



Automating Adverse Drug Reaction (ADR) Detection Using Natural Language Processing

Dr. Bhupinder Solanki

Department of Pharmacology

AIIMS Rishikesh



Definition

Adverse Drug Reaction (ADR)

A harmful, unintended response to a medication



Patient Safety Impact

- Preventable harm
- Increased healthcare costs
- Extended hospital stays



Global Burden

- 4th-6th leading cause of death worldwide
- 5-10% of hospital admissions due to ADRs
- 2-3% of inpatients experience ADRs

The Problem: ADR Detection Gap

⚠ Under-reporting Crisis

90%

of ADRs remain unreported

Massive under-detection gap in current systems

👤 Spontaneous Reporting

- Passive reporting systems
- Incomplete data capture
- Healthcare provider time constraints

📄 Manual EHR Review

- Time-intensive process
- High error rate
- Inconsistent screening

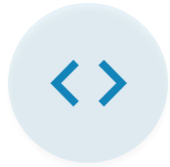
ADR Reporting Gap



Reported Unreported

Only 10% of ADRs are captured through traditional reporting systems

Limitations of Traditional ADR Detection Methods



ICD Coding Limitations

- × Captures only coded diagnoses
- × Misses narrative information
- × Limited specificity



Missed Clinical Context

- × Discharge summaries ignored
- × Progress notes not analyzed
- × Nursing documentation overlooked



Delay in Detection

- × Retrospective analysis only
- × Days to weeks after event
- × Patient harm may have occurred

Key Insight: Traditional methods miss up to 90% of ADRs due to reliance on structured data only

Why Natural Language Processing (NLP)?

Clinical Data Reality

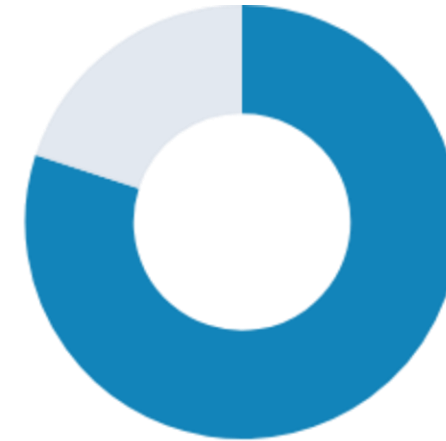
80% of clinical data is unstructured

Traditional methods cannot extract ADRs from narrative text

Examples of Unstructured Data

- Discharge summaries
- Nursing notes
- Progress notes
- Consultation reports
- Procedure notes

Data Type Distribution



 Unstructured Data  Structured Data

Vast majority of valuable clinical information remains trapped in free text



Scalable



Consistent



Continuous

What is Natural Language Processing?

Definition

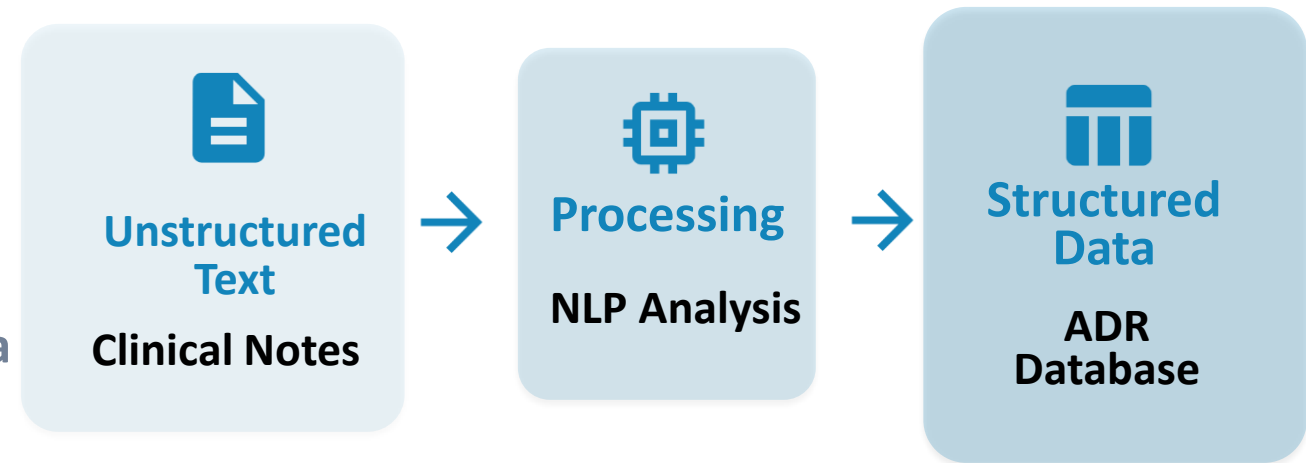
Technology that understands and interprets human language

- Extracts meaning from medical text
- Converts unstructured to structured data

Clinical Relevance

- ✓ Processes clinical documentation
- ✓ Identifies medications and doses
- ✓ Detects symptoms and adverse events
- ✓ Supports clinical decision-making

NLP Data Transformation



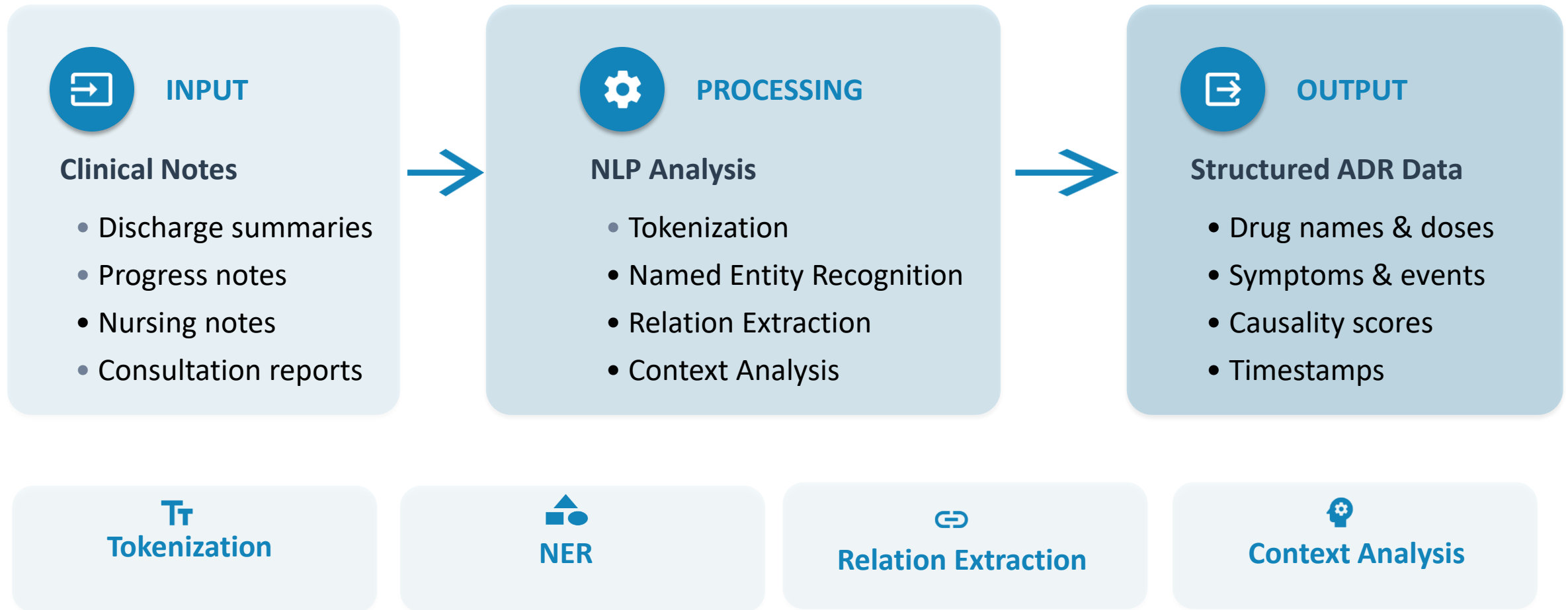

Tokenization


Classification


Relation Extraction


Validation

NLP Workflow for ADR Detection



Named Entity Recognition (NER)

What is NER?

Identifies and classifies medical entities in clinical text

Entity Types Extracted

- **Drugs**
Vancomycin, Aminoglycosides, Warfarin
- **Doses**
1g, 15mg/kg, 500mg bid
- **Symptoms**
Rash, nausea, elevated creatinine
- **Conditions**
Nephrotoxicity, hepatitis, anaphylaxis

NER in Action

Patient on **Vancomycin** **1g q12h** developed **rash** and **pruritus** after 5 days of therapy


Drug


Dose


Symptom


Condition

What is Relation Extraction?

Links drug-event relationships in clinical text to identify causality

Key Relationship Types

- **Causality**
Drug X causes Adverse Event Y
- **Temporal**
Event occurred after drug exposure
- **Association Strength**
Probable, possible, definite

Drug-Event Relationships

Vancomycin

Antibiotic



Nephrotoxicity

Kidney injury

Aminoglycosides

Antibiotic class



Ototoxicity

Hearing loss

NSAIDs

Pain medication



GI Bleeding

Gastrointestinal hemorrhage

Context & Negation Detection

Handles Negation

NEGATED "No rash observed"

NEGATED "Patient denies nausea"

NEGATED "No evidence of hepatotoxicity"

Temporal Context

PAST "History of vomiting"

PAST "Previous episode of anaphylaxis"

PRESENT "Developed symptoms on day 3"

Why It Matters



Reduces False Positives

Filters out negated and historical mentions



Improves Precision

More accurate ADR identification



Critical for Accuracy

Essential for reliable pharmacovigilance

Comparison Example

✓ **"Adverse events reported"**

→ ADR detected for review

✗ **"No adverse events reported"**




→ Correctly excluded

Practical Workflow in Hospital Setting

End-to-End Process

Seamless integration of NLP detection with clinical validation and pharmacovigilance reporting

Key Benefits

-  Real-time surveillance
-  Clinician oversight
-  System integration

1  **NLP Scans EHRs**
Real-time analysis of clinical documentation

2  **Flags Potential ADRs**
Identifies suspicious drug-event pairs

3  **Clinician Validation**
Physician review and confirmation

4  **Report to PvPI**
Pharmacovigilance

5  **Quality Improvement**
System integration

Case Study: Antimicrobial Stewardship

Focus Drugs

Aminoglycosides
Gentamicin, Amikacin

Vancomycin
Gram-positive coverage

Monitoring Focus

Nephrotoxicity
Kidney injury prevention

Biomarkers Monitored


Serum Creatinine


BUN/Cr Ratio


Urinary Output

Clinical Workflow

 Baseline renal function

 Daily monitoring

 NLP alerts for rising creat.

 Early intervention

Clinical Impact

NLP enables proactive detection of nephrotoxicity before severe injury occurs, allowing dose adjustment or drug substitution



Thank You

