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RESEARCH ARTICLE

DENGUE IN PEDIATRIC POPULATIONS: CHALLENGES AND MANAGEMENT STRATEGIES

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Abstract

Dengue fever, caused by the dengue virus (DENV), represents a significant global public health concern, with pediatric populations disproportionately affected in tropical and subtropical regions. In recent decades, the incidence of pediatric dengue has escalated sharply, particularly in countries such as India, Brazil, and Thailand, where children contribute up to 30–50% of reported dengue cases during seasonal outbreaks. Children are more vulnerable due to immature immune systems, lack of timely diagnosis, and increased risk of complications. The disease in children presents with a wide clinical spectrum, ranging from mild febrile illness to severe dengue hemorrhagic fever (DHF) and dengue shock syndrome (DSS). Severe complications, such as plasma leakage, hemorrhage, neurological involvement, hepatitis, and multi-organ failure, are not only more frequent but also more life-threatening in children. Risk factors such as obesity, secondary infections, maternal antibodies, and age-related vulnerabilities play an important role in disease progression. One of the major challenges lies in diagnostic overlap with other febrile illnesses like malaria and typhoid, particularly in resource-limited settings. The novelty of this review lies in its focused integration of pediatric clinical complexities, nursing responsibilities, and public health implications, highlighting a unique multidisciplinary approach. Supportive management through timely fluid therapy, early monitoring, and health education remains the mainstay, as no specific antiviral therapy is available. Current vaccine limitations, especially Dengvaxia's serostatus-dependent safety concerns, further complicate pediatric immunization. Nurses play a vital role in case detection, fluid management, education, and community vector control. This article emphasizes not only the clinical and nursing aspects but also the pressing need for public health measures, robust vector control, and improved vaccines. By addressing these challenges, the review contributes evidence-based insights to strengthen both bedside care and community-level interventions, aiming to reduce pediatric dengue morbidity and mortality globally.

Introduction:-

Dengue is a mosquito-borne viral infection primarily transmitted by Aedes aegypti mosquitoes. According to the WHO, approximately 390 million dengue infections occur annually, with a large proportion affecting children. Pediatric cases are of particular concern due to the higher risk of severe complications such as dengue hemorrhagic

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fever (DHF) and dengue shock syndrome (DSS). Children often present with atypical signs and symptoms, complicating early diagnosis and management. The burden is especially high in tropical and subtropical countries, including India, where monsoon seasons foster mosquito breeding. This review examines the complexities of dengue in children, focusing on epidemiology, clinical features, risk factors, diagnostic approaches, and management strategies, drawing from numerous peer-reviewed sources. Despite abundant research on dengue in general populations, there is a gap in literature focused on atypical pediatric presentations, nursing interventions, and integration of public health strategies, which this review uniquely addresses.

Review of Literature:-

Several studies have examined the complex interplay of clinical, immunological, and environmental factors contributing to pediatric dengue. Simmons et al. (2012) emphasized the rising incidence in younger populations and the need for age-specific care protocols. Gubler (2011) linked urbanization and climate change to increasing outbreaks in previously low-risk areas. Kliks et al. (1988) highlighted the antibody-dependent enhancement (ADE) phenomenon, where maternal antibodies in infants exacerbate disease severity. Zulkipli et al. (2018) conducted a meta-analysis showing that childhood obesity significantly raises the risk of severe dengue. Peeling et al. (2010) and Lanciotti et al. (1992) discussed diagnostic limitations in children due to fluctuating immune responses and restricted access to molecular diagnostics. Hadinegoro et al. (2015) and Sridhar et al. (2018) raised concerns regarding the safety of Dengvaxia in seronegative children, stressing the need for improved vaccines. These findings underline the necessity for multidisciplinary efforts involving clinicians, researchers, and nursing professionals to address pediatric dengue more effectively

Epidemiology of Dengue in Pediatric Populations:

Dengue is endemic in more than 100 countries. Asia and Latin America report the highest pediatric burden. Children aged 1–9 years are particularly susceptible. In India, children account for 30–50% of dengue cases in endemic regions, particularly during monsoon seasons. Contributing factors include climate change, poor sanitation, urban crowding, and ineffective vector control.

Pathophysiology of Dengue in Children:

Dengue fever is caused by the dengue virus (DENV), a single-stranded RNA virus belonging to the Flaviviridae family. There are four antigenically distinct serotypes: DENV-1, DENV-2, DENV-3, and DENV-4. Infection by any serotype confers lifelong immunity against that specific serotype but only temporary and partial immunity against the others. This sets the stage for secondary infections, which are often more severe due to a phenomenon known as antibody-dependent enhancement (ADE).

Viral Entry and Replication:

After the bite of an infected Aedes aegypti or Aedes albopictus mosquito, the virus enters the bloodstream and infects monocytes, dendritic cells, and macrophages. The virus uses receptors like DC-SIGN to enter cells and replicate. Infected cells release viral particles and pro-inflammatory cytokines into circulation.

Immune Response:

The innate immune system reacts with an influx of interleukins (IL-6, IL-8), TNF-α, and interferons, causing fever and constitutional symptoms. The adaptive immune response is triggered with T-cell activation and production of dengue-specific antibodies.

In primary infections, the immune response often controls the virus, and the disease remains mild. However, in secondary infections, non-neutralizing antibodies from the first infection can bind to the new serotype but fail to neutralize it. These antibody-virus complexes facilitate viral entry into immune cells via Fc receptors, enhancing viral replication — the mechanism known as antibody-dependent enhancement (ADE).

Plasma Leakage:

The hallmark of severe dengue is increased vascular permeability, leading to plasma leakage, hemoconcentration, pleural effusion, and ascites. The exact mechanism is not fully understood but it involves:

Endothelial dysfunction due to cytokine storm

Complement activation:
Release of vasoactive mediators:
This results in hypovolemia and, in severe cases, dengue shock syndrome (DSS).

Hemostatic Abnormalities:
Dengue causes a reduction in platelet production (bone marrow suppression) and increased platelet destruction, leading to thrombocytopenia. This, along with:
Coagulopathy,
Liver dysfunction,
Capillary fragility,
contributes to bleeding tendencies, especially in severe cases.

Organ Involvement:
In severe pediatric cases, dengue may affect:
- Liver – elevated transaminases, hepatomegaly.
- Central nervous system – seizures, encephalitis (rare).
- Kidneys – acute kidney injury in prolonged shock.
- Heart – myocarditis or pericardial effusion (infrequent)

Clinical Manifestations:
Pediatric dengue presents with a spectrum of symptoms, from mild fever to life-threatening DHF and DSS. Common symptoms include high fever, retro-orbital pain, headache, myalgia, arthralgia and rash, but children may also exhibit atypical signs like abdominal pain, vomiting, and lethargy, making clinical diagnosis critical. Severe dengue is characterised by plasma leakage, bleeding, and organ dysfunction, with children at higher risk due to immature vascular and immune responses. The risk of shock is notably higher in children. Obesity has been identified as a risk factor for severe dengue in children, increasing the odds of severe outcomes by 38% (Odds Ratio = 1.38; 95% CI: 1.10, 1.73).

Atypical Presentations in Children:
In addition to classical dengue symptoms, children may present with atypical features that complicate diagnosis. Neurological manifestations such as seizures, encephalopathy, and Guillain–Barré syndrome have been reported. Hepatic involvement, including acute hepatitis with elevated transaminases, has been observed in 15–20% of hospitalized cases. Cardiac complications such as myocarditis and pericardial effusion, though rare, have also been documented. Regional data from India show an increasing trend of atypical dengue, with studies indicating that up to 22% of pediatric cases present atypically, often delaying treatment initiation. These unusual presentations highlight the need for heightened clinical suspicion.

Risk Factors:
Several risk factors intensify dengue severity among children:
- Obesity: Obese children are more prone to inflammatory responses and vascular permeability (Zulkipli et al., 2018).
- Maternal Immunity: Infants with maternal dengue antibodies are vulnerable to ADE, leading to more severe presentations(Kliks et al.,1988).
- Secondary Infections: Prior infection with a different serotype increases the risk of DHF/DSS.
- Age: Children under five are particularly susceptible to DSS due to underdeveloped immunity.

Diagnostic Challenges:
Diagnosing dengue in children is challenging due to nonspecific symptoms and limited access to advanced diagnostics in resource-poor settings. Common tests include NS1 antigen detection and IgM/IgG ELISA, but these have variable sensitivity in children. RT-PCR, while accurate, is costly and unavailable in many endemic areas. Misdiagnosis with other febrile illnesses like malaria or typhoid is common, delaying treatment. Nurses play a critical role in early recognition of warning signs, such as persistent vomiting and mucosal bleeding.

Management Strategies:
Management of pediatric dengue focuses on supportive care, as no specific antiviral therapy exists. Key strategies include:

- Fluid Management: Judicious fluid replacement is critical to prevent plasma leakage and shock. WHO guidelines recommend crystalloids for initial resuscitation.
- Monitoring: Regular monitoring of hematocrit, platelet count, and vital signs is essential, particularly in severe cases.
- Nursing Care: Nurses are pivotal in administering fluids, monitoring for warning signs, and educating families on mosquito control.
- Vaccination: The Dengvaxia vaccine is currently approved for children aged 9–16 years in endemic regions, but its use is restricted to those who are seropositive due to risks of severe disease in seronegative individuals. Hence, pre-vaccination serostatus testing is recommended. Ongoing research into second-generation vaccines, such as TAK-003 and TV003/TV005, shows promise in providing safer and broader protection across pediatric age groups, including seronegative children.

Challenges in Pediatric Dengue Control:

1. Vaccine Limitations: Current vaccines are not universally safe for children, especially seronegative individuals.
2. Vector Control: Community-based mosquito control programs are inconsistently implemented.
3. Healthcare Access: Rural areas lack trained personnel and diagnostic facilities.
4. Public Awareness: Low awareness of dengue prevention among caregivers hinders early intervention.

Future DirectionsL:
Future efforts should focus on:

- Developing affordable, child-friendly diagnostics.
- Creating safe and effective vaccines for all pediatric age groups.
- Strengthening nursing education on dengue management to enhance early detection and care.

Public Health Perspectives:
From a public health perspective, pediatric dengue management requires integrated approaches involving surveillance, vector control, school-based awareness programs, and early warning systems. National programs such as India's NVBDCP emphasize source reduction, larval control, and community participation. Nurses and community health workers are essential in translating these strategies into household-level practices. Strengthening intersectoral collaboration, improving infrastructure for rapid diagnostics, and promoting school health education campaigns are critical for long-term control. Future directives should align clinical management with public health strategies to achieve a sustainable reduction in disease burden.

Conclusion:-

Additionally, future research must emphasize bridging the clinical-public health gap by developing affordable vaccines, improving pediatric diagnostic tools, and expanding nurse-led interventions at community and hospital levels. This dual approach will ensure better preparedness against pediatric dengue outbreaks.

Pediatric dengue remains a global health challenge, with children facing higher risks of severe outcomes due to physiological and diagnostic complexities. Nurses, as frontline caregivers, are crucial in managing cases and educating communities. This review underscores the need for targeted research, improved diagnostics, and accessible vaccines to reduce the pediatric dengue burden.

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