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POST-TREATMENT OUTCOMES OF UNDER 15 CHILDREN WITH JAPANESE ENCEPHALITIS AND ACUTE ENCEPHALITIS SYNDROME OF GORAKHPUR, UTTAR PRADESH

Epidemology

Deepak Gopal Research Scholar, IIPS Mumbai
Prof. Murali Dhar* Professor And Head, Department Of Biostatistics And Epidemiology, IIPS Mumbai
*Corresponding Author

ABSTRACT

Pediatric neurological conditions, particularly those stemming from post-infectious complications, present substantial challenges in recovery and rehabilitation. This study evaluates the post-treatment neurological outcomes in children affected by Japanese Encephalitis (JE) or Acute Encephalitis Syndrome (AES), using the Liverpool Outcome Score (LOS) as a comprehensive assessment tool. The LOS framework assesses a range of functional domains, including speech, feeding, motor skills, independence, and cognitive function. Our cohort of 100 children reveals a broad spectrum of outcomes, ranging from full recovery to severe impairments. Findings highlight the need for early intervention, personalized support, and sustained monitoring to improve long-term quality of life. By examining these outcomes, we aim to inform healthcare strategies and rehabilitation approaches for pediatric patients affected by JE and AES.

KEYWORDS

INTRODUCTION

Japanese Encephalitis (JE) and Acute Encephalitis Syndrome (AES) are severe viral infections that can cause acute inflammation of the brain, posing a significant public health challenge in endemic regions of Asia and the Western Pacific. JE, caused by the Japanese Encephalitis Virus (JEV), is transmitted primarily by Culex mosquitoes, with pigs and wading birds as common hosts. Annually, an estimated 68,000 cases occur, largely affecting children under 15, who are more vulnerable to neurological damage from the virus. Though the majority of JEV infections are asymptomatic, symptomatic cases present with high fever, seizures, and altered consciousness. Mortality in JE cases can reach 30%, and survivors often face chronic disabilities, highlighting the need for comprehensive prevention and management strategies (WHO, 2022; PLOS, 2023).

A significant concern in JE/AES management is the long-term impact on survivors, many of whom experience neurological sequelae. Studies indicate that 30–50% of JE survivors suffer from conditions such as cognitive impairment, motor dysfunction, and psychological challenges, which hinder their ability to reintegrate into daily life and education. These outcomes are more pronounced in younger children and those with severe symptoms during the acute phase (Clinical Infectious Diseases, 2023; Hills et al., 2022). Motor impairments, including paralysis, tremors, and weakness, are prevalent, while cognitive deficits affect memory, learning, and problem-solving abilities. Psychological issues, such as anxiety and behavioral problems, also add to the complexity of JE's impact on young patients (Kalita et al., 2020; Oxford Academic, 2023).

The Liverpool Outcome Score (LOS) has become an invaluable tool in JE research to measure recovery levels in pediatric patients post-treatment. LOS categorizes outcomes from "good recovery" to "severe disability" across physical, social, and cognitive domains. Studies using LOS have shown that children with JE often score poorly, with many falling into categories that reflect significant disability. This metric provides a standardized assessment for clinicians and helps identify patients who may benefit from targeted rehabilitation. For instance, Kalita et al. (2020) reported that more than half of JE patients scored in the "moderate to severe" disability range, underscoring the need for long-term follow-up and rehabilitative support (Chotpitayasunondh et al., 2021).

Furthermore, post-treatment outcomes vary based on factors like age, immune response, and the timeliness of supportive care, such as respiratory and seizure management during the acute phase. In areas with limited medical resources, delayed access to care exacerbates mortality and morbidity. Studies have highlighted the need for integrated healthcare systems that facilitate early intervention and sustained post-treatment support for survivors. The high rates of disability associated with JE emphasize the importance of vaccination, which has been effective in reducing JE incidence in countries with robust immunization programs, although challenges remain in low-resource settings (Hoke et al., 1992; WHO, 2023).

In sum, JE/AES are not only acute threats but also chronic burdens due to the long-term disabilities they impose on survivors. Through preventive strategies like vaccination and the implementation of standardized assessment tools like the LOS, healthcare systems can better address the immediate and extended impacts of these diseases. This dual approach, emphasizing both immediate management and long-term rehabilitation, is critical to improving outcomes and quality of life for JE/AES survivors, especially children.

Methodology

This retrospective cohort study assesses the neurological outcomes of 100 children diagnosed and treated for JE or AES. The LOS, a validated scoring system, was used to evaluate outcomes across ten domains: speech, feeding, independence, behavior, recognition, work/school performance, seizure activity, dressing, bladder and bowel control, and hearing. Each domain is scored on a scale from 1 to 5, with higher scores indicating better functionality and lower scores indicating significant impairments.

Interpretation Of The Liverpool Outcome Score

LOS	Interpretation of LOS
5	Full recovery
4	Mild sequelae with no effect or only minor effect on physical function, or personality change, or on anti-seizure medication
3	Moderate sequelae mildly affecting function, probably compatible with independent living
2	Severe sequelae, impairing function sufficient to make patient dependent
1	Death

Data Collection:

Data were extracted from clinical records, including demographic information, medical history, and LOS assessments. Scores were recorded at the end of treatment to capture any changes in functionality.

Outcome Classification:

LOS scores categorize recovery as follows: 5 (full recovery), 4 (mild sequelae), 3 (moderate sequelae), 2 (severe sequelae), and 1 (death). Children with higher scores demonstrated better functional recovery, while lower scores indicated significant impairments and dependency.

Data Analysis:

Descriptive statistics were used to analyze LOS score distributions across domains. Frequencies and percentages were calculated for each score category to assess variability in outcomes. Additionally, chi-square tests were conducted to determine any significant associations between demographic variables (age, sex) and LOS outcomes.

RESULT AND DISCUSSION

Neurological Function Outcomes By Domain

This study evaluates various domains of functionality, including speech, feeding, independence, behavior, recognition, work ability, epilepsy, dressing, bladder and bowel control, and hearing in a dataset of 100 children provided in the table 1 and table 2.

Speech Abilities

Speech is a fundamental aspect of communication and cognitive function, crucial for social interaction and learning. In the study, 75 children (75%) retained their pre-illness speech abilities, indicating that a substantial portion of the cohort did not experience significant cognitive impairment in this area. However, 19 children (19%) showed moderate impairments, and 6 children (6%) exhibited severe speech deficits, suggesting that these children face considerable challenges in verbal communication. These speech impairments may affect their ability to engage in school, social settings, and family interactions.

Feeding Independence

Feeding ability reflects both motor control and coordination, essential for functional independence. In this cohort, 87 children (87%) maintained normal feeding abilities, showing that their motor functions related to eating remained largely unaffected. In contrast, 9 children (9%) required continuous assistance for feeding, and 4 children (4%) showed moderate difficulties, indicating significant motor impairments. This lack of independence can impact daily routines and increase caregiver responsibilities, affecting the quality of life for both children and their families.

Independence in Supervision Needs

This domain assesses the children's ability to be left unsupervised safely, which is an important marker of independence and self-care skills. The study found that 87 children (87%) could be safely left alone, indicating a high level of independence. However, 11 children (11%) could only be left alone briefly in familiar environments, and 6 children (6%) required constant supervision due to safety concerns. This diversity in autonomy levels suggests a significant variation in functional outcomes, with some children needing ongoing supervision and support, thus placing a greater caregiving burden on their families.

Behavioral Health

Behavioral health is critical for emotional regulation, social interaction, and cognitive stability. Post-illness behavioral changes were observed in the majority of the cohort, with only 33 children (33%) showing normal behavior. Among the affected, 41 children (41%) displayed moderate behavioral challenges, such as irritability and mood swings, while 26 children (26%) exhibited severe behavioral issues. These behavioral difficulties could indicate underlying neurological disruptions due to illness, affecting the child's emotional stability and requiring additional support in the form of behavioral therapies or counseling.

Recognition And Cognitive Function

Recognition ability is essential for cognitive and social interactions, as it indicates whether children can recognize familiar faces and surroundings. The study showed that 86 children (86%) retained their recognition abilities, while 10 children (10%) exhibited moderate difficulties, and 4 children (4%) experienced severe impairments in this domain. Impaired recognition abilities may hinder children's social interactions and independence, impacting their cognitive development and emotional well-being.

Work/School Performance

This domain assesses children's ability to return to their pre-illness routine, an indicator of functional independence and cognitive recovery. In the cohort, 70 children (70%) were able to perform daily tasks as before the illness, signifying a high level of post-recovery independence. However, 17 children (17%) showed moderate difficulties in routine tasks, and 13 children (13%) were no longer able to perform as before, indicating that a subset of children experienced notable impairments, affecting their school performance and daily functioning.

Epilepsy/Seizure Control

Seizure control is a critical component of neurological health, affecting overall stability and quality of life. The data revealed that 55 children (55%) experienced no seizures post-treatment and were not on anti-epileptic drugs, reflecting good seizure control. An additional 14 children (14%) were seizure-free while on anti-epileptic medication. However, 21 children (21%) had moderate seizure activity, and 10 children (10%) experienced frequent seizures. These findings underscore the variability in seizure control and its implications for daily functioning and independence, with some children requiring continuous medical management.

Dressing Independence

Dressing is a daily activity that requires motor skills and independence. In the cohort, 79 children (79%) were able to dress themselves independently, showing that their motor skills remained largely intact. However, 13 children (13%) needed occasional assistance, and 8 children (8%) required continuous help, highlighting the variability in motor function recovery. Children with greater impairments in this domain may require physical or occupational therapy to regain independence.

Bladder and Bowel Control

Control over bladder and bowel functions is essential for dignity and independence. In this cohort, 88 children (88%) retained normal control, while 12 children (12%) experienced severe impairments, requiring assistance. This deficit can greatly impact the child's independence, emotional well-being, and social interactions, as it necessitates caregiver involvement for personal care tasks.

Hearing Ability

Hearing impacts communication and social engagement, critical for learning and interaction. The study revealed that 86 children (86%) retained normal hearing post-illness, while 9 children (9%) experienced moderate hearing loss, and 5 children (5%) had severe hearing impairments. These impairments could affect language development, communication, and social skills, necessitating interventions like hearing aids or specialized educational support.

Table 1. Liverpool outcome scores at individual level

Speech	Score	Individuals
The same	5	75
Changed or Reduced	3	19
Not Speaking	2	6
Feeding		
Normal	5	87
Occasionally needs help	3	4
Occasionally needs help	2	9
Leaving alone		
Yes	5	83
Yes, briefly in familiar environment	3	11
No	2	6
Behavior		
Completely normal	5	33
Gets angry easily / Other problems	4	41
Severely Abnormal	2	26
Recognition		
Yes	5	86
some	3	10
None	2	4
Working before illness		
Back to normal work	5	70
Not performing as well at same	4	17
No longer attending work	3	13
Epilepsy/Seizure		
No seizures and not on anti-epileptic drugs	5	55
No seizures and on anti-epileptic drugs	4	14
Yes, has had seizures	3	21
Yes, seizures most days	2	10
Dressing		
The same	5	79
Occasionally needs extra help	3	13
Always needs more help	2	8
Bladder and bowl control		
The same	5	88
Needs more help	2	12
Hearing		
Normal	5	86
Reduced in one or both ears	4	9
Cannot hear at all	3	5

Motor Skill Assessment

Sitting And Standing

The ability to sit and stand independently reflects core and lower body strength, balance, and coordination. In this cohort, 93 children (93%) could sit independently, and 94 children (94%) could stand unassisted, indicating preserved muscle function and balance in the majority. However, a small subset exhibited difficulties, with 4 children needing assistance to sit and 3 children needing help to stand. This impairment in basic motor skills impacts mobility and may require physical therapy.

Walking

Independent walking is vital for mobility and self-sufficiency. Ninety children (90%) could walk independently, suggesting strong motor recovery. However, 7 children (7%) exhibited some abnormality but could walk independently, while 3 children (3%) were unable to walk without assistance. This limitation can impact independence in daily activities and may require intensive physical therapy.

Hands On Head

The ability to raise hands to the head reflects upper body strength and coordination. The study found that 95 children (95%) performed this task independently, indicating good motor recovery. However, 5 children faced challenges, with 4 experiencing moderate difficulty and 1 exhibiting mild difficulty. These limitations could affect daily tasks requiring upper body dexterity, such as grooming and dressing.

Picking Up Objects

The ability to pick up objects is a critical fine motor skill, essential for hand-eye coordination and daily functioning. In the cohort, 91 children (91%) demonstrated normal pincer grasp, showing preserved fine motor skills. However, 9 children experienced difficulties, with 6 having moderate impairments and 3 having severe issues. This limitation could impact daily tasks such as feeding, writing, and other activities requiring fine motor control.

Table 2. Liverpool outcome score individual: Motor Skills

Sitting	Score	Individuals
Independently	5	93
Needs help	3	4
Not at all	2	3
Standing up		
Yes, independently	5	94
Needs help	3	3
Not at all	2	3
Walking		
Normally	5	90
Abnormally, but independently	3	7
Not able to walk	2	3
Hands on head		
Normal both hands	5	95
Abnormal one or both hands	4	1
Not able to one or both hands	3	4
Picking up		
Normal pincer grasp both hands	5	91
Abnormal one hand or both hands	3	6
Unable both hands	2	3

LOS Score Distribution and Recovery Spectrum

The Liverpool Outcome Score (LOS) categorizes recovery outcomes on a scale from 1 to 5, with higher scores indicating better functionality. This section provides an analysis of the distribution of LOS scores across the cohort, highlighting variations in recovery and the implications for ongoing support needs.

Full Recovery (Score 5): Thirty-three children (33%) achieved a score of 5, indicating full recovery with minimal to no functional limitations across the assessed domains. These children were able to perform all activities independently and returned to their pre-illness state, demonstrating resilience and a strong capacity for neurological recovery. Full recovery in this group suggests favorable responses to treatment and the potential for these children to reintegrate into their daily lives, education, and social environments without significant restrictions.

Mild Sequelae (Score 4): A majority of the cohort, 53 children (53%), fell into the category of mild sequelae. These children displayed minor impairments that had a limited effect on physical function, or only minor cognitive or behavioral changes, such as personality shifts or mild difficulties in a few specific domains. Although these children are largely capable of managing daily tasks independently, they might still require occasional support or monitoring, especially for tasks that demand higher cognitive or physical endurance. Mild sequelae may manifest as slightly reduced stamina, subtle communication challenges, or minor emotional regulation issues, which could be managed with periodic support from caregivers, therapists, or educators.

Moderate Sequelae (Score 3): Eight children (8%) scored a 3, indicating moderate sequelae. This group experienced impairments that mildly affected their functionality and, while likely able to live independently, they would benefit from some support. Functional limitations in these children might include moderate challenges in domains such as speech, motor skills, or behavioral regulation, which could hinder full engagement in school, social activities, or other independent activities. Regular rehabilitation, educational adjustments, or behavioral support may be required to help them optimize their functional abilities and adapt to their environment.

Severe Sequelae (Score 2): Six children (6%) scored a 2, reflecting severe sequelae. Children in this category have significant impairments across multiple domains, which substantially limit their ability to function independently. These impairments may include severe speech deficits, motor dysfunction, poor behavioral regulation, or frequent seizures, making daily activities challenging without assistance. Such children are likely to be dependent on caregivers or specialized support for basic tasks like dressing, feeding, and mobility. They may require intensive interventions, including physical, occupational, and speech therapy, as well as ongoing medical management. Additionally, these children may benefit from assistive devices or adaptive technologies to enhance their quality of life and functional independence.

Death (Score 1): No children fall within this range, indicating that there are no children with LOS scores falling in this specific category.

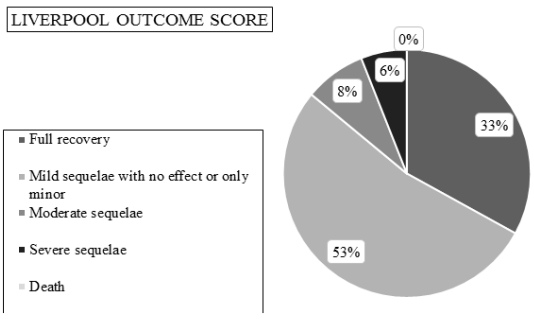

Figure 1 Pie chart showing the distribution of discharged children by their LOS range

DISCUSSION

The diverse distribution of children across levels of severity (LOS) underscores the broad spectrum of disabilities experienced by Japanese Encephalitis (JE) survivors, emphasizing the critical need for individualized care and support. Many children fall within the mid-high (55-61) and highest (69-75) LOS ranges, indicating moderate to near-normal functioning following JE treatment. However, a significant subset remains in the lowest (33-40) and low-mid (41-47) ranges, facing severe disabilities that challenge daily functioning. Solomon et al. (2014) similarly found that JE survivors often contend with a wide range of disabilities, such as cognitive impairments, motor deficits, and epilepsy, highlighting the complex nature of post-JE recovery.

The lack of children in the mid-range (48-54) further suggests that outcomes for JE survivors tend to cluster at two extremes—either improving to a moderate extent or remaining severe. This distribution underscores the importance of early intervention to optimize functional outcomes, a recommendation supported by Hills et al. (2018), who found that timely access to rehabilitation services can substantially improve long-term outcomes for children with acquired brain injuries, including those resulting from JE. Moreover, the World Health Organization (WHO) emphasizes a multidisciplinary approach to rehabilitation for children with neurological disabilities, advocating

for tailored support depending on the severity of impairments (World Health Organization, 2020).

Children in the mid-high range may benefit from ongoing therapeutic and educational assistance to enhance skills and independence, while those in the lowest ranges may require intensive interventions, such as assistive devices and specialized care. Tailored support is essential for addressing the unique needs of each severity level, ensuring that interventions match the child's specific challenges and capabilities.

Socioeconomic and cultural factors also influence JE outcomes, affecting access to rehabilitation services, quality of care, and the overall recovery process. Wang et al. (2019) point out that socioeconomic status, healthcare accessibility, and cultural beliefs shape healthcare experiences and outcomes. Addressing these disparities is crucial to providing equitable support and maximizing recovery prospects for all affected children, regardless of their socioeconomic background.

Furthermore, the high number of children in the highest LOS range reflects positive outcomes for many JE survivors, yet long-term monitoring and support remain necessary. Some survivors may face late-onset complications or require ongoing management for residual disabilities. Hills et al. (2020) emphasize the need for longitudinal studies to understand the long-term trajectory of JE recovery and identify supportive strategies for survivors as they age. Continued research and monitoring will enhance the ability of healthcare systems to provide targeted support and improve life quality for JE survivors.

In conclusion, the heterogeneous distribution of LOS among JE survivors highlights the need for early intervention, individualized support services, and long-term monitoring to improve outcomes and enhance quality of life. Drawing on insights from multiple studies informs a comprehensive approach to care that can better meet the complex needs of JE survivors worldwide.

CONCLUSION

The analysis of LOS scores in the dataset offers valuable insights into the outcomes of pediatric neurological conditions, spanning a continuum from full recovery to severe impairment. By categorizing children based on their LOS, we have delineated distinct outcome profiles, ranging from minor sequelae to profound deficits in neurological function.

These findings underscore the importance of early intervention, comprehensive rehabilitation, and ongoing support for children with neurological conditions. By tailoring treatment strategies to individual needs and addressing the multifaceted aspects of recovery, healthcare professionals can optimize outcomes and improve the quality of life for affected children and their families.

Moving forward, further research is warranted to elucidate the underlying mechanisms driving different neurological outcomes and to develop targeted interventions aimed at maximizing functional recovery and promoting neurodevelopmental resilience in pediatric populations. Through continued collaboration and interdisciplinary efforts, we can advance our understanding of pediatric neurological conditions and enhance the care and support provided to affected children, paving the way for brighter futures and improved outcomes.

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