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## **PEDIATRIC STROKE DIAGNOSIS: CURRENT CHALLENGES AND FUTURE PERSPECTIVES**

*Annotation: The article discusses the crucial role of emergency physicians in managing acute neurological disorders in children, with a specific focus on pediatric stroke. It emphasizes the intricate challenge of differentiating serious conditions, such as stroke, from more benign disorders like migraine, underlining the significance of early recognition. The review explores diagnostic challenges, highlighting delays in hospital presentation and the under-recognition of pediatric stroke. It delves into neuroimaging challenges, recommending methods like diffusion-weighted MRI for acute ischemic stroke diagnosis in children. The article also addresses laboratory and cardiac evaluations, providing insights into the associated risk factors and necessary tests. Lastly, it advocates for a comprehensive, individualized approach, incorporating precision medicine and advancements in imaging technologies for more accurate and timely diagnoses in pediatric stroke.*

*Keywords: pediatric stroke, neuroimaging, diagnostic challenges, genetic markers, brain vessels*

**Introduction.** Emergency physicians play a critical role as the primary point of contact for children presenting with acute neurological disorders, facing the intricate challenge of distinguishing serious conditions like stroke from more benign disorders such as migraine. The outcome of clinical assessments significantly shapes decision-making processes, particularly in determining the necessity for emergent neuroimaging to confirm diagnoses. This comprehensive

review aims to illuminate the spectrum of disorders giving rise to 'brain attack' symptoms—acute onset focal neurological dysfunction—with a specific focus on childhood stroke. The early recognition of such conditions is paramount as it paves the way for improved accessibility to thrombolytic treatments, which have demonstrated enhanced outcomes in adults.

Within this exploration, we delve into the nuanced clues crucial for diagnosing specific conditions, unraveling symptoms and signs that differentiate stroke from its mimics. Notably, the discussion highlights distinctions in pediatric presentations, underlining the need for a nuanced understanding that differs from the diagnostic paradigms observed in adults. Emphasizing the diversity between hemorrhagic and ischemic strokes, we explore how these differences influence the selection of the most appropriate imaging modalities to ensure maximal diagnostic accuracy.

Recognizing that advancements in the care of children with brain attacks necessitate coordinated approaches and system improvements akin to those developed for adults, this review aims to contribute valuable insights into optimizing the management of acute neurological disorders in the pediatric population. Through an enhanced understanding of the unique challenges posed by pediatric cases, we can pave the way for improved early recognition, timely interventions, and ultimately, enhanced outcomes for children facing acute neurological challenges.[3]

**Method.** This review employs a comprehensive literature review approach to investigate the diagnostic challenges associated with strokes related to endothelial dysfunction in children. The study synthesizes existing research articles, reviews, and relevant publications to provide a comprehensive overview of the current state of knowledge on this topic.

**Literature Search:** A systematic literature search was conducted using electronic databases, including Google Scholar, PubMed, Embase, and Web of Science. The search terms included combinations of "pediatric stroke,"

"endothelial dysfunction," and "diagnostic challenges." The inclusion criteria encompassed articles published within the last ten years to ensure relevance to current diagnostic practices.

## **Results and Discussion.**

### **1. Diagnostic Challenges and Delays:**

- The average time from symptom onset to hospital presentation for children with arterial ischemic stroke (AIS) is reported to be 24 hours, with recent studies suggesting that much of the delay in diagnosis now occurs within hospitals.

- Pediatric stroke symptoms can be rapid and dramatic, but sometimes they are insidious, making recognition challenging.

- Pediatric stroke is often under-recognized, with only 38% of children having AIS suspected on initial assessment in one study.

### **2. Neuroimaging Challenges:**

- Diffusion-weighted MRI is the most sensitive method for diagnosing acute AIS, but in children under 8 years old, sedation or anesthesia may be needed.

- Head CT is less sensitive for AIS detection. MRI, MRA, and MRV are recommended for vascular imaging, but challenges include the need for sedation, exposure to contrast agents, and potential movement during imaging.

- CTA and CTV may be used, but they have disadvantages such as radiation exposure and the need for accurate contrast injection timing.

### **3. Laboratory and Cardiac Evaluation:**

- For arterial ischemic stroke, echocardiography is suggested to identify congenital heart disease. The role of patent foramen ovale (PFO) in childhood stroke is controversial.

- ECG is recommended for all children with AIS, and longer monitoring is indicated if arrhythmia is suspected.

- Laboratory evaluation includes tests for inflammation, hyperlipidemia, rheumatologic disease, thrombosis, and a basic thrombophilia evaluation.

- Thrombophilia risk factors are associated with pediatric AIS, including deficiencies in antithrombin, protein C, protein S, factor V and II gene mutations, and high lipoprotein(a) levels.

- In hemorrhagic stroke, laboratory evaluation is less well-defined, involving platelet count, clotting studies, and additional tests based on the family's history and clinical presentation.

Histological examination involves studying tissue samples under a microscope. To assess the condition of endothelial layers in brain vessels, a brain biopsy or post-mortem examination would be required. However, brain biopsies are invasive procedures and are typically reserved for specific clinical situations.

In living patients, non-invasive imaging techniques like MRI and MRA are preferred for assessing brain vessels due to their safety and effectiveness. Histological examination is usually limited to research or specific medical cases where it is deemed necessary to analyze tissue samples.

If you have concerns about the condition of your brain vessels, it's important to consult with a healthcare professional who can recommend the most appropriate diagnostic approach based on your individual circumstances.

Figure 1.

<b>Histological Features</b>	<b>Healthy Brain Vessels</b>	<b>After Stroke</b>
<b>Cellular morphology</b>	normal, elongated	swollen, irregular
<b>Permeability</b>	tight junctions, low permeability	increased permeability, leaky junctions
<b>Inflammation</b>	minimal	infiltration of immune cells
<b>Thrombosis</b>	minimal or absent	increased risk, possible thrombi
<b>Edema</b>	absent	swelling and fluid accumulation

<b>Hemorrhage</b>	absent	possible hemorrhagic transformation
<b>Capillary density</b>	normal	variable, potential capillary loss
<b>Basement membrane</b>	intact	disrupted or thickened
<b>Vascular remodeling</b>	stable	potential remodeling and angiogenesis
<b>Micro vessel Structure</b>	regular pattern	disorganized and irregular
<b>Expression of Adhesion Molecules</b>	low	increased, promoting immune response

This table (Figure 1.) provides a broad overview of the differences in histological features of the endothelial layer between healthy brain vessels and those affected by a stroke.

Pediatric stroke presents a significant challenge in childhood disability, marked by distinct factors compared to adult strokes. Overcoming obstacles such as low awareness, the need for anesthesia during diagnostic procedures, and limited treatment studies is imperative. The upcoming PedNIHSS scale holds promise in quantifying stroke severity and establishing a baseline for outcome comparisons. Anticipated trials, including acute AIS treatment with tPA and aspirin vs. warfarin for prevention, underscore the need for urgent research in this realm. Developing well-validated outcome measures is critical to assessing the efficacy of various treatments.

In the realm of childhood stroke management, the 2017 UK guidelines advocate for a cohesive approach, emphasizing the urgency of translating adult stroke care advancements to the pediatric population. Acknowledging the rarity and heterogeneity of childhood stroke, a nuanced, case-by-case consideration is crucial. Challenges posed by certain guideline suggestions, such as the necessity of arterial occlusion on imaging, highlight the need for flexible and tailored approaches. Triage based on symptoms, cause, severity, and careful consideration of contraindications is advocated. Proposing a cultural shift

toward hyperacute MR for enhanced diagnostic capabilities aims to empower pediatricians in making confident decisions, ultimately contributing to improved outcomes for pediatric stroke patients.[2, 4, 5]

These conclusions underscore the multifaceted nature of pediatric stroke, calling for continued research, adaptive guidelines, and a comprehensive, individualized approach to enhance the overall care and outcomes in this vulnerable population.

In addition to above examination methods, also we have to focus on to as certain thrombotic complications, it is imperative to incorporate assessments of genetic polymorphisms related to thrombophilia genes in the examination. Additionally, a crucial criterion involves ongoing monitoring of homocysteine levels and scrutinizing the parameters of the natural anticoagulant system.[1]

**Conclusion.** Looking ahead, the future of pediatric stroke diagnosis holds promise. The integration of precision medicine, advancements in imaging technologies, and a deeper understanding of the unique aspects of childhood stroke will undoubtedly contribute to more accurate and timely diagnoses. By breaking new ground and embracing change, we can pave the way for a paradigm shift in how we approach and address the diagnostic challenges in pediatric stroke.

As we stand at the cusp of this transformative journey, it is our collective responsibility to advocate for continued research, support, and awareness. By doing so, we not only improve the current state of pediatric stroke diagnosis but also lay the foundation for a future where children facing neurological challenges receive the most effective and compassionate care. In the evolving landscape of pediatric stroke diagnostics, there is not just a call for change but a call to chart a course towards a brighter and more hopeful tomorrow.

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