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Grade 1 Leprosy: A Review On Peripheral Neuropathy, Disability And Physiotherapy Rehabilitation

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ABSTARCT:
At the national level, the evaluation and management of leprosy eradication program effectiveness primarily rely on the documentation of grade-2 disabilities. However, for effective prevention of disabilities, the assessment and management of grade-1 conditions hold greater significance. This is due to the fact that impairment of nerve function, whether sensory, motor, or both, generally manifests prior to the appearance of the visible deformities associated with grade-2 disabilities. Consequently, individuals diagnosed with grade-2 disabilities must have previously encountered grade-1 conditions. Therefore, when assessing any case of leprosy, it is crucial to conduct a comprehensive neurological examination of the peripheral nerves, and treatment strategies should be integrated from the stage of grade-1 disability itself. In order to attain comprehensive rehabilitation, the main emphasis must be placed on addressing the physical disabilities resulting from leprosy, whereas the secondary emphasis should be on tailoring lifestyle adjustments for the patients, their families, and their communities. The rehabilitation process for those affected by leprosy should commence at the time of diagnosis and persist until the patient is capable of leading a completely active and normal life.

KEYWORDS: Leprosy, peripheral neuropathy, disability.

INTRODUCTION:

Leprosy is a prevalent infectious disease that primarily affects the peripheral nervous system and can lead to significant disability if not treated promptly.
Therefore, early detection and rapid intervention for neural involvement are crucial. This chronic, systemic granulomatous disease predominantly impacts the peripheral nerves and skin. The initial neurological symptom frequently manifests as sensory loss or paraesthesia in one or more areas of the skin. These neurological symptoms arise from various mechanisms, including the activation of the intracutaneous neural network, larger nerves in cooler areas, or inflammation within larger nerves during leprosy reactions. The first indication of leprosy usually involves cutaneous nerves, leading to a loss of thermal sensation, which may later extend to other sensory modalities such as pain and touch.In the later stages of the disease, sensory modalities associated with larger fibers may also be affected. Motor symptoms may emerge in the advance stages [(1)].

In order to effectively prevent disabilities, it is crucial to prioritize the assessment of grade-1 conditions. This is due to the fact that impairments in nerve function, whether they are sensory, motor, or a combination of both, generally manifest prior to the emergence of the visible deformities linked to grade-2 disabilities. Consequently, individuals who are diagnosed with grade-2 disabilities must have previously undergone grade-1 conditions. Therefore, when assessing any case of leprosy, it is vital to conduct a comprehensive neurological examination of the peripheral nerves [(2)].

Update on WHO and National Eradication programme of Leprosy

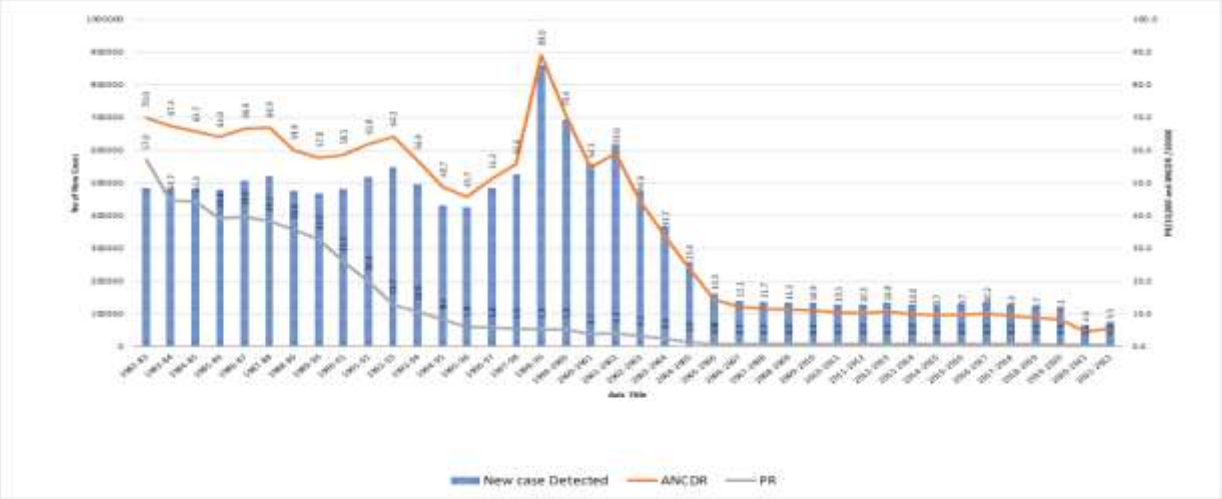
Data on leprosy are reported to WHO routinely by most countries, except those of the European Region, and published annually in the Weekly Epidemiological Record (WER) (8). While such data are useful in providing a broad picture of leprosy patterns and trends, their interpretation is made difficult by operational differences between different national programmes and the fact that the data cover different time period [17].

The implementation of the National Strategic Plan and Roadmap for Leprosy 2023- 2027 for leprosy aims to achieve interruption of transmission at district level evidenced by zero occurrence of new child cases for at least five consecutive years. After achieving interruption of transmission, districts shall move on to achieve elimination of leprosy as a disease with zero new cases reported for at least three consecutive years [14].

WHO 2030 Target, Sub-Targets and Milestones

INDICATOR	**2020**	**2023**	**2025**	**2030**
Number of countries with zero new autochthonous leprosy cases	50 (26%)	75 (39%)	95 (49%)	120 (62%)
Annual number of new leprosy cases detected	184,000	148,000	123,500	62,500
Rate (per million population) of new cases with grade 2 disability	1.3	0.92	0.68	0.12
Rate (per million children) of new pediatric cases with leprosy	7.81	5.66	4.24	0.77
Source: the NTD roadmap: WHO [14].				

Trends of New cases detected, ANCDR and PR [14].



National Strategic Plan and Roadmap for Leprosy 2023-2027 [14].

2023-2025 - Accelerated case finding, Quality Services to all patients.

2025-2026-Sustain gains & continue, surveillance, Sustain expertise Targetted active case detection.

2026-27- Sustain gains & continue, surveillance.

Leprosy and Physiotherapy

Physiotherapy is essential in the interdisciplinary management of leprosy, with physiotherapists making significant contributions to functional physical diagnosis, prevention, rehabilitation, and the alleviation of physical disabilities.

Various physiotherapeutic techniques, including advanced neurophysiological methods such as Rood's approach and musculoskeletal strategies like neural mobilization, are recognized for their efficacy in pain relief, minimizing disability, and enhancing the electromyographic function of affected nerves.

The rehabilitation process for leprosy patients involves evaluating nerve function impairments and applying physiotherapeutic strategies to tackle these issues. This is accomplished by focusing on restoring functionality through therapeutic exercises aimed at alleviating symptoms such as pain, swelling, and joint restrictions [3-4].

Rood's Approach is a neurophysiological method grounded in the reflexes of the central nervous system. Its fundamental principle posits that motor patterns evolve from primitive reflexes through suitable sensory stimuli directed at the pertinent sensory receptors, following a typical sequential developmental pattern to improve motor performance. This technique utilizes both facilitatory and inhibitory methods, emphasizing that motor output is contingent upon sensory input. Consequently, facilitatory techniques can be advantageous in addressing sensory deficits, while inhibitory techniques may help reduce hypersensitivity, ultimately resulting in improved motor performance. Rapid brief stimuli yield considerable synchronous motor output, whereas fast repetitive sensory input elicits sustained responses. Hand disabilities significantly impact daily living activities, rendering the assessment and enhancement of hand dexterity a primary focus in rehabilitation for these conditions. Considering the crucial role of physiotherapy in managing disabilities, leprosy has traditionally been treated with conventional rehabilitation methods; however, there is an urgent necessity for more advanced rehabilitation techniques. The strategies associated with Rood's Approach have demonstrated notable effectiveness in improving hand dexterity in individuals afflicted with leprosy [5].

A primary objective of physiotherapy following peripheral nerve injuries is to facilitate adequate movement between the nerve and its anatomical connections.

Various techniques, known as Neurodynamic Mobilization (NM), can be employed to apply specific tension to individual nerves, nerve trunks, and plexuses.

When symptoms manifest, these techniques may aid in restoring appropriate mechanical properties. Despite an increasing comprehension of how mechanical stress influences biological tissues and the application of these techniques in diagnosing and treating peripheral nervous system disorders, it is essential to acknowledge that the mechanical behavior of peripheral nerves is frequently altered due to injuries.

Gradual mechanical loading methods may assist in the regeneration of peripheral nerves through various mechanical and physiological mechanisms.

While excessive mechanical stress can be harmful, proper clinical oversight can mitigate such risks. This oversight may involve the application of neurodynamic tensioning techniques alongside imaging and electrophysiological assessments to determine the optimal timing and strategy for neurodynamic mobilization to effectively enhance nerve regeneration [6].

This article is about review of literature present on peripheral neuropathy and disability in leprosy grade 1 which can be manage by different physio therapeutic rehabilitation techniques. Review of articles on different conventional and advance physiotherapy techniques for rehabilitation of grade 1 leprosy. Two major physiotherapy techniques which can be beneficial to treat the leprosy disease are Rood’s approach and neural tissue mobilization techniuqe are disscussed in this article.

Peripheral neuropathy:

Leprosy is a common infectious disease that mainly impacts the peripheral nervous system and can result in considerable disability if not treated in a timely manner. The first neurological indication typically appears as sensory loss or paraesthesia. These neurological manifestations stem from various mechanisms, including the involvement of the intracutaneous neural network, larger nerves in cooler regions, or inflammation within larger nerves during leprosy reactions. The mechanisms that lead to nerve damage in leprosy can be outlined as follows, although the exact sequence of events is still unclear: M. leprae tends to flourish in the cooler areas of the body, primarily affecting the segments of trunk nerves that are situated near the skin. It seems that M. leprae accesses the endoneurial compartment of nerves via the blood supply and endothelial cells. Various molecules found on Schwann cells attach to M. leprae, aiding in its uptake. Once inside, M. leprae is capable of surviving and proliferating within Schwann cells. In response to M. leprae, Schwann cells generate several proteins that may contribute to demyelination. Infected nerves become the center of chronic inflammation and immune activity, which can last for many years [1,7].

Mycobacterium leprae infects nerves via an outside-in mechanism. Initially, the bacteria accumulate in the epineural blood vessels and lymphatics. From this position, they adhere to Schwann cells, enabling them to penetrate these cells and subsequently access the nerve. The internal environment of the Schwann cell is conducive to the proliferation and survival of these bacilli. Infected Schwann cells become susceptible to the host's immune response and are eliminated by activated T cells. Concurrent inflammatory and immunological factors affect the nerve impacted by leprosy. Pathologically, segmental demyelination is predominant in lepromatous lesions, whereas Wallerian degeneration is more pronounced in tuberculoid lesions. A common feature of leprosy pathogenesis is inflammation, which begins in the blood vessels supplying the nerve, extends beyond the nerve, encircles it, and ultimately infiltrates it. This 'outside-in' infection pathway of nerves by Mycobacterium leprae was established through electron micrographic studies conducted on nerves in the armadillo model. The inflammation is influenced by both the bacilli and the immune factors of the host[8].

Leprosy and disability:

Despite a significant reduction in the global prevalence of leprosy since the World Health Organization (WHO) launched the free multidrug therapy initiative in 1995, it remains a considerable cause of morbidity due to the long-term disabilities and complications affecting around 2 million people globally. The WHO's goal is to decrease the incidence of leprosy-related disabilities to below 1 per million individuals by improving strategies aimed at preventing and mitigating deformities. These strategies include the early detection and prioritization of leprosy patients who display traits associated with physical disabilities, with the main aim of control programs and rehabilitation centers being to avert and address physical impairments to improve the quality of life [9].

Disability classification

Grade	**Symptoms**
Garde 0	Absence of anaesthesia along with no observable deformity or damage
Garde 1	Presence of anaesthesia without any visible deformity or damage
Grade 2	Existence of visible deformity or damage

WHO grades for leprosy disability [17].

The World Health Organization (WHO) has advocated for a 'disability classification' system for leprosy since 1960, which comprises the following categories for assessing hands and feet: Grade 0 signifies the absence of anaesthesia along with no observable deformity or damage; Grade 1 denotes the existence of anaesthesia without any visible deformity or damage; and Grade 2 reflects the presence of visible deformity or damage. Each hand and foot must be assessed and graded separately, with 'damage'

including ulcerations, shortening, disorganization, stiffness, and the loss of part or all of the hand or foot [10,11].

There exists a correlation between the occurrence of physical disabilities and factors such as sex, MB leprosy, leprosy reactions, and a lepromatous presentation. These insights can inform the creation of targeted strategies aimed at identifying individuals at an early risk of physical disabilities and can support educational campaigns that encourage prompt consultation for the initiation of treatment for leprosy reactions and the prevention of further physical disabilities. Continuous long-term follow-up is essential to track the factors linked to the development of disabilities, alongside the provision of interventions that promote self-care, disability prevention, and access to rehabilitation services [9].

Disparities in social determinants of health are linked to increased disability scores, suggesting that inadequate living conditions are prevalent among individuals affected by leprosy-related disabilities. Thus, social determinants of health are crucial not only in relation to the risk of transmission and infection, or the likelihood of effective treatment, but also in their association with the disability status of those impacted. Our findings indicate that factors such as age and limited living space are significant predictors of greater disabilities resulting from leprosy [12].

At the national level, the evaluation of program effectiveness relies solely on the records of grade-2 disabilities. However, for the prevention of disabilities, the assessment of grade-1 is of greater significance. This is due to the fact that nerve function impairment, whether sensory, motor, or both, occurs prior to the manifestation of visible deformities classified as grade-2. Consequently, patients diagnosed with grade-2 disabilities must have
previously experienced grade-1 conditions. Therefore, when assessing any leprosy case, it is crucial to conduct a comprehensive neurological examination of the peripheral nerves following the evaluation of skin lesions. This includes the assessment of sensory nerve function impairment, motor nerve function impairment, and palpation of the nerves to check for thickening, tenderness, and reactions indicative of grade-1 disabilities. Such thorough examinations will contribute to achieving the objectives outlined in the World Health Organization's Global Leprosy Strategy, aimed at reducing the prevalence of grade-2 disabilities [13].

Physical rehabilitation:

The approach to preventing disabilities associated with leprosy consists of three key components: early detection and appropriate treatment (MDT), prevention of leprosy-related disabilities (POD), and rehabilitation. Despite treatment, disabilities continue to arise among patients at an alarming rate, making the establishment of effective POD services a pressing priority. POD is defined as a comprehensive concept that includes all activities at the individual, community, and program levels aimed at preventing impairments, activity limitations, and participation restrictions. It encompasses the identification and management of reactions and nerve damage, training patients in self-care, counselling and ulcer care, provision of footwear and other assistive devices, and reconstructive surgery. In addition to these essential elements of the leprosy control strategy, the rehabilitation of individuals with leprosy-related disabilities is crucial. 'Disability' serves as an overarching term for impairments, activity limitations, and participation restrictions resulting from the interplay between an individual with a health condition and their contextual factors, including environmental influences. In leprosy, impairments primarily involve the loss of function in the eyes, hands, and/or feet, which in severe cases can result in blindness, chronic ulcers, and permanent deformities of the hands and feet. Individuals affected in this manner often face stigma and may be ostracized by their communities and even their families [14].

The aim of rehabilitation is to provide individuals with equal opportunities to participate in both domestic and societal roles, thereby enhancing their overall quality of life. According to the United Nations, rehabilitation encompasses all actions aimed at mitigating the effects of disability for a person, allowing them to attain independence, social inclusion, improved quality of life, and self-fulfilment [14].

In recent years, there has been an increasing focus on the physical rehabilitation of individuals affected by leprosy. However, for these individuals, the limitations in daily activities and restrictions on social participation are often more significant than the impairments themselves. To ensure that a person can live with dignity and respect, a holistic approach to rehabilitation is essential. Effective prevention of disability (POD) and rehabilitation initiatives enhance the credibility of services, which encourages early self-reporting of new cases and improves treatment adherence, thereby aiding in the reduction of

leprosy as a public health issue. Timely and appropriate rehabilitation can prevent individuals with leprosy-related disabilities from becoming homeless and help combat the negative perception of leprosy as a debilitating disease that leads to poverty. The National Leprosy Eradication Program (NLEP) adheres to the principle of incorporating the rehabilitation of individuals affected by leprosy and associated disabilities into broader rehabilitation initiatives. This does not imply that they will receive preferential treatment or superior quality services compared to individuals with other disabilities in the same regions. As the responsibility for leprosy control activities has transitioned to various health workers within general health services, it is essential that the rehabilitation of individuals with leprosy-related disabilities is similarly integrated into general rehabilitation services. Such an integrated approach will contribute to reducing stigma and improving the sustainability of rehabilitation services [(14)].

The primary objective of physical rehabilitation is to restore an individual to optimal physical health. Nevertheless, rehabilitation encompasses more than just the physical aspect; it addresses the individual as a whole. To achieve comprehensive rehabilitation, the foremost aim should be to reverse the physical disabilities resulting from leprosy, while the secondary aim should involve tailoring lifestyle adjustments for the patients, their families, and their communities. The rehabilitation process for individuals affected by leprosy should commence at the time of diagnosis and persist until the patient can resume a fully active and normal life. The physical rehabilitation of those affected by leprosy can be categorized into three main areas: 1. Assessing nerve function impairment (NFI), 2. Tracking impairments, and 3. Preventing further decline in impairments [(15)].

The process of rehabilitating an individual affected by leprosy begins with diagnosis and extends until the patient is able to resume a normal life. A comprehensive rehabilitation program encompasses the evaluation of nerve function impairment and the implementation of strategies to enhance recovery through physical therapy, assistive devices, surgical interventions, and vocational training. Given that neuropathies can result in long-term complications, it is crucial to conduct regular monitoring of nerve function using monofilament testing and muscle power assessments. Physical therapy involves both passive and active exercises for the affected muscles, as well as electrical stimulation. In addition to the deformities and loss of sensation caused by nerve dysfunction, secondary complications such as contractures, ulcers, and shortening of digits require focused attention. The use of various assistive devices and custom-designed splints can greatly enhance the ability to perform daily tasks. Furthermore, community-based interventions play a vital role in the overall rehabilitation process, enabling individuals to engage effectively within their communities [(16)].

Neurosciences Physiotherapy treatment encompasses both conventional therapies and neurophysiological methods. Traditional therapies, which include Therapeutic Exercises and conventional Functional Retraining, consist of Range of Motion (ROM) Exercises such as passive, active assisted, active, and active resisted exercises, Muscle Strengthening Exercises aimed at reducing flaccidity, stretching techniques to alleviate spasticity, Mobilization techniques, Fitness training, and Compensatory Techniques. The neurophysiological methods include: 1. Muscle Re-education Approach. 2. Neurodevelopmental Approaches: – Sensorimotor Approach (Rood, 1940s), Movement Therapy Approach (Brunnstrom, 1950s), NDT Approach (Bobath, 1960-70s), PNF Approach (Knot and Voss, 1960-70s). 3. Motor Relearning Program for Stroke (1980s). 4. Contemporary Task Oriented Approach (1990s). The study concludes that neurophysiological methods are more effective in enhancing the patient's condition compared to conventional therapies [(17)].

The role of physiotherapy in the interdisciplinary management of leprosy is critical, with physiotherapists playing a key part in functional physical diagnosis, prevention, rehabilitation, and the mitigation of physical disabilities. Among various physiotherapeutic approaches, neural mobilization techniques are recognized for their efficacy in pain management, decreasing disability levels, and enhancing the electromyography function of affected nerves. The rehabilitation process for individuals with leprosy involves evaluating nerve function impairment and applying physiotherapeutic interventions to ameliorate these issues. This is accomplished by focusing on restoring functionality through therapeutic exercises aimed at alleviating symptoms such as pain, swelling, and joint restrictions. In leprosy patients, physiotherapy utilizing proprioceptive neuromuscular facilitation has been shown to significantly enhance the range of motion (ROM) in wrist extension, dorsiflexion, and plantarflexion, thereby preventing and alleviating the symptoms and consequences of leprosy. The findings indicate that neural mobilization during physiotherapy is vital for alleviating neural pain and

enhancing muscle strength in leprosy patients. In this investigation, both the conventional physiotherapeutic protocol and the protocol that integrates photo-bio-modulation (PPBM) demonstrated notable improvements when compared to their respective control groups. Nevertheless, the PPBM group exhibited superior outcomes in terms of effect size related to the functionality of the median, radial, and fibular nerves in comparison to the physiotherapeutic group [18].

It was previously thought that leprosy solely impacts the peripheral nerves without involving the brain; however, recent research has demonstrated that brain plasticity can also occur following amputation, nerve damage, or injury. A study conducted by a multidisciplinary team at the Federal University of Rio de Janeiro found that damage to the peripheral nerves from leprosy can result in alterations in the brain. This research utilized trans-cranial magnetic stimulation (TMS) to establish a link between the brain and the hand grip muscles in adult leprosy patients exhibiting claw hand deformity. The findings indicated that the brain's representation of a specific muscle may change, suggesting that the effects of leprosy extend beyond peripheral nerve damage and provide evidence for brain plasticity. Various factors can contribute to the development of peripheral neuropathies, and while current treatment strategies focus on addressing the underlying causes, improving nerve fiber repair remains a significant challenge. This highlights the potential for applying the principles of neuroplasticity in clinical therapies. Additionally, brain-derived neurotrophic factor has been identified as a crucial mediator in motor learning, with its secretion through activity-dependent pathways playing a vital role in fostering neural plasticity in response to experiences [19].

The research aimed to investigate the combined effects of mirror therapy and sensory re-education on patients with leprosy. The control group received only sensory re-education, while the experimental group underwent both sensory re-education and mirror therapy. Mirror neurons constitute approximately 20% of all neurons in the human brain and play a crucial role in laterality reconstruction, which is the ability to distinguish between the left and right sides. Utilizing the Mirror box activates these mirror neurons, facilitating the recovery of the affected areas. Cortical reorganization following nerve injury leads to a loss of functional sensitivity. In a healthy hand, a stimulus generates a specific pattern of neural impulses that travel to the sensory cortex. These impulses are linked to past memories or experiences, resulting in conscious perception. However, after a nerve injury, the same stimulus produces a diminished or altered pattern of neural impulses. When these impulses reach the somatosensory cortex, they may not correspond or may only partially correspond with the association cortex. Consequently, the sensation may be diminished, perceived as unfamiliar, or even go unnoticed. Cortical connections and maps can be modified through experience. Research indicates that activity, behaviour, and skill acquisition can affect cortical patterns. This brain plasticity allows for adaptation to changes induced by peripheral nerve influences, which can be harnessed for rehabilitating hand function in patients with peripheral nerve injuries. This rehabilitation approach is known as sensory re-education. Sensory re-education focuses on enhancing cortical receptive fields for improved sensory resolution, promoting the reversal and normalization of the distorted hand map, and enhancing processing within the sensory network at a higher cortical level, thereby aiding in the interpretation of the altered hand map. This system is believed to utilize movement observation to activate the motor processes associated with that movement. There are parallels with motor imagery, where individuals mentally visualize movements instead of merely observing them in a mirror. It is suggested that the brain naturally prioritizes visual feedback above other sensory inputs [20].

CONCLUSION:

Leprosy is a significant public health issue globally.It is essential for all healthcare professionals to possess fundamental knowledge about this disease to effectively diagnose it, provide timely treatment to patients, and prevent disabilities.The advancement of enhanced diagnostic and therapeutic strategies for leprosy continues to pose a considerable challenge. This review offers insights into the epidemiology, clinical diagnosis, and physiotherapy methods for managing leprosy, facilitating the potential for its global eradication. Further research is needed to explore how advanced physiotherapy techniques, such as Rood's approach and neural tissue mobilization, contribute to rehabilitation and the early management of disabilities.

References

1. Joy Vijayan, Einar P.W- Smith. The international textbook of leprosy. Chapter2.5. Neurological Manifestation of leprosy.1-20.
2. Jhuma Sarkar, Aparajita Dasgupta, Debashis Dutt. Disability among new leprosy patients, an issue of concern: An institution based study in an endemic district for leprosy in the state of West Bengal, India. Indian Journal of Dermatology, Venereology, and Leprology. 2012; 78(3):328-334.
3. Vandana Yadav, Charu Gera, Ravinder Yadav. Evolution in Hemiplegic Management: A Review. International Journal of Health Sciences and Research.2018; 8(5): 360-369.
4. Dinorá S Santi Bonazza, Vanessa Matias Souza Duarte, Thiago da Rosa Lima, Ciro Martins Gomes, Treatment of neuropathic pain in leprosy patients with a physiotherapeutic protocol combined with photobiomodulation. Universidade Federal de Mato Grosso.2024;10(18):1-16.
5. Dr. Maithili Samrat Patil. Effect of Roods Approach on Dexterity of Hand for Grade 1 Disability in Leprosy. International Journal for Multidisciplinary Research (IJFMR).2023; 5(5):1-12
6. Herman Henrique Silva Santana, Iasmyn Adélia Victor Fernandes de Oliveira, Êmyle Martins Lima, Alena Ribeiro Alves Peixoto Medrado, Katia Nunes, Ana Maria Blanco Martinez, Abrahão Fontes Baptista.Neurodynamic Mobilization and Peripheral Nerve Regeneration: A Narrative Review. International Journal of Neuro rehabilitation.2015; 2(2):163-168.
7. Gigi J.E, Michael P, David M.S. The international textbook of leprosy. Chapter 9.2. Mechanisms of nerve injury in leprosy.1-19.
8. Satish V. Khadilkar, Sarika B. Patil, Vanaja P. Shetty. Neuropathies of leprosy. Journal of the Neurological Sciences.2021: 240:1-10.
9. Hidyanara L. de Paula, RN; Carlos D. F. de Souza; Sara R. Silva, RN; Paulo R. S. Martins Filho; Josafá G. Barreto; Ricardo Q. Gurgel,; Luis E. Cuevas, MTrop Med; Victor S. Santos, Risk Factors for Physical Disability in Patients With Leprosy A Systematic Review and Meta-analysis JAMA Dermatol. 2019; 155(10):1120-1128.
10. WHO Expert committee on leprosy. Sixth Report 1988. (World Health Organization Technical Report Series768)
11. WHO Expert committee on leprosy. Eighth Report 2012. (WHO technical report series; no.968)
12. Martin Heidinger, Markus Puchinger, Johann Pfeifer, Andrea J Grisold. Analysis of Social Determinants of Health and Disability Scores in Leprosy Affected Persons in Salem, Tamil Nadu, India. International Journal of Environmental Research and Public Health (IJERPH). 2018; 12(6):1-13.
13. Jhuma Sarkar, Aparajita Dasgupta, Debashis Dutt. Disability among new leprosy patients, an issue of concern: An institution based study in an endemic district for leprosy in the state of West Bengal, India. Indian Journal of Dermatology, Venereology, and Leprology. 2012; 78(3):328-334.
14. National Leprosy Eradication Program. Disability Prevention and Rehabilitation. https://r.search.yahoo.com/_ylt=AwrPpSk6jiFoqKQPgALnHgx.;_ylu=Y29sbwMEcG9zAzEEdnRpZAMEc2VjA3Ny/RV=2/RE=1747058363/RO=10/RU=https%3a%2f%2fwww.iapsmgc.org%2fuserfiles%2f1GUIDELINES_ON_DISABILITY_PREVENTION_AND_REHABILITATION_LEPROSY.pdf/RK=2/RS=SOcIx35aul_dMLAOE2YCvsAcBMU- Searched on 12 May 2025.
15. M Sathish Kumar P, David P Kumar, Karthikeyan G. The International textbook of leprosy. Chapter 4.3. Physical rehabilitation in leprosy.1-43.
16. Satish V. Khadilkar, Sarika B. Patil, Vanaja P. Shetty. Neuropathies of leprosy. Journal of the Neurological Sciences.2021: 240:1-10.
17. WHO Expert committee on leprosy. Eighth Report 2012. (WHO technical report series; no.968).
18. Vandana Yadav, Charu Gera, Ravinder Yadav. Evolution in Hemiplegic Management: A Review. International Journal of Health Sciences and Research.2018; 8(5): 360-369.
19. Dinorá S Santi Bonazza, Vanessa Matias Souza Duarte, Thiago da Rosa Lima, Ciro Martins Gomes, Treatment of neuropathic pain in leprosy patients with a physiotherapeutic protocol combined with photobiomodulation. Universidade Federal de Mato Grosso.2024;10(18):1-16.
20. Anshika Singh1, Sumit Raghav, Suresh Mani. Role of TMS in Improving the Nerve Functions in Radial, Median, and Ulnar Neuritis among Patients with Leprosy: Study Protocol for a Randomized Controlled Trial. Asian Pacific Journal of Health Sciences.2022; 9(2):151-154.

21. Dr. Tushar Dhawale, Dr. Ujwal Yeole , Arjun Mhadgut , Dr. Rasika Panse. Effect of Mirror Therapy on Hand Functions in Leprosy Patients. International Journal of Research & Review (www.ijrrjournal.com).2018:5(12) : 13-17