

Assessing the applicability of adult functional prognostic stroke scores in pediatric population in resource limited settings

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Keypoints

Adult functional prognostic stroke scores provide a useful foundation for understanding outcomes, but their direct application to pediatric populations, especially in resource-limited settings, has clear limitations.

Abstract

Stroke in children is a rare but potentially devastating condition, with long-term functional, cognitive, and psychosocial consequences. Adult functional prognostic scores, including the National Institutes of Health Stroke Scale (NIHSS) and the modified Rankin Scale (mRS), are extensively utilized to forecast outcomes post-stroke; however, their relevance in pediatric populations is still ambiguous. Pediatric stroke differs from adult stroke in etiology, including sickle cell disease, congenital heart defects, arteriopathies, and infections, and recovery trajectories are influenced by neurodevelopmental plasticity. Resource-limited settings further complicate prognostication due to constrained access to neuroimaging, rehabilitation, and specialized care. This perspective examines the limitations of applying adult functional prognostic scores to children, highlighting risks of misclassification and bias. We propose the development of hybrid, pediatric-adapted prognostic tools that integrate clinical, developmental, and contextual determinants of recovery.

Artificial intelligence (AI) presents significant prospects for improving prediction accuracy by integrating multi-dimensional data and simulating outcomes under diverse resource constraints. We emphasize ethical considerations, such as the equitable allocation of scarce resources and parental engagement. Developing validated, context-sensitive pediatric stroke prognostic scores could improve individualized care, optimize resource utilization, and support long-term functional recovery in children, particularly in low-resource environments.

Keywords

Artificial Intelligence; Child; Prognosis; Stroke/diagnosis; Stroke/rehabilitation

Introduction

Stroke remains a major cause of morbidity and mortality worldwide, affecting both adults and children, though with markedly different epidemiological patterns and clinical presentations [1,2]. Functional prognostic scores,

including the National Institutes of Health Stroke Scale (NIHSS) and the modified Rankin Scale (mRS), have been thoroughly validated in adult populations and are commonly employed to inform acute management, rehabilitation planning, and prognostic counseling [2, 3].

In children, strokes are less common but often result in significant long-term functional impairment [1]. The causes of stroke in children are very different from those in adults. They include sickle cell disease (SCD), congenital heart defects, and arteriopathies [1, 4, 5].

Neurodevelopmental plasticity affects recovery trajectories, which means that functional outcomes are less stable and more unpredictable based only on initial deficits [5, 6, 7, 8]. Additionally, in low-resource settings, limited access to neuroimaging, rehabilitation services, and follow-up care further complicates prognostication [1,8].

Adult-derived functional scores are sometimes applied to pediatric patients due to the lack of validated pediatric-specific tools. However, this practice assumes equivalence in pathophysiology, outcome determinants, and recovery potential, which may lead to systematic bias and misclassification of functional prognosis [2,3,5,6].

This perspective critically examines the applicability of adult functional prognostic stroke scores in pediatric populations, highlighting limitations, contextual challenges, and the need for adapted predictive tools suitable for resource-limited environments.

Epidemiology of Stroke in Adults and Children

Stroke epidemiology differs substantially between adults and children. In adults, the incidence of stroke increases sharply with age, and traditional vascular risk factors—such as hypertension, diabetes mellitus, hyperlipidemia, and atrial fibrillation—predominate [2,3]. About 85% of strokes in adults are ischemic, and the other 15% are hemorrhagic [2]. In low-income countries, particularly sub-Saharan Africa, the adult stroke burden is increasing due to urbanization, lifestyle changes, and limited public health interventions [2,3]. Mortality rates are elevated, partially due to delayed presentation and restricted access to acute reperfusion therapies.

Pediatric stroke, though less common (incidence 2–13 per 100,000 children per year), carries a disproportionately high risk of long-term neurological disability [1,5]. Registries such as the Chinese Paediatric Ischaemic Stroke Registry (CPISR) offer invaluable information about pediatric stroke risk factors, clinical features, and outcomes [1]. Pediatric stroke etiologies include SCD, congenital heart defects, vascular malformations, and infections—conditions that are uncommon in adults [1,5,8]. Functional consequences are broader in children, encompassing cognitive, motor, and psychosocial domains, and recovery trajectories are highly variable [5,6]. Comparative studies highlight age-specific patterns relevant for prognostic assessment. Adults typically present with acute focal deficits within defined vascular territories and with comorbidities that influence prognosis [2,3]. In contrast, children may have multifactorial etiologies, delayed symptom recognition, and evolving deficits that challenge early prediction [1,5]. Understanding these epidemiological distinctions is essential for evaluating the applicability of adult-derived prognostic scores in pediatric populations.

Unique Characteristics of Pediatric Stroke

Pediatric strokes demonstrate distinct pathophysiology and clinical presentation compared to adult strokes. Etiologically, hematologic disorders such as SCD, arteriopathies, and congenital heart defects are the most common contributors [1,5,8]. Infections and inflammatory conditions can also precipitate strokes, particularly in low-resource settings [1,8]. By contrast, adult strokes are predominantly ischemic and atherosclerotic, with hypertension being the most significant risk factor [2,3].

Clinically, pediatric strokes may present with hemiparesis, seizures, or subtle neurological changes that evolve over time, making early diagnosis challenging [5,7]. Neuroimaging often reveals multifocal or evolving infarcts, complicating the application of adult prognostic scales [5]. Functional outcomes in children extend beyond motor deficits and include cognitive performance, academic achievement, and social participation [6,7,8].

Neurodevelopmental plasticity is a hallmark of pediatric recovery. Children often exhibit substantial functional gains over months to years, influenced by age, lesion location, and early intervention [5,6,7]. Structured rehabilitation—physical, occupational, and cognitive therapy—plays a pivotal role in maximizing recovery potential [5,6]. Adult-derived scores, which assume relatively static early deficits, may underestimate the child’s capacity for functional recovery and long-term reintegration [2,3,5,6]. Contextual factors in low-resource environments, including malnutrition, limited access to rehabilitation services, and delayed diagnosis, further modify recovery trajectories and must be incorporated into any pediatric-specific prognostic framework [1,8]. Collectively, these features demonstrate that pediatric stroke outcomes are multidimensional and dynamic, underscoring the limitations of directly applying adult prognostic scores.

Adult Functional Prognostic Stroke Scores

Adult functional prognostic scores are well-established tools used to predict outcomes after ischemic or hemorrhagic stroke. Commonly applied scales include the National Institutes of Health Stroke Scale (NIHSS), the modified Rankin Scale (mRS), and the Intracerebral Hemorrhage (ICH) score [2,3]. These scores integrate clinical variables such as the severity of initial neurological deficits, imaging findings, vascular comorbidities, age, and time from symptom onset to reperfusion therapy [2,3]. The NIHSS quantifies neurological deficits across motor, sensory, language, and visual domains, and higher scores correlate with poorer functional outcomes [2]. The mRS evaluates global disability and independence, providing a reliable measure for rehabilitation planning and prognosis [2,3]. The ICH score is used specifically for hemorrhagic strokes, incorporating hematoma volume, location, age, and Glasgow Coma Scale at presentation [2,3]. These adult scores have been validated in large multicenter cohorts, predominantly in high-income countries, and are central to clinical decision-making and research [2,3]. However, their applicability outside the original study populations—particularly in pediatric

patients or in resource-limited environments—is uncertain. Adult scores may overestimate disability in children due to differences in neuroplasticity or underestimate the impact of pediatric-specific risk factors such as SCD or malnutrition [1,5,7]. Despite these limitations, adult scores remain widely used in pediatric care where validated pediatric tools are unavailable, reflecting a critical gap in pediatric stroke prognostication. Understanding the limitations of these tools is essential for clinicians to avoid misclassification of outcomes and to guide the development of adapted scoring systems [2,3,5].

Pediatric Stroke Prognostic Scores

Pediatric-specific prognostic scores are scarce, reflecting the relative rarity of childhood stroke and the complexity of predicting outcomes in a developing brain. Some new tools, like the PREDICT-Juvenile-Stroke score, look at adolescents and young adults and use clinical severity, imaging results, and demographic information to predict functional outcomes after three months [6]. Unlike adult scores, pediatric prognostic models must account for developmental neuroplasticity, potential for functional recovery, and long-term outcomes, including cognitive performance, academic achievement, and social integration [5,6,7,8]. Rehabilitation access, nutrition, and comorbid conditions such as SCD significantly modify recovery trajectories and must be incorporated into prognostic modeling [1,5,7]. Large cohort studies have documented the functional trajectory of pediatric stroke patients in inpatient rehabilitation settings, showing that early interventions significantly improve motor, cognitive, and self-care outcomes [4,5,7]. However, these studies are often single-center or conducted in high-income countries, limiting generalizability to low-resource settings [4,5]. Overall, pediatric prognostic scores remain underdeveloped, and there is no standardized framework equivalent to adult NIHSS or mRS, particularly for children in resource-limited environments [1,5,6,7]. This gap points to the need for adapted predictive tools that account for both clinical and contextual determinants of recovery. (Table 1)

Determinants	Adult Stroke	Pediatric Stroke	Notes for Resource-Limited Settings
Neurological Deficit	NIHSS score	Pediatric-adapted NIHSS or PSOM	Baseline severity influences outcome
Imaging	CT/MRI, lesion volume	CT/MRI, lesion location, arteriopathy	Limited imaging access may affect prognosis
Comorbidities	Hypertension, diabetes, atherosclerosis	Sickle cell disease, congenital heart defects, infections	Comorbidities modify recovery trajectory
Age	Older adults	Developmental stage (infant, child, adolescent)	Neuroplasticity higher in children
Nutrition	Usually adequate	Malnutrition common	Critical determinant in low-resource settings
Rehabilitation Access	Standard physiotherapy	Pediatric rehab + school reintegration	Limited access may worsen outcomes
Outcome Prediction	Validated adult scores (mRS, BI)	Few pediatric-specific scores	Adult scores need adaptation or AI-assisted modeling

Table 1. Comparison of Adult vs Pediatric Stroke Determinants in Functional Prognosis

Applicability of Adult Scores in Pediatric Populations

The direct application of adult functional prognostic scores to children carries several risks. Adult scores focus on early neurological deficits and age-dependent comorbidities, assuming limited neuroplasticity, which may not apply to developing brains [2,3,5]. Using adult scores in children can result in systematic bias, either underestimating the potential for recovery or failing to capture *Mabiala Konde et al. Pediatric stroke prognostic scores in resource limited settings*

pediatric-specific determinants such as SCD, nutritional status, and schooling impact [1,5,6].

Comparative analyses suggest that adult and pediatric stroke trajectories differ substantially. Pediatric recovery is influenced by neuroplasticity, environmental factors, and access to rehabilitation, which are generally not integrated into adult scores [5,6,7,8]. Consequently, unmodified adult scores may misclassify long-term functional outcomes or lead to inappropriate clinical decisions, particularly in low-resource settings where rehabilitation resources are scarce [1,8].

A hybrid, simplified prognostic score adapted for children could combine validated adult metrics with pediatric-specific determinants. Such a tool should incorporate neurological deficit, lesion characteristics, and time to intervention, alongside variables like developmental stage, nutrition, comorbid conditions, and rehabilitation access. Integration with context-sensitive indicators is especially critical in resource-limited countries [1,5,8].

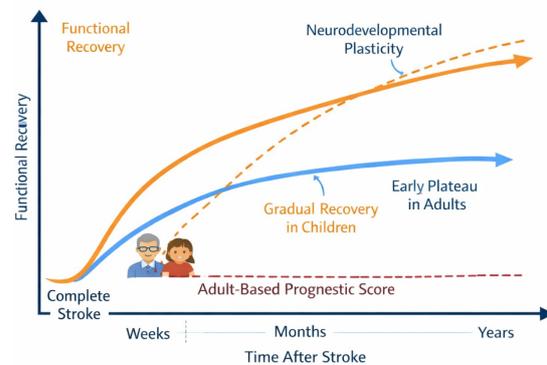


Figure 1. Stroke Outcome Trajectories in Children vs Adults
 Legend: Hypothetical recovery curves illustrating differences in functional outcome between children (orange line) and adults (blue line) following stroke. The adult curve shows early plateauing of recovery, whereas the pediatric curve demonstrates gradual improvement over time due to higher neurodevelopmental plasticity. The dashed red line represents the predicted functional outcome if adult-based prognostic scores were directly applied to children, highlighting potential underestimation of pediatric

Resource-Limited Settings

Resource-limited settings impose significant challenges for pediatric stroke care, affecting both diagnosis and outcome prediction. Limited access to neuroimaging, thrombolysis, ICU care, and specialized rehabilitation delays interventions and increases mortality rates [1,8,9].

Malnutrition, infectious comorbidities, and insufficient family or community support further influence functional recovery [1,9]. In Africa, stroke-related mortality is high in both adults and children, driven by delayed hospital presentation, lack of specialized care, and comorbidities including sickle cell disease and malnutrition [9]. The determinants identified in recent umbrella reviews indicate that improving early recognition, access to acute stroke care, and structured rehabilitation can meaningfully reduce mortality [9]. For pediatric populations, these constraints dramatically modify stroke recovery trajectories. Preventive measures such as transcranial Doppler (TCD) screening and hydroxyurea therapy for children with sickle cell disease reduce stroke incidence, but their implementation is limited by infrastructure and personnel shortages [1,5,7,8]. Predictive models must therefore balance simplicity and robustness. Hybrid scores incorporating neurological deficits, lesion characteristics, developmental stage, nutrition, comorbidities, and rehabilitation access can improve triage and resource allocation in constrained healthcare environments [1,5,8,9]. Recognizing determinants of higher mortality in African pediatric and adult populations reinforces the need for context-adapted prognostic tools [9].

Role of Artificial Intelligence

Artificial intelligence (AI) is emerging as a transformative tool in stroke care, particularly in resource-limited settings where pediatric patients face unique prognostic challenges [1,4,6,10]. Beyond traditional statistical models, AI can process complex, multi-dimensional datasets—including clinical variables, neuroimaging, laboratory markers, demographic information, and developmental indices—to generate individualized functional outcome predictions [10].

Diagnostic applications:

AI-assisted imaging analysis can identify subtle ischemic lesions, microinfarcts, and hemorrhagic changes that may be missed by general radiologists, especially in hospitals with limited neuroradiology expertise. Algorithms using convolutional neural networks (CNNs) have

demonstrated high sensitivity and specificity in lesion detection on CT and MRI, potentially shortening the time to diagnosis and intervention in pediatric stroke patients [10].

Predictive modeling for functional outcomes:

Machine learning models can integrate neurological deficit scores, neuroplasticity potential, comorbidities (e.g., sickle cell disease), nutrition status, and rehabilitation access to predict short- and long-term outcomes [10]. This approach directly addresses the limitations of applying adult functional prognostic scores to children, as AI can account for age-dependent recovery trajectories and contextual factors unique to low-resource environments. For instance, models can simulate how delays in rehabilitation or malnutrition affect predicted functional independence, enabling more nuanced risk stratification [10].

Workflow and resource optimization:

AI tools can prioritize patients for ICU admission, rehabilitation scheduling, and follow-up based on predicted functional outcomes.

In settings with limited personnel, AI-guided triage ensures that high-risk pediatric patients receive timely interventions, thereby optimizing scarce clinical resources [10].

For example, AI can flag children at highest risk for motor or cognitive deficits, allowing targeted allocation of physiotherapy or occupational therapy resources.

Implementation in resource-limited settings:

While promising, AI deployment in low-resource contexts requires careful consideration. Models need minimal yet reliable input data—such as simplified neurological assessments, portable imaging, and key demographic and comorbidity variables—to function effectively [10]. Local validation is essential, as the majority of AI systems are trained on adult or high-income datasets that may not accurately reflect pediatric stroke etiologies or outcomes in Africa or comparable regions. Infrastructure constraints, including intermittent electricity, limited digital record systems, and lack of trained personnel, are significant barriers [10].

Future perspectives:

AI can serve as the foundation for developing hybrid pediatric prognostic scores, combining adult score elements with pediatric-specific determinants. By continuously learning from local patient data, AI models could adapt thresholds and weighted risk factors, creating context-sensitive tools for functional outcome prediction.

Such adaptive scoring systems have the potential to reduce bias, improve clinical decision-making, and ultimately enhance survival and long-term functional recovery in children recovering from stroke in resource-constrained environments [10]. (Table 2)

AI Application	Function	Benefit in Pediatric Stroke	Relevance in Low-Resource Settings
Diagnostic Support	Automated lesion detection on CT/MRI	Early identification of ischemic/hemorrhagic lesions	Reduces reliance on scarce neuro-radiologists
Predictive Modeling	Machine learning integrating deficits, comorbidities, neuroplasticity	Individualized outcome prediction, addresses bias from adult scores	Can optimize triage and rehab allocation
Workflow Optimization	Prioritization of ICU admission and rehab	Ensures high-risk children receive timely care	Optimizes scarce clinical and rehab resources
Score Adaptation	AI-assisted hybrid pediatric score	Combines adult score elements + pediatric-specific factors	Generates context-adapted prognostic tools
Decision Support	Clinical recommendations for intervention timing	Improves functional outcomes, reduces mortality risk	Reduces delays in care where guidelines are limited

Table 2. Potential Role of Artificial Intelligence in Pediatric Stroke Prognostication

Ethical Considerations

Pediatric stroke prognostication raises several ethical issues, particularly when applying adult-based scores or AI-driven models in low-resource settings [1,5,6]. First, the risk of misclassification may lead to inappropriate

clinical decisions, including withholding or delaying rehabilitation or life-sustaining interventions [1,5]. Children’s neuroplasticity and developmental potential make early outcome predictions inherently uncertain, emphasizing the principle of non-maleficence.

Equity is another critical concern. In resource-limited environments, predictive scores may influence allocation of scarce rehabilitation or ICU resources. Using unadapted adult scores risks disadvantaging children who could otherwise achieve substantial recovery with appropriate interventions [1,5,8]. Incorporating pediatric-specific determinants—such as nutritional status, access to rehabilitation, and school performance—supports ethically informed prognostication.

Informed consent and parental engagement are also essential. Families must understand the limitations of prognostic tools and the potential impact on decision-making. Transparent communication regarding uncertainty and individualized risk assessment is vital to maintain trust and ethical standards [1,5,6].

Finally, AI-based tools introduce additional ethical challenges, including algorithmic bias, data privacy, and accountability. Models must be validated locally and continuously monitored to ensure that predictions do not exacerbate existing health inequities [1,4,5,6].

Conclusion

Adult functional prognostic stroke scores provide a useful foundation for understanding outcomes, but their direct application to pediatric populations—especially in resource-limited settings—has clear limitations. Pediatric strokes differ from adult strokes in etiology, recovery potential, and contextual factors, including neuroplasticity, nutrition, and comorbidities such as sickle cell disease. Using adult scores without making changes could lead to wrong conclusions about recovery potential and bad clinical decisions. There is a clear need for hybrid prognostic tools that integrate pediatric-specific determinants while remaining practical for low-resource environments. Artificial intelligence presents opportunities to

enhance prediction and individualized care but must be implemented with careful validation and ethical oversight. Developing robust, context-sensitive pediatric prognostic tools will support more accurate functional assessment, equitable allocation of resources, and improved long-term outcomes for children recovering from stroke.

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Ethical Considerations

As this article is a perspective piece that does not involve human participants, patient data, or primary data collection, formal ethical approval was not required.

Data Availability

This article did not generate or analyze new data. The content is based exclusively on previously published studies and publicly accessible sources.

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