

A Dual-Track Knowledge Graph for Evidence-Based Pediatric Medication Management in Neurological Disorders: Implications for Rational Drug Use and Public Health Governance

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Article

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Abstract

Background

Pediatric neurological disorders represent a leading cause of chronic childhood disability and integrity of domestic pediatric drug indicisability and necessitate long-term standardized pharmacological intervention. Current clinical practice for pediatric neurological disorders is constrained by fragmented research evidence, incomplete pediatric drug labeling specifications, prevalent off-label drug use, and the scarcity of age-appropriate pharmaceutical formulations, resulting in inconsistent clinical medication standards and persistent pediatric medication safety risks. As an efficient tool for integrating heterogeneous biomedical data, the knowledge graph facilitates standardized medication management and evidence mining for public health research. This study constructed a dual-track knowledge graph framework centered on clinical practice guideline evidence and semantic-derived potential medication associations. The framework systematically organizes multi-dimensional medication evidence for pediatric neurological disorders, identifies critical gaps in pediatric medication resources, and provides empirical support for optimized evidence-based medication management and refined pharmaceutical public health governance.

Methods

This study synthesized multi-source authoritative data, including global clinical practice guidelines for pediatric neurological disorders (2008–2025), official drug approval labeling documents, and professional pharmaceutical databases. A dual-track evidence integration framework was implemented for standardized knowledge organization in pediatric neurological evidence-based medication management. The primary track extracted explicit disease–drug therapeutic associations recommended by clinical practice guidelines to form authoritative, standardized clinical medication evidence. The auxiliary track supplemented potential rational medication associations via textual semantic similarity analysis, expanding the coverage of medication evidence for pediatric neurological disorders. Multi-dimensional safety filtering rules were established to guarantee the rationality of exploratory evidence. All structured evidence was visualized and quantitatively analyzed using the Neo4j platform to elucidate the current status and structural deficiencies of existing pediatric medication resources.

Results

The established dual-track knowledge graph covered 32 common pediatric neurological disorders and 7,847 standardized drug specifications, encompassing 1,549 authoritative disease–drug relationships validated by clinical practice guidelines and 3,300 clinically viable latent medication associations. Quantitative analysis identified three prominent structural deficiencies in domestic medication resources for pediatric neurological disorders: insufficient officially approved pediatric drug indications for first-line therapeutic agents, severe shortages of child-adapted dosage forms, and inequitable cross-border

accessibility of specialized pediatric medications. The dual-track framework achieved hierarchical classification of authoritative consensus evidence and exploratory potential evidence, enabling comprehensive integration and traceable management of evidence-based medication management resources.

Conclusions

This study proposed a targeted dual-track knowledge graph framework for evidence-based medication management in pediatric neurological disorders, effectively addressing the fragmentation and ungraded classification of existing pediatric medication evidence. The framework not only supports standardized clinical evidence-based medication and expands individualized medication reference schemes for complex conditions but also quantitatively identifies key gaps in pediatric drug approval, dosage form allocation, and public health resource distribution. It provides reliable empirical evidence for optimizing pediatric pharmaceutical governance, promoting rational pediatric drug use, and constructing a refined digital public health service system for pediatric medication management.

1. Introduction

Pediatric neurological disorders are a primary cause of chronic disability and diminished quality of life among children, with prevalent conditions including epilepsy, cerebral palsy, tic disorders, migraine, and neuromuscular diseases that require long-term standardized pharmacological intervention^[1]. Distinct from adult patients, children exhibit ongoing nervous system development and age-specific variations in drug metabolism, rendering evidence-based medication management for pediatric neurological disorders far more complex^[2]. Standardized medication can effectively control clinical symptoms and improve long-term pediatric health outcomes, whereas inappropriate prescription practices elevate the risks of adverse drug reactions, medication errors, and poor treatment adherence^[2]. Accordingly, implementing safe, effective, and evidence-based medication management has become a core priority of pediatric clinical healthcare and public health practice^[1].

Despite sustained advancements in pediatric pharmacotherapy, standardized evidence-based medication management for pediatric neurological disorders remains challenging^[3]. Most therapeutic drugs recommended for pediatric neurological disorders lack dedicated pediatric indications and comprehensive labeling information, leading to widespread off-label medication use in clinical settings^[5]. Additionally, many commonly used medications lack child-appropriate dosage forms, forcing clinical practitioners to conduct manual dose adjustments in routine practice^[6]. Variations in pharmaceutical availability and regulatory approval standards further exacerbate inequitable access to specialized pediatric medications globally and domestically^[3]. To enhance medication safety and standardize pharmaceutical management, regulatory authorities have issued targeted policies to promote pediatric drug research and development, standardize drug labeling specifications, and

popularize evidence-based medication management^[7]. Nevertheless, medication-related evidence remains dispersed across clinical practice guidelines, regulatory documents, and pharmaceutical databases, hindering efficient evidence translation and clinical application^[8].

The knowledge graph serves as a powerful tool for integrating heterogeneous biomedical data into structured semantic networks^[9]. By establishing interconnected semantic relationships among disease entities, drug entities, pharmaceutical attributes, and clinical evidence, knowledge graphs streamline evidence retrieval, systematic knowledge management, and intelligent clinical decision support^[10]. Existing research has validated the application value of knowledge graphs in biomedical knowledge organization and digital healthcare development^[14]. However, most current studies focus on disease diagnosis, biomedical entity recognition, and algorithm optimization, with limited attention to evidence integration for evidence-based medication management in pediatric neurological disorders^[9]. Furthermore, authoritative clinical practice guidelines, regulatory drug labeling, and pharmaceutical data are typically analyzed independently rather than integrated into a unified evidence framework, reducing the transparency, traceability, and accessibility of pediatric medication evidence^[14].

To address the above research gaps, this study developed a dual-track knowledge graph framework dedicated to evidence-based medication management for pediatric neurological disorders^[8]. The primary knowledge graph incorporates disease–drug therapeutic associations explicitly recommended by clinical practice guidelines to ensure evidence authority and clinical standardization, while the auxiliary knowledge graph stores potential rational therapeutic associations derived from semantic similarity analysis to supplement limited guideline evidence^[7]. By integrating clinical practice guideline recommendations, regulatory drug labeling specifications, and professional pharmaceutical information, the proposed framework supports multi-functional evidence retrieval, standardized medication evaluation, and systematic identification of pediatric medication resource deficiencies^[8]. This study aims to construct an interpretable evidence integration system to facilitate rational pediatric drug use and provide data support for pediatric pharmaceutical governance and digital public health development.

2. Methods

2.1 Overall Study Design

This study adopted a multi-source evidence integration methodology tailored to public health-oriented pediatric medication research, focusing on standardized evidence sorting, systematic evaluation of pediatric medication status, and quantitative analysis of pharmaceutical resource gaps. The overall research workflow comprises standardized multi-source data collection, dual-track evidence construction for pediatric neurological medication, knowledge network visualization, and public health-oriented quantitative analysis. Different from technology-centric algorithm research, this study prioritizes evidence authority, clinical practicability, and public health application value. The innovative dual-track structure hierarchically distinguishes standardized consensus-based medication evidence and

exploratory potential medication associations, balancing the standardization of routine clinical medication and the innovation of individualized medication research for refractory pediatric neurological disorders, thereby providing multi-dimensional evidence support for refined pediatric pharmaceutical governance.

2.2 Multi-Source Data Collection and Standardization

To ensure the authority, comprehensiveness, and clinical applicability of research data, this study integrated three categories of core authoritative resources closely related to evidence-based medication management for pediatric neurological disorders, covering clinical diagnosis and treatment norms, national drug regulatory specifications, and professional pharmaceutical datasets.

Clinical practice guidelines constitute the core authoritative evidence for standardized pediatric medication. A total of 40 domestic and international clinical practice guidelines and expert consensus documents for pediatric neurological disorders published between 2008 and 2025 were included, covering mainstream and rare conditions such as epilepsy, tic disorders, cerebral palsy, and migraine. Over 85% of the included guidelines were updated after 2015, guaranteeing the timeliness and practicality of medication recommendations. All enrolled documents are evidence-based clinical guidance with explicit pediatric medication schemes, excluding simple policy announcements and non-clinical technical documents.

Official drug regulatory labeling data serves as the fundamental basis for evaluating the standardization and compliance of pediatric medication practice. This study systematically collated core drug attribute data from the NMPA official database and FDA public drug specification database, including generic drug names, therapeutic classifications, approved indications, age adaptation ranges, dosage form specifications, contraindications, and domestic and foreign market access status^{[6][7]}. Duplicate data was eliminated and missing attribute information was supplemented via cross-verification with professional pharmaceutical databases to ensure data integrity and accuracy.

Unified data standardization was implemented in accordance with international pediatric diagnostic criteria and national clinical medical naming specifications to standardize heterogeneous data expressions, including inconsistent dosage descriptions and non-standard age grouping rules across multi-source datasets. Finally, a standardized research dataset covering 32 pediatric neurological disorders and 7,847 valid drug specifications was established, laying a solid data foundation for subsequent evidence integration and medication resource gap analysis.

2.3 Dual-Track Evidence Construction for Pediatric Medication Management

To resolve the limitations of single-dimensional and undifferentiated evidence in traditional pediatric medication research, this study constructed a dual-track evidence system integrating authoritative guideline evidence and semantic-derived potential evidence, realizing hierarchical and classified management of medication knowledge for pediatric neurological disorders.

The primary track focuses on clinical standardization and regulatory authority, extracting explicit disease–drug therapeutic relationships from authoritative clinical practice guidelines^[4]. All extracted evidence was manually screened and verified strictly referring to publicly available pediatric clinical guidelines and published expert consensus, to ensure clear guideline sources and clinical consensus support. Each piece of authoritative evidence was annotated with detailed guideline sources, recommendation levels, and evidence grades, enabling full traceability of clinical medication basis and providing direct guidance for standardized routine clinical medication^[11](Fig. 1).

[Figure 1 here]

The auxiliary track focuses on evidence supplementation and exploratory innovation to compensate for the limited coverage of traditional clinical practice guideline consensus. Potential rational disease–drug associations with validated pharmacological mechanisms but no explicit guideline recommendations were mined via semantic matching of pediatric disease symptoms and drug indications^{[23][24][25]}. A multi-dimensional pediatric medication safety filtering mechanism was established to eliminate false-positive associations, including pediatric contraindication screening, pharmacological mechanism consistency verification, and age applicability evaluation^{[26][27][28]}. Only clinically viable latent medication associations were retained as supplementary exploratory evidence for individualized medication of complex and rare pediatric neurological disorders (Table 1).

[Table 1 here]

Table 1		
Classification standard of similarity threshold for entity matching		
Similarity Range	Interpretation	Application
0.00–0.25	Noise or irrelevant	Filter out
0.25–0.35	Weak correlation	Manual review
0.35–0.50	Moderate correlation	Candidate inclusion
> 0.50	Strong correlation	High-confidence recommendation

2.4 Knowledge Graph Visualization and Public Health-Oriented Quantitative Analysis

This study adopted the mature Neo4j graph database to integrate dual-track evidence and construct a visualized knowledge graph for pediatric neurological medication^[29]. The knowledge network sets up standardized entity nodes (diseases, drug specifications, dosage forms, evidence sources) and semantic relationships (guideline-recommended treatment, potential therapeutic correlation), with all entities carrying complete attribute information and traceable evidence labels, forming a structured and traceable evidence-based medication management system^[12].

Different from simple technical visualization, the core purpose of the knowledge graph construction is to support public health governance analysis^[13]. Based on the integrated knowledge network, multi-dimensional quantitative evaluation was conducted to analyze the distribution characteristics of authoritative medication evidence for pediatric neurological disorders, thations, the reserve status of child-adapted dosage forms, and cross-border inequities in pediatric drug accessibility. Quantitative statistical analysis systematically clarified the structural deficiencies and resource bottlenecks of current domestic medication services for pediatric neurological disorders, providing objective data support for optimizing pediatric pharmaceutical policies and public health resource allocation^[15].

3. Results

3.1 Overall Structure and Scale of the Dual-Track Medication Evidence System

The constructed dual-track knowledge graph forms a complete, hierarchical evidence system for evidence-based medication management of pediatric neurological disorders, covering 32 pediatric neurological disease entities and 7,847 standardized drug specification nodes. The primary track contains 1,549 guideline-validated disease–drug therapeutic triples, all derived from high-level clinical practice guidelines to support standardized and compliant clinical medication decisions. After multi-layer semantic screening and safety filtering, the auxiliary track retained 3,300 high-value latent medication associations, effectively supplementing evidence gaps for complex, refractory, and rare pediatric neurological disorders that lack sufficient guideline recommendations (Table 2).The visualized structure of the established knowledge graph is displayed in Fig. 2.

[Figure 2 here]

[Table 2 here]

Table 2
Graph nodes and relationships

Category	Count
Diseases	32
Drugs (specifications)	7,847
Primary-track relations	1,549
Auxiliary-track relations (similarity > 0.35)	3,300

The dual-track structure achieves effective differentiation between standardized routine medication evidence and exploratory individualized medication evidence, addressing the long-standing problem of undistinguished evidence application scenarios in traditional pediatric medication research. The

integrated knowledge network unifies clinical practice guideline norms, drug regulatory specifications, and pharmaceutical attribute data, supporting multi-dimensional evidence query and medication resource gap mining with superior public health application value compared with scattered traditional literature evidence.

3.2 Distribution Characteristics of Authoritative Guideline Medication Evidence

Quantitative statistical analysis demonstrated that the distribution of guideline-supported medication evidence is highly consistent with the clinical disease burden of pediatric neurological disorders^[16]. Epilepsy, as the most prevalent chronic pediatric neurological disorder requiring long-term medication, accounts for 42.3% of all authoritative disease–drug relationships, covering generalized epilepsy, focal epilepsy, and various pediatric epilepsy syndromes. Tic disorders and attention deficit hyperactivity disorder, which exhibit high prevalence and frequent clinical comorbidity in school-age children, contribute 28.7% of total guideline medication evidence. In contrast, rare pediatric neurological syndromes and cerebral palsy have relatively limited standardized medication recommendations in clinical practice guidelines, reflecting a general shortage of high-level evidence for rare pediatric neurological disorder medication^[17].

Comparative analysis of domestic and international clinical practice guidelines revealed distinct complementary characteristics. Domestic guidelines prioritize the physical tolerance and developmental characteristics of Chinese children, with medication dosages and treatment cycles tailored to local clinical practice habits. International guidelines provide more comprehensive medication schemes for rare epilepsy syndromes and novel targeted drugs, offering detailed guidance for refractory and complex pediatric neurological disorders^[18]. The integrated evidence network unifies multi-source guideline resources, eliminating clinical medication confusion caused by scattered and inconsistent guideline documents.

3.3 Structural Deficiencies in Domestic Medication Resources for Pediatric Neurological Disorders

By cross-matching clinical practice guideline medication recommendations with domestic and foreign drug approval labeling data, this study systematically identified three core structural deficiencies restricting the standardized and safe evidence-based medication management of pediatric neurological disorders in China, which are key bottlenecks in pediatric public health governance.

First, pediatric drug indications are severely insufficient. Over 58% of drugs with definite therapeutic effects on pediatric neurological disorders recommended by authoritative clinical practice guidelines lack official pediatric indications in domestic drug labeling, with only adult-approved indications available clinically. This leads to widespread off-label medication use in pediatric neurological treatment, resulting in inconsistent medication schemes across medical institutions and prominent pediatric medication safety risks due to the absence of regulatory basis^[19].

Second, child-adapted dosage forms are extremely scarce. More than 70% of first-line therapeutic drugs for pediatric neurological disorders only have adult-specification dosage forms in the domestic market, lacking age-appropriate formulations such as oral liquids, chewable tablets, and fine granules for infants and young children^[30]. Clinical staff must conduct manual dose segmentation and adjustment for pediatric patients, causing inaccurate dosage administration, unstable therapeutic efficacy, and significantly elevated risks of medication errors and adverse drug reactions^{[31][32]}. Long-term non-standard dose adjustment adversely affects the long-term neurological rehabilitation and developmental prognosis of children with neurological disorders (Fig. 3).

[Figure 3 here]

Third, significant inequities exist in cross-border pediatric drug accessibility. A large number of novel targeted therapeutic drugs and optimized child-adapted dosage forms widely used in international pediatric neurological disorder treatment have not obtained domestic marketing approval^[20]. The slow update of domestic pediatric medication resources leaves Chinese children with complex and refractory pediatric neurological disorders unable to access cutting-edge standardized treatment schemes, restricting the equitable acquisition of high-quality pediatric public health services.

3.4 High-Value Exploratory Medication Associations for Refractory Pediatric Neurological Disorders

The auxiliary track semantic mining results verify the critical supplementary value of the dual-track knowledge graph for evidence-based medication management of rare and refractory pediatric neurological disorders, screening multiple high-value latent medication associations supported by clinical empirical evidence but not explicitly recorded in clinical practice guidelines, providing novel individualized medication references for intractable clinical cases.

Clobazam presents high clinical rationality as an adjuvant therapy for refractory epilepsy comorbid with attention deficit hyperactivity disorder in children. Existing clinical studies have confirmed that clobazam exerts significant therapeutic effects on refractory epilepsy represented by Lennox–Gastaut syndrome, effectively controlling recurrent seizures and improving children’s behavioral and attention deficits without increasing neurological adverse reactions^{[33][34]}. Domestic multidisciplinary expert consensus further validates its clinical application value in refractory epilepsy combined with behavioral comorbidities^[35], supporting the expanded clinical application of clobazam in comorbid pediatric neurological disorders.

Additionally, ethosuximide exhibits high clinical matching value for pediatric Doose syndrome, a rare refractory pediatric epilepsy syndrome without unified gold-standard treatment protocols^[21]. Clinical case series have confirmed that combined treatment with ethosuximide and zonisamide can effectively control myoclonic and atonic seizures and improve the disease prognosis of children with Doose syndrome. The consistency between mining results and existing clinical empirical evidence validates the

reliability of the auxiliary evidence system in supplementing medication evidence for rare pediatric neurological disorders^[22].

4. Discussion

4.1 Research Innovations and Methodological Advantages

Distinct from traditional technology-oriented medical knowledge graph research, this study focuses on public health practice and pediatric pharmaceutical governance, with prominent methodological and application innovations. First, the innovative dual-track evidence integration model realizes hierarchical classification of medication evidence for pediatric neurological disorders, effectively solving the problem of mixed application of authoritative consensus evidence and exploratory potential evidence in previous studies. Isolated evidence application scenarios ensure the safety and standardization of routine evidence-based medication management while retaining exploratory space for individualized treatment of refractory pediatric neurological disorders, which is more aligned with the actual demands of pediatric clinical medication management.

Second, this study adopts a guideline-centered authoritative evidence system, abandoning the single literature or electronic medical record data sources used in most data-driven medication research. As the highest-level clinical diagnosis and treatment basis, clinical practice guidelines guarantee the authority, repeatability, and clinical interpretability of research conclusions, avoiding the low credibility of pure algorithm-mined results.

Third, this study expands the application scope of medical knowledge graph technology from single clinical auxiliary diagnosis to integrated clinical service and public health governance. By incorporating drug regulatory specification evaluation, dosage form suitability analysis, and cross-border accessibility assessment, this study quantitatively reveals structural defects in domestic pediatric medication resources, achieving dual output of clinical medication guidance value and pharmaceutical policy optimization value and filling the research gap in public health-oriented pediatric medication governance.

4.2 Clinical and Public Health Application Value

Clinically, the dual-track knowledge graph framework provides standardized, traceable, and hierarchical medication decision support for pediatric neurologists. It integrates scattered clinical practice guideline medication schemes and fragmented drug specification information into a unified structured system, enabling clinical practitioners to rapidly acquire authoritative medication basis, verify pediatric drug applicability, and standardize off-label medication behaviors, thereby reducing pediatric medication errors and adverse reaction risks^[2]. For complex, refractory, and rare pediatric neurological disorders with insufficient guideline evidence, the supplementary latent medication associations provide reliable individualized medication references, improving the diagnosis and treatment level of intractable pediatric cases.

From a public health and pharmaceutical governance perspective, the quantitative research results provide objective data support for optimizing domestic pediatric pharmaceutical management policies. The systematically identified deficiencies in pediatric drug indications, child-adapted dosage form scarcity, and unbalanced drug accessibility help regulatory authorities clarify priority directions for pediatric drug label supplementation, child-specific drug research and development, and market access optimization^{[6][7]}. Meanwhile, the research findings guide medical institutions to optimize pediatric pharmacy configuration and conduct targeted rational medication training, improving the overall level of institutional pediatric pharmaceutical management. In the long term, this study provides a digital evidence foundation for standardizing pediatric medication systems and realizing equitable allocation of pediatric public health resources.

4.3 Research Limitations

This study has several limitations that require further optimization in subsequent research. First, although multi-dimensional safety filtering is implemented for exploratory evidence, the latent medication associations mined via semantic matching lack prospective clinical trial and real-world medical record validation. Accordingly, such evidence is only applicable for clinical reference and exploratory research, rather than routine clinical prescription basis.

Second, clinical practice guidelines and drug labeling specifications are dynamically updated iterative resources. The current evidence system is constructed based on the latest public data up to 2025; regular data iteration and manual verification are required to sustain the long-term timeliness and accuracy of the medication evidence database.

Third, this study focuses on macro evidence integration and medication resource gap analysis, without developing individualized medication recommendation modules based on pediatric individual differences such as age, weight, and disease severity. The refined individualized guidance capability of the framework requires further improvement.

4.4 Future Research Prospects

Subsequent research will expand the research dimension and enhance the public health service capacity of the current framework. In terms of data resources, real-world pediatric electronic medical record data and adverse drug reaction monitoring data will be integrated to add drug efficacy evaluation and safety risk assessment indicators, further improving the comprehensiveness of the evidence system.

In terms of application expansion, the static evidence network will be upgraded to a dynamic pediatric medication safety monitoring platform, enabling real-time evidence update and automatic early warning of pediatric medication resource gaps. This optimization is expected to provide long-term quantitative data support for evaluating the implementation effect of pediatric pharmaceutical policies and improving the refined construction of pediatric public health service systems.

5. Conclusion

This study constructed a dual-track knowledge graph framework integrating authoritative clinical practice guideline evidence and semantic exploratory evidence for evidence-based medication management of pediatric neurological disorders, forming a hierarchical, traceable, and multi-dimensional pediatric medication evidence system. The primary authoritative evidence track supports standardized, evidence-based routine clinical medication, while the auxiliary exploratory track compensates for insufficient guideline evidence coverage for rare and refractory pediatric neurological disorders. Quantitative analysis based on the structured knowledge network systematically reveals three prominent structural problems in domestic pediatric neurological medication resources: insufficient official pediatric drug indications, severe scarcity of child-adapted dosage forms, and unbalanced cross-border drug accessibility.

The proposed dual-track evidence integration framework balances the standardization of routine pediatric medication and the innovation of individualized medication research for complex conditions. It not only provides an efficient digital auxiliary tool for clinical medication decision-making and safety risk prevention in pediatric neurological disorder treatment but also delivers systematic empirical evidence for pediatric drug research and development, drug regulatory policy optimization, and refined pediatric pharmaceutical public health management. With excellent scalability and practical public health promotion value, this framework provides a novel feasible paradigm for intelligent and standardized evidence-based medication management in pediatric neurological disorders.

Declarations

Clinical trial number: not applicable.

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Ethics approval and consent to participate

Ethics approval and informed consent were not required for this study. All data used in this research were extracted from publicly published literature and open-access databases; no original clinical samples, patient medical records or human participants were involved.

Consent for publication: not applicable.

Competing interests

The authors declare that they have no competing interests.

Data availability

The structured triple dataset generated after manual extraction, normalization and semantic processing in this study is deposited in Figshare (DOI: <https://doi.org/10.6084/m9.figshare.33922651>). Access to the dataset is restricted to avoid potential copyright constraints of the original guideline texts.

Researchers who wish to access the data may submit an access request, which will be reviewed by the corresponding author.

Authors' contributions

Chen Qiuyue: Conceptualization, Methodology, Data curation, Writing – original draft, Visualization;

Zhuang Qian: Supervision, Writing – review & editing, Funding acquisition

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Figures

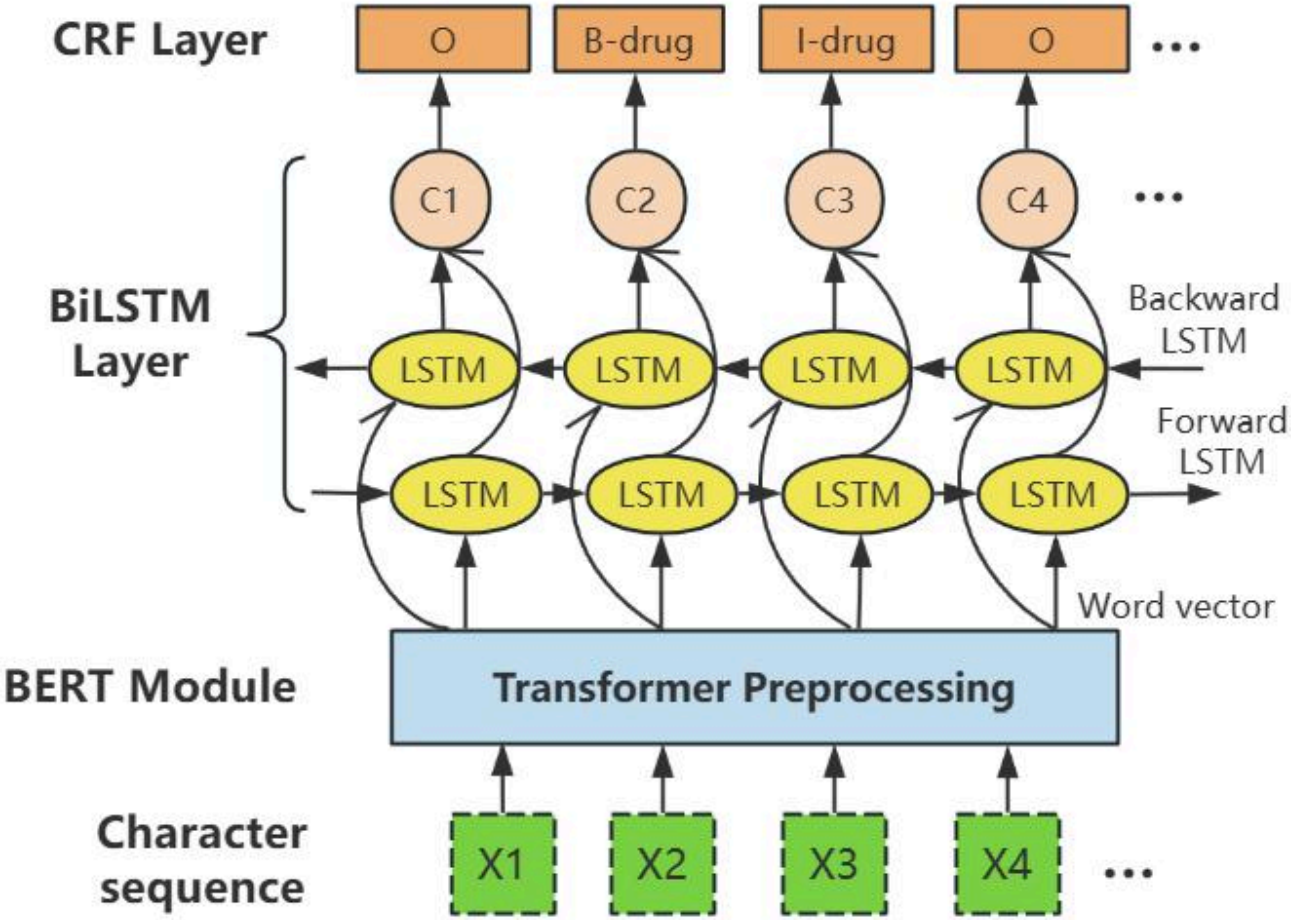


Figure 1

model architecture. The overall architecture of the BERT-BiLSTM-CRF entity recognition model. The character sequence is first encoded via the Transformer preprocessing module of BERT to generate word vectors, which are then fed into the bidirectional LSTM layer to extract contextual features. Finally, the CRF layer outputs sequence labeling results including the tags "O", "B-drug", and "I-drug".

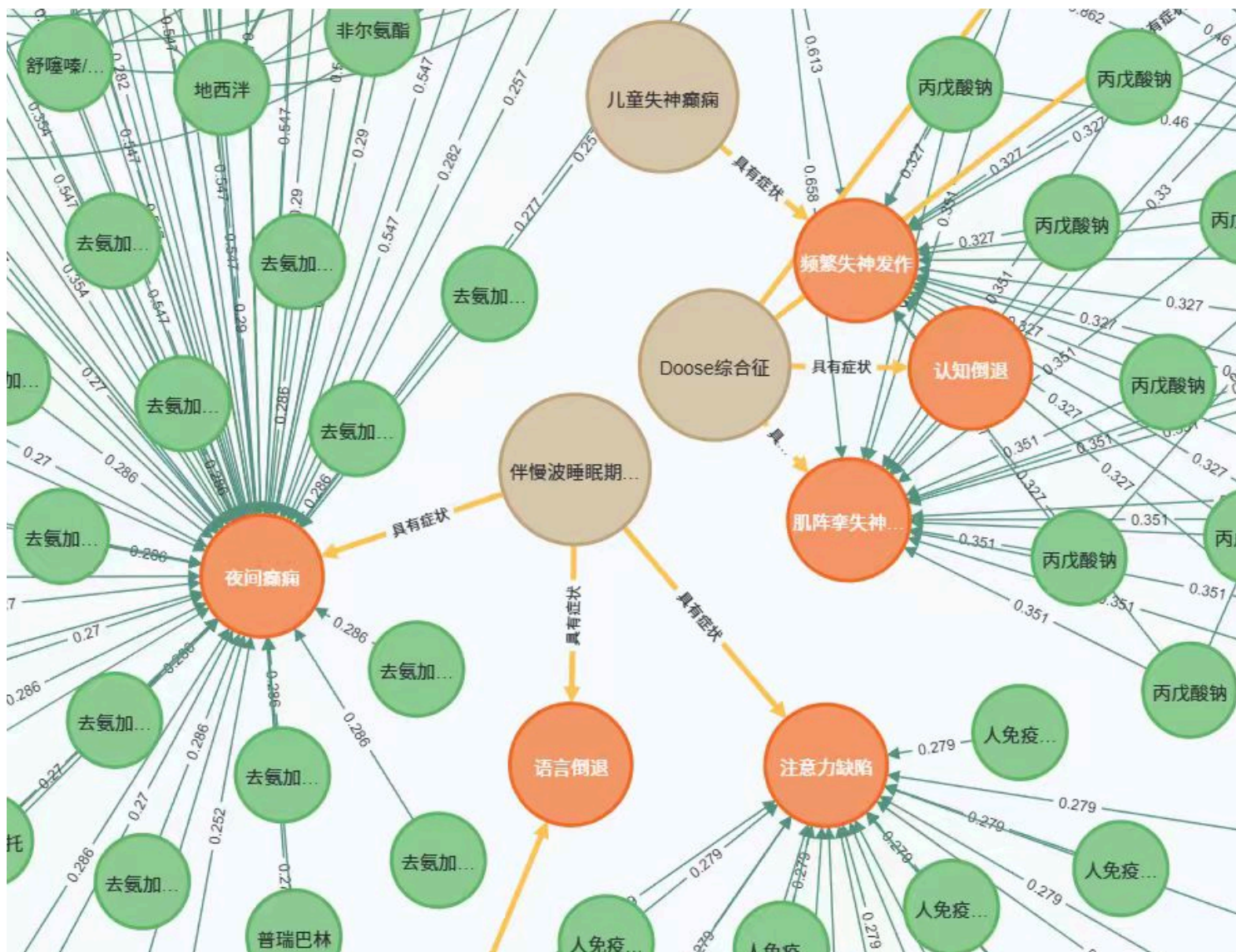


Figure 2

Visualization of the constructed rare pediatric neurological disease knowledge graph. The left subgraph displays the entity connections centered on disease nodes, while the right subgraph illustrates the multi-layer association relationships among disease, clinical symptom and drug entities; nodes with different colors represent distinct entity types, and connecting lines denote semantic relationships between paired entities.

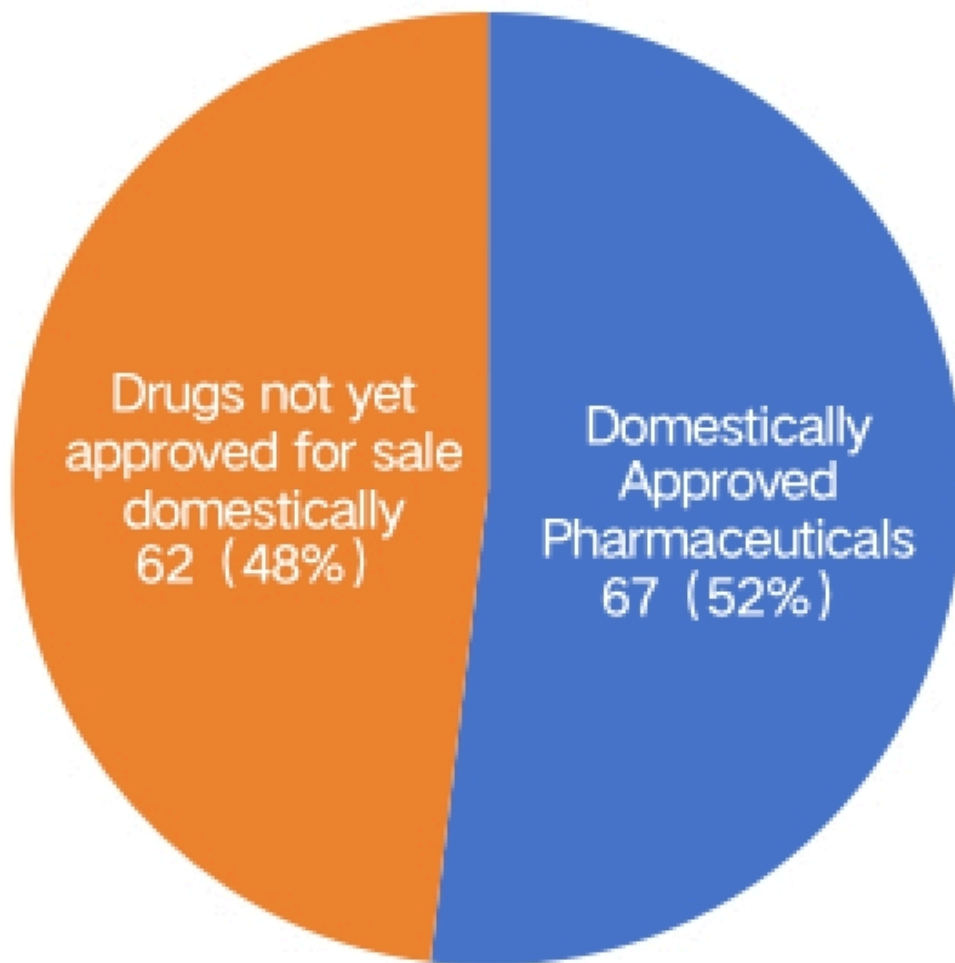


Figure 3

Pie chart illustrating the proportion of drugs for rare pediatric neurological disorders with domestic approval status. The blue segment accounts for 48% (67 drugs) representing pharmaceuticals approved domestically in China, while the red segment occupies 52% corresponding to medications without domestic marketing approval.