



Non-Pharmacological Interventions Role in Neurological disorders Management – A Comprehensive review

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Abstract:

Some of the most common neurological disorders are epilepsy, Alzheimer and other dementias, strokes, migraine and other headaches, multiple sclerosis, Parkinsons disease, neurological infections, brain tumors, traumatic conditions of the nervous system such as head injuries and disorders caused by malnutrition. Those may include, but are not limited to, mental health assessment, therapy, skills building, parenting assistance or family therapy. Medication should be only one part of a comprehensive treatment plan. Therapies for neurological disorders may often consist of; lifestyle changes to either prevent or minimize the impact of such conditions.

Physiotherapy to manage the symptoms and restore some function. Pain management, as many impairments can be associated with considerable discomfort. Nonpharmacological treatment of epilepsy includes surgery,

vagal nerve stimulation, ketogenic diet and other alternative/complementary therapies, Eg; yoga, Ayurveda, electroencephalography (EEG) biofeedback technique, aerobic exercise, music therapy, transcranial magnetic stimulation, acupuncture and herbal etc., The goal of physical therapy for neurological disorders is to restore as much function as possible, in order to help and regain independence and move freely. Non-pharmacological intervention (NPI) is any type of healthcare intervention which is not primarily based on medication. Some examples include exercise, sleep improvement and dietary habits.

Keywords: Non-pharmacological intervention (NPI), Neurological disorders, Physiotherapy, Therapeutic exercise, Virtual Reality, Electrotherapy, Ketogenic diet, Non-Invasive Brain Stimulation.

Introduction: Non-pharmacological interventions (NPI) are any non-chemical intervention (theoretically supported) performed on and benefitting the patient. NPI have been employed as medical interventions (predating modern pharmacology) and are intended to improve quality of life, slow down deterioration or relieve pain. NPI also reduce health costs reduced and have minimal environmental impact. Following a healthy lifestyle is possibly the best NPI, contributing to improved health and quality of life.¹

Physiotherapy: A Non-Pharmacological Intervention - A wide range of NPI modalities are used by physiotherapists, including manual therapies, electrophysical agents, thermotherapy, hydrotherapy, therapeutic exercise, meditation and acupuncture. The physiotherapists goal is to reduce pain and restore or maintain optimal physical functioning via these NPI.

Some of the NPIs used:

Patient education - The importance of increasing a patients understanding of their condition and treatment plan is not only of benefit for improving a patients adherence to treatment, but can also improve health outcomes.² Self-management of chronic conditions as well as preventative health intents rely heavily on provision of contemporary information and communication practice.³ Primary focus for long term conditions commonly involves promotion of informed lifestyle choices, risk-factor modification and active patient self-management.³ Education can be provided through a variety of health care professionals, preferably done by providers who have undertaken adequate training for education and patient communication. Recognized physiotherapy programmes typically include a component of patient education within their training.⁴

Physical Activity - Physical activity prescription (a NPI) is an under-utilised tool for improving community health. In the right dose, physical activity can help to prevent, treat and manage a range of chronic health conditions that increasingly impact the quality of life and physical function of individuals on a global scale.⁵

Electrotherapy modalities - Electrophysical agents is a term describing electrical devices applied by trained professionals to an injury site in effort to enhance, expedite or improve the treatment plan and recovery process. There are a wide range of electrotherapy modalities used in physical therapy. Conventionally, they are used for pain management, reducing swelling, increasing local blood flow and breaking down scar tissue and can be applied across various stages of injury recovery.⁶ Common electrotherapy modalities used in pain management include transcutaneous Electrical Nerve Stimulation (TENS), Interferential Current (IFC), ultrasound and laser therapy.

Thermotherapy - involves use of heat or cold.

1. Heat can give relief in subacute and chronic inflammatory and traumatic disorders, Heat increases blood flow, helping reduce inflammation, oedema and exudates from connective tissue injuries.
2. Cold helps relieve muscle spasms, myofascial or traumatic pain and acute inflammation.

Thermal modalities can also be used as adjuncts to exercise therapy and/or electrophysical modalities, for a variety of therapeutic purposes.⁷

Manual Therapy – It has a long history within the profession of physical therapy. There are a wide variety of techniques that can be grouped into 4 - major categories: manipulation, mobilization, static stretching and muscle energy techniques.⁸ Contemporary research reveals intricate neurophysiologic mechanisms are also at play and the beneficial psychological effects of providing hands-on examination and intervention have been substantiated.⁹

Therapeutic exercise – These techniques include passive movements, active assisted movements, active movements, resisted movements and assisted resisted movements with aims to correct impairment, improve musculoskeletal function or maintain well-being.¹⁰

Meditation –

Benefits include: Removes the accumulated stress and help increase the positive energy; decreases anxiety, depression and pain (both physical and psychological); increases regional cerebral blood flow in the frontal and anterior cingulate region of the brain; decreases sympathetic overstimulation reduces cholesterol and risk of heart disease and helps in reducing smoking; has been shown to be beneficial in epilepsy, premenstrual symptoms, menopausal symptoms, autoimmune illness and emotional disturbance in neoplastic disease; improves telomerase activity in the body which slows down the aging process and related diseases.¹¹

Mindfulness - It is a stress-reducing strategy where an individual develops an awareness that arises through paying attention, on purpose, in the present moment, non-judgmentally and accepting them as they are.

Virtual Reality - During physical therapy, virtual reality (VR) can shorten recovery times by Eg;

- Making it easier for patients with pain to do their exercises. VR changes the focus from pain to an absorbing alternative reality that entrances, motivates and encourages them to complete perform the task.
- Helping patients who are recovering from a stroke to be able to practice specific movements without the risk of further injuring themselves by a fall. This boosts confidence when it they are then ready to move in real-life setting.¹²

Findings from a scoping review¹³ suggests virtual reality intervention is beneficial for exercise therapy and it can be used for various rehabilitation purposes, such as pain management, improving functional ability, increasing range of motion, promoting muscular strength, increasing motivation and enhancing quality of life. Many studies state to have use Nintendo Wii for developing VR systems in exercise therapy; more research is needed to confirm and improve the effectiveness of the treatments.

Other NPIs -

- Alternative Therapies for Pain Conditions
- Yoga
- Cognitive Behavioural Therapy

- Tai Chi
- Acupuncture
- Massage Therapy

1. Non-pharmacological interventions (NPI) of Epilepsy:^{14, 15} The non-pharmacological management of epilepsy encompasses surgical procedures, vagal nerve stimulation and ketogenic diets. Alternative therapies encompass a variety of techniques, including aromatherapy, yoga.

Ketogenic diet or KD - is a low-carb, high-fat eating plan that causes ketones. When the body is in a state known as ketosis, it starts using ketone bodies, which are produced when the liver breaks down fatty acids, instead of carbohydrates as its main energy source. The ratio of fat to carbohydrate plus protein in the traditional KD is 3.4:1. To further enhance efficacy and maintain the proper ratio, long - or medium - chain triglycerides (MCT or LCT) can be added to classical KD. 36 – 85% of epilepsy patients report a reduction in seizures of more than 50% when following the diets, suggesting that they are quitting. Certain epileptic disorders are particularly sensitive to KD, including impairment of glucose transporter 1 (GLUT1).

Vagal nerve neurostimulation - One non-drug therapeutic option for epilepsy is vagal nerve neurostimulation (VNS). The left vagal nerve is chronically electrically stimulated via an implanted stimulator, which is the basis for this technique. Patients with Drug-Refractory Epilepsy (DRE), who are not candidates for resection surgery, are the main recipients of this methods application. The primary disqualifiers for this technique include vasovagal syncope, type - I diabetes, bronchial asthma, cardiac arrhythmia, acute peptic and duodenal ulcers, pregnancy and breastfeeding and chronic obstructive pulmonary disease. 4.8 – 17.5 % of patients showed a total cessation of seizures against the backdrop of VNS therapy over the course of three months to three years. In 27.3 – 47% of cases, there was a 50% or greater reduction in the number of seizures.

Yoga - an ancient Indian concept and practice, is becoming more and more important in epilepsy therapy and research. Yoga offers a very modern, but old, method of treating seizures. Ayurveda refers to epilepsy which means bodily loss of awareness. 9 - conditions that cause convulsions in children and 4 - forms of epilepsy are described in the ancient Indian books known as the Vedas. Yogas physical approach to treating epilepsy is to restore harmony (union) between the parts of a persons body that trigger seizures. Restoring this balance is the aim of one of the oldest known formal practices, yoga.

Aromatherapy - As part of a behavioural treatment plan for epilepsy, aromatherapy can be helpful in inducing a relaxed mood. But the treatment of conditions like depression and anxiety that accompany epilepsy makes more sense for its use. sage and rosemary should not be used while applying aromatherapy to epileptic patients, as these herbs are known to worsen the disease and increase the frequency of epileptic seizures.

2. Non-pharmacological interventions (NPI) of Stroke:^{16, 17}

Non-Invasive Brain Stimulation - For patients with major depressive disorder, non-invasive brain stimulation is a well-researched non-pharmacologic therapeutic option. Its usefulness in Post-stroke depression (PSD), however, still needs more research. One method that has been investigated in this area is transcranial direct current stimulation (tDCS).

Quit tobacco - Among the top 5 - priority interventions for non-communicable diseases (NCDs), a group of experts identified tobacco control as the highest priority. A micro-simulation model based on data from India

suggests that if the effects of both programs are cumulative, smoke-free laws and tobacco taxes together could prevent 25 % of myocardial infarctions and strokes. Mass media efforts, an advertising prohibition and healthcare providers quick advice to quit were probably less successful than these. The theory was that the least successful population-level tactic would be counselling on cessation.

Psychosocial Interventions - Psychosocial therapies have been shown to be a crucial part of PSD management. Stroke rehabilitation should incorporate strategies such as motivational interviewing, transitional care, social support and psychoeducation because patients and their caregivers experience a significant decline in social involvement and functioning following a stroke. An important framework for recovery has been proposed, which calls for an individual patient-level examination of their requirements, an assessment of any potential obstacles and assistance for the networks and skills necessary to make this happen. The ultimate goal of these tactics needs to be self-efficacy, since research has demonstrated that this trait is adversely related to PSD.

Diet - The use of low-sodium high-potassium salt substitutes, a safe product commercially available for many years, remains a useful strategy to circumvent the need to change dietary habits.

3. Non-pharmacological interventions (NPI) of Cerebral palsy:¹⁸

Acupuncture - the Anat Baniel Method (ABM), aquatic therapy and the Adeli Suit are various treatments used to treat cerebral palsy. ABM is based on the work of Moshe Feldenkrais and her "Nine Essentials" that prepare the brain for making changes. Aquatic therapy involves treatments and exercises performed in the pool, while the Adeli suit is a modified piece of equipment from the Soviet Space Program. Chinese scalp acupuncture uses very short, fine needles to achieve desired therapeutic effects.

Conductive education - is an educational model that uses meaningful play or actions to encourage learning lifelong skills. Craniosacral Therapy targets specific areas of the head to improve health and immunity. Dance therapy promotes emotional, social, cognitive and physical integration for health and well-being. Feldenkrais and Functional Integration (FI) is a form of movement education that relies on gentle movement and directed attention. Functional Electrical Stimulation (FES) applies small electrical charges to weakened muscles, stimulating them to move.

Hippotherapy - is a type of therapy that takes place on a horse and provides motor and sensory input. Hyperbaric Oxygen Therapy (HBOT) is a popular alternative therapy used by families with children with cerebral palsy, but has been studied repeatedly without proof of its benefit for improving motor function. Massage therapy manipulates soft tissues to reduce stiffness and pain. Masgutova Neurosensorimotor Reflex Integration (MNRI) works with reflexes and sensory integration systems to help those with cerebral palsy.

Stem cell therapy - is based on the idea that stem cells act as building blocks for many different types of cells and tissues in our bodies. Researchers are looking at the potential ability of stem cells to regenerate/create new cells, help with repair and recovery after an injury, support and rebuild blood vessels and reduce inflammation. Yoga is built on exercise, breathing and meditation, preparing the body and mind for meditation and healing from everyday stress.

4. Non-pharmacological interventions (NPI) of Multiple Sclerosis (MS)¹⁹ - Poor quality sleep can appear before cognitive symptoms in the early or preclinical phase of MS and sleep disturbances are associated with more severe cognitive decline and higher risk of mild cognitive impairment. Aerobic training (AT) is an important factor preventing deconditioning, osteoporosis, cardiovascular problems, obesity and other MS-specific symptoms in MS patients. Studies show that AT may improve cognitive functioning, reduce age-related atrophy and increase hippocampal volume due to increased levels of brain-derived neurotrophic factor. **Neuropsychological rehabilitation** aims to reduce cognitive impairment and increase patients awareness of cognition deficits in everyday activities. Cognitive training can increase memory span and working memory and combined with other neuropsychological methods, it can improve attention, immediate verbal memory and delayed memory. Whole body cry stimulation (WBC) is a new therapy used mainly as biological regeneration in sport medicine, aiming to reduce inflammation and pain in various disorders.

Brain stimulation techniques - such as Transcranial Direct Current Stimulation (tDCS) and Transcranial Magnetic Stimulation (TMS), have been used in psychiatry or neurology to enhance memory and learning processes. TMS and tDCS stimulation methods of the anterior temporal lobe help enhance speed of recall and performance of working memory tasks, learning and recall of words during stimulation of the left dorso-lateral prefrontal cortex (DLPFC). However, headaches, local pain, confusion and seizure are common side effects after or during these techniques.

Computer-based repetitive stimulation is a new therapy that allows for training many cognitive tasks, improving memory, attention, executive function and processing speed. These programs can be administered both in the young and elderly to prevent dementia and age-related cognitive impairment.

5. Non-pharmacological interventions (NPI) of Parkinsons Disease:²⁰

Speech Therapy - regimen will vary depending on the stage of Parkinsons disease. Patients learn techniques and exercises to help with breathing, facial expressions, speech tempo, volume and clear word pronunciation in the early stages of the disease. Therapists can offer advice on eating and drinking issues as well as how to communicate in a loud environment. Therapists can provide guidance on ways to survive as the illness worsens and communication becomes limited. Using voice amplifiers or computers as assistive technology, maintaining eye contact when conversing or scheduling activities for when patients feel most well are a few examples.

Occupational therapy - seeks to assist in preserving freedom in day-to-day living for as long as feasible, enabling you to take care of yourself. To better meet your demands, you might need to modify your house and place of employment. A therapist can help you come up with strategies for managing your symptoms more effectively. You can enhance both your gross and fine motor skills with occupational therapy activities. Practices include getting dressed, cooking and using special aids (such as walkers or specialized knives and forks). Occupational therapy may also involve arts and crafts, such as painting or creating objects. The therapist and you decide on the goals and appropriate exercises.

Physiotherapy - is a component of the multidisciplinary strategy used to treat the symptoms of Parkinson's disease.

Two types of physical therapy are beneficial to patients: strengthening exercises that help patients develop and maintain their muscular mass and conditioning that helps patients reduce mobility issues and targets

specific issues like balance issues, tremors and hand and leg stiffness. A physiotherapist with knowledge of Parkinsons disease will assess the patients symptoms and create an exercise regimen based on their capabilities at the current stage of the condition. Parkinsons disease development and symptom severity can be slowed down by beginning physical therapy early.

Sports and exercise - As Parkinsons disease worsens, people walk more slowly. In addition to occasionally being completely unable to walk, kids may also struggle with balance and coordination. Peoples muscles progressively deteriorate as a result of reduced movement. Sports and exercise can aid in slowing down that process. Stretching, weight training, balance training, muscular activation and relaxation, dance, music therapy, tai chi, qigong, walking and running are a few examples. Exercise can help to increase one's capacity to move and walk more quickly, according to studies. It also enhances balance and coordination. This lowers the chance of falling.

Psychological support - Psychologically, Parkinsons disease can be extremely difficult to manage, especially in its latter stages. Some people experience severe depression as it worsens and may even require medical attention. However, dealing with the diagnosis and the awareness that the symptoms will worsen significantly over time can be challenging, particularly in the early stages. Thats why getting psychological assistance can be a smart move. In addition, friends, family and numerous support organizations offer a variety of psychological support choices and can serve as valuable resources.

6. Non-pharmacological interventions (NPI) of Trigeminal Neurology (TN):²¹

Microvascular decompression (MVD) - is the most invasive surgical procedure for patients with classic TN, offering the highest success rate of pain-free status. It is typically reserved for healthy patients who have no other major medical problems or those who may have failed less invasive procedures like radiosurgery and rhizotomy. A systemic review by AAN/EFNS identified 5 -studies on MVD for TN, revealing that 90% of patients experience initial pain relief, with over 80 % still pain-free after 1 - year, 75 % after 3 - years and 73 % after 5 - years.

Percutaneous rhizotomies on the Gasserian ganglion are less invasive and have relative advantages and disadvantages. They are used more in patients with high operative risks, such as elderly or ill patients or as a partially diagnostic procedure in atypical disease. All these procedures are associated with a significant risk of recurrence.

Gamma knife radiosurgery (GKRS) - has recently been established as an effective treatment for TN, providing a non-invasive outpatient procedure that delivers a high dose of radiation at the trigeminal root entry zone, interrupting pain signals. The success of GKRS depends on a very accurate stereotactic system and 69 % of patients are pain-free at 1 - year after radiosurgery and 52% are still pain-free at 3 - years.

TN is a painful but easily treatable condition, with many medical and surgical treatments available. Microvascular decompression remains the best approach in patients when MRI shows a loop of the aberrant vessel. Other options include percutaneous ablative procedure and GKRS. The selection of surgical procedure needs to be individualized, depending on patients preference, age, underlying pathology and comorbidities.

7. Non-pharmacological interventions (NPI) of Alzheimer's disease (AD):^{22, 23}

Cognitive therapy approaches - which involve mental abilities like perception, thinking and remembering are used to improve mental performance and wellbeing in individuals with mild to moderate AD. These interventions include arithmetic problems, word and puzzle exercises and everyday activities like shopping. Reality orientation training is another popular approach, focusing on improving orientation in space and time. However, it's unclear whether these interventions improve mood or self-care. Side effects of cognitive approaches, such as frustration and confusion, can also occur. It's crucial to tailor cognitive approaches to individual needs and be overseen by a professional.

Physical, emotional and social stimulation - Interventions for AD include social activities, physical activities and art and music. Social activities improve the quality of life, prevent apathy and reduce care needs. Physical activity has health benefits for AD, allowing them to stay mobile for longer. Exercise programs, including walking, strength-building and endurance exercises, can help them perform daily activities independently. However, some exercise programs may lead to increased hospital visits, so it's crucial to adapt programs based on individual abilities. Additionally, it's unclear whether exercise positively impacts mental health.

Emotion-oriented interventions - Emotion-oriented treatment approaches, such as validation therapy and reminiscence therapy, focus on the feelings, values and experiences of ADs to improve their quality of life. Validation therapy uses special communication techniques to create a safe and comfortable environment, allowing caregivers to understand and accept the patients feelings without judgment. Reminiscence therapy encourages individuals to discuss topics like hometown, school days or work, aiming to improve mental abilities and quality of life, reduce psychological effects like depression and positively affect mood and mental performance.

Caregiver training programs - Alzheimer patients require increased support and care, posing a significant challenge for their families. Education programs aim to help non-professional caregivers maintain their abilities and understand the disease better. Sharing experiences with other caregivers is crucial. Research suggests that training programs can help Alzheimer patients live at home longer and reduce challenging behavior like aggression and restlessness. Caring for Alzheimer patients can be enriching, providing a familiar environment and close care. Therefore, non-professional caregivers need support to cope with stressful situations.

Diet - Experts suggest a Mediterranean diet, rich in vegetables, fruits, legumes, nuts, olive oil, whole grain products, fish and poultry, may help prevent or slow down Alzheimers. However, no scientific evidence supports this claim. Additionally, research on fish oil capsules and other dietary supplements has shown no effect on Alzheimers.

Milieu therapy or environmental manipulation ⁻²⁴ is suitable for mild and moderate ADs. It involves adjusting the environment to make the patient feel pleasant and better orientated. Facilities designed for dementia patients often accept this concept, ensuring easy interior orientation and stability. This approach can be achieved by camouflaging entrance doors or using wallpaper.

Conclusions: Based on the conducted literature review, it can be stated that an adequate number of studies of the analyzed period are dedicated to nonpharmacological treatment methods with proven clinical effectiveness

and low-reliable treatment options were found in the studied literature. Most of the authors emphasize a positive influence of physical activity on epileptic patients, including prevention of epileptic seizures. Besides, physical activity is reported to have a positive influence on patients' psychic function, preventing cognitive disorders. However, up until now, physical exercises as an additional therapy are not included in any treatment program for patients with epilepsy.

Given the available evidence, we conclude that non-pharmacological interventions show promising results in reducing age-associated cognitive decline and offer hope to target the underlying cause of neurological disorders by augmenting neurogenesis and preventing neuronal death, thereby stimulating neuronal regeneration in the adult brain. Besides promoting neuro-rehabilitation in pathological conditions, these therapies can also be adapted by the younger generation as preventive measures to delay the onset of neurodegenerative disorders in adulthood.

Considering the fact that brain plasticity is maintained well into adulthood and old age, when devising strategies to combat age-related neurological disorders, it is best to adapt a combinatorial approach involving drug-based therapies, psychological interventions and lifestyle modifications to overcome the adverse effects of medications and facilitate plastic changes in the brain to speed up the process of recovery.

Future Research: Even though the effectiveness of non-pharmacological interventions in enhancing neuroplasticity has been well established, there are many unanswered questions with regard to the implementation of these therapies in real-life settings. Furthermore, there is a clear need for more randomized controlled trials and funding to systematically address the long-term benefits of non-pharmacological intervention for enhancing neuroplasticity.

Also, a common or different molecular mechanisms underlying the beneficial effects of non-pharmacological interventions in enhancing neuroplasticity still remain to be satisfactorily elucidated. Therefore, further investigations linking the benefits of non-pharmacological interventions for improving cognition, mood, quality of life, behavior and day-to-day functioning, with the measurement of the changes in the levels of molecular mediators of adult neurogenesis, can strengthen the existing evidence and support the theoretical basis of these non-drug-based therapies.

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