Drugs Standard Control Organization (CDSCO) officially launched the Pharmacovigilance Programme of India (PVPI) in July 2010 [6][7]. Initially, the All-India Institute of Medical Sciences (AIIMS) in New Delhi served as the National Coordinating Centre (NCC) [6][7]. However, to provide institutional stability and ensure long-term growth, the Indian Pharmacopoeia Commission (IPC) took over the role of the NCC for PVPI on April 15, 2011[7][8]. This shift marked a pivotal step towards establishing a more structured and enduring pharmacovigilance system in India.

This review aims to provide a detailed and analytical exploration of PVPI. It will cover its historical evolution, intricate structural framework, evolving data flow mechanisms, and critical signal detection processes. Furthermore, it will delve into the program's significant achievements, identify persistent challenges, and offer a comparative analysis with leading global pharmacovigilance systems. By integrating recent statistical data, relevant case studies, and a comprehensive examination of available information, this paper seeks to offer an evidence-backed understanding of PVPI's current functions, its opportunities for growth, and the hurdles it must overcome. The ultimate objective is to outline strategic future directions for PVPI to fully realize its potential in safeguarding public health across India.

2. Methodology

2.1. Information Sources and Inclusion Criteria

This review utilized a qualitative, narrative synthesis approach to evaluate the Pharmacovigilance Programme of India (PVPI) comprehensively. The primary sources of information included an initial preliminary query exploration and eighty supplementary digital snippets, each representing focused extracts from official documents, peer-reviewed articles, regulatory reports, PVPI newsletters, and international pharmacovigilance databases. All sources were screened to ensure relevance, with inclusion criteria emphasizing direct pertinence to PVPI's structure, operational mechanisms, recent developments (2023–2025), regulatory actions, reporting pathways, challenges, and international comparisons.

2.2. Data Extraction and Synthesis

Data extraction was conducted using a structured template with predefined thematic categories: historical evolution; organizational framework and governance; reporting infrastructure and data flow; signal detection and regulatory actions; capacity building and stakeholder engagement; integration with national health programs; achievements and success stories; persistent challenges and limitations; global comparisons; and future directions and recommendations.

2.3. Analytical Approach

The analytical process extended beyond descriptive summarization to incorporate in-depth thematic analysis and mapping. Thematic analysis was used to identify recurring patterns, systemic challenges, and operational trends within PVPI. Comparative benchmarking was performed to position PVPI alongside international pharmacovigilance systems such as the US FDA, EMA, and MHRA, highlighting both strengths and areas for improvement. This iterative and integrative approach allowed for the continual refinement of findings as new evidence emerged, ensuring that the synthesis remained current and contextually relevant.

This robust and transparent methodology enabled the construction of a comprehensive, critically analytical review of PVPI, supporting evidence-based insights and actionable recommendations.

3. Results

3.1. Historical Evolution of Pharmacovigilance in India

India's formal engagement with pharmacovigilance began in 1997 through its participation in the WHO Programme for International Drug Monitoring (PIDM), initially coordinated via select regional centers [9][10]. However, these early efforts were hampered by fragmented governance and a lack of central coordination, resulting in limited effectiveness [9][11]. In 2004, a National Pharmacovigilance Programme (NPVP) was launched with financial support from the World Bank, representing an ambitious attempt to build a nationwide system. Despite initial progress, the program was suspended in 2009 due to sustainability challenges, including the end of external funding and the absence of a robust regulatory framework [9][11][12].

A pivotal turning point came in July 2010, when the Central Drugs Standard Control Organization (CDSCO) officially launched the Pharmacovigilance Programme of India (PVPI), with the All-India Institute of Medical Sciences (AIIMS), New Delhi, serving as the initial National Coordination Centre (NCC) [12][13]. In April 2011, the NCC was shifted to the Indian Pharmacopoeia Commission (IPC) in Ghaziabad, providing the program with a specialized institutional anchor and a stronger administrative foundation [14][15]. This transition was instrumental in ensuring long-term program stability and growth, addressing the shortcomings of previous initiatives by securing sustained institutional backing [16].

Further international recognition followed in 2017, when IPC-PVPI was designated as a WHO Collaborating Centre for Pharmacovigilance in Public Health and Regulatory Services, affirming the maturity of India's pharmacovigilance system and its alignment with global standards [14][17]. Demonstrating a holistic approach to patient safety, IPC-PVPI broadened its mandate in July 2015 to become the NCC for the Materiovigilance Programme of India (MVPI), thereby expanding its surveillance to include adverse events related to medical devices [14][18]. This evolution reflects a regulatory philosophy that recognizes patient harm can arise from various medical products, not just pharmaceuticals, and underscores India’s commitment to comprehensive medical product safety.

Table 1 Key Milestones in the Evolution of Pharmacovigilance in India (1997–2024)

Year	Event/Initiative	Significance/Impact
1997	India joins the WHO Programme for International Drug Monitoring (PIDM)	Initial formal engagement with global PV efforts, though fragmented [9][10]
2004	National program initiated with World Bank funding	Although a national system was attempted, it was undermined by significant sustainability issues and regulatory uncertainties prevalent in India’s pharmacovigilance landscape at the time [11]
2009	Suspension of 2004 national program	Highlighted need for more robust and sustainable institutional framework [9][11][12]
July 2010	Pharmacovigilance Programme of India (PVPI) launched	Establishment of a centralized national PV system [12][13]
April 2011	NCC shifted from AIIMS to IPC, Ghaziabad	Reinforced institutional commitment and administrative support, providing long-term stability [14][15]
July 2015	IPC-PVPI becomes NCC for Materiovigilance Programme of India (MVPI)	Expanded scope to include medical device safety, reflecting a broader patient safety mandate [14][18]
2017	IPC-PVPI designated as WHO Collaborating Centre	Affirmed maturity of India's PV system and its contribution to global efforts [14][17]
2023	CDSCO releases Guidance for Industry on Pharmacovigilance for Vaccines	Detailed compliance framework for vaccine PV post-licensure [19]
2024	IPC celebrates 4th National Pharmacovigilance Week	Ongoing commitment to awareness and stakeholder engagement [20]

3.2. Organizational Framework and Governance

The success of PVPI is anchored in its robust, multi-layered governance structure, with the Indian Pharmacopoeia Commission (IPC) serving as the National Coordination Centre (NCC) to orchestrate and oversee nationwide pharmacovigilance activities [21]. This framework is designed to ensure scientific rigor, policy alignment, and consistent stakeholder engagement at all operational levels [21][22].

Key governance bodies within PVPI include

- Steering Committee: This committee is responsible for strategic policy-making, guiding the overall direction and priorities of the program. It is chaired by the Drugs Controller General of India (DCGI) and includes representatives from the Ministry of Health and Family Welfare, the Central Drugs Standard Control Organization (CDSCO), the Indian Pharmacopoeia Commission (IPC), and subject experts in pharmacovigilance. The IPC acts as the secretariat and supports the committee in reviewing data, suggesting interventions, and reporting to the Drugs Technical Advisory Board (DTAB) [21][23].
- Signal Review Panel (SRP): Comprising scientists and clinical experts, the SRP undertakes scientific validation of detected safety signals, ensuring that potential drug safety issues are thoroughly assessed before regulatory action is taken [21][24].
- Core Training Panel (CTP): The CTP is dedicated to capacity building, identifying training needs, organizing national and international training programs, designing modules, and identifying trainers for regional centers [21][23].
- Quality Review Panel: This panel maintains high standards of data quality control, which is crucial for accurate signal detection and reliable regulatory decision-making [21][24].

The explicit establishment of these specialized panels within PVPI's governance structure, beyond the general oversight of the NCC, signifies a deliberate move toward functional specialization and enhanced scientific rigor [21]. This structure addresses the distinct operational needs of a comprehensive pharmacovigilance system. The presence of dedicated bodies for strategic policy, scientific assessment, human resource development, and data integrity indicates that PVPI has evolved beyond a basic reporting system into a sophisticated program that systematically addresses various facets of drug safety, essential for achieving its goals of scientific rigor, policy alignment, and consistent stakeholder engagement [21][22]. The designation of IPC-PVPI as a WHO Collaborating Centre in 2017 further underscores the maturity of India's PV system and its role in guiding other developing nations, reflecting adherence to international standards and best practices [20].

Table 2 Organizational Structure and Key Functions of PVPI Governance Bodies

Body Name	Primary Function	Key Responsibilities
Indian Pharmacopoeia Commission (IPC) / NCC	National coordination and oversight	Collects, collates, and evaluates ADR reports; global database contribution; training; regulatory support [21][23]
Steering Committee	Strategic policy-making	Guides overall direction and priorities of PVPI; ensures policy alignment [21][24]
Signal Review Panel (SRP)	Scientific signal validation	Assesses and validates potential drug safety issues; defines biostatistical methods [21][23]
Core Training Panel (CTP)	Capacity building and training programs	Identifies training needs; organizes training; designs modules; identifies trainers [21][23]
Quality Review Panel	Data quality control	Ensures accuracy and completeness of data for reliable signal detection [21][24]

3.3. Reporting Infrastructure and Data Flow

The Pharmacovigilance Programme of India (PVPI) operates through an extensive and continually expanding network of Adverse Drug Reaction Monitoring Centers (AMCs), primarily located in medical colleges and tertiary hospitals across the country [25][26]. The number of AMCs has grown substantially, from approximately 250 in the early years of the program to over 346 by 2020–2021[25], and further to more than 500 by the most recent accounts [27]. During the

2022–2023 period, expansion efforts focused on enrolling new AMCs in previously underserved states and regions, aiming to enhance national coverage and inclusivity [28].

AMCs are responsible for collecting Individual Case Safety Reports (ICSRs) through various surveillance methods, including spontaneous, stimulated, and active surveillance [25]. These reports are uploaded and managed via VigiFlow, a web-based tool developed by the Uppsala Monitoring Centre (UMC) in Sweden [25][29]. After validation by trained pharmacovigilance professionals, the data are forwarded to the WHO's global ICSR database, VigiBase [25][29].

The volume of ICSRs reported in India has shown marked progress, increasing from approximately 11,000 reports in 2006–2008 to over 78,000 by mid-2014 [25]. More recent data indicate that over 113,000 ICSRs were collected during the 2022–2023 fiscal year [28]. India's contribution to the global VigiBase database stood at 3% by 2015 and has remained around 2% in subsequent years [25]. Despite this quantitative expansion in AMC numbers and ICSR volume, the ADR reporting rate per million population remains relatively low [40] for India compared to 130 for high-income countries), suggesting that the infrastructure growth has not yet fully translated into comprehensive population-level surveillance [25]. This highlights that, despite expanded infrastructure, persistent issues such as underreporting continue to limit the representativeness and completeness of the collected data, potentially impacting the accuracy of signal detection and the broader regulatory influence.

To further facilitate reporting, PVPI has implemented several additional support mechanisms, including a toll-free helpline (1800-180-3024) [30], an SMS feedback system [25], and a dedicated mobile application, "ADR PVPI," launched in 2017[25][31]. The ADR PVPI app has been downloaded by over 5,500 users, with a notable increase in reports submitted through it, accounting for 96.45% of app-based reports in 2018 compared to 3.55% in 2017 [31]. The development and promotion of these digital reporting tools demonstrate a strategic shift toward leveraging technology to overcome geographical barriers and improve reporting accessibility, particularly for healthcare professionals and consumers. The rapid increase in app-based reporting reflects the significant potential of such innovations to boost reporting rates by reducing the barriers associated with traditional methods and making the process more integrated into daily clinical practice.

Capacity building and standardization are also integral to PVPI's infrastructure. Nine Regional Training Centers (RTCs) conduct nationwide capacity-building programs, and PVPI actively develops educational toolkits and guidelines to ensure uniform standards across all AMCs [25][32]. Looking ahead, future directions for PVPI include expanding AMC coverage to all medical colleges and district hospitals, mandating ADR reporting in private sector institutions, and further developing advanced e-reporting platforms and mobile applications [25].

3.4. Signal Detection and Regulatory Actions

PVPI employs a combination of quantitative and qualitative methods for signal detection, the process of identifying potential drug safety issues from aggregated Adverse Drug Reaction (ADR) data [21][25]. Statistical techniques such as disproportionality analysis are used to flag drug-event combinations that occur more frequently than expected [21][25]. Following initial signal detection, causality assessment is performed using the internationally recognized WHO-UMC causality assessment system [21][25][33].

Historically, PVPI's efforts have led to significant regulatory outcomes. A landmark example involved carbamazepine, where the identification of a genetic association with the HLA-B*1502 allele for Stevens-Johnson Syndrome (SJS) prompted regulatory action. This included updates to drug labels and recommendations for pre-treatment genetic screening in at-risk populations, particularly where the allele prevalence may reach 6% [34][35]. This case demonstrates PVPI's capacity to translate pharmacovigilance data into actionable public health interventions. Similar safety communications have been issued for drugs such as piperacillin-tazobactam, clozapine, and newer antidiabetics [21].

Recent regulatory actions and safety alerts (2020–2025) from Indian authorities reflect a comprehensive approach to drug safety

- CDSCO Alerts: The Central Drugs Standard Control Organization (CDSCO) regularly issues alerts, with a focus on "Not of Standard Quality (NSQ)" drugs, spurious/adulterated/misbranded drugs, and medical devices [36]. These are published monthly, including recent examples from April–May 2025 [37]. Notable actions include drug recalls, such as for Digene Gel in August 2023 [38]. The focus on drug quality and authenticity underscores the regulatory emphasis on ensuring the fundamental integrity and legitimacy of products in the market, which is foundational for effective pharmacovigilance.

- IPC Alerts: In parallel, the Indian Pharmacopoeia Commission (IPC), through PVPI, issues drug safety alerts that focus on specific ADRs linked to individual drugs [13][39]. Recent safety alerts have highlighted various ADRs, including Acute Generalised Exanthematous Pustulosis (AGEP) associated with metronidazole, hypersensitivity reactions linked to mefenamic acid, chloasma/melasma with luliconazole, muscle spasms with dalteparin, and erythema multiforme with gliclazide [39]. An alert was also issued for vancomycin in July 2024 due to Drug Reaction with Eosinophilia and Systemic Symptoms (DRESS) syndrome [40]. This distinction in focus, CDSCO on quality/spurious drugs and IPC on drug-specific ADRs, demonstrates a coordinated yet specialized approach to drug safety communication.
- New Regulatory Frameworks: The regulatory landscape has also evolved, with CDSCO releasing 'Guidance for Industry on Pharmacovigilance Requirements for Human Vaccines' in August 2024, detailing compliance for post-licensure submissions [19]. The 'New Drugs and Clinical Trials (Amendment) Rules, 2024,' effective April 1, 2025, mandate registration of Clinical Research Organizations (CROs) [22]. Revised Guidelines on Similar Biologics (2025) are also open for stakeholder comments, indicating ongoing regulatory modernization [23].
- Mandatory Reporting Discussions: Although the current system relies mainly on voluntary reporting, recent discussions and proposals highlight the need for mandatory ADR reporting by all healthcare providers, aligning with international best practices [25][41]. The Drugs & Cosmetics Act & Rules 1945 already require the establishment of pharmacovigilance cells within pharmaceutical industries [42].

Table 3 Selected Regulatory Actions and Safety Alerts Issued by Indian Authorities (2020–2025)

Date	Issuing Authority	Type of Action	Specific Drug/Issue	Brief Description
May 20, 2025	CDSCO	NSQ/Spurious Alert	Various drugs, devices, vaccines, cosmetics	Monthly list of products declared Not of Standard Quality, Spurious, Adulterated, or Misbranded [37]
April 18, 2025	CDSCO	Drug Alert (Revised)	Various drugs (Nov 2024, Jan 2025 lists)	Revised lists of drug alerts for previous months [37]
March 29, 2025	CDSCO	NSQ/Spurious Alert	Various drugs, devices, vaccines, cosmetics	Monthly list of products declared Not of Standard Quality, Spurious, Adulterated, or Misbranded [37]
Aug 7, 2024	CDSCO	Guidance Document	Human Vaccines	Release of 'Guidance for Industry on Pharmacovigilance Requirements for Human Vaccines' [19]
July 30, 2024	IPC	Drug Safety Alert	Vancomycin	Alert issued regarding ADRs linked to vancomycin [40]
Aug 31, 2023	CDSCO	Voluntary Recall	Digene Gel (Abbott India)	Voluntary recall of Digene Gel due to safety concerns [38]
Sep 6, 2023	CDSCO	WHO Alert	DEFITELIO (DEFIBROTIDE)	Alert on falsified version of DEFITELIO identified in India [43]
July 14, 2023	CDSCO	Drug Alert	Pholcodine	Alert on pholcodine-containing cough and cold remedies [44]
Ongoing	IPC	Drug Safety Alerts	Metronidazole, mefenamic acid, minoxidil, etc.	Alerts issued for specific ADRs linked to these drugs [39]
May 6, 2025	CDSCO	Draft Guidelines	Similar Biologics	Inviting comments on Revised Guidelines on Similar Biologics, 2025 [23]

3.5. Capacity Building and Stakeholder Engagement

PVPI has implemented extensive training initiatives to enhance the pharmacovigilance capabilities of healthcare professionals (HCPs), including doctors, nurses, and pharmacists [25][45]. These programs are crucial, as insufficient training remains a significant barrier to effective Adverse Drug Reaction (ADR) reporting [25]. To institutionalize pharmacovigilance (PV) awareness, PV modules have been integrated into both undergraduate and postgraduate

medical education curricula [46][47]. The Pharmacy Council of India has also mandated pharmacovigilance as a core subject in the undergraduate pharmacy curriculum [48]. This strategic integration reflects a long-term vision to embed PV principles at the foundational level of healthcare education, thereby fostering a sustainable and widespread culture of ADR reporting.

Collaboration with professional bodies further strengthens stakeholder engagement. The Society of Pharmacovigilance, India (SoPI), actively partners with PVPI to advance research and awareness initiatives [25][49]. Annual awareness campaigns, such as National Pharmacovigilance Week, are regularly observed, featuring continuing medical education (CME) programs and stakeholder meetings. In 2021 alone, over 33,000 stakeholders participated in PVPI events [50]. The IPC celebrated the 4th National Pharmacovigilance Week from September 17 to 23, 2024, underscoring its ongoing commitment to awareness and outreach [20].

To address the need for continuous skill development and broader accessibility, the IPC announced the 32nd Skill Development Programme on Pharmacovigilance, an online program scheduled for March 2025, specifically designed to train HCPs in ADR monitoring and reporting [20]. Additionally, workshops for NABH-accredited hospitals were conducted in January 2025, further broadening the reach of PV training [20].

Despite these substantial efforts, underreporting of ADRs persists as a critical challenge, often attributed to lingering gaps in awareness and knowledge among HCPs [25][51]. The persistence of underreporting, even with digital tools and widespread training, suggests that deeper systemic barriers exist beyond knowledge deficits. Factors such as fear of legal repercussions, perceived lack of importance, and heavy workloads indicate that a profound cultural shift, supported by clear incentives and protective measures, is necessary to significantly improve reporting behavior. Policy interventions must therefore address not only the mechanics of reporting but also the underlying motivations and perceived risks that influence HCP engagement in pharmacovigilance [51].

3.6. Integration with National Health Programs

PVPI has strategically integrated its pharmacovigilance activities with several major national public health programs, ensuring that drug safety monitoring is embedded within disease-specific initiatives and not functioning as an isolated vertical [25][52]. This integration enhances both the relevance and reach of pharmacovigilance across India's healthcare landscape.

Key collaborations include

- National Tuberculosis Elimination Programme (NTEP): Under the former Revised National Tuberculosis Control Program (RNTCP), now NTEP, PVPI has implemented active drug safety monitoring (ADSM) for newer anti-tuberculosis drugs such as bedaquiline and delamanid. This initiative includes targeted training for healthcare workers and the designation of 21 AMCs specifically for monitoring ADRs related to anti-TB drugs [25][53].
- National AIDS Control Program (NACP): In collaboration with the National AIDS Control Organization (NACO), PVPI monitors ADRs arising from antiretroviral therapy (ART). Data from AMCs are regularly analyzed and submitted to the global pharmacovigilance database, contributing to safer management of HIV patients [25][54].
- Universal Immunization Programme (UIP): PVPI is responsible for identifying and monitoring Adverse Events Following Immunization (AEFI), thereby supporting the safety of mass vaccination campaigns [25][55].
- Antimicrobial Resistance (AMR) Mission: PVPI actively contributes to the national AMR mission, including the addition of an appendix on antimicrobial resistance in the National Formulary of India, which serves as a key reference for healthcare professionals [25][56].
- National Vector Borne Disease Control Programme (NVBDCP): In August 2016, PVPI signed a Memorandum of Understanding (MoU) with NVBDCP to monitor drug safety for vector-borne diseases such as leishmaniasis. This collaboration involves 58 designated centers in endemic states focused on this surveillance [25][57].

This comprehensive integration with national health programs demonstrates a sophisticated understanding of public health priorities and a pragmatic approach to embedding pharmacovigilance into existing health infrastructure. Such collaboration is particularly crucial for programs involving long-term drug regimens (e.g., TB and HIV treatment) or mass drug administration campaigns (e.g., immunization), where ADRs can have significant public health consequences. This model allows for targeted surveillance, optimized resource allocation, and a more comprehensive approach to patient safety across diverse health initiatives.

4. Discussion

4.1. Key Achievements and Success Stories

Since its inception, the Pharmacovigilance Programme of India (PVPI) has achieved substantial progress and several notable milestones. One of the most significant achievements is the dramatic increase in the volume of Individual Case Safety Reports (ICSRs) received. The number of ICSRs escalated from approximately 11,000 in 2006–2008 to over 78,000 by mid-2014[25], and further to more than 113,000 in 2022–2023 [28][51]. This growth reflects the strengthening of reporting infrastructure and heightened awareness among healthcare professionals and stakeholders.

A pivotal moment in PVPI's evolution was its designation as a WHO Collaborating Centre for Pharmacovigilance in Public Health and Regulatory Services in 2017 [49]. This international recognition attests to the program's increasing maturity and positions India as a leader capable of guiding other developing nations in establishing robust pharmacovigilance systems. The expansion of the Adverse Drug Reaction Monitoring Centre (AMC) network [25][50], combined with the WHO Collaborating Centre status, signifies PVPI's transformation from a nascent program into a globally recognized contributor to drug safety. This growth not only enhances India's credibility as a pharmaceutical hub but also strengthens its capacity to influence international drug safety standards.

The carbamazepine-induced Stevens–Johnson Syndrome (SJS) case exemplifies PVPI's regulatory impact. Through its pharmacovigilance activities, PVPI identified a genetic association between carbamazepine and the HLA-B*1502 allele, which led to influential regulatory actions, including label updates and recommendations for pre-treatment genetic screening in at-risk populations [34][35]. This case highlights the unique value of a national pharmacovigilance system operating within a genetically diverse population, demonstrating how localized data can reveal safety signals that might be overlooked by global systems predominantly based on Western populations. Such findings contribute significantly to global drug safety knowledge.

PVPI has also made notable advances in digital pharmacovigilance. The development and adoption of the ADR PVPI mobile app and the Adverse Drug Monitoring System (ADRMS) online portal underscore its commitment to leveraging technology for more efficient reporting and data management [31]. The continuous expansion of the AMC network, now exceeding 500 centers [50], with a focus on enrolling new centers in underserved regions [28][51], further demonstrates a commitment to achieving broader geographical coverage for drug safety monitoring.

International collaboration has become an increasingly important aspect of PVPI's activities. Regular exchanges of safety information with countries in the South-East Asia Regulatory Network (SEARN) and visits from international delegations, such as the Uzbek Delegation in 2024, highlight India's growing influence in the global pharmacovigilance landscape [52]. The combination of quantitative growth in reporting and infrastructure, international recognition, and collaborative engagement creates a positive feedback loop: more data and a stronger network led to improved signal detection, which in turn enhances regulatory credibility and fosters greater international collaboration, positioning India as a significant contributor to global drug safety.

4.2. Persistent Challenges and Limitations

Despite its notable achievements, the Pharmacovigilance Programme of India (PVPI) continues to face several significant challenges that impede its optimal effectiveness:

4.2.1. Under-reporting: a pervasive and critical issue.

It is widely attributed to a complex interplay of factors, including limited awareness among healthcare professionals (HCPs) regarding reporting mechanisms and the importance of pharmacovigilance, fear of legal repercussions, and the absence of clear incentives for reporting [25][42]. The ADR reporting rate in India is approximately 40 reports per million population, significantly lower than the average of 130 per million observed in high-income countries [25]. Many HCPs remain unaware of the existence or purpose of the National Pharmacovigilance Center [42]. The persistence of under-reporting, even with ongoing awareness campaigns and digital tools, points to deeper systemic barriers beyond knowledge gaps, such as fear of legal action, perceived threats to professional competence, and heavy clinical workloads. Effective policy interventions must therefore go beyond information dissemination and focus on fostering a supportive reporting culture, potentially including legal protections and integration into professional performance metrics.

4.2.2. Incomplete Reports and Data Quality

A substantial proportion of ICSRs submitted to PVPI lack critical information, such as precise drug dosages, comorbidity details, and accurate event timelines [15][25]. This incompleteness directly compromises the reliability of signal detection and regulatory decision-making. Inadequate training among HCPs further exacerbates the issue, leading to suboptimal data quality [25][42].

4.2.3. Inadequate Private Healthcare Involvement

Another major limitation is the insufficient participation of private healthcare institutions. Since over 70% of healthcare delivery in India occurs in the private sector, their underrepresentation in PVPI's reporting network creates significant blind spots in national drug safety data [53]. Many private hospitals lack the necessary infrastructure and trained personnel for effective pharmacovigilance activities, which limits the comprehensiveness and generalizability of PVPI's findings.

4.2.4. Limited Surveillance Scope: Historically

PVPI's monitoring scope has been limited, with insufficient emphasis on traditional medicines, biologics, and the issue of counterfeit drugs. While efforts are underway to expand surveillance in these areas, they still represent important gaps in comprehensive patient safety [25].

4.2.5. Funding Constraints: Pharmacovigilance activities have historically been underfunded

Accounting for only about 2.1% of India's healthcare budget in 2009–10 [1]. Inadequate funding continues to impact infrastructure development, training, and operational efficiency [25].

4.2.6. State-level Variability

The implementation and effectiveness of PVPI vary significantly across states, complicating uniform data collection and hindering comprehensive national surveillance. Infrastructure limitations and shortages of trained staff are prevalent in some AMCs, contributing to these disparities [25].

Table 4 Major Challenges and Proposed Solutions for PVPI

Challenge	Specific Manifestation/Causes	Proposed Solution(s)
Under-reporting	Lack of awareness, fear of legal repercussions, absence of incentives, high workload; low ADR rate	Mandate ADR reporting in private sector; integrate PV into curricula; develop advanced e-reporting platforms; promote awareness campaigns
Incomplete Reports / Data Quality	Missing vital information; inadequate training	Strengthen training; simplify reporting forms; provide feedback; leverage AI for data validation
Inadequate Private Sector Involvement	Over 70% healthcare is private; underrepresentation; lack of infrastructure/manpower	Mandate ADR reporting in private sector; public-private partnerships
Limited Surveillance Scope	Historically limited monitoring of traditional medicines, biologics, counterfeit drugs	Systematically include traditional medicines, biologics, biosimilars; strengthen anti-counterfeit efforts
Funding Constraints	Low budget allocation; underfunded PV systems	Advocate for increased and sustainable funding at national and state levels
State-level Variability	Disparities in implementation and effectiveness; infrastructure/staff shortages	Expand AMC coverage; ensure uniform standards through toolkits/guidelines

4.3. Comparison with Global Pharmacovigilance Systems

While the Pharmacovigilance Programme of India (PVPI) has made significant advancements and achieved international recognition, a comparison with established pharmacovigilance systems in developed regions such as the United States and the European Union highlights several areas where India continues to lag, particularly regarding integration, mandatory reporting, and risk management frameworks.

4.3.1. Regulatory Bodies

In India, pharmacovigilance is primarily regulated by the Central Drugs Standard Control Organization (CDSCO), with the Indian Pharmacopoeia Commission (IPC) serving as the National Coordination Centre (NCC) for PVPI [7][15]. In contrast, the United States Food and Drug Administration (USFDA) oversees pharmacovigilance through the Center for Drug Evaluation and Research (CDER) and the Center for Biologics Evaluation and Research (CBER) [54]. The European Medicines Agency (EMA) coordinates pharmacovigilance activities across the EU [55], while the Medicines and Healthcare products Regulatory Agency (MHRA) independently manages post-marketing surveillance in the UK following Brexit [56].

4.3.2. ADR Processing and Reporting

PVPI relies largely on spontaneous reporting from stakeholders, with data managed via Vigil Flow and uploaded to VigiBase. India uses a single ADR form for all products, with non-serious cases ideally reported within 30 days and serious cases or deaths within 7 days [18]. In the US, the FDA Adverse Event Reporting System (FAERS) is used, with voluntary reports from healthcare professionals and patients via MedWatch, and mandatory reporting from manufacturers within 15 days for serious and unanticipated events. Distinct forms (FDA 3500B for voluntary, 3500A for mandatory) are used, and the Sentinel System complements FAERS for large-scale data [54][57]. The EMA coordinates reporting through the Eudra Vigilance database, requiring Periodic Safety Update Reports (PSURs) and comprehensive Risk Management Plans (RMPs) from companies [55][58]. The UK's MHRA continues to use the Yellow Card Scheme for adverse event data collection [56].

4.3.3. Risk Management

PVPI incorporates a risk management system within its framework [15]. The USFDA requires Risk Evaluation and Mitigation Strategies (REMS) for high-risk drugs and employs Risk Minimization Action Plans (Risk MAPs) [54][59]. The EMA's RMPs are centrally reviewed by the Pharmacovigilance Risk Assessment Committee (PRAC) [55], while the MHRA has introduced the Innovative Licensing and Access Pathway (ILAP) for post-launch oversight [56][60].

4.3.4. Mandatory Reporting

A fundamental difference is the statutory requirement for ADR reporting. In India, ADR reporting is generally not mandatory for doctors, although it is for pharmaceutical industry pharmacovigilance cells [18][32][33]. In contrast, the US and EU have stringent mandatory reporting requirements for the pharmaceutical industry and more structured frameworks for healthcare professionals [54][55].

This comparison underscores a key difference in regulatory philosophy. While the US FDA and EMA have moved toward mandatory, highly structured, and industry-driven reporting with robust risk management (e.g., REMS, RMPs), India's system still relies primarily on voluntary reporting by healthcare professionals and consumers. This reliance contributes to lower reporting rates and potential data gaps, representing a significant area for policy reform. Furthermore, while PVPI is integrated with the global VigiBase, differences in data completeness, reporting forms, and risk management approaches, such as the lack of specific modules for biologics, suggest that further harmonization with global standards is needed. Improved alignment in reporting standards and data richness would enhance India's ability to contribute to and benefit from international pharmacovigilance efforts.

Table 5 Comparison of PVPI's Reporting Mechanisms with International Standards

Feature	PVPI (India)	US FDA (USA)	EMA (EU)	MHRA (UK)
Regulatory Body	CDSCO, IPC (NCC) (7,15)	USFDA (CDER, CBER) (54)	EMA (coordinates EU-wide) (55)	MHRA (independent) (56)
Primary Reporting Method	Spontaneous reporting (18)	FAERS; MedWatch (voluntary) (54)	Eudra Vigilance database (55)	Yellow Card Scheme (56)
Mandatory Reporting	Not mandatory for doctors; mandatory for industry (18,32,33)	Mandatory for industry; voluntary for HCPs/consumers (54)	Mandatory for companies (PSURs, RMPs) (55)	Mandatory for industry; voluntary for HCPs/consumers (56)
Database Used	Vigi Flow (uploads to VigiBase) (18,21)	FAERS, Sentinel System (54,57)	Eudra Vigilance (55)	Yellow Card Scheme database (56)
Risk Management Framework	Includes Risk Management System (15)	REMS, Risk MAP (54,59)	RMPs reviewed by PRAC (55)	ILAP (56,60)
Reporting Timeframes	Non-serious: 30 days; Serious/Death: 7 days (18)	Serious/Unanticipated ADEs: 15 days (54)	PSURs (periodic); ICSRs (varied) (55)	Varies by seriousness/type (56)
Reporting Forms	One ADR form for all products (18)	FDA 3500B (voluntary); 3500A (mandatory) (54)	Standardized forms (E2B) (55)	Yellow Card form (56)

5. Future Directions and Recommendations

To overcome existing limitations and fully realize its potential in safeguarding public health, the Pharmacovigilance Programme of India (PVPI) should strategically pursue several key directions:

5.1. Expand AMC Coverage

PVPI should accelerate the expansion of its Adverse Drug Reaction Monitoring Centre (AMC) network to encompass all medical colleges and district hospitals nationwide [18]. The Indian Pharmacopoeia Commission's (IPC) goal of including all hospitals, government and private, will be crucial for achieving broader geographical reach and increasing reporting density, thereby ensuring a more representative and comprehensive national dataset [18].

5.2. Mandate ADR Reporting in the Private Sector

Legislative action to mandate ADR reporting in private healthcare institutions is paramount [18][53]. The private sector currently represents a significant blind spot in national pharmacovigilance data. Regulatory enforcement, coupled with infrastructure and training support, will be essential for integrating this large segment into the national surveillance system.

5.3. Integrate Pharmacovigilance into All Health Sciences Curricula

Pharmacovigilance modules should be further embedded into undergraduate and postgraduate curricula for all health sciences, including medicine, pharmacy, dentistry, and nursing [37][38]. This will foster a universal culture of reporting by instilling PV principles at the foundational level of healthcare education, thereby ensuring sustainable and widespread awareness and practice.

5.4. Develop Advanced E-Reporting Platforms and Mobile Applications

Building on the success of the ADR PVPI mobile app, PVPI should further streamline workflows by developing more user-friendly, comprehensive, and multilingual e-reporting platforms and mobile [23]. These digital tools can significantly enhance accessibility and efficiency, especially in rural and resource-limited settings.

5.5. Promote AI-Driven Analytics

Leveraging Artificial Intelligence (AI) and Machine Learning (ML) for real-time signal detection, automated case processing, and advanced data analytics is a crucial next step [61][62]. Given India's vast population and the complexity of its pharmaceutical market, AI/ML can enable faster, more accurate ADR identification, improve data quality, and facilitate a shift from reactive to proactive pharmacovigilance.

5.6. Broaden Surveillance Scope

PVPI should systematically include traditional medicines (Ayurveda, Siddha, Unani, Homoeopathy), biologics, and biosimilars in its surveillance activities [18]. Initiatives like AYUSHSURAKSHA should be expanded, and efforts against counterfeit drugs should be strengthened, potentially through a dedicated task force and mandatory QR code implementation for drug tracking [63][64]. This holistic approach is essential for comprehensive patient safety in India's diverse pharmaceutical landscape.

5.7. Enhance International Collaboration and Regional Mentoring

PVPI should continue to leverage its status as a WHO Collaborating Centre to mentor other developing nations and participate actively in global pharmacovigilance harmonization initiatives [49]. Such collaboration fosters shared vigilance, knowledge exchange, and capacity building.

5.8. Address Funding and Resource Constraints

Advocating for increased and sustainable funding for pharmacovigilance at both national and state levels is essential [18]. Adequate resources are fundamental for infrastructure development, training, and the adoption of advanced technologies.

5.9. Improve Data Quality and Completeness

Measures to ensure comprehensive and high-quality reporting should be implemented. This includes simplifying reporting forms, establishing robust feedback mechanisms for reporters, and conducting targeted training programs that clearly articulate what and how to report [15][18].

By pursuing these strategic directions, PVPI can address its current limitations, strengthen its operational framework, and further establish itself as a global leader in pharmacovigilance, ultimately enhancing drug safety and public health outcomes in India.

6. Conclusion

PVPI has rapidly emerged as a global leader in drug safety, expanding its surveillance network, embracing digital innovation, and earning WHO recognition. However, persistent challenges, especially underreporting from the private sector, data quality gaps, and uneven implementation, still limit its full potential. Moving forward, expanding AMC coverage, mandating private sector reporting, integrating pharmacovigilance into all health curricula, leveraging AI-driven analytics, and broadening surveillance to traditional medicines and biologics are essential. As India advances toward universal health coverage, a robust, integrated pharmacovigilance system will be fundamental to ensuring that the benefits of medicines consistently outweigh their risks for every citizen.

Compliance with ethical standards

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