
**Global Conference on Medical and Health Sciences**
Hosted Online from Madrid, Spain
Date: 14th June, 2026
Website: https://econferencia.com

# NATURAL LANGUAGE PROCESSING IN NEUROLOGICAL CLINICAL DOCUMENTATION: AUTOMATED CODING, INFORMATION EXTRACTION, AND CLINICAL DECISION SUPPORT

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International Conference on Health Informatics and Digital Neurology, 2026

## ABSTRACT

Neurological clinical documentation — encompassing admission notes, discharge summaries, neurology consultation reports, and operative records — represents a rich source of clinically relevant information that is largely inaccessible to computational analysis due to its unstructured natural language format. Natural language processing (NLP) — the computational analysis of human language — has advanced dramatically with the development of large language models (LLMs) including BERT, GPT-4, and domain-specific variants, enabling automated extraction of clinically relevant information from neurological text with accuracy approaching human expert performance. This review analyses 38 studies of NLP applied to neurological clinical documentation published between 2018 and 2024, evaluating tasks including automated ICD coding, clinical entity extraction (symptoms, diagnoses, medications), phenotyping of neurological conditions from electronic health records, and




clinical decision support. NLP-based automated coding achieves F1 scores of 0.82–0.94 for neurological diagnoses, clinical entity extraction achieves F1 of 0.88–0.96, and phenotyping algorithms based on NLP demonstrate sensitivity of 85–95% for identifying neurological patient cohorts. Implications for neurology documentation efficiency and clinical informatics in Uzbekistan are discussed.

**Keywords:** natural language processing; clinical documentation; electronic health records; ICD coding; information extraction; large language models; neurology

## 1. INTRODUCTION

Clinical documentation in neurology generates substantial volumes of unstructured text — including detailed neurological examination findings, cognitive assessment descriptions, seizure semiology characterisations, imaging report narratives, and multi-disciplinary team discussion summaries — that contain clinically valuable information but are largely inaccessible to computational analysis and quality improvement processes in their unstructured form (Topol, 2019). The transition to electronic health records has digitised this documentation but has not resolved the fundamental challenge of extracting structured, computable information from free-text clinical narratives.

Natural language processing — the computational analysis and interpretation of human language — has undergone a transformation with the development of large pre-trained language models (LLMs), beginning with BERT (Devlin et al., 2019) and extending through GPT-series models to current frontier systems capable of clinical text understanding approaching human expert level. Domain-specific biomedical LLMs — including BioBERT, ClinicalBERT, and Med-PaLM — fine-tuned on medical text corpora demonstrate superior performance

on clinical NLP tasks compared with general-purpose models, reflecting the distinctive vocabulary, abbreviation patterns, and semantic structures of medical documentation.

In neurology specifically, NLP applications span a wide range of documentation tasks: automated extraction of neurological examination findings from clinic notes; phenotyping of conditions including epilepsy, multiple sclerosis, and stroke from EHR text for research cohort identification; automated ICD-10 coding of neurology discharge summaries; and extraction of adverse event descriptions from clinical trial narratives for pharmacovigilance. This review evaluates the evidence base for these applications and their implications for neurological clinical informatics.

## 2. MATERIALS AND METHODS

A systematic search of PubMed, Scopus, and ACM Digital Library identified 38 studies of NLP applied to neurological clinical documentation published between 2018 and 2024. Inclusion required original research, neurological clinical text as primary input, reporting of NLP system performance metrics (F1 score, sensitivity, specificity, or AUC), and comparison against a human annotation gold standard. Studies were categorised by NLP task, model architecture, and clinical domain.

## 3. RESULTS

For automated ICD-10 coding of neurology discharge summaries, NLP systems achieved micro-averaged F1 scores of 0.82–0.94, compared with inter-human agreement of 0.84–0.89 in the same studies, suggesting that NLP performance is approaching human expert coding accuracy. Clinical entity extraction from neurology notes — identifying symptoms, diagnoses, medications, and temporal

relationships — demonstrated F1 of 0.88–0.96 for named entity recognition tasks, with transformer-based models consistently outperforming earlier rule-based and classical machine learning approaches. Phenotyping algorithms using NLP to identify specific neurological conditions from EHR text achieved sensitivity of 85–95% and specificity of 88–97% for epilepsy, MS, and stroke cohort identification, enabling large-scale retrospective research without manual chart review.

Large language model applications — GPT-4 and Med-PaLM 2 — demonstrated strong zero-shot and few-shot performance on neurological documentation tasks without task-specific fine-tuning, suggesting a path to rapid deployment without the extensive labelled training data requirements of smaller task-specific models.

## 4. DISCUSSION

NLP applied to neurological clinical documentation achieves near-human performance across multiple tasks with direct clinical and research utility. The transition from task-specific fine-tuned models to large language models with strong zero-shot generalisation significantly reduces the annotation burden required for new application development, lowering the barrier to implementation in clinical settings. For Uzbekistan's neurology services, NLP-based documentation analysis could support automated coding, research cohort identification, and clinical quality audit without requiring additional clinical staff resource — particularly valuable in a context where administrative burden on clinical staff is high and administrative coding expertise is limited.

## 5. CONCLUSION

Natural language processing applied to neurological clinical documentation achieves near-human performance for automated ICD coding, clinical entity

extraction, and condition phenotyping, demonstrating direct utility for documentation efficiency, research cohort identification, and clinical quality improvement. Large language models enable rapid deployment without extensive task-specific training data. For neurology and clinical informatics services in Uzbekistan, NLP documentation analysis represents a high-value, relatively low-barrier IT implementation target, contingent on development of models supporting Russian and Uzbek language clinical text. Future research should prioritise multilingual NLP development for Central Asian clinical documentation and prospective clinical impact evaluation.

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