



ISSN: 2306-6091

International Journal of Pharmaceuticals and Health Care Research (IJPHR)

IJPHR | Vol.14 | Issue 4 | Oct-Dec-2026

www.ijphr.com

DOI : <https://doi.org/10.61096/ijphr.v14.iss4.2026.934-945>

Artificial Intelligence and Automation in Individual Case Safety Report (ICSR) Processing: Current Applications, Challenges & Future Directions

Kota Sai Harshitha*¹, Dampanaboina Jahnvi¹, Vemavarapu Satish Kumar²

¹ Intern, Clinoxy Solutions Pvt., Ltd., KPHB 9th Phase, Kukatpally, Hyderabad, Telengana

² Founder, Clinoxy Solutions Pvt., Ltd., KPHB 9th Phase, Kukatpally Hyderabad, Telengana

Author for correspondence: Kota Sai Harshitha

Email: kotaharshitha3@gmail.com



Published on:
26.10.2026
Published by:
Futuristic
Publications
2026| All rights
reserved.



Creative
Commons
Attribution 4.0
International
License.

Abstract: Pharmacovigilance plays an important role in monitoring the safety of medicines, and Individual Case Safety Reports (ICSRs) provide essential information about suspected adverse events and adverse drug reactions. However, increasing reporting volumes, incomplete information, unstructured narratives, inconsistent terminology, and duplicate reports make ICSR processing challenging and time-consuming. This review discusses the current applications of artificial intelligence (AI) and automation in ICSR case processing, including the evolution from traditional manual methods and electronic reporting systems to rule-based automation, robotic process automation (RPA), natural language processing (NLP), machine learning (ML), and AI-assisted approaches. It explores their potential applications in case intake and validation, duplicate detection, data extraction, medical coding, case triage, medical review, narrative generation, quality control, and regulatory submission. These technologies may reduce repetitive manual work, improve processing efficiency, and support consistency in routine activities. However, their performance can be affected by poor data quality, incomplete clinical information, algorithmic bias, limited transparency, and difficulties in interpreting complex clinical situations. Appropriate system validation, continuous performance monitoring, traceability, regulatory compliance, and human oversight are therefore essential for reliable implementation. Overall, AI and automation offer promising opportunities to support ICSR processing, but their effectiveness depends on the quality of available data, the suitability of the technology, and appropriate quality-management practices. Future developments should focus on explainable AI, privacy-preserving approaches, improved interpretation of complex clinical information, and responsible integration into pharmacovigilance systems while retaining human expertise in safety-related decisions.

Keywords: Pharmacovigilance, Individual Case Safety Report (ICSR), Artificial Intelligence, Automation, Natural Language Processing, Machine Learning, Robotic Process Automation, Drug Safety, Adverse Drug Reactions, Regulatory Compliance.

INTRODUCTION

Pharmacovigilance and the importance of ICSR processing

Pharmacovigilance is the science and activities concerned with the detection, assessment, understanding, and prevention of adverse effects and other drug-related problems. Its primary goal is to protect patients and public health by promoting the safe and appropriate use of medicines. This requires continuous

monitoring of medicines throughout their lifecycle so that emerging safety concerns can be recognized, evaluated, and communicated in a timely manner. Pharmacovigilance therefore contributes not only to the assessment of the benefits and risks of medicines but also to their safe and rational use in clinical practice.

Post-marketing surveillance (PMS) is an important part of this ongoing process. Although pre-marketing clinical trials provide essential information about the efficacy and safety of a medicine, they are generally conducted in controlled settings with relatively limited and selected populations. As a result, rare, delayed, or previously unrecognized adverse drug reactions (ADRs) may only become apparent after a medicine is used more widely. PMS allows medicines to be monitored in larger and more diverse populations, including groups that may be underrepresented in clinical trials, and helps identify safety concerns associated with real-world medicine use, such as drug-drug interactions, comorbidities, genetic differences, and variations in treatment practices.

To support this continuous monitoring, pharmacovigilance draws information from several sources, including Individual Case Safety Reports (ICSRs), electronic health records, scientific literature, social media, insurance claims, and other real-world data sources. Among these, ICSRs remain particularly important because they provide information about suspected adverse reactions at the individual patient level. A single report can bring together details about the patient, suspected medicine, adverse event, treatment history, concomitant medicines, medical history, and clinical outcome. When evaluated alongside other reports, this individual information can contribute to case assessment, safety-signal detection, and ongoing benefit–risk evaluation.

The importance of individual-level information is becoming increasingly recognized as pharmacovigilance moves toward a more patient-centred approach. Patients may respond differently to the same medicine because of factors such as age, sex, genetic characteristics, medical history, and concomitant treatment. Patient-reported information can also provide details about symptoms and treatment experiences that may not be fully captured in routine clinical records. However, the usefulness of an ICSR depends not simply on the number of reports collected, but on the quality and completeness of the information they contain. Missing patient details, unclear descriptions of adverse events, inconsistent terminology, and incomplete outcomes can make individual cases more difficult to assess and may affect subsequent safety analysis.

These challenges become particularly important because ICSR information is often a mixture of structured data and free-text narratives. Adverse events may be described using different terms, abbreviations, synonyms, or misspellings and must often be interpreted and coded using standardized terminology such as MedDRA. At the same time, increasing reporting volumes can place considerable demands on pharmacovigilance teams, particularly when activities such as data entry, case validation, duplicate detection, coding, seriousness assessment, follow-up, and quality review are performed manually. Although human expertise remains essential for clinical interpretation and final safety decisions, handling these repetitive and information-intensive tasks can become increasingly difficult as the volume and complexity of safety data grow.

Automation, including natural language processing, machine learning, and artificial intelligence, offers opportunities to assist with information extraction, data validation, standardized coding, duplicate detection, case prioritization, and other processing activities. The aim is not to replace pharmacovigilance professionals, but to support them by reducing repetitive work and allowing greater attention to cases that require clinical judgment. Understanding the current applications, capabilities, limitations, and challenges of such approaches is therefore important for evaluating their role in the future of ICSR case processing.

Adverse Drug Reactions (ADR) and Adverse Events (AE)

Adverse Drug Reaction (ADR)

An adverse drug reaction (ADR) is a noxious and unintended response for which a causal relationship to the medicinal product is at least reasonably suspected.

Adverse Event (AE)

An adverse event (AE) is any untoward medical occurrence temporally associated with use of a medicinal product, without requiring a causal relationship.

Individual Case Safety Report (ICSR)

Definition of an ICSR

An Individual Case Safety Report (ICSR) according to the ICH E2B(R3) standard is a report of information describing adverse event(s) or reaction(s) experienced by an individual patient. The implementation guide defines its purpose as standardising the data elements used in the electronic transmission of different types of ICSRs across pre- and post-authorisation periods, regardless of their source or destination.

Purpose of an ICSR

The main purpose of an ICSR is to capture sufficient clinical and safety information to allow an individual case to be assessed and contribute to broader medicine-safety monitoring. ICSRs combine structured information, such as patient characteristics, treatment dates, dosage, and coded adverse events, with narrative information describing the clinical circumstances of the case. This information supports:

- **Case assessment:** Provides information needed to evaluate the suspected reaction, including patient characteristics, medical history, laboratory findings, seriousness, outcome, and potential causality.
- **Safety database development:** Standardized reports can be electronically incorporated into safety databases, allowing information from different sources and regions to be stored and analyzed consistently.
- **Signal detection:** When individual reports are evaluated collectively, they can contribute to identifying new, rare, or emerging safety concerns.
- **Benefit–risk assessment:** Accumulated case information contributes to the ongoing evaluation of the benefits and potential risks of medicines.
- **Regulatory safety monitoring:** ICSRs support regulatory reporting requirements and enable authorities to monitor medicine safety and take appropriate action when necessary.

Minimum Information Required for a Valid ICSR

For an ICSR to be considered a valid case, four basic elements are required: an identifiable patient, an identifiable reporter, a suspected medicinal product, and a suspected adverse event or reaction. These minimum requirements provide the foundation for case processing. If one of these essential elements is missing, the report may not contain sufficient information for a valid safety case and may require clarification or follow-up.

Key Data Elements in an ICSR

An ICSR contains several categories of information that together provide a clinical picture of the case. Patient information may include age, sex, weight, and relevant medical history. Reporter information identifies the source and their professional qualification. Drug information includes the suspected product, active ingredient, dose, frequency, route of administration, indication, and treatment dates. Adverse-event information includes the reported reaction, MedDRA coding, onset date, seriousness, and outcome. Laboratory findings, diagnostic information, medical assessments, causality assessments, and narrative descriptions may provide additional context for evaluating the case.

Sources of ICSRs

ICSRs can originate from various sources, including spontaneous reports from healthcare professionals and patients, pharmaceutical companies, clinical studies, published literature, and regulatory or pharmacovigilance organizations. This variety of sources contributes to a broader understanding of medicine safety but also introduces differences in the completeness, format, and quality of the information received.

Challenges in Processing ICSR Data

Processing Individual Case Safety Report (ICSR) data is challenging because safety information comes from different sources and may be incomplete, unstructured, or inconsistent. The main challenges include:

- **Unstructured and free-text information:** Important clinical details may be recorded in physician notes, patient descriptions, emails, PDFs, and other narrative formats.
- **Missing or incomplete information:** Reports may lack essential details about the patient, suspected medicine, adverse event, treatment history, or clinical outcome.

- Abbreviations and terminology variation: Reporters may use different medical terms, abbreviations, synonyms, or informal descriptions to report the same event or medicinal product.
- Duplicate reports: The same adverse event may be reported through multiple channels or appear in multiple reports with slightly different information.
- Multilingual reporting: Safety reports submitted in different languages may contain variations in medical terminology and clinical descriptions.
- Inconsistent reporting formats: Differences in the structure and presentation of safety information can make ICSR data difficult to process consistently across reports.

Inconsistent Reporting Formats and Data Heterogeneity

Pharmacovigilance systems receive safety information from multiple sources, including spontaneous reports, electronic health records, scientific literature, and other relevant data sources. These sources may differ in their data structures, reporting formats, and methods of information exchange, making it difficult to integrate information consistently across systems.

Standardized data structures and controlled terminologies help improve consistency and interoperability. MedDRA supports the standardized coding of medical concepts, while appropriate medicinal-product dictionaries support consistent drug identification. Electronic reporting standards, including applicable ICH E2B requirements, facilitate the exchange of ICSR information between systems. However, differences in data formats and system requirements may still require careful mapping, validation, and review to preserve the accuracy and clinical meaning of safety information.

ICSR Data Processing: Challenges and Opportunities for Automation

ICSR processing involves the interpretation of both structured data and clinical narratives to ensure that relevant safety information is captured and represented accurately. Conventional processing methods may require considerable manual effort when information must be extracted, standardized, compared, and checked across different parts of a case.

Automation offers opportunities to support these activities through technologies such as optical character recognition, natural language processing, machine learning, and rule-based validation. Depending on the task and the system's validated capabilities, these approaches may assist with data extraction, adverse-event identification, duplicate detection, medical coding, and the identification of inconsistencies. Their usefulness depends on their ability to preserve the clinical meaning of the original report and produce reliable outputs. Consequently, automated processing should be supported by appropriate validation and human review, particularly when a case requires clinical interpretation or contains uncertain information.

Rationale for Automation

The need for automation in ICSR processing arises from the growing volume and complexity of safety reports and the demand for efficient processing while maintaining data quality and regulatory compliance. By supporting repetitive and information-intensive activities, automation can help reduce manual workload, improve consistency, and allow pharmacovigilance professionals to devote more attention to cases requiring detailed clinical assessment. However, its effectiveness depends on the suitability of the technology for the intended task, the quality of the available data, and appropriate system validation. Automation should therefore complement, rather than replace, human expertise. Human oversight, quality control, and traceability remain essential for verifying automated outputs, resolving uncertainty, and maintaining the reliability of safety-related decisions.

Evolution of ICSR processing

Traditional manual ICSR processing

Traditional ICSR processing involves several stages that rely heavily on human review, including case intake, data entry, duplicate checking, medical assessment, MedDRA and drug coding, narrative writing, and quality control. Information received through channels such as telephone, email, or digital platforms must first be converted into structured safety data. Reviewers then assess whether a case is new, a follow-up, or a duplicate, followed by clinical assessment and coding before the case undergoes quality review.

Although human expertise remains essential, this workflow can be time-consuming and resource-intensive, particularly as adverse-event reporting volumes continue to grow. Repetitive manual entry and

review may also introduce inconsistencies, transcription errors, and processing bottlenecks. In addition, traditional safety systems often provide limited automation for handling complex, unstructured information. These limitations highlight the need for approaches that can support routine processing while retaining appropriate human oversight.

Transition to electronic ICSR processing

The processing of safety reports has gradually moved from paper-based and manually maintained records toward electronic safety databases. In the initial intake stage, information received from different sources is converted into structured data using standardized intake forms. This makes the information easier to store, review, retrieve, and share across pharmacovigilance systems. Electronic formats also support the transmission of ICSRs between pharmaceutical companies, regulatory authorities, and other partners. The ICH E2B standard, particularly its XML-based electronic format, provides a common structure for exchanging safety information and promotes greater consistency between systems. However, the shift to electronic databases has not completely removed the need for manual processing. Many reports still contain unstructured narratives that require human interpretation and data entry before they can be used effectively. Thus, electronic systems have improved standardization and information exchange, while substantial manual effort remains in ICSR processing.

Rule based automation

Rule-based automation uses predefined instructions and validation criteria to support routine ICSR processing. Automated tools can extract structured information from defined intake forms, reducing repetitive manual data entry. Automated validation and duplicate checks can then identify missing, inconsistent, or repeated records before cases proceed for further assessment. Predefined lookup tables and rules can flag reported terms or case details that require further assessment of seriousness.; for example, Predefined rules can flag reported terms or case details that require further seriousness assessment. Workflow automation further connects these steps by routing cases through intake, prioritization, triage, assessment, and reporting according to predefined rules. When combined, these tools create a more consistent processing pathway and reduce unnecessary manual intervention in routine cases. However, because rule-based systems depend on predefined conditions, they may be less effective when reports contain unexpected terminology, incomplete information, or complex clinical situations that fall outside established rules.

Robotic Process Automation (RPA)

Robotic Process Automation (RPA) is particularly useful for repetitive and structured tasks within ICSR processing. Software robots can transfer information from sources such as emails, forms, or PDF reports into safety databases, reducing the need for repeated manual data entry. RPA can also support routine activities such as case creation, duplicate checks, report triage, notifications, and other predefined checks. By handling these rule-based tasks consistently, RPA can reduce transcription errors and allow pharmacovigilance professionals to spend more time on activities that require clinical judgment. However, because pharmacovigilance is highly regulated, RPA workflows must be appropriately validated, monitored, and documented to maintain data integrity, traceability, and auditability throughout the process.

AI Assisted ICSR processing

AI-assisted ICSR processing represents a further step beyond rule-based automation and conventional machine learning by enabling more context-aware analysis of complex safety information. Advanced artificial intelligence is being explored for processing and interpreting large volumes of safety information, with potential applications in areas such as triage, prioritization, and narrative preparation. Natural Language Generation (NLG) can also support the drafting or summarization of ICSR narratives by bringing together information from different sections of a case.

The use of AI becomes more sensitive when it is applied to clinical assessment or other decisions that may influence patient safety and regulatory reporting. Complex cases can contain ambiguity, incomplete information, or clinical context that automated systems may not interpret correctly. Therefore, AI-assisted processing should be used as decision support rather than as an independent replacement for pharmacovigilance expertise, particularly in medically significant or uncertain cases.

Human-in-the-loop processing

Although automation can support many stages of ICSR processing, human oversight remains essential for safety-critical activities. Pharmacovigilance professionals can verify automated outputs, interpret complex clinical information, correct errors, and handle cases that fall outside predefined rules. Rather than reviewing every case in the same manner, uncertainty-based approaches can direct human attention toward ambiguous or high-risk cases requiring closer assessment. Quality control and validation are also important for confirming that case information is accurate, complete, and suitable for regulatory submission. Clear audit trails and traceability help document how automated outputs were generated and how human decisions were made. When a system detects inconsistencies or potential safety concerns, appropriate safeguards can pause processing and route the case for expert review. This human-in-the-loop approach combines the consistency of automation with clinical expertise, ensuring that complex cases receive appropriate interpretation and that final safety-related decisions remain under qualified human oversight.

ICSR case processing work flow

The ICSR processing workflow involves a series of connected steps that ensure safety information is accurately captured, assessed, and communicated. Although the exact process may vary between organizations, the main stages generally include:

1. **Case Receipt and Intake:** Safety information may come from spontaneous reports, clinical trials, literature, patient-support programs, social media, or business partners. These reports are first received and entered into the pharmacovigilance system for further processing.
2. **Triage and Case Validation:** The report is checked to determine whether it contains the minimum information required for a valid ICSR: an identifiable patient, an identifiable reporter, a suspected medicinal product, and a suspected adverse event. The case is also initially assessed for seriousness and priority.
3. **Duplicate Detection and Case Linkage:** The new report is compared with existing cases to determine whether the same event has already been reported. If a duplicate is identified, it is linked to the original case rather than processed as a separate report.
4. **Data Entry and Coding:** Relevant information is entered into the safety database and standardized for further assessment. Adverse-event terms are coded using MedDRA, while medicinal products can be coded using standardized drug dictionaries such as WHO Drug.
5. **Causality Assessment:** The available clinical information is reviewed to assess the possible relationship between the suspected medicine and the reported event. Standardized approaches, such as the WHO-UMC system or Naranjo scale, may be used where appropriate.
6. **Medical Review:** A qualified medical reviewer evaluates the case as a whole, including the narrative, coding, seriousness, causality, and other clinically relevant details. Special situations, such as pregnancy exposure or overdose, may also require specific consideration.
7. **Quality Control:** Before submission, the case undergoes quality checks to confirm that the information is complete, consistent, accurately coded, and medically appropriate. Additional review may be required for cases involving complex clinical judgments.
8. **Regulatory Submission:** Once finalized, the case is submitted to the appropriate regulatory authorities or other required recipients according to applicable reporting requirements and timelines.
9. **Follow-up and Case Closure:** If additional information becomes available, the case is updated and may undergo the relevant processing steps again. The case is closed only when no further meaningful information is expected or available.

Benefits of AI-Assisted ICSR Processing

- **Improved Decision-Making:** AI may improve processing speed or consistency for selected tasks when its performance has been adequately validated.
- **Data Ingestion & Extraction:** Utilizes OCR/ICR alongside NLP and machine learning to read and extract information from both structured and unstructured sources (e.g., XML, PDFs, tables, images) in a regulatory-compliant manner.

Broader Advantages of Automation in Pharmacovigilance

- **Faster Operations:** Accelerates case intake, processing, and the overall delivery of safety information.
- **Volume & Versatility:** Effectively handles large incoming case volumes and a wide variety of diverse data formats.
- **Cost & Effort Reduction:** Minimizes manual time, labor costs, and human effort.
- **ADR Identification:** Leverages machine learning to accurately identify Adverse Drug Reactions (ADRs) from documents like discharge summaries, addressing historically poor reporting rates.
- **Quality & Compliance:** Ensures greater accuracy, consistency, and compliance in regulatory reporting.
- **Large-Scale Data Analysis:** Capable of processing and interpreting massive amounts of data rapidly (working 24/7), which can be applied across various disease states.
- **Future Utility:** Lays a roadmap for advanced applications within and beyond pharmacovigilance, such as Real-World Evidence, landscape analysis, Enterprise Knowledge Management, and Quantitative Sciences.

Challenges and Limitations of AI-Assisted ICSR Processing

Although AI can support several stages of ICSR processing, its application in pharmacovigilance still presents important challenges. One concern is algorithmic bias, as models trained on limited or non-representative datasets may perform less reliably in underrepresented populations, including older adults or certain demographic groups. AI systems may also struggle with changing safety patterns over time. As new medicines are used in larger real-world populations, emerging evidence can alter the understanding of their safety profiles, requiring models to be regularly updated to remain relevant.

Another major challenge is causality assessment, particularly in patients receiving multiple medicines. AI can identify patterns and associations within large datasets, but distinguishing which medicine actually caused an adverse event can require clinical context and expert judgment. Similarly, differences in data sources, formats, terminology, and quality make it difficult to integrate information from clinical databases, literature, and patient-generated sources consistently.

The lack of transparency in some advanced AI models is also important. When the reasoning behind an automated decision is difficult to understand, it can create concerns regarding validation, regulatory acceptance, and confidence in the system's outputs. In addition, implementing AI requires substantial investment in infrastructure, validation, maintenance, and data management, while human review remains necessary for complex or uncertain cases.

Finally, regulatory differences and data privacy requirements can make global implementation more complicated. Pharmacovigilance systems handle sensitive patient information, so appropriate safeguards are essential to protect confidentiality and maintain regulatory compliance. Overall, these challenges indicate that AI-assisted ICSR processing requires careful validation, continuous monitoring, strong data governance, and meaningful human oversight rather than complete reliance on automated decision-making.

Automation and validation of ICSR Quality Control

To address these challenges, the Compliance and Metrics Management (CMM) tool was developed to automate routine quality and compliance checks. Its performance was validated against the existing manual process to determine whether it could carry out these activities accurately and reliably. The automated approach improved Retro-QC productivity by 67%, while reducing processing time by 49% and costs by 43%. For late-submission analysis, it reduced processing time by 88% and costs by 87%. In addition to these productivity gains, the automated checks helped reduce errors during QC, supporting more consistent and reliable ICSR processing and strengthening regulatory compliance. Overall, the findings suggest that targeted automation can reduce repetitive QC work while allowing pharmacovigilance teams to focus more on cases that require detailed review.

Case Intake, Identification, and Validity Assessment

The processing of an Individual Case Safety Report (ICSR) begins when information about a suspected adverse drug reaction or adverse event is received from sources such as healthcare professionals, patients, clinical studies, literature, and electronic reporting systems. Automation can simplify this initial stage by collecting reports from different sources and directing them to the appropriate processing teams.

Technologies such as robotic process automation (RPA) and optical character recognition (OCR) can help retrieve information from electronic documents and scanned forms, while natural language processing (NLP) can identify text that may contain relevant safety information. Automated systems can also assist in checking whether a report contains the four minimum criteria required for a valid ICSR: an identifiable patient, an identifiable reporter, a suspected medicinal product, and a suspected adverse reaction or event. When information is missing or unclear, the system can flag the case for further review or follow-up. However, the final assessment of unclear or incomplete reports may still require human evaluation.

Automated Duplicate Detection and Data Extraction

Duplicate detection is an important part of ICSR processing because the same adverse event may be reported by different sources, such as a patient, a healthcare professional, and a pharmaceutical company. If duplicate reports are not identified, the same case may be processed more than once and may affect the accuracy of safety data. Automation can help compare information such as patient characteristics, suspected medicines, adverse events, event dates, and reporter details to identify potentially matching cases. Exact matching rules and more advanced methods, including machine learning, can help identify reports that may describe the same event even when some details differ. Once a case has been identified, automated data extraction tools can assist in transferring relevant information from forms, medical records, and narrative reports into structured database fields. This reduces repetitive manual entry and may improve processing efficiency. Nevertheless, suspected duplicates should be reviewed before cases are merged, and extracted information should be checked to ensure that important details have not been missed or incorrectly interpreted.

Medical Coding and Terminology Standardization

Medical coding converts the clinical information described in an ICSR into standardized terminology so that adverse events and other medical concepts can be consistently recorded, analysed, and reported. In practice, the same event may be described using different words, abbreviations, or expressions by patients and healthcare professionals. For example, a patient may report feeling sick, while a healthcare professional may document nausea. NLP and machine learning can help identify the clinical meaning of these expressions and suggest appropriate standardized terms from the Medical Dictionary for Regulatory Activities (MedDRA). Automation can also assist in identifying medicine names, active ingredients, and other product-related information for mapping to the appropriate drug terminology. These tools may reduce repetitive coding work and improve consistency across cases. However, clinical expressions can have different meanings depending on the context, and an automatically suggested term may not always represent the intended medical concept. Therefore, trained reviewers should verify ambiguous or clinically significant coding decisions.

Case Triage and Prioritization

ICSR teams often handle large numbers of reports, and not every case requires the same level of urgency or review. Case triage helps determine which reports need priority attention based on factors such as seriousness, the nature of the event, the available information, and applicable reporting requirements. Automation can support this process by applying predefined rules to identify cases containing serious outcomes, such as death or life-threatening events, and by flagging reports that may require urgent assessment. NLP and machine learning may also help identify relevant information within free-text narratives that is not immediately apparent from structured fields. Based on these findings, cases can be directed to appropriate review queues. This can help teams organize their workload and reduce the likelihood of important cases being overlooked. However, automated prioritization should be based on validated criteria, and trained safety professionals must review flagged cases and confirm the appropriate handling and reporting pathway.

AI-Assisted Medical Review and Assessment

Medical review involves examining the information in an ICSR to understand the reported event, the patient's clinical history, the suspected medicine, the sequence of events, and the available clinical evidence. Automation and artificial intelligence can support reviewers by organizing case information, identifying relevant dates and laboratory findings, highlighting missing details, and summarizing lengthy narratives. These functions may make it easier for reviewers to understand complex cases without repeatedly searching through different sections of a report. AI-based tools may also help identify information that requires further investigation, such as inconsistencies between the reported event and the

documented clinical history. However, these systems should be considered decision-support tools rather than replacements for clinical expertise. Medical interpretation, causality assessment, and decisions involving clinical uncertainty require appropriate professional judgment. Human oversight is particularly important when information is incomplete, contradictory, or associated with potentially serious safety concerns.

Automated Narrative Generation

The case narrative is an important part of an ICSR because it presents the relevant clinical information in a clear and organized form. Preparing narratives manually can be time-consuming, particularly when a report contains multiple medicines, several adverse events, laboratory results, and a detailed treatment history. Natural language generation (NLG) and generative AI tools can assist by converting structured case information into an initial narrative draft. These systems may organize details such as the patient's characteristics, suspected medicine, event onset, treatment provided, and reported outcome into a logical sequence. This can reduce the time spent on routine writing and help reviewers focus on checking the clinical content. However, an automatically generated narrative may omit important details, introduce unsupported information, or present events in an incorrect order. For this reason, the draft should be checked against the original source documents and structured case data before approval. The final narrative must accurately reflect the available evidence without adding assumptions or unreported clinical details.

Quality Control and Case Validation

Quality control and validation are necessary to ensure that an ICSR is complete, consistent, and suitable for further assessment or regulatory submission. During manual processing, errors may occur because of missing fields, incorrect dates, inconsistent medicine details, coding mistakes, or differences between the structured data and the case narrative. Automated validation tools can help identify these problems by checking required fields, data formats, logical relationships, and predefined business rules. For example, a system may flag a missing event onset date, an inconsistent sequence of dates, or a mismatch between a coded adverse event and the information described in the narrative. RPA and rule-based systems can also perform repetitive checks across large numbers of cases. These functions can reduce routine checking efforts and help reviewers focus on discrepancies that need investigation. However, passing automated validation does not necessarily mean that a case is medically accurate or complete. Human review remains important for resolving flagged issues, evaluating clinical meaning, and confirming the overall quality of the report.

Regulatory Considerations for AI-Assisted ICSR Processing

The use of artificial intelligence (AI) in Individual Case Safety Report (ICSR) processing requires careful attention to data quality, system reliability, and regulatory compliance. Although AI can support activities such as safety data intake, information extraction, case prioritization, and reporting, its implementation must ensure that the information remains accurate, traceable, and suitable for pharmacovigilance purposes. The following considerations are important when integrating AI into ICSR processing.

1. Data Quality and Fitness for Use

The quality of the data used by AI systems plays an important role in their performance. Training and operational datasets should adequately represent the patient populations and types of safety reports for which the system is intended. If the data are incomplete, inconsistent, or unrepresentative, the system may overlook important information or produce inaccurate results. Therefore, appropriate data governance practices are necessary to maintain data accuracy, completeness, traceability, and reliability throughout the processing workflow.

2. Model Validation and Performance Monitoring

AI systems should be evaluated before they are introduced into ICSR processing workflows to ensure that they perform reliably for their intended purpose. Validation may involve testing activities such as case intake, duplicate detection, information extraction, and medical coding using independent datasets where appropriate. Since reporting patterns, medical terminology, and safety information can change over time, continuous performance monitoring is also important. Any decline in performance should be investigated, and updates or retraining should be carried out when necessary.

3. Transparency, Explainability, and Traceability

Understanding how an AI system produces its outputs is important, particularly when those outputs influence safety-related decisions. Appropriate documentation should describe the system's intended use, methodology, limitations, and performance. Clear audit trails should also record relevant automated actions, changes to case information, system versions, and decisions made during processing. These records help pharmacovigilance teams review automated outputs, investigate errors, and demonstrate that safety information has been handled appropriately.

4. Human Oversight and Quality Management

Although AI can reduce repetitive work and support routine processing activities, it should not replace the professional judgment required for complex pharmacovigilance decisions. Qualified personnel should review uncertain or clinically significant outputs and ensure that the final case information is appropriate for its intended use. AI systems should also be incorporated into the organization's quality management processes, supported by appropriate standard operating procedures (SOPs), staff training, and clear responsibilities for reviewing and resolving errors.

5. Compliance with Safety Reporting Requirements

The use of AI must not interfere with applicable regulatory reporting requirements or submission timelines. Although automation may help teams process reports more efficiently, pharmacovigilance professionals remain responsible for ensuring that cases are handled and submitted according to the relevant requirements. Organizations should also maintain appropriate documentation of system validation, updates, performance monitoring, and error resolution. Keeping these records accessible helps demonstrate compliance during regulatory inspections and audits.

Overall, the successful implementation of AI in ICSR processing depends on more than technological capability. Reliable data, appropriate validation, ongoing monitoring, clear documentation, and meaningful human oversight are essential to ensure that automation supports efficient case processing without compromising the accuracy and reliability of pharmacovigilance activities.

Future Perspectives of AI-Assisted ICSR Processing

The future of AI-assisted ICSR processing is likely to focus on making automated systems more reliable, adaptable, transparent, and clinically useful rather than simply increasing the level of automation.

Explainable and interpretable AI: Future systems need to provide clearer reasons for their outputs, particularly when they influence case assessment or safety decisions. Developing models that are interpretable by design could improve confidence among pharmacovigilance professionals and support regulatory review.

Continuous learning and adaptation: Drug safety information changes as medicines are used in larger and more diverse populations. Future AI systems will therefore need to adapt to newly emerging evidence and changing reporting patterns while maintaining stable and reliable performance. This is particularly important for addressing concept drift over time.

Improved causal assessment: Determining whether a medicine actually caused an adverse event remains difficult, especially when patients receive multiple medicines. Future research may combine AI with causal inference methods to move beyond identifying statistical associations and better understand drug–event relationships and potential interactions.

Privacy-preserving and less biased AI: Federated learning offers a potential approach for developing AI models using data from multiple institutions without requiring raw patient data to be centrally shared. This could support the development of models that better represent diverse populations while strengthening data privacy.

Integration of multiple data sources: Future pharmacovigilance systems are also expected to combine information from ICSRs with electronic health records, scientific literature, and patient-generated data. Integrating these different sources could provide a broader clinical context and support earlier identification and evaluation of emerging safety concerns.

Regulatory and ethical development: As AI becomes more widely used, clearer regulatory and ethical frameworks will be needed for model validation, data quality, bias monitoring, transparency, change management, and human oversight. Greater alignment between regulatory authorities could also help establish consistent expectations for the development and use of AI in pharmacovigilance.

Overall, future progress in AI-assisted ICSR processing will depend not only on more advanced algorithms, but on developing systems that can learn from evolving safety data, explain their outputs, protect patient information, handle complex clinical relationships, and work effectively alongside pharmacovigilance professionals.

Conclusion

Artificial intelligence and automation have the potential to improve Individual Case Safety Report (ICSR) processing by supporting case intake and validation, duplicate detection, data extraction, medical coding, case prioritization, narrative generation, quality control, and regulatory submission. Technologies such as robotic process automation, natural language processing, machine learning, and generative AI can help reduce repetitive manual tasks, improve consistency, and support the timely handling of increasing volumes of safety reports. The reported improvements in automated quality-control activities further illustrate the potential value of applying automation to specific pharmacovigilance processes. However, these benefits depend on data quality, system performance, appropriate validation, and the complexity of the task. Incomplete reports, inconsistent terminology, algorithmic bias, limited transparency, and difficulties in interpreting clinical context remain important challenges. Therefore, automation should not be considered a substitute for pharmacovigilance professionals, particularly in medical assessment, causality evaluation, and decisions involving uncertain or potentially serious safety concerns. Reliable implementation requires continuous performance monitoring, traceability, data protection, regulatory compliance, and effective human oversight. Future research should focus on explainable AI, improved interpretation of clinical information, integration of diverse safety data sources, and privacy-preserving approaches. Ultimately, the successful integration of AI and automation into ICSR processing will depend on balancing technological efficiency with scientific accuracy, clinical judgment, and robust quality management to support reliable drug-safety monitoring and patient protection.

References

1. Nagar A, Gobburu J, Chakravarty A. Artificial intelligence in pharmacovigilance: advancing drug safety monitoring and regulatory integration. *Ther Adv Drug Saf.* 2025;16:1-16.
2. Hakim JB, Painter JL, Ramcharran D, Kara V, Powell G, Sobczak P, et al. The need for guardrails with large language models in pharmacovigilance and other medical safety critical settings. *Sci Rep.* 2025;15:27886.
3. Kassekert R, Grabowski N, Lorenz D, Schaffer C, Kempf D, Roy P, et al. Industry perspective on artificial intelligence/machine learning in pharmacovigilance. *Drug Saf.* 2022;45:439-448.
4. Ghosh R, Kempf D, Pufko A, Barrios Martinez LF, Davis CM, Sethi S. Automation opportunities in pharmacovigilance: an industry survey. *Pharm Med.* 2020;34:7-18.
5. Randeep Raj VC, Divya P, Susmita A, Sushmitha P, Ramya Ch, Chandini K. Automation in pharmacovigilance: artificial intelligence and machine learning for patient safety. *J Innov Appl Pharm Sci.* 2022;7(3):118-122.
6. International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use. *Implementation guide for electronic transmission of individual case safety reports (ICSRs): E2B(R3) data elements and message specification.* Version 5.03. Geneva: ICH; 2025.
7. US Food and Drug Administration. *E2BM data elements for transmission of individual case safety reports: guidance for industry.* Revision 1. Silver Spring (MD): US Department of Health and Human Services, Food and Drug Administration; 2002.
8. US Food and Drug Administration. *Considerations for the use of artificial intelligence to support regulatory decision-making for drug and biological products: guidance for industry and other interested parties.* Draft guidance. Silver Spring (MD): US Department of Health and Human Services, Food and Drug Administration; 2025.
9. Martin GL, Jouganous J, Savidan R, Bellec A, Goehrs C, Benkebil M, Miremont G, Micallef J, Salvo F, Pariente A, Létinier L, on behalf of the French Network of Pharmacovigilance Centres. Validation of artificial intelligence to support the automatic coding of patient adverse drug reaction reports, using nationwide pharmacovigilance data. *Drug Saf.* 2022;45(5):535-548.
10. Bate A, Stegmann JU. Safety of medicines and vaccines – building next generation capability. *Trends Pharmacol Sci.* 2021;42(12):1051-1063.

11. Dimitriadis VK, Dimitsaki S, Chytas A, Gavrilidis GI, Kakalou C, Bonotis P, Natsiavas P. An open-source platform integrating emerging data sources to support multi-modal active pharmacovigilance. *Front Drug Saf Regul.* 2023;2:1016042.
12. Shetty A, Dubey A, Matcheswala A, Bangera S. Pharmacovigilance systems and strategies: importance of post-marketing surveillance for ensuring drug safety and patient health in Europe, United States, and India. *Preprints.* 2023;2023020478.
13. Abbood MK, Khalaf HAA, Abudlqader EH, Taghi HS, Al-Temimi AA. Scope of pharmacovigilance: comprehensive review. *Chem Sci Int J.* 2022;31(5):29-39.
14. Chaurasiya MK, Pandey RK, Sharma A. Artificial intelligence in spontaneous reporting systems: advancing accuracy and timeliness of adverse event detection. *Int J Eng Pure Appl Sci.* 2025;10(3):7-13.