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President's Message

Dr. Muralidharan P.C
President of the Kerala Chapter of IAPMR

The Kerala Journal of PMR has come a long way, since it's inception in 2006. I'm proud & happy that we have been publishing this journal without any breaks for more than 2 years, and also for the acclaim it has received. This issue deals with stroke rehabilitation. Since neurorehabilitation cases, & stroke cases in particular, form a large chunk of the cases managed by Physiatrists, I'm sure the information contained within the pages of this journal will benefit everyone.

I take this opportunity to pay tribute to Dr. Ahmed Pillai, who was a great Physiatrist & a revered teacher. He went to great lengths for promoting our speciality, besides working tirelessly to help the disabled. May God Almighty grant peace to the departed soul, & strength to his near & dear ones to bear this irreparable loss.

This journal is voluminous & I'm sure it will be of great use for Residents & practising Physiatrists to widen their horizons. If you can't read it in one sitting, read it in parts. I congratulate the young Physiatrists who bagged gold medals in the DNB examinations.

With the Covid pandemic showing signs of slowing down, hope the Kerala Chapter can organize more activities for it's members & Residents. I wish the PMR fraternity all the very best & seek your whole hearted cooperation in all endeavours of the Kerala Chapter.

Jai IAPMR!!

Dr. P.C Muralidharan
President of Kerala Chapter of PMR

From the Editor's Desk

The PMR community seems to be careening towards a better future, with more job opportunities & visibility than ever before. This journal has been up & running for more than 2 years now, thanks to everyone's support & contributions. The responsibility to regularly publish this, now esteemed journal, rests on our shoulders.

The PMR fraternity is deeply pained by the loss of a gifted Physiatrist, a compassionate teacher & a wonderful human being. The sad demise of Dr. Ahmed Pillai has left a void that cannot be filled. We pay our humble homage to this gem of a human being & pray to God almighty to give strength to the bereaved kith & kin.

The topic for this issue is Stroke rehabilitation. It goes without saying that this is one field of rehabilitation where progress is made in leaps & bounds. This issue is teeming with information. I am grateful to all who have made contributions. Special thanks are due to Dr. Manjusha Rajesh, Dr. V. Ravi Kumar, Dr. Vasundhara Ghosal & Mrs. Kavita Panchal for their write ups.

We have new sections in this issue. 'In the News'deals with news items pertaining to the topic of stroke recovery & rehabilitation. Short fillers have been used to make reading more comfortable. Links' gives you contact information of Physiatrists from various parts of Kerala. This time we're focusing on Thiruvananthapuram.

This smörgåsbord of articles is intended to pique the interests of practising Physiatrists & Junior Residents alike.

Our next issue will be on 'Cerebral Palsy Rehabilitation', & I hope everyone will contribute articles, anecdotes & other material generously. I believe we need more RCTs, Metanalyses, & Systematic reviews if we are to nudge closer to the target of getting indexed…

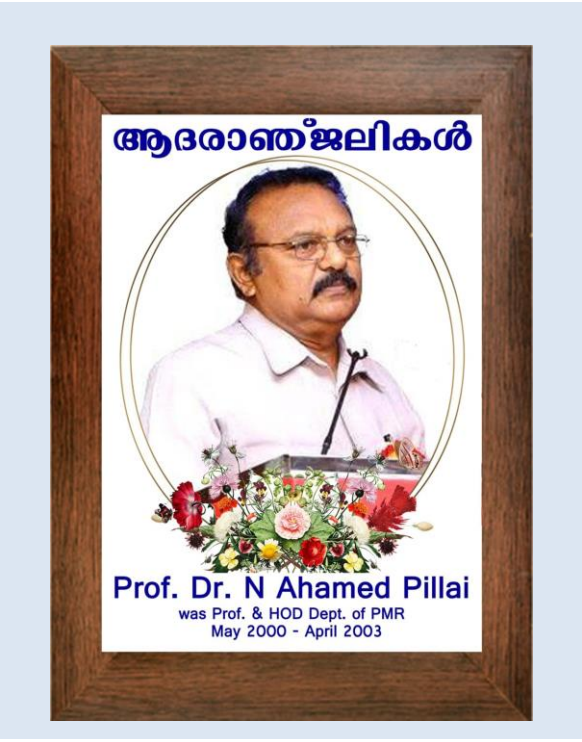
"Change may not always bring growth, but there is no growth without change."

— Roy T. Bennett

So until next time, hope you enjoy reading this issue…

Dr. Bineesh Balakrishnan
Editor

Tribute



Dr. Ahmed Pillai who has been in my department until I retired, has been very much fond of our speciality ever since he joined in Trivandrum Medical college, PMR department, in the early 1980s. Within a very short time, he could achieve positive contacts with all the staff in the department both medical & non medical. His dealing with the staff was a great support for me in the routine administration of our department. He used to visit me very often, enquiring about development of our speciality & activities of the department. Dr.Ahmed Pillai was a self made man & I'm very happy to say that he became very popular in the Department as well as in the whole of Medical College Trivandrum, within 5 years of his joining as tutor in the Department of PMR.

Along with the other colleagues, I used to specifically call him also during discussions in the Department. He was well-liked by his colleagues as well as people with disabilities attending the department. In the early days of his career in the department he had shown lot of leadership & organizational qualities which many people do not have. His percolation in the social circles has benefited our speciality, especially in the early stages of development of PMR. Dr. Ahmed Pillai made it a point to take up any responsibility in the department as well as in Trivandrum Medical college. He used to grab the opportunity of becoming RMO/Deputy Superintendent/ Superintendent of the hospital. This quality of him had helped PMR especially to gain publicity & advertisement, among other specialities of the institution. I was his examiner for Dip. NB in PMR & he could come out successfully in the first chance itself. He was president of Trivandrum Muslim's Association at that time & through his leadership he was promoting PMR speciality in a great way. Another quality of Dr. Ahmed Pillai was to promote political will- he believed that in our condition political will development was a prerequisite for the growth of our speciality. He was popular among the various political parties both the Left & Right fronts, of our state. Through this contact he became the chairman of Kerala State Handicap Welfare Corporation, which position was previously decorated by politicians & bureaucrats. He was the first doctor to lead this corporation meant for the welfare of differently abled.

After the PWD act of Government of India, back in 1995, he could grasp the opportunity to become the State Commissioner of People With Disabilities. Through high positions in this state he had traveled extensively all over Kerala & organized welfare camps for the disabled in every nook & corner of the state. During his tenure in these two positions, he used to consult me periodically for progressing the

development of services to the differently abled people. I would even say that Dr.Ahmed Pillai was responsible for streamlining the issue of disability certificates & permanent identity cards for all people with disabilities in our state. In this context I could remember how Ahmed Pillai was trying to sow the seeds of an eminent state institute of PMR, when he was the commissioner for PWDs in the state. The present NIPMR at Irinjalakuda was not existent at that time, when the owner of that big building wanted to donate it to Kerala state. The altruistic owner handed over the building to the Government. That letter of donation was seen by Dr. Ahmed Pillai, at that time, when I had retired from Government service. He asked me whether I could personally come with him to that building & give him sound advice on how that building could be best used to further the cause of PMR. We went to Irinjalakuda in his car & we both came to the conclusion that it could be suitable to develop an institute of PMR in that building. He presented our recommendation to the government & government gladly approved it. But unfortunately the government's term was over at that time & hence this decision could not be implemented immediately. It took another 5 years for the UDF government to come back to power & they decided to start National Institute of PMR on 15th August 2005.

Dr. Ahmed Pillai as the State Commissioner of PWD could also initiate lots of research projects all over Kerala & the Government was supporting various organizations for research for various services of PWDs. He also asked me to certify regarding the eligibility of various NGOs for these research grants. He had lot of organizational skills & because of this I could organize two national IAPMR conferences in Trivandrum during my presence in the Department. Ahmed Pillai's contributions to the success of these conferences was immense.

To finish the undue waiting list in artificial aplliances (Prostheses & Orthoses) through our limb fitting centre in Trivandrum Medical College, I organized a Jaipur foot camp inviting the Bhagawan Mahavir Sahayatha Samithi from Jaipur in 1986. For the success of this camp, Ahmed Pillai's contribution was praiseworthy.

His social commitment to the people gave him the chance of acquiring the governorship of a Lion's district extending to the whole of Kerala& Kanyakumari district of Tamil Nadu. Lots of service camps were arranged for PWDs when he held this post. In this context he traveled extensively & even visited the US. On his return he was welcomed by a sea of well wishers, shouting his praises, following him all the way to his home.

Now, about his personal & family life. I am happy to record that he was a teetotaler, non smoker & he could give good education to his two children- both of them are doctors (one son & daughter). I was attending obituary functions during the last 2-3 days after his death. People who talked during these functions were of high praise, especially his students in our speciality were remarking about his lecture & oratorial skills. He loved to speak, & used to do so for long, in good literary Malayalam, as well as in English. His friends were full of praise for his clinical skills in examining patients & administering treatment. I'm deeply pained at the loss of my dearest Ahmed Pillai & I consider his demise an irreplaceable loss to the PMR fraternity.

By Dr. S .Hariharan
Past President of IAPMR, Past Principal of Govt. Medical College, Trivandrum,
Past HOD of Department of PMR at Govt. Medical College, Trivandrum

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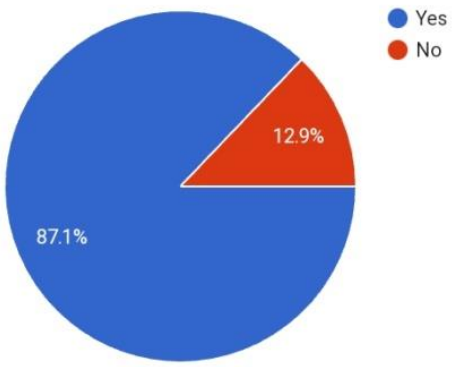
"Articles are the responsibility of the Authors"

Survey 1

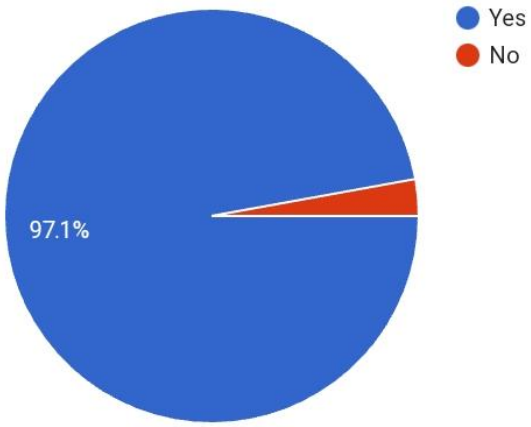
Here we will discuss the responses to the first survey on Stroke rehabilitation…

1. Does your institution handle IP stroke rehabilitation?



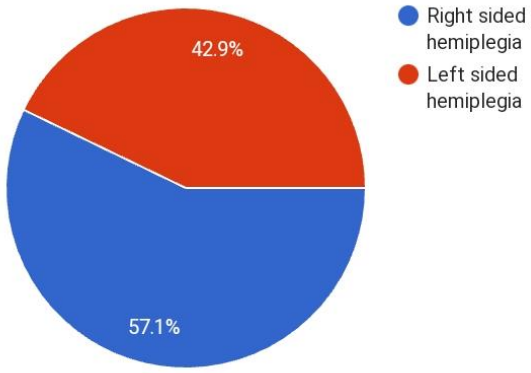
Nearly 13% of the respondents claimed that they didn't have IP facilities for stroke rehabilitation.

2. Do you follow early mobilization measures in stroke rehabilitation?



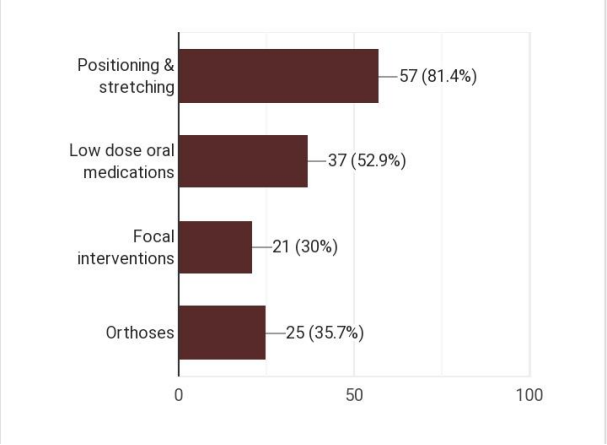
Early mobilization is now the norm & more than 97% of the respondents follow early mobilization while rehabilitating stroke patients.

3. Which sided hemiplegia is more common in your center?



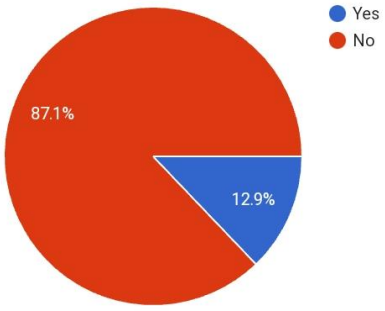
As expected, right sided hemiplegia is more commonly encountered than left sided hemiplegia.

4. Which measures are used predominantly for spasticity management at your centre?



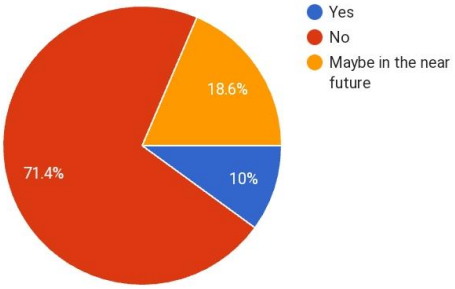
Now, this is one question where more than one option could be opted while answering it. As can be seen, most Physiatrists prefer to use positioning, stretching & low dose oral medications to combat spasticity.

5. Do you use Apps for stroke rehabilitation?



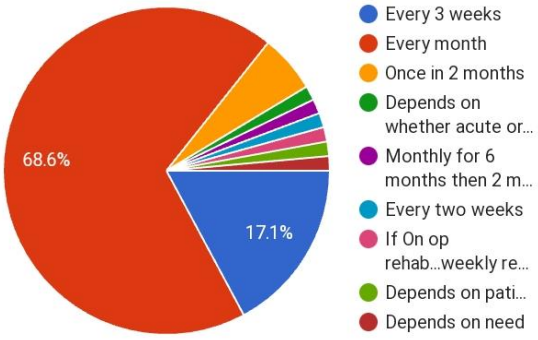
Nearly 13% of the respondents use apps while rehabilitating stroke patients. I wonder how the responses will change, if this same question was asked,a decade or so from now…

6. Do you use robotics for stroke rehabilitation?



While more than 71% of respondents didn't use robotics for stroke rehabilitation, more than 18% hoped to use it in the near future..

7. For OP stroke patients how often do you ask for review consultations?



About scheduling OPD follow up, nearly 68% of Physiatrists ask their patients to review on a monthly basis, while nearly 17% prefer reviewing their patients every 3 weeks. The next most common option chosen was reviewing once every 2 months. Other responses received were..

Depends on whether acute or chronic case – 1 response

Monthly for 6 months then 2 monthly or SOS– 1 response

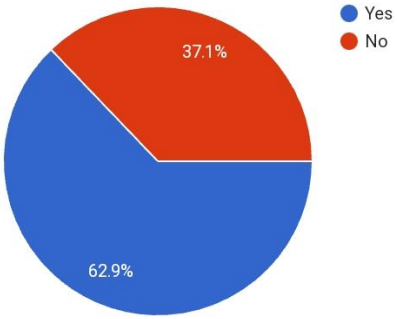
Every 2 weeks – 1 response

If on OP rehab weekly review – 1 response

Depends on patient condition & rehab goals – 1 response

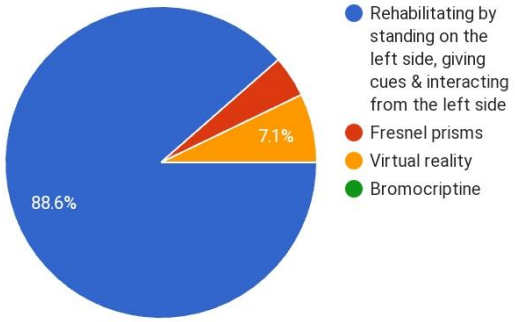
Depends on need- 1 response

8. Have you managed a case of thalamic pain in a stroke patient?



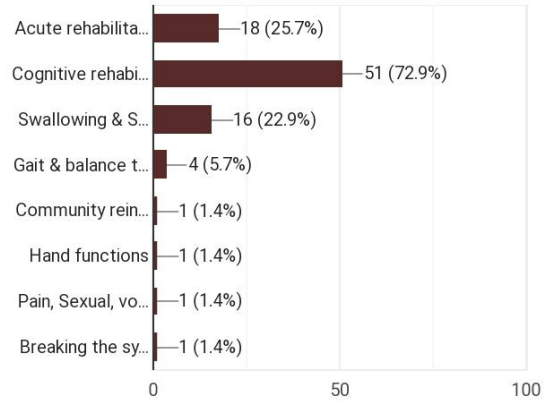
Nearly 63% of respondents have managed thalamic pain in stroke patients…

9. How do you manage hemispatial neglect (left sided) in stroke patients?



Most Physiatrists, 88.6%, rehabilitate left sided hemispatial neglect by rehabilitating (using cues, interaction, & rehab exercises) from the left side of the patient. The second most opted response was the use of virtual reality for rehabilitating the same, which was opted by 7.1%. The rest of the respondents chose to use Fresnel prisms for rehabilitating hemispatial neglect.

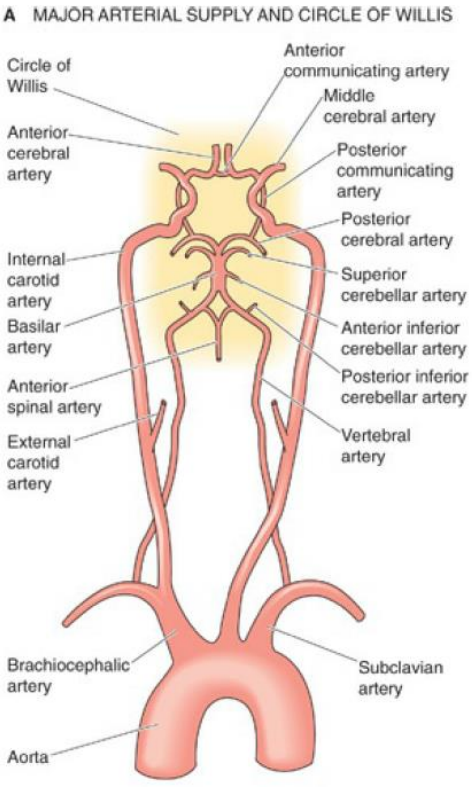
10. Which according to you is a highly neglected domain in stroke rehabilitation?



Again more than one option could be chosen while responding to this question by the same respondent. The most neglected domain according to the responses is cognitive rehabilitation, followed by acute stroke rehabilitation, & speech & swallowing rehabilitation…

Cerebral Blood flow, the factors influencing it, & physiological adaptations following Stroke

Brain is a pivotal organ for sustaining life. Even the determination of death often depends upon whether the brain is viable or not. Understanding how this viability is maintained by perfusion and the potential changes that occur during an insult like stroke are extremely important.



Dr. V. Ravi Kumar completed his MBBS from Government Medical College, Kottayam and MD in Physiology from Government Medical College, Thrissur. He worked as tutor in Andaman & Nicobar Islands Institute of Medical Science (ANIIMS). Dr. Ravi is currently working as Assistant Professor in Physiology in Sree Narayana Institute of Medical Sciences (SNIMS)

Functional anatomy of cerebral blood flow:

Blood supply of brain is by two internal carotid arteries, and two vertebral arteries that join to form the basilar artery. Anastomosis on inferior surface of brain forms the Circulus Arteriosus / Circle of Willis. Circle of Willis is formed by the anterior and middle cerebral arteries that are branches of internal carotid artery, and the posterior cerebral artery formed by division of basilar artery. Cerebral arteries divide into central and cortical arteries. The central arteries are end arteries. The Cortical branches of anterior, middle and posterior cerebral arteries supplying the surface overlap each other, forming border zones between the areas supplied – water shed areas. They are susceptible to ischemic damage known as ***water shed infarcts,*** which constitute almost 10% of all brain

infarcts.Veins of brain are wide, thin-walled structures that are nearlydevoid of smooth muscle and valves. Intracerebral veins drain into superficial pial plexus that in turn drain into dural sinuses.Dural sinuses empty into internal jugular vein.A characteristic feature of capillaries of brain is the blood-brain barrier. Blood-brain barrier prevents the movement of large molecules and highly charged ions from blood into the brain and spinal cord. It also protects brain from harmful substances and pathogens from blood entering into brain tissue. The barrier is mainly constituted by endothelial cells of brain capillaries. They are joined by tight junctions rather than large slit-pores between them as in most of the capillaries of the body.(1), (2), (3), (4), (5),(7)

Cerebral blood flow (CBF) can be measured by various means – Kety's method (using inhaled nitrous oxide), single photon emission computed tomography (SPECT), positron emission tomography (PET) and magnetic resonance imaging (MRI).

Characteristic features of cerebral blood flow:

Normal CBF is about 50 to 65 ml/100g of brain tissue/min or 750 to 900 ml/min (15% of resting Cardiac Output). Critical blood flow for brain is 18 mL/100 g tissue/min, below which unconsciousness can occur. Rate of oxygen utilization by brain tissue is about 3.5 ml/100 grams/minute. Normal flow interruption of cerebral blood flow will cause loss of consciousness in 5-10 seconds,cessation ofneuronal function after 1 minute, and irreversible changes starts within 4 minutes.(6), (8), (9).

There is a marked local fluctuation in brain blood flow with neural activity,but the total blood flow is maintained relatively constant by various mechanisms. These factors include–Metabolic regulation,Autoregulation of cerebral blood flow, Intracranial pressure and Neural regulation.

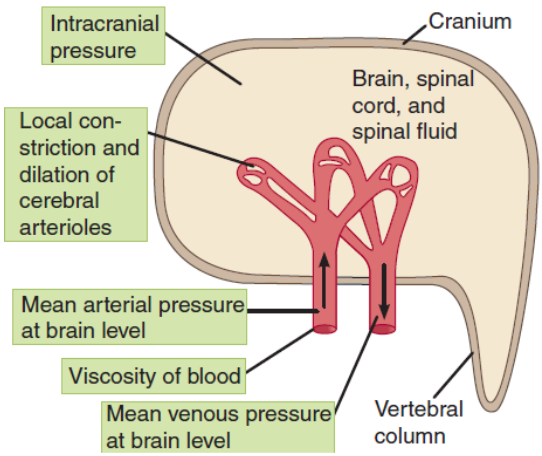
1. **Metabolic regulation**: changes in CO2 or H+, O2 and K+ play an important role in regulating cerebral blood flow.

CO2 is the most potent vasodilator of cerebral blood vessel. A 70% increase in CO2 approximately doubles the CBF.

O2: Slight fall in pO2 causes vasodilation and produces increase in cerebral blood flow due to rapid formation of adenosine.

K+: An increase in K+ concentration in CSF causes rapid increase in cerebral blood flow.

2. **Autoregulation of cerebral blood flow**: Cerebral blood flow remains nearly constant between 60and 140-mm Hg blood pressure because of autoregulation of cerebral blood flow. There are two theories for autoregulation – metabolic theory and myogenic theory.
   - Metabolic theory says decreased blood flow causes accumulation of metabolic waste. These are potent vasodilators and they increase the blood flow.
   - Myogenic theory states it is the intrinsic contractile response of smooth muscle to increase in wall tension.



3. **Role of Intracranial pressure (ICP):** ICP regulates CBF by two mechanisms: Monro-Kellie doctrine and Cushing's reflex.
    - Monro-Kellie doctrine: At any time, the volume of brain, blood & spinal fluid in the cranium should be constant since the brain case is rigid. When ICP increases it compress blood vessels and CBF decreases.Any change in venous pressure cause similar change in ICP.
    - Cushing's Reflex: When intracranial pressure is increased and becomes equal to the arterial pressure, there occurs compression of cerebral arteries and causing decreased blood supply to vasomotor centre (VMC). The hypoxia and hypercapnia produced locally increases the discharge from VMC. The resultant rise in a systemic pressure tends to restore the cerebral blood flow and also cause reflex bradycardia.
4. **Neural regulation**: In severe hypertension, the noradrenergic sympathetic nerves cause vasoconstriction reducing cerebral bloodflow. In severe hypotension, the cholinergic sympathetic cause vasodilatation thereby increasing cerebral blood flow.

<u>Changes in brain following stroke:</u>

Strokes are broadly classified based on etiology into Ischemic and Hemorrhagic stroke(10)

Capillary brain endothelial cells (ECs) and surrounding pericytes, astrocytes,microglia, neurons, and extracellular matrix (ECM) of the basement membrane altogether compose the neurovascular unit (NVU). Stroke result in neurovascular uncoupling and affect the integrity of the BBB. Remodeling of the NVU post stroke can be grouped as those occurring in Ischemic stroke and in Hemorrhagic stroke. Structural and functional remodeling occur in stroke.

Structural remodeling occurring in Ischemic stroke include -reparative angiogenesis primarily in the peri-infarct region,breakdown of BBB by increased caveolae-mediated transcytosis and breakdown of tight junction,secretion of matrix metalloproteinases by pericytes and endothelial cells, pericyte migration, astrocytes contributing to glial scar formation (11), (12), (13).Functional remodeling in Ischemic stroke includes process like acute loss of CBF that initiates vascular remodeling by release of endothelial NOS,acute hypoxia induces pericyte relaxation, impairment of astrocytic regulation of CBF, cell death of perivascular neurons increasing brain damage leading to neurovascular uncoupling, upregulating VEGF signaling that promotes angiogenesis, angiogenic response provides a platform for neuronal regeneration(14),(15).

Structural remodeling in Hemorrhagic stroke includes proliferation of endothelial cells around hematoma, breakdown of BBB and tight junction disruption, astrocyte-derived basement membrane proteins are lost, rapid microglia activation due to blood in parenchyma,VEGF increases BBB permeability, that may helpperipheral macrophage infiltration into brain (16), (17).Functional remodeling in Hemorrhagic stroke includes persistent upregulation of VEGF and its receptors,aquaporin-4mediated beneficial effects of VEGF, improved stroke outcome because of increased VEGF which increases vessel density(18), (19).

Changes in other systems after stroke:

Following stroke there is a decline in cardiorespiratory (CR), sensorimotor and metabolic functions.

There are major structural and molecular abnormalities observed in hemiparetic leg muscle with serious implications for impairment of strength, insulin sensitivity mobility function and CR fitness (20), (21). Following stroke there is muscle wasting and increased intramuscular fat with higher proportion of fast twitch muscle fibers that are insulin resistant and fatigue prone; decrease in number of capillaries per muscle fiber in paretic leg muscles with low capillary density and glucose intolerance; increase in expression of tumor necrosis factor-alpha (TNF-α) (22), (23). Following these changes there is decreased gait efficiency and increased energy expenditure leading to chronic fatigue (24). Pro-inflammatory Markers and Metabolism: there is an increase in circulating cytokines such as TNF-alpha and IL-6. Elevated levels of pro-inflammatory markers have been strongly associated with larger infarct size and poor outcomes. Insulin resistance and glucose intolerance are highly prevalent after stroke(25), (26), (27), (28).

Cardiovascular regulation after stroke: Impairments related to autonomic control of blood flow and cardiac regulation are seen after stroke, especially if stroke occurs around parietal and insular cortex (29). In chronic stroke, blood flow in the paretic leg is significantly lower at rest and during exercise on comparing with nonparetic limb and is attributed to decreased physical activity and vessel wall thickening in paretic limb(30), (31), (32).

Respiratory function after stroke: respiration may be compromised as a direct result of the stroke itself, associated complications, comorbidities or lifestyle factors (33). Respiratory insuffiency may manifest as low pulmonary diffusing capacity, ventilation-perfusion, or decreased lung volumes includingsignificantly lower minute ventilation andtidal volume. Impaired respiratory mechanics have been reported (34), (35). Expiratory dysfunction may be due to motor impairment of expiratory group of muscles while inspiratory limitations is due to decreased chest wall because of gradual development of rib cage contracture.(36), (37).

Exercise-Induced physiological adaptations after Stroke:

Exercise is a potent physiological stimulus that can induce wide range of adaptations. These adaptations in brief include enhanced cardiorespiratory fitness, reduced respiratory effort, changes in vascular function and vascular morphology and improved glucose metabolism and insulin sensitivity. Cardiorespiratory adaptations involved improvement in VO_2 in stroke patients in subacute and chronic stages of recovery following aerobic exercises were seen in studies (38), (39). Even modest gains in CR fitness reported in some stroke exercise studies (e.g., 8%, 6%) may be adequate to raise the anaerobic threshold, thereby, prolonging the time during which muscle contractions can be maintained with oxidative metabolism (40), (41).Interindividual variations were noted, causes could be attributed to factors like severity of stroke, time since onset, variations inintensity and mode of training, and level of compliance withthe exercise regimen (42).Most rapid improvement in exercise capacity were noted in previously sedentary people (43).

Muscular adaptations and Metabolic: Studies pertaining to effect of strength training in stroke patients are less. In study conducted by RyanA S et al among chronic stroke patients showed skeletal muscle hypertrophy along with molecular adaptations in both paretic and nonparetic limbs. Hafer-Macko C E et al in theirstudy reported marked conversion of fast- to slow-twitch MHC fiber following tread mill aerobic exercise in chronic stroke patients (44).Preliminary findings in study by Ivey F M et al demonstrated reversal of impaired glucose tolerance and type 2 diabetes status in chronic stroke patients subjected to 6 months moderate intensity treadmill training (21).

Vascular and Respiratory adaptations: Billinger S A et al in their study demonstrated substantial vascular changes on the paretic limb with improved blood flow and diameter following 4 weeks of unilateral leg training (45). Ivey F M et al in their study using treadmill training over 6 months exhibited improved resting and hyperemic blood flow in paretic and non-paretic legs when compared to conventional stroke rehabilitation. Treadmill training can have positive impact on cerebral vasomotor function in both hemispheres (21).One trial examined concluded inspiratory muscle training produced significant improvements in pulmonary function variables and cardiopulmonary outcomes during peak exercise testing (46).Britto et al. published findings from a double-blind randomized controlled trial in chronic stroke survivors demonstrated significant improvements in respiratory function (maximal inspiratory pressure and inspiratory muscular endurance) for the stroke patients(47).

Adaptations in Memory and Cognition: Animal studies have demonstrated favorable effects of aerobic training on neural function through modulation of synaptic plasticity underlying neuroprotective and neuroadaptive processes (48), exercise attenuated the effects of traumatic brain injury, again in a rodent model, through a BDNF-mediated mechanism (49). Evidence of a causal relationship between exercise training and improved cognition has been reported in older adults without known cognitive impairment. Quaney and colleagues studied the effects of exercise training on cognitive executive function and motor learning in chronic stroke survivors and they demonstrated significant improvements in information processing and complex motor learning tasks (50).

Benefits of Low and High intensity intermittent exercise training in stroke patients:

Low intensity intermittent exercise training: Aerobic training improves CR fitness, exercise tolerance to fatigue, quality of life and reduces the risk of cardiovascular disease and recurrent stroke (51). After 10 weeks of aerobic training, stroke patients had lower systolic blood pressure at submaximal workloads duringgraded exercise test (52).

High intensity Intermittent exercise Training (HIT): Gjellesvik TI et al conducted HIT study on stroke patients on treadmill and found an increase in VO_{2peak} (+11.6%) and increase in peak pulmonary ventilation (53). Similarly, studies conducted by Katz- Leurer et al and Duncan et al also found improvement in endurance abilities in stroke patients after interval training (54), (55).

Conclusion:

Cerebral circulation is one of the special circulations in human body with various mechanisms to regulate its flow. Disruption of these mechanisms leads to stroke which

could be either ischemic or haemorrhagic. Exercise has a major role in post stroke survival, preventing recurrence of stroke and adaptation in acute and chronic stroke patients. More studies need to be done on the benefits of exercise on acute and chronic stroke survival patients.

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Respected all,

I would just like to pen down a few thoughts that went into the compilation of the -The Competency Based Medical Education (CBME) Model Logbook for MBBS undergraduates. NMC regulations were followed while drafting this logbook. I would like to specially draw your attention to these salient points:-

- The core essential structure of PMR according to CBME has been laid out in this logbook.
- The 9 Competencies pertaining to the PMR topics have been highlighted .
- Additional subtopics of Professionalism, Self Directed learning, Reflections have been included to include AETCOM modules.
- Scope of Vertical & Horizontal Teaching integration have also been mentioned.

This logbook was compiled for & by the Dept of PMR -GMC-Kozhikode. Dr Heera Selsa helped in the type & editing. Prof Sreedevi Menon P helped in editing & oversaw the whole compilation. I would also like to thank the Dr. Arun John for uploading the soft copy onto the website of the Kerala Chapter of IAPMR.

I'm sharing the soft copy of this book for easy access to the PMR faculty. This has been made with the intention of access to all PMR faculty who would like to carry it out in their own institutions. Hoping this may be of help to all of you. Feel free to suggest modifications or clarify any doubts pertaining to this logbook.

You can access the book through this link - https://www.iapmrkerala.org/downloads

Thanks
Dr Reeba Mary Mani

Paediatric Stroke- What do we know?

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(in Pediatrics)

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Stroke is one of the serious and life-threatening Paediatric emergencies. The full impact of stroke on the developing brain emerges over time, with neurocognitive function deficit, and impact on educational and social roles. This has widespread and long-lasting impact on the individual, family and society.

Acute Ischemic stroke (AIS) accounts for about half of all strokes in children compared to adults. There is significant morbidity and mortality associated with Paediatric Stroke. There is about 10–25% mortality ,25% of children have a recurrence, and 66% have permanent neurological deficits or develop subsequent seizure disorders, learning, or developmental problems. Quality of life of the child is impaired and there are emotional and economical costs involved.

Classification:

- Perinatal stroke: Stroke occurring from 28 weeks gestation to 28 postnatal days of life.
- Childhood stroke: stroke occurring after 28 days to 18 years of age.
- Ischemic stroke : caused by arterial/ venous occlusion- acute ischemic stroke (AIS) and venous infarction caused by cerebral sinovenous thrombosis (CSVT) or cortical vein thrombosis
- Hemorrhagic stroke

Epidemiology:

AIS accounts for 80% of the perinatal and majority of the strokes in children. Agarwal and colleagues identified 60 individuals with perinatal stroke among a cohort of 208 876 live births. This represents a frequency of 29 in 100 000 live births, or 1 per 3500 live births. Incidence of childhood stroke varies by age and sex of the child. The incidence is highest in infants and children <5 years of age and has higher sex predilection for boys than girls. Intracerebral hemorrhage (ICH), IVH, or SAH is the cause of Hemorrhagic stroke in children. Arteriopathy is the strongest predictor of stroke recurrence (5-fold increased recurrence

risk).Cardioembolic stroke may present with abrupt onset of symptoms.

Risk Factors:

Multiple risk factors are often present in as many as 25% of children with stroke.The various risk factors are:

- ***Cardiac***- post cardiac repair, cardiac catheterization, cyanotic congenital heart diseases, cardiomyopathies, rheumatic heart disease, prosthetic valves, valvular vegetation from endocarditis, patent foramen ovale (both thromboembolic and hemorhagic stroke)
- ***Hematological***- Sickle cell disease, prothrombotic disorder(Protein C, S deficiency, nephrotic syndrome etc), iron deficiency anemia, coagulation disorders
- ***Infections***- Varicella(basal ganglia infarction), HIV, mycoplasma,chlamydia, enterovirus, parvovirus 19, influenza A, coxsackie, Rocky Mountain spotted fever, cat scratch disease, TB meningitis, bacterial meningitis, head and neck infections (mastoiditis or periorbital infections)
- ***Vascular***- Arteriovenous malformations (AVM), Osler-Weber-Rendu syndrome (hereditary hemorrhagic telangiectasia), Sturge-Weber disease, neurofibromatosis, von Hippel-Lindau syndrome, Moyamoya disease
- ***Syndromic and Metabolic***- Tuberous Sclerosis, Homocystinuria, nutritional deficiencies of folic acid or vitamin B12, familial lipoprotein disorders
- ***Malignancy***- Brain tumours, leukemia,lymphoma, treatment with L-asparaginase
- ***Trauma***- head and neck trauma, direct intraoral trauma (foreign object such as a pencil in the mouth or after tonsillectomy), spontaneous
- ***Drugs***- Illicit (amphetamines, ecstasy, cocaine, phencyclidine , glue sniffing), prescribed (overuse of ergot alkaloids, OCPs)

Clinical Features:

Clinical settings vary according to the age and stroke subtype:

- Hemiparesis and hemifacial weakness (up to 90%)
- Speech or language disturbance (20% - 50%)
- Vision disturbance (10% - 15%)
- Ataxia (8%-10%)
- Other non-localizing signs- headache (20% - 50%), altered mental status (up to 38%), vomiting.
- Seizures (15% - 25%)
- Transient ischemic attack (TIA) : high prevalence in moyamoya-type arteriopathies
- Posterior circulation stroke -hemiparesis, ataxia, dysarthria, visual field deficits, oculomotor deficits

Stroke Mimics:

Stroke mimics cause delay and challenges in diagnosis and management of stroke in children.The median time from symptom onset to parent seeking medical care is highly variable, ranging from 1.7 to 21 hours, although a majority usually present within 6 hours. Focal deficits are more common in children with stroke. But the non-specific symptoms like headache, vomiting can be seen in both.

The most common stroke mimics are:

Migraine with aura	**Cerebellitis**
Bell palsy	Encephalitis
Seizures especially with Todd paresis	Epidural abscess
Brain tumour	Traumatic brain injury
Demyelinating disease	Syncope
Intoxication	
Metabolic disease	
Psychogenic disorders.	

Imaging:

Non-contrast head computed tomography (CT) is sensitive for acute bleeding and should be obtained immediately to exclude a hemorrhagic cause of stroke. ***MRI***is used to exclude an acute intraparenchymal bleed or SAH (sub arachnoid hemorrhage). Noncontrast CT can also be used as the initial study for diagnosing AIS. Infarcts appear as low-density lesions within vascular territories, and CVST may present as linear densities in the deep and cortical vein. ***Magnetic resonance arteriography (MRA)*** and ***Magnetic resonance venography (MRV***) should also be carried out to confirm vessel patency and define the vascular anatomy. MRA will yield further information about blood flow, and MRV will more reliably identify CVST. ***Catheter angiography*** is superior for visualization of tertiary branches and small cerebral arteries.But it is expensive and difficult to perform in children. ***CT angiography (CTA)*** can also be used for assessing vascular anatomy and relative cerebral blood flow.

Laboratory assessment may include a variety of nonspecific blood tests and more specific laboratory tests looking for specific causes of stroke such as coagulopathies, hematological disorders, or vasculitides.

Management:

Once the type of stroke is identified, treatment depends on the etiology. In AIS irreversible tissue injury is shorter in the central core of the infarct and longer in the surrounding penumbra where collateral arterial supply can continue to perfuse tissue. Neuroprotective strategies to balance metabolic substrate supply with tissue metabolic demand aim to increase brain tissue survival primarily in the penumbra. In Hemorrhagic stroke there is need to prevent rebleeding which includes correction of coagulation defects and hematologic disorders. Patients with mass effect may benefit from early surgical evacuation. Other surgical options include stereotactic radiosurgery, microsurgical or endovascular techniques, and endoscopic surgical evacuation of the intracerebral hematoma or obliteration of aneurysms and AVMs

The various measures include:

- Fever control, normalization of serum glucose, and maintenance of normal oxygenation.
- Measures should be taken to decrease intracranial pressure (ICP), treat dehydration, and correct anemia.
- Control of systemic hypertension is recommended.
- Target oxygen saturations above 92%.
- Treat hypotension.
- Anticonvulsants may be considered in children with hemorrhagic strokes and cerebral venous sinus thrombosis (CVST).
- Anticoagulation is also often used in children with arterial dissection, dural sinus thrombosis, coagulation disorders, high risk of embolism, or progressive deterioration during the

initial evaluation of a new cerebral infarction. It is done with low molecular weight heparin (LMWH) or unfractionated heparin (UFH).

- Thrombolytic therapy in children with ischemic strokes must be carried out in a guarded and judicious manner.
- Ischemic strokes in Sickle cell disease should be treated with hydration and simple or partial exchange transfusion to achieve a hemoglobin SS fraction of less than 30% and a hemoglobin level not greater than 10 g per dL to avoid problems of hyperviscosity.

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Pediatric Stroke Rehabilitation

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Perinatal stroke affects up to one in 2300 term and seven in 1000 preterm infants, the majority of which are due to ischaemic events.

Perinatal stroke may be defined as an acute neurologic syndrome with chronic sequelae due to cerebral injury of vascular origin occurring between 20 weeks gestation and 28 days post natal life.

These disorders include focal cerebral injury due to arterial ischemic stroke, cerebral venous thrombosis, and primary intracerebral haemorrhage. Perinatal stroke is a common cause of acute neonatal encephalopathy, and may manifest as seizures, altered mental status, and sensorimotor deficits.

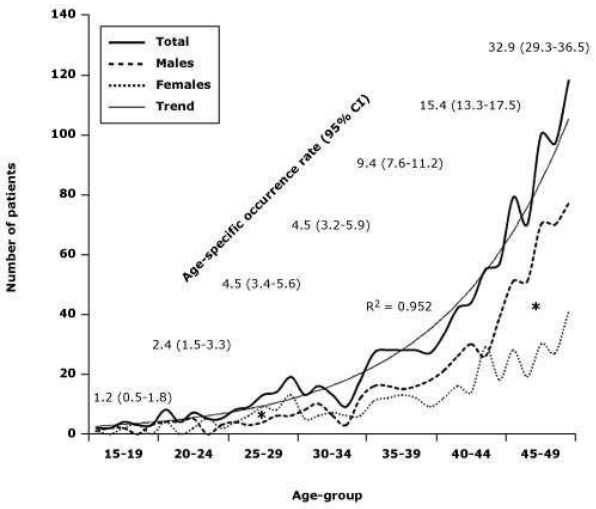
Up to 60% of perinatal strokes result in neurological deficits with hemiplegic cerebral palsy (CP) being a frequent adverse motor outcome. Perinatal stroke an important cause of chronic neurologic disability and is the most common cause of hemiplegic CP.

Annual incidence rates of arterial ischemic stroke in infants and children range from 0.6to 7.9/100,000 children per year. Stroke occurrence increases exponentially with age.

Several studies have found that pediatric ischemic stroke is more common in boys than in girls.

A study among 1187 children in a multinational pediatric stroke registry, boys accounted 540 of 925 cases (58 percent) of arterial ischemic stroke (n = 925) and 170 of 262 cases (65 percent) of cerebral sinovenous thrombosis cases. The explanation for the apparent male predominance is unknown.

Age and stroke rate:



Number of patients according to age and age-specific occurrence rates per 100,000.

Causes of stroke in children:

The etiologies and risk factors for arterial ischemic stroke in children and young adults differ from those typical in older adults. In children and young adults, congenital and acquired heart problems, hematologic conditions, vasculopathies, metabolic disorders, and drug ingestion are more common.

In older adults, hypertension, smoking, diabetes, and hypercholesterolemia are more common. These risk factors are also present in some young adultsand rarely in children.

The most common etiologies and risk factors for ischemic stroke in children include cardiac abnormalities, vascular lesions (eg, focal cerebral arteriopathy), hematologic abnormalities, infection, head and neck trauma, genetic conditions. The incidence of these factors varies greatly depending on the population being studied.Some etiologies may often overlap (eg, infection may cause arteriopathy).

CAUSES : TABLE No.1:

Cardiac causes: Congenital heart disease, Patent foramenovale, Atrial septal Aneurysm, Atrial myxoma, Atrial fibrillation, other arrhythmias, Cardiomyopathy, Myocarditis, Myocardial infarction, Cardiac surgery, Cardiac catheterization, Extracorporeal membrane oxygenation (ECMO), Endocarditis, Rheumatic heart disease, Prosthetic valve

Hematologic causes: Inherited prothrombotic states-Protein C deficiency, ProteinS deficiency, AntithrombinIII deficiency, FactorV Leiden gene mutation (associated with activated protein C resistance), Prothrombin gene mutation, Elevated homocysteine, Elevated lipoprotein(a), Polycythemia vera, Acquired prothrombotic states: eg.Antiphospholipid antibody syndrome, L-asparaginase, Protein-losing enteropathy, Disseminated intravascular coagulation, Leukemia and other malignancies

Vascular:

Noninflammatory-Arterial dissection-Spontaneous, Traumatic, Secondary to connective tissue disease (Ehlers-Danlos, Marfan), Fibromuscular dysplasia, Transient cerebral arteriopathy, Hypertension, Radiation vasculopathy, Moyamoya-Primary moyamoya disease , Secondary moyamoya syndrome- Sickle cell disease, Neurofibromatosis type 1, Down syndrome, Williams syndrome, Cranial radiation, Fibromuscular dysplasia, Vasculitis and postinfectious vasculopathy, Viral or bacterial infection, Congenital heart disease, Vasospasm following subarachnoid hemorrhage, Congenital vessel hypoplasia, Migraine

Inflammatory-Takayasuarteritis, Giantcellarteritis, Kawasakidisease, Polyarteritisnodosa, Vasculitis associated withrheumatologic disease, Primarycentral nervous systemangiitis, Infectious/ post infectious vasculitis (Human Immuno deficiency Virus (HIV)- Varicella, Bacterial meningitis, Syphilis, TuberculosIs, Fungal)

Metabolic: Cerebral autosomal dominant arteriopathy with subcortical infarcts and leukoencephalopathy (CADASIL), Fabry disease, Homocystinuria, Menkes'disease, Mitochondrial encephalopathy with lactic acidosis and stroke-like episodes (MELAS)

Ingestion: Cocaine, methamphetamine

This lifelong condition has implications for performance in activities of daily living, quality of life, and self-esteem. Adults with

hemiplegic CP are less likely than their peers to live independently or be in full-time employment.

Apart from hemiplegia, other adverse outcomes include cognitive, language and visual deficits, seizures, and behavioural problems. Not surprisingly, there is a substantial long-term financial burden associated with perinatal stroke.

Whereas stroke in adults is quickly detected, perinatal stroke often presents non-specifically in the first days of life with seizures, lethargy, and/or poor feeding.The aetiology of perinatal stroke is multifactorial and incompletely understood, limiting preventative options

Around 40% of cases ('presumed perinatal strokes') are first detected outside the neonatal period. For this group, presentation occurs on average 5 months after birth, often with asymmetrical movement difficulties.

Early identification and referral of at-risk infants for rehabilitation intervention, rather than referral of infants with established CP, has been called for and is the need of the hour to prevent and limit disabilities.

This approach, however, requires both more widespread use of appropriate tools for early diagnosis and more evidence for effective early interventions.

Late intervention approaches for children with established hemiplegia, range from orthoses and botulinum toxin injections to orthopaedic surgery.

General principles and the organization of stroke rehabilitation also apply to children undergoing stroke rehabilitation

Assessment for Rehabilitation: All children with stroke should have an initial assessment to determine the severity of stroke and rehabilitation needs, conducted by medical professionals as soon as possible after diagnosis.

Paediatric acute and rehabilitation stroke care should be provided on a specialized paediatric unit so that care is formally coordinated and organized. *Standardized and valid assessment tools* should be used to evaluate the patient's stroke-related impairments, functional activity limitations, role participation restrictions, mood and behaviour changes, and environmental restrictions.

Individualized rehabilitation plans should be developed and regularly updated based on review of patient status and progress through developmental milestones. Ideally, these reviews should take place annually.

Once a child who has experienced a stroke has undergone assessments, the appropriate setting for rehabilitation (inpatient, outpatient, community, school, and/or home-based settings) may be determined.

At any point in their recovery, paediatric stroke survivors who have experienced a change in functional status, and those who would benefit from additional rehabilitation services, should be offered outpatient support.

The Paediatric Stroke Rehabilitation Team: *Applicable for all stroke rehabilitation settings (acute care hospital, ambulatory clinic, community-based services and programs).*

Stroke rehabilitation should be delivered by a full complement of health professionals, experienced in providing post-stroke paediatric care, regardless of where services are provided, to ensure consistency and reduce the risk of complications.

The core team should include clinicians with expertise/core training in developmental

paediatrics and paediatric stroke rehabilitation, including physicians (such as rehabilitation physicians /PM&R specialists aka physiatrists and specialized paediatricians), occupational therapists, physical therapists, speech-language pathologists, nurses, social workers, psychologists, and dietitians. The parent(s) and other family members are also included as part of the core team.

Additional team members may include recreation therapists, vocational therapists, educational therapists, childhood educators, kinesiologists, orthotists, and rehabilitation therapy assistants.

General Principles of Stroke Rehabilitation Therapy for Children

Children who have had a stroke should engage in training that is meaningful, engaging, repetitive and progressively adapted, age appropriate, task-specific and goal-oriented in an effort to enhance motor control and restore sensorimotor function.

Training should encourage the use of patients' affected limb during functional tasks and be designed to simulate activities of daily living appropriate to the patient developmental level.

Objective, functionally relevant outcomemeasures should be applied before and after interventions and interpreted in a blinded fashion whenever possible to determine benefit for individual patients.

Therapy should be guided by functionally relevant goals determined by the child and family under the guidance of a knowledgeable therapist.

- ***Specific Therapies for Arm and Hand:***

  Range of motion exercises (passive and active assisted) should be provided that includes placement of the upper limb in a variety of appropriate and safe positions within the patient's visual field.

  Hand and wrist splints and other splints should be considered in appropriate patients, and be customized to individual patients. A plan for monitoring these devices should be put in place.

  Traditional or modified constraint-induced movement therapy (CIMT) should be considered for suitable paediatric patients with stroke with upper limb impairment to reduce motor impairment and improve upper extremity function.

  Functional Electric Stimulation (FES) may be considered to increase awareness of extremity, reduce motor impairment and improve upper extremity function.

  Mirror Therapy should be considered as an adjunct to motor therapy for select patients. It may help to improve grasp and pinch strength.

  Chemodenervation using Botulinum Toxin Type A may be considered to increase range of motion for patients with focal and/or symptomatically distressing upper limb spasticity or dystonia.

  Repetitive Transcranial Magnetic Stimulation (rTMS) may be considered as an experimental adjunct to upper extremity therapy within a clinical trial.

  Surgical interventions such as tendon repositioning to promote more functional joint mechanics should be considered in select patients.

- ***Specific Therapies for Lower Limb:***

  Range of motion exercises (passive and active assisted) should be provided as

well as physical activity and gait training to promote ambulation.

Ankle-foot orthoses and other splints should be considered in appropriate patients, and be customized to individual patients.

Chemodenervation using Botulinum Toxin Type A may be considered to increase range of motion for patients with focal and/or symptomatically distressing lower limb spasticity.

Surgical interventions such as tendon repositioning to promote more functional joint mechanics may be considered in select patients.

❖ ***Adaptive and Assistive Devices and Mobility Aids:***

Adaptive devices including splints and orthoses designed to improve safety and function may be considered if other methods of performing specific functional tasks are not available or tasks cannot be learned.

The need for special equipment like mobility aids (such as wheelchair trays, walkers) should be evaluated on an individual basis. Once provided, patients should be reassessed as they grow and develop to determine if changes are required or equipment can be discontinued with the aim of achieving independent function.

❖ **Life Roles, Activities, & Family Wellness**

Return to School- School age stroke survivors in the community will require ongoing assessment of educational and vocational needs throughout their development. Resumption of education should be encouraged where possible and when appropriate. School-aged children affected by stroke should receive educational rehabilitation and support services to assist with function and safety in the classroom, as appropriate, and individualized educational plans should be created when required to meet the needs of a child who has experienced a stroke.

Leisure Activity- Children affected by stroke should be offered treatment aimed at achieving play and leisure related skills that are developmentally relevant and appropriate in their home, community, and school environments.

Children affected by stroke and their families should be offered relevant information regarding leisure activities and adaptive programs in the community and/or be referred to relevant agencies. Use of peer support groups should be encouraged.

Family Wellness- Simple educational interventions aimed at reducing or eliminating misplaced maternal guilt or parental blame should be provided. Parents, and mothers in particular, should be educated regarding the causes of perinatal and childhood stroke and that virtually none are preventable by the parents or otherwise. Mothers should be directly and repeatedly reminded that they are not responsible.

Families of children who have had a stroke should be offered information and support regarding adjustment to changes in physical needs of the child and possible increased dependency; changes in social roles of family members, leisure activities, impact on other family members and potential resource issues.

Conclusion:

Achieving optimal outcomes in stroke rehabilitation and recovery at any age starts

with early post stroke rehabilitation assessment, and the development of an individualized rehabilitation plan. These plans should incorporate patient goals, environmental factors (e.g., social supports, living arrangements), current functional, cognitive and emotional deficits, and potential for recovery.

The plan should clearly describe the types of therapies required based on the results of clinical assessments across all domains of rehabilitation. Throughout the rehabilitation and recovery process, the individualized plan must be regularly reassessed and revised to reflect patient progress and evolving goals. These assessments happen through patient-provider interactions and are further discussed at regular meetings of the interprofessional care team.

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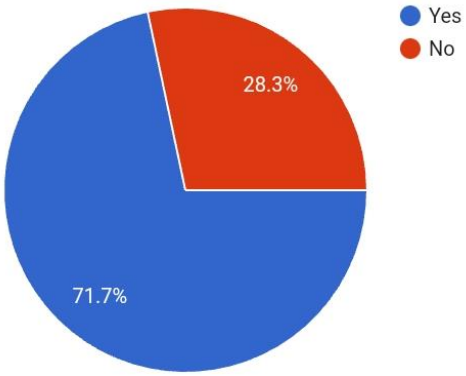
Survey 2

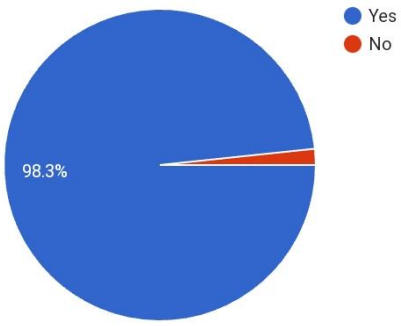
Now let's briefly analyze the responses to the second survey on stroke rehabilitation…

1. **Do you routinely use functional measures while assessing IP stroke patients?**



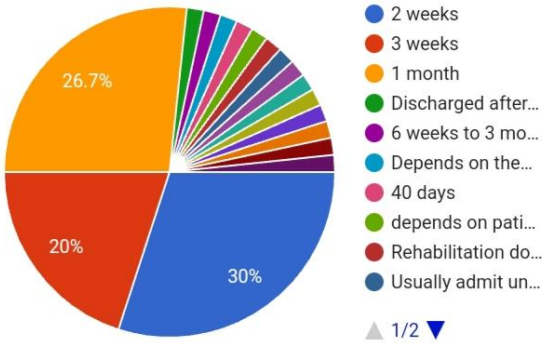
Functional measures like FIM & Modified Barthel Index were routinely used by 71.7% of the Physiatrists who responded to this survey….

2. **Do you give prognostic information to your stroke patients or their bystanders?**



Prognostic information was discussed by 98.3% of respondents. By using this kind of information, Physiatrists can help in streamlining rehabilitation of patients, while explaining the expected outcomes to the patient & bystander…

3. **In the first 2 months following a stroke how long would you admit a stroke patient for IP rehabilitation?**



In the first survey we had noted that nearly 13% of the Physiatrists who responded don't have IP facilities for rehabilitating stroke patients. In the first 2 months following a stroke, IP admissions for rehabilitation can help in fast tracking the process. 30 % of the respondents prefer to admit patients for 3 weeks, while 26.7% for 1 month. 20% of the Physiatrists who took this survey admit patients for 3 weeks. Some Physiatrists opted to respond to this question with:-

Discharged after acute care. OP follow up. Admission when needed- 1 response

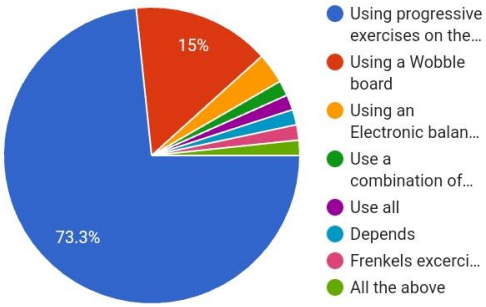
40 days -1 response

If medically stable & family willing & progress is good we sometimes extend the stay -1 response

Depends on patient functional status 2 days to 2 weeks -1 response

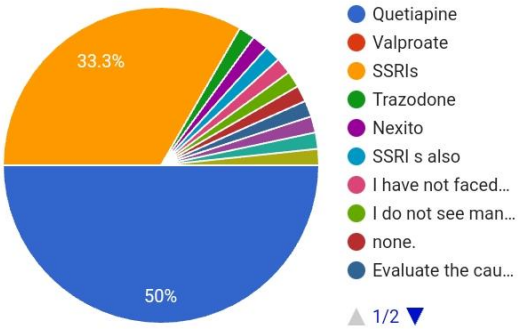
Depends on the assessment status of the patient & goals to be attained -1 response
Depending on the improvement -1 response
8-12 weeks depending on the extend of neurological ststus & presence of external tubings. -1 response
Depends on progress. Willingness of bystanders. Financial situation. Maximum 1 month -1 response
Usually admit under Neuro -1 response
Rehabilitation is done when patient is admitted for acute stroke care under Neurology around 5 to 7 days -1 response
Depends on Admission FIM -1 response
6 weeks to 3 months -1 response
Depends on goals. No generalization -1 response
2 to 3 months -1 response….

4. How do you train for improving balance in your stroke patients?



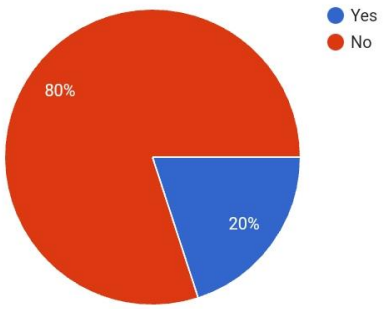
Balance training in stroke can be effected through multiple measures. 73.3% of the respondents preferred using progressive exercises on the ground, while 15% preferred to use a Wobble board for the same. Using an Electronic balance machine was preferred by 3.3%. Two respondents preferred to use all the mentioned options so far, while one respondent preferred to use Frenkel's exercise, & another respondent stated that the technique used depends on the patient.

5. The drug you use most frequently to manage agitation in stroke patients?



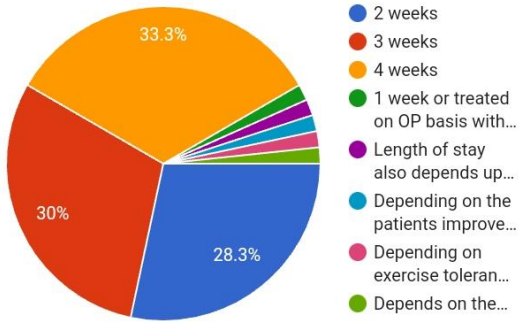
Agitation can be managed by myriad ways, starting from environmental modifications to the use of drugs. As far as pharmacotherapy is concerned using Quetiapine was the most opted measure, which constituted nearly 50% of the responses. The second most frequently used class of drugs were the SSRIs. The other responses included..
Trazadone – 1 response
Clonazepam – 1 response
I have not faced such a situation- 1 response
I do not see many agitated patients with stroke- 1 response
Evaluate the cause & treat accordingly- 1 response
SSRIs also- 1 response
Nexito – 1 response
None- 1 response

6. Do use music therapy routinely for your stroke patients?



80% of respondents don't use music therapy while rehabilitating stroke patients routinely…

7. A patient with history of right hemiplegia one year ago, has features of parkinsonism. He is diabetic, hypertensive, & dyslipidemic & is on medications regularly. He has a Parkinsonian gait & history of falls in the last 3 months. You have to admit this patient for gait & balance training. How long (approximately) will the admission last?



For the patient mentioned in the question, most respondents, 33.3% preferred to admit him/her for 4 weeks. 30% of the respondents preferred to admit the patient for 3 weeks. A 2 week admission was preferred by 28.3% of the respondents. The other responses obtained include..

Depending on the patients improvement- 1 response

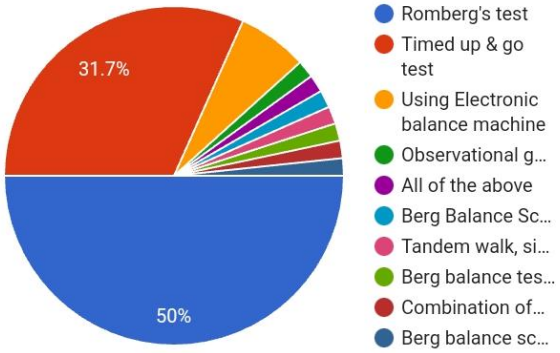
Length of stay also depends upon the external tubings he has. Nothing has been mentioned about his swallow/ speech/bladder status- 1response

1 week or treated on OP basis with frequent follow up – 1 response

Depends on exercise tolerance, response to medications, participation – 1 response

Depends on the patient – 1 response

8. How do you assess balance impairment & fall risk in your patients?



50% of the Physiatrists use Romberg's test to assess balance impairment & fall risk. Given the ease of administration of this test it is perfectly understandable. The next most opted choice was the 'Timed up & go test'(TUG), with 31.7% of the respondents resorting to that. Electronic balance machines were used by 6.7% of the respondents for this purpose. The other responses obtained were…

Berg Balance Scale – 2 responses

Tandem walk, Single limb stand test- 1 response

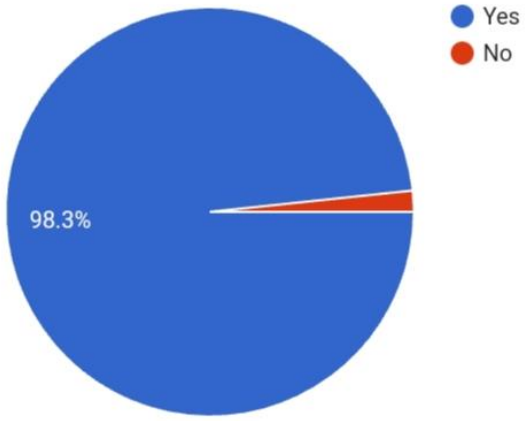
Observational gait analysis – 1 response

All of the above- 1 response

Berg Balance Scale & TUG – 1 response

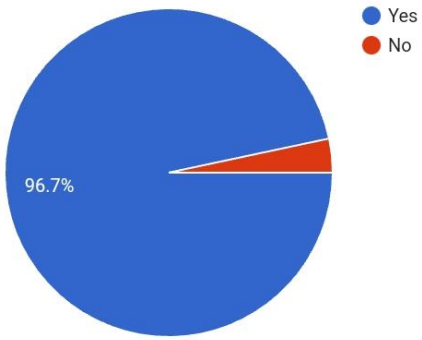
Combination of Romberg's, Timed Up & go, Berg Balance Score, & other coordination tests- 1 response

9. Do you routinely advise risk factor modifications for your stroke patients?



98.3 % of the respondents routinely discuss risk factor modifications with their stroke patients. This is very important for preventing stroke recurrence, & also to improve the quality of life of these patients. It could be really useful if we could develop proper targets for each risk factor, which will definitely help streamline our efforts at secondary stroke prevention.

10. Do you routinely suggest environmental modifications for your stroke patients?



Environmental modifications are useful while managing stroke patients. According to the responses from this survey, 96.7% of the Physiatrists routinely suggest environmental modifications for their stroke patients. Again it will be better if we can have standardized recommendations(for environmental modifications) for the different disabilities seen in stroke patients….

Functional Assessment in Stroke

Dr. Nitin A Menon

MBBS, MD (PMR from Safdarjung Hospital, N. Delhi), Fellowship in Neurological Rehabilitation (NIMHANS), MUHS Fellowship in Pain Medicine (Lilavati Hospital, Mumbai)

Dr. Nitin is Senior Consultant and Dept Head of PMR in Rajagiri Hospital, Aluva - a tertiary care facility providing OP and IP care. Under his aegis the department is adept at managing a wide variety of patients with needs in Neurological rehabilitation, pain management, cardio-pulmonary conditions and other rehabilitation needs.

Need for Functional Assessment

Neurological examination can measure impairments like weakness, sensory deficit, incontinence and aphasia. However, the loss of ability to perform tasks which are deemed essential to the patient's survival and well-being as a result of these impairments (disability) cannot be captured by standard neurological examination. Moreover, the size of brain lesion does not correlate with loss of function (1). Recovery after a stroke can be neurological or functional. Neurological recovery depends on kind of stroke and size of lesion but functional recovery depends on external environment, continuity of rehabilitation care and motivation. Thus, there is a non-linear relationship between impairment and disability. Improvement in loss of muscle strength does not always lead to gain in functional ability. At the same time, rehabilitation care can improve performance of a particular task without any corresponding gain in muscle strength. (2)

Current standards of care dictate that comprehensive assessment of a person with stroke should record previous functional status and current impairments – cognitive, bodily functions, pain and psychological. (3) Measuring functional limitations is important to determine the type and number of services that the person may require. Data regarding patients, burden of care of such individuals, quality of their life, causes of distress and general health status may all be inferred by measuring functional status. (4) Stroke rehabilitation is a dynamic, progressive and goal-oriented process to enable a stroke survivor to reach their optimal health status for which rehabilitation service providers need to perform certain activities to maximise recovery. They need to develop a plan that incorporates patient's and their family's needs, state of neurological deficits and potential for recovery. Such a plan is contingent on continuously assessing functional deficits and improvements and modifying the rehabilitation plan accordingly. (5) Clearly, documenting and assessing functional status is important to the process of stroke rehabilitation

Types of Functional Assessments

a. Assessing bodily function – motor power, sensory loss, bladder control, dysphagia, language and communication, vision

b. Assessing higher functions – mood, memory, executive functions
c. Assessing performance – task completion, balance, walking ability
d. Instrumented assessments – Functional MRI, (fMRI) wearables, sensor-based data capture.

In the early stages of stroke, assessment of impairment takes precedence due to the demands of early stroke intervention programs like intravenous thrombolysis, surgical decompression or thrombectomy. In the first week after stroke typically the NIHSS is recorded to assess the patient's status. By the end of the first week, functional scales like Barthel Index may be used to plan discharge. In patients needing more long-term rehabilitation, specific scales like Fugl-Meyer or FIM may be used to track progress with rehabilitation measures. Later scales try to address mood, cognitive status and quality of life and as individuals gain more function, late rehabilitation needs can be assessed with independence measures in driving, shopping, household activities etc. (6)

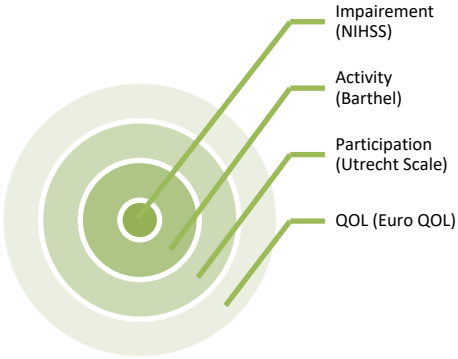


Fig 1 - Assessment Scales Used in Various Stages of Stroke Rehabilitation

QOL = Quality of Life

Table 1 – Examples of Functional Assessment Scales in Stroke (7)

Assessment Tool	Purpose	Description	Comments
Functional Independence Measure (FIM)	For assessment of physical and cognitive functioning	18 items evaluate: self-care, sphincter, mobility, walking, communication and cognition. Derivatives such as Wee-FIM and Alpha-FIM take shorter time for administration	Reliable and most-widely used tool. Specialised training is recommended before its use.
Barthel Index	For evaluating independence in self-care	10 common items of ADL – 8 related to self-care and 2 to mobility	Free to use tool. Wide familiarity with its use.
6-minute walk test	Assessment tool for walking capacity and endurance	Total distance walked in 6 mins including rest periods are measured.	Standardised test protocol available. Cannot be used in highly dependent patients.
10 metre walk test	Assessment tool for walking speed	Time taken to walk 10 metres is recorded	Standardised protocol available. Walkway needed.
National Institute of Health Stroke Scale (NIHSS)	Assessment of neurological impairment after stroke	11 items are assessed: consciousness, facial palsy, neglect, sensory, motor, language and speech. Score 1-4 = mild, 5-14 = moderate, 15-24 = severe and more than 25 = significant	Widely used in early stroke care units.
Orpington Prognostic Scale	For assessment of stroke severity	Assessment of motor function, balance, proprioception and cognition	Should be used only in medically stable patients.
Chedoke-McMaster Stroke Assessment Scale	Assessment of physical impairment and functioning	Assessment of shoulder pain, posture control, arm, hand, leg and foot control. Also used to assess gross motor functioning and walking ability	Comprehensive tool. Takes more than 30 mins to complete assessment.
Fugl-Meyer Motor Assessment	For assessment of motor	Separate items for upper limb, lower limb,	Motor tool only used more commonly –

Scale	functioning	balance, sensations and pain	separately for upper limb and lower limb
Functional Ambulation Categories	Tool for rating ambulation status	0 to 5 (cannot walk to can walk anywhere)	Subject to ceiling effect – cannot elucidate finer aspects of gait problems.
Timed Up and Go test	Screening tool for mobility	From seated position to 3 m and back timing is noted	Useful for balance assessment
Action Research Arm Test	Assessment tool for upper extremity function and dexterity	Assesses grasp, grip, pinch and gross movements	Floor and ceiling effects are present
Box and Block Test	Assessment of gross manual dexterity	Move small blocks one at a time from one compartment to another in one minute	Kit available for purchase
Nine Hole Peg Test	Assessment of fine hand functions	Insert 9 pegs from a container to a peg board and back to a container with timer	Susceptible to practice effects
Wolf Motor Function Test	Assessment tool for upper extremity function	17 items of complexity progressively going from proximal to distal movements	Strength and quality of movement can be assessed.
Hospital Anxiety and Depression Scale	Screening tool for presence and severity of anxiety and depression	14 items (7 each for anxiety and depression)	Simple tool, extensively validated
Mini Mental State Examination	Screening tool for cognitive impairment	11 items related to orientation, registration, recall, attention, calculation and language	Low sensitivity in mild impairment
Montreal Cognitive Assessment	Screening tool for cognitive impairment	11 items in 8 domains. Maximum score is 30	Requires stopwatch for scoring
Line Bisection Test	Screening tool for neglect	18 lines for which patient is asked to bisect each at mid-point	Can also throw positive results in visual field defects
Modified Ashworth Scale	Assessment tool for spasticity	Scored from 0 to 4	Highly used tool
Modified Tardieu Scale	Assessment tool for spasticity	Joint is moved through 2 velocities – slow (V1) and fast (V2) and difference noted	Can be used to differentiate contractures from dynamic spasticity to enable interventions like surgery or chemical neurolysis.

Though the above table is by no means a comprehensive list of functional assessment tools, it is clear that a vast number of measures are available to document functional status of a particular individual. However, applying so many scales is time-consuming and expensive and hence there is a need for fewer but more comprehensive scales covering more items in less time. Functional assessment of stroke which combines Fugl-Meyer assessment motor scale, postural assessment scale for stroke and Barthel Index has good reliability, validity and responsiveness. (8) Oftencomplementary scales can be employed together in certain patients to better elucidate functional status (9) One such scale called activity measure of post-acute care (AMPAC) combines data from scales capturing mobility, daily living and cognition to provide comprehensive outcomes data to guide rehabilitation at the community or state level. (10) The International Classification of Functioning, Disability and Health (ICF) is a framework for measuring health and disability designed by the World Health Organization. Studies have shown a strong correlation between functional scales and ICF and there may soon come a time when ICF may replace existing scales. (11) ICF and ICD-10 taken together may become the standard when reporting on disabling health conditions.

Future Trends

Functional MRI measures the local changes in neural activity using blood oxygenation level dependent signals. It can identify functional brain networks in response to a stimulus or performance of tasks. Studies have shown that fMRI combined with functional scales like Fugl-Meyer are better at predicting functional outcomes than scales

alone in early stroke patients. (12) The exciting developments in wearables have come about with improvements in measuring limb movements with accelerators. As more data becomes available, use of wearable devices to record functional impairments and improvements in both hand functions and walking may be feasible. (13) Large amounts of data generated and reported using functional scales may also aid machine learning and artificial intelligence algorithms to design better and more effective rehabilitation strategies in the future.

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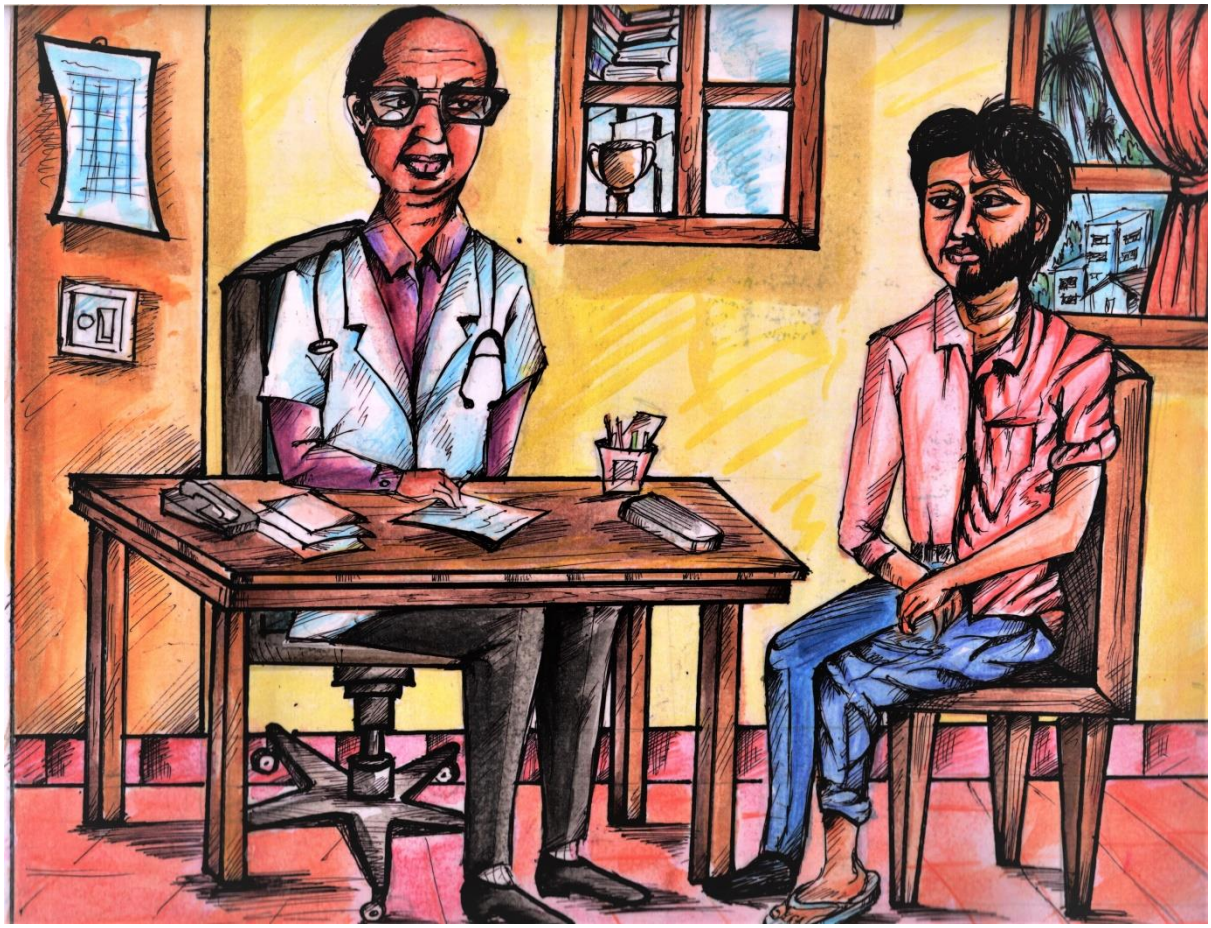
I'm doing 'all right', doctor!!



Cutting Edge Neurorehab Services- The Need of the Hour

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Advanced Rehab cannot & should not be seen in isolation. It should be seen as a part of a complex rehab process. Therefore, before I elaborate on advanced rehab technology, I would like to talk about how our Rehab department came into existence at Jupiter hospital Thane.

This was made possible by comprehensive engagement with administration 2 years prior. I had expressed my concern, that in the present day state of the art rehabilitation services are limited , expensive& do not have easy access. There was a need of making Rehabilitation services accessible to all sections of the society and not just the super rich. It is about time that global & Indian healthcare give due importance to Physical Medicine & Rehabilitation. Inadequate rehab services result in huge burden on society by overloading long-term care facilities. Not just that, the emotional trauma can destroy families.

For any healthcare service to be sustainable it has to be affordable. With a solid backing of Chairman Jupiter group of Hospitals, Dr. Ajay Thakker, we have made this vision a reality by setting up successful state of the art, yet affordable, advanced rehabilitation facilities at Mumbai & Indore. Jupiter lifeline hospitals Ltd is also poised to set up a 100 beded state of the art neuro-rehab center in the UK.

We will be talking about components that make an advanced Rehab centre but, before that the most important ingredient that a Rehab physician and his team should have are Empathy & Compassion.

In my opinion below are three best practices that can be implemented to help establish a more empathetic approach to patients with paralysis.

1. Giving a Personal touch

This can be controversial and many Rehab physicians may not agree with this but relationships matter. Take the time to get to know a few personal details about each patient, their hobbies / interests. Not only does it matter when considering treatment options, but it is also crucial for expressing compassion and empathy. This makes the patient & their family feel that the Rehab team cares. This goes a long way.

2. Positive Gestures

Expressing empathy and compassion include the use of nonverbal cues and positive gestures such as open body language, listening, making eye contact, taking notes, or repeating what a patient says to confirm understanding. Positive gestures demonstrate empathy and reaffirm that the patient is being listened to. Listening to what the patient has to say is extremely important instead of predominantly keeping them at the receiving end of a conversation.

3. Ask for Patients Feedback / Reviews

Providing patients with the opportunity to share their thoughts is an important part of effective communication. Open-ended questions such as "What do you think?" or "How do you feel about that?" are effective ways to engage patients in an open discussion while demonstrating compassionate care.

Empathy and compassionate care is not only the responsibility of the Rehab physician, but is also the responsibility of every member of the rehab team. Patients spend a significant portion of their time interacting with the therapist, nurses, medical assistants, and receptionists. These interactions can provide many opportunities for demonstrating compassion and empathy toward patients. Therefore, training, encouraging, and ensuring support staff engage in compassionate, empathetic patient care will significantly influence a patient's overall experience.

Indications (target population) - but not limited to...

- Early intervention rehab in ICU
- Stroke
- Spinal cord Injury
- Traumatic brain Injury
- Cerebral palsy
- Movement disorders
- Any progressive & non-progressive neurological condition
- Musculoskeletal conditions
- Sports Injuries
- Pain Management
- Amputee rehabilitation
- Post transplant rehab
- Post Bariatric surgery
- Cancer rehab including lymphoedema prophylaxis
- Patients on intra-thecal baclofen pump
- Vestibular Rehab

Common problem areas identified

- Weakness of the arms and/or legs
- Spasticity
- Decrease or loss of sensation
- Bladder and bowel dysfunction
- Aphasia
- Swallow dysfunction
- Breathing difficulty
- Cognitive deficit
- Dysequilibrium
- Inability to perform ADL, etc

Medical complications if timely rehab care not given -

- ICU acquired weakness
- Infections such as Pneumonia and Urinary tract infection

- Venous thromboemobolism such as Deep vein thrombosis (blood clot in the veins of your arms and/or legs) or Pulmonary embolus (blood clot in your lungs)
- Pressure ulcers
- Heterotopic ossification – a condition which causes stiffness of your joints
- Nerve pain, as well as muscle, tendon and joint pain
- Spasticity – muscle tightness
- Autonomic dysreflexia – a condition which causes headache, increased flushing and sweating, changes in your blood pressure and heart rate
- Orthostatic hypotension – a condition which causes a decrease in blood pressure with change in position
- Sexual dysfunction
- Fracture
- Osteoporosis – a condition which causes thinning of bones
- Changes in the mood such as depression and anxiety

How Rehabilitation Can Help

Rehab programs need to be inter-disciplinary in the true sense. Rehabilitation is an integral part of the hospital services in line with evidenced based medicine & best practice guidelines. The coordinated, structured & integrated team approach makes it truly interdisciplinary with weekly case conferences by the rehab team keeping the patients needs at the centre.

Convenient one stop access should be available to all multiple therapy services, all under one roof that cater to all the rehabilitation needs of the patient .The Rehab program provides customized & tailor made programs suited to the needs of the individual. Regular interdisciplinary case conferences to monitor the progress of the program towards achieving measurable functional goals & endpoints, should be arranged.

Goals of Rehab program should be Specific, measurable, achievable, relevant & time bound.

Aims of Rehab Program should be to promote maximal restoration of function , to facilitate early / smooth reintegration of the patient into the community

Spectrum of Rehab care

Integrating rehabilitation services to the main stream healthcare is the need of the hour. The rehab should start from the intensive care units followed through the inpatient ward journey till they are discharged & continue their rehab as needed on outpatient basis. Rehabilitation should be integrated with hospital healthcare at all levels

- ICU based Early mobilization protocol
- Comprehensive Inpatient Inter-diciplinary rehabilitation program
- Out-patient rehabilitation program
- Daycare rehabilitation program
- Rehab OPD Clinic

The Roles of Team Members Need to be Specified

Rehab physician (Physiatrist)

Rehab Physician has admitting rights. He / she leads the interdisciplinary rehab team. Patients are evaluated by the Rehab physician first to determine the nature and severity of the medical condition and then come up with a comprehensive treatment plan that best suits them. Depending on the patient's symptoms and medical complications , the treatment plan will include recommending type of therapy, intensity, duration, frequency & if needed treatment modification. Prescribing medications and performing injections as needed. Medications are commonly prescribed for medical complications as well as to reduce symptoms such as pain, tightness of muscles of arms and legs and bowel and bladder dysfunction. The physician performs injections such as tendon injections, joint injections for joint or muscle pain as well as Botulinum toxin (commonly referred as Botox injections) and nerve block injections to help relieve muscle and tendon tightness. A Rehab physician is also the crucial link between other speciality doctors & the rehab team to ensure all their concerns are addressed.

Physiotherapist

Physiotherapist will focus on various physical exercises to improve weakness in legs, improve their bed mobility, static / dynamic sitting balance, walking and reduce muscle tightness. They can also use physical modalities to reduce pain and inflammation, muscle and tendon tightness, and prevent muscle atrophy.

Occupational therapist

The Occupational Therapist will focus on various physical activities required for daily living for patients with severe physical and/or cognitive impairment and also teach cognitive exercises thereby compensating the cognitive deficits in any. Occupational therapists also focus on various physical exercises to improve weakness in the upper limbs & transfer training. The final phase of treatment involves patient training for successful community integration (education, employment etc).

Speech & Language Therapist

They focus on treatments for Aphasia and disariculation (practicing word retrieval, exercising conversation skills in a group setting, having structured discussions and role-playing everyday communications). Also speech therapists play an important role in dysphagia (evaluation & management).

Orthotist

They can fit you with an orthosis to reduce muscle tightness as well as improve your walking and arm function.

Neuropsychologist

A Neuropsychologist evaluates patients with depression and anxiety, that is commonly seen after any major life-changing illness or injury and guides them through the process of rehabilitation thereby

improving their quality of life through motivation and counselling.

Nutritionist

Malnutrition or undernourishment is a common problem in this population. For optimal recovery, a Nutritionist recommends an appropriate intake of nutrition.

Rehabilitation nurse

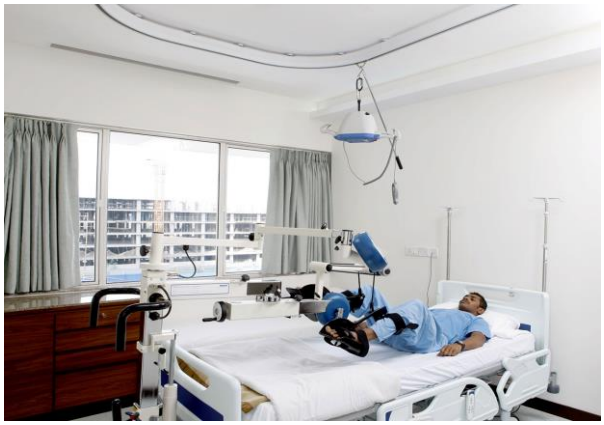
Inpatient rehab program is strengthened by dedicated Rehabilitation Nurses. They train patients with central nervous system injury to manage their bowel and bladder with guidelines laid down by Rehab physician, as part of bowel & bladder training. Performing and training wound care management for patients with pressure ulcers are also handled by a Rehabilitation Nurse.

Expectations of Recovery

Rehab Physician is the best person to counsel the patients . Depending on the severity and chronicity (time duration since injury/illness) of the injury/illness, recovery duration may differ. Complete neurological recovery is often possible if the injury is mild and incomplete. In the case of a moderate to severe incomplete injury or a complete injury, full neurological recovery may not be possible; in that case Rehab Physician will help you to optimize your independence and integrate you into the community despite your physical limitation. If the injury is too severe, then the goal would be to improve your quality of life by helping patient be as independent as possible with your day to day living, decrease pain and prevent complications. Rehab counselling plays a huge role. Indeed at times it is a tight rope walk as we do not want to push a patient into depression but at the same time at all costs avoid making promises we cannot keep. This is why making realistic goals is so important. At times, this can also be very stress-full for the Rehab team as along with the patient we too have to face the harsh realities of life at times.

Advanced Rehab Technology

Advanced rehab facility needs adequate space , not just for the rehab training area but with dedicated rooms for inpatient rehab program & complete array of joint specific advanced rehab technology (Robotic rehab, sensor based rehab, computer assisted rehab & virtual reality), all in the same vicinity for easy / safe patient transfer & maximise sessions as per need of the patient.



Times are changing

Today India has centres providing specialised rehab services such as:-

- Robotic Rehabilitation
- Motor Re-learning program
- Balance & coordination training
- Gait training
- Hand Rehabilitation
- Facial Rehabilitation
- Sensory integration therapy
- Constraint induced motion therapy (CIMT)
- Proprioceptive neuromuscular facilitation (PNF)
- Neuro-developmental therapy for adult & children (NDT)
- Geriatric Rehabilitation

- Spasticity management
- Bladder & Bowel retraining
- Activity of daily living Training
- Splinting / Orthotic management
- Assistive devices (Assessment & training)
- Wheel chair training
- Transfer training (Surface to surface transfer)
- Sexual Rehabilitation
- Job evaluation& modifications
- Home modification for architectural barriers
- Fall prevention
- Patient & family counselling& education

Advanced Rehab technologies available in India

- Robotic & computer assisted rehabilitation for Wrist, hand & fingers
- Robotic & computer assisted rehabilitation for arm & shoulder for task oriented training
- Interactive therapy surface for motor training
- Sensor based rehabilitation device for static & dynamic balance assessment & training with seating & standing features
- Computerized work station for continuous record of all patients
- Myofeedback using surface & cavity electrodes which gives visual biofeedback on a LCD screen.
- EMG biofeedback & Functional electrical stimulation
- Virtual Reality treadmill with unweighing system
- Antigravity treadmill
- Dynamic stair trainer
- Lokostation (USA) – Advanced Robotic Gait rehabilitation tool which comfortably redistributes the patients weight with offloading system to reduce the risk of falls
- Lokomat- Exoskeletal BWS Robotic gait trainer.
- Mechanised devices for early mobilisation (Sit to stand) - Sara Plus & Sara steady
- Over-head rail system connecting patient room to any part of the Rehab lab for gait training & patient transport.

Advanced Rehab Technology – Advantages

- One of the fastest growing industries and there's A LOT of it!
- Offers many additional treatment options
- Better patient engagement
- Provides tool to produce high repetition dosing
- Provides task specific training
- Provides sensory and motor feedback
- Alters negative effects of gravity
- Improves ability to control emerging movement patterns

Advanced Rehab Technology - Disadvantages

- Slow translation of evidence to clinical practice.
- Quantity and speed at which novel rehab technologies are being introduced.
- Organizational barriers
- Adequately trained people providing technology intervention
- Institutional financial constraints

- Space & environmental considerations
- Technology can be costly, may or may not produce revenue.
- Long term and ongoing access to technology by the patient is inadequate.

Integration of technology

- The Stakeholders
- Patient
- Researchers
- Clinicians
- Administrators
- Developers & Sales

Is it clinically applicable ?

1. What percentage of our patient population could use this device as a primary source of treatment?
2. Is there empirical or anecdotal evidence that this technology had therapeutic benefit for our clients?
3. How strong is this evidence?
4. Is there evidence to support use of this device with similar patient populations?
5. Is there adequate space available to house the device?

Ensure patient safety

- Is it FDA Approved?
- Is it approved by hospital review board?
- Does the vendor offer training?
- Is there a history of serious adverse events with the device?

Global concensus

What is the rehab technology industry getting right?

- Ability to grade along recovery
- Inclusion of visual & auditory feedback for motor learning principles
- Use of gaming approach to engage patients
- Ability to deliver repetitions and intensity to support changes in plasticity
- Filling of gaps in clinical tools available
- Incorporation of functional tasks in virtual environment

What's still deficient in the rehab technology?

- Portability of devices
- Affordability
- Contributions to body of evidence

Sharing one of our success stories

Saloni Merchant- Factors that led to a miraculous recovery

(Rehabilitation perspective)

A 16 year old girl who had fallen off a 15 feet high wall leaving her paralysed waist down, she is now able to walk & run independently. The fall had led to a spinal fracture & paraplegia. Timely surgery & rigorous neuro-rehabilitation at Jupiter hospital for over 2 months helped her finally recover fully.

Saloni underwent a comprehensive inter-diciplinary coordinated rehab program including conventional therapy as well as

advanced rehab technologies in the form of robotic , sensor based, computer aided & virtual reality rehabilitation. Rehabilitation is an important part of the patient journey to recovery after a medical setback in life so as to live an independent life.

Apart from this I would like to share my thoughts on what attributed to a miraculous recovery in Salonis case.

1. I really appreciate Spine surgeon not only for his surgical skills but the faith he put in me & my rehab team. I was the first person he called when he came out of the operating room as he told me that she needs a good rehab program to compliment the surgery. **There is an immense need to spread the awareness about rehabilitation amongst healthcare professionals.**
2. The faith that the family put into us. Saloni has excellent family support. Her parents were extremely cooperative & understanding.
3. Team approach & team spirit in the rehabilitation team is always crucial to a successful rehab process.
4. She had access to state of the art advanced rehabilitation technology.
5. Last but not least, regular rehab counselling of patients & her family. This was a devastating incident not only for the patients but the family as well. The parents were shattered & at times seemed to lose hope & think about the worst. Rehab counselling assured them that they are not alone in this struggle. We advice our patients to concentrate on things their disability does-not prevent them from doing & don't regret the things it interferes with. Its important to have a emotional connect with the patient & their family.

In the end me & my rehabilitation team are happy that we are a part of this family's most memorable experience. Their smile says it all as they told me that they had never imagined that they could be happy again. There is nothing more satisfying than that.

The Afterglow…

Stroke Prevention

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In this two part article we'll briefly discuss about prevention of strokes. I'm only trying to galvanize the reader to dive deeper into this topic, which is as interesting as it is complicated.

Risk Factors Vs. Risk Markers

Before we dive into the realm of stroke prevention, we need to differentiate between a risk factor & a risk marker. The term "risk factor" refers to factors that heighten risk for a condition and when modified reduce the risk of that condition (e.g., hypertension increases the risk of stroke and treatment of hypertension reduces stroke risk). The term "risk marker" refers to factors that elevate risk for a condition but have not as of yet been shown to reduce that risk because they have either not been tested or efforts at successful modification have failed (e.g.,homocysteine increases the risk of stroke but reduction of homocysteine with B-complex vitamins has not been shown to reduce stroke risk)[1].

According to the Indian Stroke Association, the incidence of stroke has increased by 100 percent in the past decade. As per a certain estimate, 18 lakh people suffer from stroke in India every year. Stroke contributes to around 30 percent of the overall morbidity in India. One Indian suffers from a stroke every 20 seconds. Stroke risk in India: 1 in 5 in a lifetime[2].

About 90% of all strokes can be attributable to modifiable risk factors, after accounting for joint effects of combinations of risk factors. The remaining 10%, or so, of strokes are likely attributable to independent effects of genetic factors, unmeasured and unknown risk factors, and gene-environment interactions[3].

The ideal evaluation for stroke risk should include the following:-

- *The usual suspects*- Demographic Risk Factors, Hypertension, Physical Inactivity, Heart Disease, Smoking, etc

- *Subclinical brain, retinal & systemic lesions*
- *Subclinical vascular lesions & haematological abnormalities*
- *Biomarkers & Genetic Factors*

The Usual Suspects

These risk factors have long been discussed. They include:-

Age- Age is probably the risk factor best correlated with stroke. The Framingham Study showed that as a person ages, his or her risk of stroke increases, with incidence rates per 10,000 increasing from 22% to 32% to 83% in the age groups 45–55, 55–64, and 65–74 years, respectively. With increasing age, an exponential increase occurs in the frequency of stroke.

Sex- Men have a greater frequency of stroke than women, but because life expectancy is higher in women, overall, more women die of stroke than men and often outnumber men in many stroke studies.

Ethnicity- Asians have a higher risk of intracerebral hemorrhage than whites. However ischemic stroke is the most common type of stroke in Asians.

Hypertension- A relatively new concept that Sacco emphasized in his 2006 Feinberg lecture is the idea of "vascular risk modulators". Doctors and epidemiologists have been accustomed to analyzing various risks as binary variables. For example, an individual is considered to have or not have hypertension if their blood pressure exceeds or falls below a set number such as 140/90 mmHg. Similarly, they are defined as diabetic, or to have hypercholesterolemia if their blood sugar and blood cholesterol levels are above or below arbitrarily designated value. Studies have shown, however, that risk factors are all continuous rather than categorical (yes or no) variables. A systolic blood pressure of 160 carries more risk than 150, and in turn 150 has more risk than 140, and 140 more risk than 130[1].

High blood pressure is often referred to as the 'crown jewel' of stroke prevention and the most important modifiable risk factor for stroke.

Hypertension is extremely common & many individuals with high blood pressure are either untreated or undertreated. Blood pressure reduction is effective along a range of systolic and diastolic blood pressures, and at all ages, including the elderly. Antihypertensive treatment reduces stroke incidence and mortality in individuals aged over 80 who have high blood pressures.

Systolic blood pressure is at least as important and may be more important in promoting stroke and other manifestations of cardiovascular disease as diastolic pressure. In the Framingham study, average systolic blood pressure increased by 20 mmHg between ages 30 and 65. The Systolic Hypertension in the Elderly Program (SHEP) showed that isolated systolic blood pressure in the elderly is a very important stroke risk factor, and that optimizing systolic blood pressure reduction decreases the risk of stroke.

Blood pressure reduction is as important in women as it is in men. Women incur as many, if not more, complications of hypertension than men. In women over 65, stroke is the most common vascular event, exceeding myocardial infarction.

What about pulse pressure? Pulse pressure was an important risk factor for the development of atrial fibrillation in the Framingham study. In other studies pulse pressure was the best predictor of stroke

mortality outperforming systolic, diastolic, and mean arterial pressures, and pulse pressure during an acute stroke was an independent predictor of long-term mortality.

Casual blood pressure measurement in a doctor's office are inadequate to quantify the severity of hypertension. Twenty-four-hour blood pressure monitoring yields more useful information than casual or even multiple daytime blood pressures. Blood pressure may not appropriately dip at night (referred to as non-dipping) or often dips too much at night (dipper status). Studies using ambulatory 24-hour blood pressure monitoring have shown that patients with excessively high and abnormally low nocturnal blood pressures and high pulse pressures have a higher frequency of new strokes and hypertension-related white matter damage than patients who have normal nocturnal blood pressures.

The type of antihypertensive agent is important. A variety of different types of antihypertensive agents – diuretics, alpha-blockers, beta-blockers, calcium-channel blockers, angiotensin-converting enzyme (ACE) inhibitors, and angiotensin-receptor binding (ARB) agents – have all proved effective in reducing blood pressure and cardiovascular mortality. The ideal antihypertensive agents for a patient with CAD, or post MI are Beta blockers or ACE Inhibitors, while the best drugs for patients with a stroke or TIA are Thiazide diuretics or ACE inhibitors.

Cardiac Diseases:- The incidence of various cardiac diseases is highly correlated with stroke risk. Cardiac disease is a direct cause of stroke when the heart is a donor source of emboli to the brain. Heart disease, usually related to hypertension or coronary artery disease, coexists with hypertensive and atherosclerotic disease of the cervico-cranial arteries in other patients. Particularly important is that heart disease is the major cause of death in patients with strokes, TIAs, and carotid artery disease.

Metabolic syndrome, Obesity, Diabetes, Insulin Resistance:-Studies show clearly that risk in relation to glucose utilization, like blood pressures, should be considered over a continuum. Knowledge of the interrelationship of abdominal obesity to glucose metabolism, insulin sensitivity and resistance, and hypertension has led to definition of a "metabolic syndrome" that represents a very important risk factor for stroke as well as other cardiovascular conditions.

The components of Metabolic syndrome, as we all know, include abdominal obesity, atherogenic dyslipidemia, raised blood pressure, insulin resistance with or without glucose intolerance. It is a pro-inflammatory state & prothrombotic state.

Obesity is an important component of the metabolic syndrome, and data now clearly identifies obesity as a major risk factor for all forms of cardiovascular disease including stroke. BMI greater than 30 is an important risk factor for stroke in men and women[1].

In one study, the annual number of strokes and deaths due to stroke increased substantially from 1990 to 2019, despite substantial reductions in age-standardised rates, particularly among people older than 70 years. The highest age-standardised stroke-related mortality and DALY rates were in the World Bank low-income group. The fastest-growing risk factor for stroke between 1990 and 2019 was high body-mass index. Without urgent implementation of effective primary prevention strategies, the stroke burden will probably continue to grow

across the world, particularly in low-income countries[4].

Diabetes is a risk factor for intracranial and extracranial large artery occlusive disease and penetrating artery disease. Intracranial branch artery atheromatous disease is particularly common among diabetic patients. Atheromatous branch disease affects predominantly the paramedian pontine penetrating arteries, anterior choroidal arteries, and anterior inferior cerebellar arteries[1].

Smoking:-Paffenbarger and Williams found that smoking was one of the most important risk factors among college students who later had ischemic strokes. Smoking is an important modifiable risk for ischemic stroke and SAH. The risk of stroke begins to revert at about 2 years' time after smoking cessation and reverts to approximately that of a non-smoking population by 5 years after smoking cessation. The posited mechanisms by which smoking increases the risk of stroke include: an increase in blood viscosity and fibrinogen levels, vascular endothelial damage and subsequent formation of atherosclerosis, platelet aggregation, and vasoconstriction.

Dyslipdemia:- In the past, abnormalities of blood lipids, especially total cholesterol, triglycerides, and high- and low-density lipoproteins, have been considered less closely correlated with stroke than with coronary heart disease. However, elevated levels of triglycerides are a risk factor for large-artery atherosclerotic stroke. In the Framingham study and others, the risk is primarily shown in patients younger than 55 years old. A relationship between low cholesterol and ICH in Asians has been shown in several reports. The mechanism of how low cholesterol levels increase the risk for brain infarction and SAH remains obscure. A recently published meta-analysis of trials supports the use of statins for stroke prevention as there is a 22% relative risk reduction for stroke.

Alcohol Use:-Excess alcohol intake increases the risk of brain hemorrhage. In the Honolulu Heart Study, alcohol consumption was associated with intracranial hemorrhage, but not with ischemic stroke. Most epidemiologists describe a J-shaped curve in relation to alcohol consumption and the risk of ischemic stroke. Light to-moderate regular consumption of alcohol seems to be inversely related to carotid artery and systemic atherosclerosis, yet acute and chronic heavy use of alcohol increases ischemic stroke risk.

Symptomatic Peripheral Vascular Disease:- Peripheral vascular arterial occlusive disease is a strong predictor of extracranial cerebrovascular and coronary artery disease. Patients with claudication and peripheral arterial disease have a high frequency of stroke and cardiovascular mortality.

TIAs:-When properly diagnosed, TIAs are an indication that occlusive cerebrovascular disease has already become established.

A retrospective review of 2146 stroke admissions in the United Kingdom showed that a preceding TIA was present in 23%; 17% of TIAs occurred on the day of the stroke, 9% on the preceding day, and 43% during the preceding week. Patients with clinical TIAs who have infarcts on brain imaging may have an especially high risk of stroke soon after the TIA.

Hormones &OCPs:- Most of the data that attributed a risk of stroke to the use of oral contraceptives were acquired in patients who used pills with a relatively high estrogen content (50 μg of ethinyl estradiol or

estranes). Lower-dose estrogen (20–40 μg of ethinyl estradiol) combined with newer progestational drugs are now usually prescribed as oral contraceptive agents. Studies show that young women who take these lower-dose pills do not have an important increased risk of stroke.Among users of low-dose contraceptives, strokes most often occur in older women who have other stroke risk factors, such as hypertension and cigarette smoking.

Women with six or more pregnancies are at a higher risk for stroke and cerebral infarction than women who have had fewer pregnancies. The risk of cerebral venous thrombosis is especially high during the puerperium. Under the US Preventive Services Task Force a systematic review concluded that menopausal hormone therapy with estrogen plus progestin and estrogen therapy alone decreased the risk of fractures but increased the risk for stroke, thromboembolic events, gallbladder disease, and urinary incontinence.

Sedentary Lifestyle & Lack of Exercise:- Lee and Paffenbarger studied the relationship between physical activity (walking, climbing stairs, sports participation, and recreational physical activities) and stroke risk among 11,130 men who were Harvard University alumni. They found that decreased stroke risk was found at energy expenditures of 1000–1999 kcal per week, with further decrements found at 2000–2999 kcal per week. Higher rates of exercise did not further decrease the risk of stroke.

A meta-analysis of 23 studies concluded that there was strong evidence that moderate and high levels of physical activity were associated with reduced risk of total, ischemic, and hemorrhagic stroke.

A 2013 guideline statement from the American College of Cardiology/American Heart Association recommended moderate to vigorous physical activity for about 40 minutes per session at a frequency of 3–4 sessions on average per week to reduce LDL-cholesterol and non-HDL cholesterol and to lower blood pressure. The target heart rate during exercise is 60–85% of the maximum for age or about 220 minus one's age[1].

Diet & Nutrition:- Diet and nutrition are important to address in stroke prevention counseling. Not only have dietary patterns been associated with risk factor management, but recent studies have indicated an independent role in stroke risk reduction. As large-scale nutritional studies are difficult to conduct, data come primarily from observational or cohort studies. Findings from the Nurses' Health Study and Health Professionals Follow-Up Study have provided examples of dietary patterns associated with lower risk of stroke[5].

Increased fruit and vegetable intake was associated with reduced stroke risk, with the highest protective effect from cruciferous and green leafy vegetables and citrus fruits and juices. Each additional one serving per day was associated with a 6% lower risk of ischemic stroke. A single serving of caffeinated or decaffeinated coffee decreased stroke risk by approximately 10%. However, daily servings of soda appear to increase the risk of ischemic stroke, with 13% increase per serving per day of sugar-sweetened soda and 7% increased risk of ischemic stroke per daily serving of low-calorie soda. An additional meta-analysis indicates lower stroke risk with two to four or more than five servings of fish per week compared to less than one serving per week.

Perhaps the most compelling evidence for the influence of nutrition specific to stroke risk comes from the Prevencion con Dieta Mediterranea (PREDIMED) study comparing the Mediterranean diet supplemented with either extra-virgin olive oil or mixed nuts compared to a low-fat control diet. The Mediterranean diet is characterized by high intake of olive oil, fruits and vegetables, nuts, and whole grains with moderate intake of fish and poultry and low intake of dairy, red and processed meats, and sweets. The Mediterranean diet with either olive oil or nut supplementation was associated with lower risk of a composite primary end point of myocardial infarction, stroke, or cardiovascular death. Secondary end point analysis revealed a significant decline in stroke compared to the control diet, but the difference in other end points was not significant. Lower risk of ischemic stroke with adherence to the Mediterranean diet was confirmed in the REGARDS cohort as well.

The dietary pattern that is most effective for lowering both LDL-C and blood pressure includes intake of vegetables, fruits, whole grains, low-fat dairy products, poultry, fish, legumes, nontropical vegetable oils, and nuts while limiting intake of sweets, sugar-sweetened beverages, and red meats. These recommendations are consistent with the DASH dietary pattern and the AHA Diet.

Also of importance in lowering blood pressure is reduction of sodium intake. Lowering of blood pressure was seen with sodium reduced to 2400 mg/d, with further improvement with a sodium intake of only 1500 mg/d. A 1000 mg/d reduction of sodium intake reduces cardiovascular events by approximately 30%, and higher sodium intake is associated with a greater risk of fatal and nonfatal stroke and cardiovascular disease…..

(Continued on page 56)

"I exist as I am, that is enough.."

The above quote was by Walt Whitman, the reputed American poet, essayist & journalist. I don't intend to digress into realism or literary discussions in this article. This short piece discusses his struggle with stroke...

A paralytic prod descended upon **Walt Whitman** (May 31, 1819–March 26, 1892) in his fifty-third year when a stroke left him severely disabled. Writing to a German friend on his own sixty-third birthday, a decade after his paralytic stroke, Whitman reflects on what the limitations of living in a disabled body have taught him about the meaning of a full life:

From to-day I enter upon my 64th year. The paralysis that first affected me nearly ten years ago, has since remain'd, with varying course — seems to have settled quietly down, and will probably continue. I easily tire, am very clumsy, cannot walk far; but my spirits are first-rate. I go around in public almost every day — now and then take long trips, by railroad or boat, hundreds of miles — live largely in the open air — am sunburnt and stout, (weigh 190) — keep up my activity and interest in life, people, progress, and the questions of the day. About two-thirds of the time I am quite comfortable. What mentality I ever had remains entirely unaffected; though physically I am a half-paralytic, and likely to be so, long as I live. But the principal object of my life seems to have been accomplish'd — I have the most devoted and ardent of friends, and affectionate relatives — and of enemies I really make no account[*].

* https://www.themarginalian.org/2017/12/20/walt-whitman-specimen-days-meaning-of-life/?mc_cid=23ad5053f9&mc_eid=f8d2c9f53e

Stroke Prevention – Part Deux!!

Now we're gonna deal with risk factors & markers with which you may not be well acquainted….

Subclinical Brain, Eye & Systemic Lesions

Silent Infarct??(there's no such thing!!)

Modern brain imaging often reveals abnormalities related to vascular diseases even when an individual has not had a known stroke. In the Rotterdam Scan Study, a population-based cohort study of 1077 individuals aged 60–90, "silent brain infarcts" were five times more common than symptomatic brain infarcts. These lesions give evidence that the patient has a biologically active process that has already damaged the brain.

White Matter Lesions

When the white matter abnormalities are irregular and are located in the corona radiata or centrum semi-ovale and jut out from the periventricular area into these regions, then active vascular disease is present. Most often the underlying condition is one that predisposes to penetrating artery disease – hypertension, diabetes, or hyperviscosity.

Brain Microbleeds

Echo planar MRI scans often show small old lesions that image as discrete, black, usually round abnormalities. These abnormalities are often referred to as microbleeds. The two most common conditions that produce small hemorrhages are hypertension and cerebral amyloid angiopathy. Hypertension usually causes deep microbleeds and cerebral amyloid angiopathy causes mostly cortically based ones.

Retinal & Systemic Lesions

Old retinal infarcts, Hollenhorst plaques and other retinal emboli, and the presence of venous stasis retinopathy provide evidence of a potential embolic source or severe occlusive disease in the heart-aorta-carotidophthalmic artery pathway.

We know that systemic embolisms to peripheral and visceral locations are often present but difficult to diagnose clinically. In one study, among 27 consecutive patients with non-valvular atrial fibrillation, 6 had subdiaphragmatic visceral infarcts on diffusion-weighted abdominal MRI imaging.

Subclinical cardiac-cervico-cranial-hematological lesions:-

Cardiac & Aortic Lesions

Electrocardiogram (ECG) can detect regions of myocardial hypertrophy and ischemic damage and identify arrhythmias. Transthoracic echocardiography yields a good image of the cardiac valves and ventricles and can show areas of akinesis, hypokinesis, and generalized cardiac dysfunction with a low ejection fraction. Transesophageal echocardiography (TEE) shows the atria, and is useful in identifying cardiac septal abnormalities as well as providing a view of the aortic arch and ascending aorta. Large aortic plaques are readily visible on TEE. CT angiography (CTA) can show the aortic arch in more detail than TEE and can identify

calcifications and plaques. Non-invasive coronary artery imaging using modern electron-beam CT or MRI can show coronary artery calcifications that correlate well with coronary artery occlusive disease. Coronary angiography is sometimes useful even in asymptomatic patients in whom the ECG, echocardiography, stress testing, or non-invasive vascular imaging gives rise to a strong suspicion of important coronary artery disease.

Subclinical Cervico- Cranial & Intracranial Lesions

Patients with extracranial carotid and vertebral artery plaques and thickened arterial walls have atherosclerosis, and thus have a higher risk of ischemic strokes and brain and retinal infarcts. The risk increases proportionately to the severity of arterial stenosis and also correlates with the presence of ulcerated carotid artery plaques. The availability of duplex carotid and vertebral artery ultrasound scanning makes it possible to objectively detect and measure the severity of atherosclerotic abnormalities within the neck arteries. The intima-media thickness of the carotid artery is also an important parameter to study since increased thickness correlates with atherosclerotic disease. The progression or regression of these abnormalities during and after treatment gives clinicians a means of monitoring the atherosclerotic process in the arteries studied.

Heamatological Conditions

Polycythemia and severe anemia both predispose to stroke and cerebral venous occlusions. Thrombocytosis and thrombocytopenia also convey important stroke risks. A complete blood count including a platelet count and a prothrombin time reported as an international normalized ratio (INR) should be part of the routine evaluation for stroke risk.

Biomarkers & Genetic Factors

Haematocrit

Pathologically elevated and high normal hematocrits have been associated with increased stroke and TIA risk even when hypertension and cigarette smoking are accounted for in the analysis. Cerebral blood flow nearly doubles when a hematocrit of 45 is lowered to 35.

High WBC Count

The white blood cell (WBC) count is often elevated in patients with myocardial infarction and is also often slightly high in patients with brain infarcts. A high WBC at entry into the Warfarin-Aspirin Symptomatic Intracranial Disease (WASID) trial was associated with an increased risk of stroke and vascular death when compared with patients with the lowest quartile of WBC counts.

hs CRP & LpPLA2

Elevated, high-sensitivity C-reactive protein levels correlate with a risk of stroke, cardiovascular disease, and carotid and intracranial large-artery atherosclerosis. An inflammatory marker that is specific to blood vessel inflammation, lipoprotein-associated phospholipase A2 (LpPLA2), is a useful marker to determine risk of stroke and myocardial infarction.

High Fibrinogen Levels

The plasma level of fibrinogen is also an important determinant of stroke risk. Individuals with high levels of fibrinogen have an increased risk of developing myocardial infarction and stroke.

High Plasma Homocysteine Levels

Elevated levels of plasma homocysteine increase the risk of developing myocardial

infarction and stroke. The risk is important especially when the homocysteine level is very high. High plasma homocysteine levels and low concentrations of folic acid and vitamin B6 (probably because of their role in homocysteine metabolism) are associated with increased risk of large artery atherosclerosis.

Glycosuria & Proteinuria

Glycosuria and heavy proteinuria predispose to stroke. Even relatively small amounts of protein in the urine (microalbuminuria) and reduced glomerular filtration rate are risk factors for stroke.

Genetic Disorders

Some genetic disorders, such as Fabry's disease, homocystinuria, Ehlers–Danlos syndrome, and pseudoxanthoma elasticum, are recognized to confer increased stroke risk. Various genetically-related disorders affect blood coagulability including factor V Leiden and a prothrombin gene mutation.

Levels of Stroke Prevention, Risk Calculators & the Polypill…

Prevention is customarily separated into primary prevention (strategies to prevent stroke in patients who have never had a stroke) and secondary prevention (strategies to prevent a stroke recurrence).

Primary prevention

For primary prevention, public education must be improved, especially in underdeveloped countries. Improvement in general health practices in the population undoubtedly decreases modifiable stroke risk factors in many patients. Educating the public to implement good general health measures probably would have a large impact on the frequency of stroke and other cardiovascular disease. The public should be encouraged to stop smoking, avoid excessive alcohol intake, exercise regularly, make time for leisure activities, avoid becoming overweight, and decrease intake of foods high in sodium, fat and cholesterol.

Secondary prevention

For secondary stroke prevention, identification of the mechanism of the initial stroke is most important. In patients who have lacunar infarcts caused by penetrating artery disease due to hypertension and in patients who have hypertensive ICHs, control of blood pressure is the most important strategy. In patients with severe carotid artery stenosis, surgery or angioplasty of the involved carotid artery may be the best strategy for secondary prevention. In patients with non-stenosing plaques, statins, and an agent that decreases platelet functions, such as aspirin, clopidogrel, cilostazole, or combined low-dose aspirin and modified-release dipyridamole, are probably most effective. In patients who have had brain embolism caused by atrial fibrillation, anticoagulation with warfarin or one of the newer oral anticoagulant agents (e.g., direct thrombin inhibitor, factor Xa inhibitor) represents the best strategy for secondary stroke prevention unless contraindications to the use of oral anticoagulants are present.

Tertiary prevention

Tertiary prevention goes beyond secondary prevention measures to address the care of persons who have already suffered a first stroke. Tertiary measures are aimed at the prevention of a second or third stroke and the minimalization of disability through patient rehabilitation, in order to reestablish partial or complete independence and improve quality of life[6].

Risk Calculators

Numerous clinical risk prediction scores have been developed all aiming to do the

same thing – identify patients at high risk of stroke to prioritise services. However, the ABCD2 and related scores have achieved particular prominence such that the ABCD2 score is recommended for use in UK stroke prevention services[8].

An ideal stroke risk assessment tool that is simple, widely applicable and accepted, and takes into account the effects of multiple risk factors does not exist. Based on some Indian studies, Framingham Risk Scoring – Cardiovascular Disease (FRS-CVD) may be used to predict risk for stroke over 10-20 years for an individual, subject to further validation in Indian patients with stroke. Research is needed to validate risk assessment tools across age sex, and regional groups; to evaluate whether any of the more recently identified risk factors add to the predictive accuracy of existing scales; and to determine whether the use of these scales improves primary stroke prevention[8].

Polypill

A fixed-dose combination polypill combining several medications, which are used in clinical practice for CVD risk reduction (e.g., blood pressure (BP) and lipid lowering medications, aspirin) in conjunction with lifestyle modification, may be the optimal therapy for stroke prevention. olypills may close gaps in prevention and therapy, improve adherence, and simplify drug regimes.

A polypill strategy might be optimal for stroke prevention in a developing region such as India with a large, relatively young population at high cardiovascular risk, low awareness of risk factors, and with low compliance in primary and secondary prevention treatment. A publicly financed mass-strategy with a single polypill available at low cost may increase compliance for primary prevention and might be superior to an individual approach with several medications. In developing countries with stroke occurring at younger age, polypill interventions containing just BP and lipid-lowering components could start at younger age (e.g., 40 years). Inclusion of aspirin in the polypill in these settings should be avoided because of its known hemorrhagic side effects and the already high risk of hemorrhagic strokes in developing countries. Smartphone apps can be used as cheap recruitment and motivational tools in a large population that does not necessarily have access to medical doctors[9].

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Journal Scan

Stroke Rehabilitation

Maureen Le Danseur

Acute stroke care is completed, and it is time for discharge. Depending on patient needs, they may continue care with outpatient therapies, home health, long-term acute care, or an acute inpatient rehabilitation facility. This is an overview of the rehabilitation process, nursing care, an interdisciplinary team approach, and psychosocial aspects of acute inpatient rehabilitation. Rehabilitation nursing focuses on goals, outcomes, the attainment or maintenance of functional capacity, understanding long-range patient needs, and wellness. From the moment care delivery is initiated we should all be a part of the rehabilitation process, a link in the chain toward improved quality of life.

Crit Care Nurs Clin North Am. 2020 Mar;32(1):97-108.

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He is the Consultant Physiatrist at Meitra Hospital, Kozhikode. Dr.Noufal completed his MBBS from Govt. Medical College, Kozhikode. He went on to do his MD in PMR from AIIMS, Delhi. After bagging a gold medal in DNB exam in 2018, he went on to work as Consultant Physiatrist at Baby Memorial Hospital, Kozhikode. His areas of interest include Neurorehabilitation & Interventional Physiatry.

Prediction of motor recovery after stroke: advances in biomarkers

Cathy M Stinear

Stroke remains a leading cause of adult disability, and the recovery of motor function after stroke is crucial for the patient to regain independence. However, making accurate predictions of a patient's motor recovery and outcome is difficult when based on clinical assessment alone. Clinical assessment of motor impairment within a few days of stroke can help to predict subsequent recovery, while neurophysiological and neuroimaging biomarkers of corticomotor structure and function can help to predict both motor recovery and motor outcome after stroke. The combination of biomarkers can provide clinically useful information when planning the personalised rehabilitation of a patient. These biomarkers can also be used for patient selection and stratification in trials investigating rehabilitation interventions that are initiated early after stroke. Ongoing multicentre trials that incorporate motor biomarkers could help to bring their use into routine clinical practice.

Lancet Neurol. 2017 Oct;16(10):826-836.

Stroke Rehabilitation: Therapy Robots and Assistive Devices

Verena Klamroth-Marganska

Motor impairments after stroke are often persistent and disabling, and women are less likely to recover and show poorer functional outcomes. To regain motor function after stroke, rehabilitation robots are increasingly

integrated into clinics. The devices fall into two main classes: robots developed to train lost motor function after stroke (therapy devices) and robots designed to compensate for lost skills (i.e., assistive devices). The article provides an overview of therapeutic options with robots for motor rehabilitation after stroke.

Adv Exp Med Biol. 2018;1065:579-587.

Future directions of stroke rehabilitation

Wataru Kakuda

Recently, in the field of stroke rehabilitation, some novel concepts and therapeutic interventions have been proposed. It seems that earlier mobilization for acute stroke patients could lead to better functional outcome. In addition, neural plasticity during acute phase of stroke is enhanced, which means that this phase of stroke could be the period when the patients are likely to respond to rehabilitation training. In the future, acute rehabilitation should be aggressively provided in stroke centers in Japan. Some interventions such as non-invasive brain stimulation, centrally-acting drugs and vagus nerve stimulation have been reported to enhance neural plasticity. If these interventions are introduced combined with rehabilitation training, compensatory mechanism for impaired neurological function could be facilitated, leading to further functional recovery. Some robotic devices to support joint movements of the limbs externally have been developed. Robot-assisted rehabilitation can improve the efficacy of rehabilitation training, especially when applied for gait training. Neurofeedback is a sophisticated training system applying real-time monitoring of brain activity with the use of functional neuroimaging. Neurofeedback can be introduced in order to remedy motor imagery of stroke patients even if motor function is severely impaired. Regenerative therapy is a promising therapeutic intervention and some institutions in Japan have already started to introduce this therapy for stroke patients. It is proposed that rehabilitation training should be provided following the introduction of regenerative therapy so that structural reorganization caused by the therapy could lead to beneficial functional reorganization of the damaged brain. With the aim of improving active motor functions of hemiparetic limbs, botulinum toxin injection for limb spasticity after stroke should be combined with rehabilitation training. If these concepts and interventions are introduced aggressively and more widely for stroke patients, it is expected that functional outcome of such patients could be generally improved.

Rinsho Shinkeigaku. 2020 Mar 31;60(3):181-186.

Aquatic therapy in stroke rehabilitation: systematic review and meta-analysis

Jitka Veldema, Petra Jansen

The main object of this systematic review and meta-analysis is to collect the available evidence of aquatic therapy in stroke rehabilitation and to investigate the effect of this intervention in supporting stroke recovery. The PubMed, the Cochrane Central Register of Controlled Trials and the PEDro databases were searched from their inception through to 31/05/2020 on randomized controlled trials evaluating the effect of aquatic therapy on stroke recovery. Subjects´ characteristics, methodological aspects, intervention description, and outcomes were extracted. Effect sizes were calculated for each study and outcome. Overall, 28 appropriate studies (N = 961) have been identified. A comparison with no

intervention indicates that aquatic therapy is effective in supporting walking, balance, emotional status and health-related quality of life, spasticity, and physiological indicators. In comparison with land-based interventions, aquatic therapy shows superior effectiveness on balance, walking, muscular strength, proprioception, health-related quality of life, physiological indicators, and cardiorespiratory fitness. Only on independence in activities of daily living the land- and water-based exercise induce similar effects. Established concepts of water-based therapy (such as the Halliwick, Ai Chi, Watsu, or Bad Ragaz Ring methods) are the most effective, aquatic treadmill walking is the least effective. The current evidence is insufficient to support this therapy form within evidence-based rehabilitation. However, the available data indicate that this therapy can significantly improve a wide range of stroke-induced disabilities. Future research should devote more attention to this highly potent intervention.

Acta Neurol Scand. 2021 Mar;143(3):221-241.

Home-based technologies for stroke rehabilitation: A systematic review

Yu Chen [1], Kingsley Travis Abel [2], John T Janecek [3], Yunan Chen [2], Kai Zheng [2], Steven C Cramer [4]

Many forms of home-based technology targeting stroke rehabilitation have been devised, and a number of human factors are important to their application, suggesting the need to examine this information in a comprehensive review. The systematic review aims to synthesize the current knowledge of technologies and human factors in home-based technologies for stroke rehabilitation. We conducted a systematic literature search in three electronic databases (IEEE, ACM, PubMed), including secondary citations from the literature search. We included articles that used technological means to help stroke patients conduct rehabilitation at home, reported empirical studies that evaluated the technologies with patients in the home environment, and were published in English. Three authors independently conducted the content analysis of searched articles using a list of interactively defined factors.The search yielded 832 potentially relevant articles, leading to 31 articles that were included for in-depth analysis. The types of technology of reviewed articles included games, telerehabilitation, robotic devices, virtual reality devices, sensors, and tablets. We present the merits and limitations of each type of technology. We then derive two main human factors in designing home-based technologies for stroke rehabilitation: designing for engagement (including external and internal motivation) and designing for the home environment (including understanding the social context, practical challenges, and technical proficiency). This systematic review presents an overview of key technologies and human factors for designing home-based technologies for stroke rehabilitation.

Int J Med Inform. 2019 Mar;123:11-22.

Virtual Reality Design for Stroke Rehabilitation.

Charles D, Holmes D, Charles T, McDonough S.

Stroke is a leading cause of disability, and with the stroke survivor population rising in most countries it is increasingly difficult to provide optimal treatment to patients once they return home. Assistive technology solutions can potentially contribute to

meeting demand, and also be cost effective. In this chapter, we consider the design and development of engaging serious virtual reality (VR) games for upper arm stroke rehabilitation. Fundamental design principles are summarised and related to our experience of creating game-based VR rehabilitation. The application of ideas from psychology, particularly behavioural change and flow theory are discussed, as well as related learning and gamification principles. We address how to manage differences between people through design, user profiling, and intelligent dynamic system behaviour, and we also explore how to account for variation in stroke survivor capability and personality. The idea of a hero's journey as a metaphor for stroke recovery is introduced and we discuss how this metaphor may guide system design, its relationship to game design principles, and how patient narratives and embedded stories might support engagement with treatment. An overview of our previous work is summarised and we discuss how our experience and increased knowledge and capability has informed improved approaches to development processes. Finally, our approach is illustrated with reference to a recent EU project.

Adv Exp Med Biol. 2020;1235:53-87.

The Use of Repetitive Transcranial Magnetic Stimulation for Stroke Rehabilitation: A Systematic Review

Ana Dionísio [1], Isabel Catarina Duarte [2], Miguel Patrício [3], Miguel Castelo-Branco [4]

Stroke is a leading cause of disability. Alternative and more effective techniques for stroke rehabilitation have been sought to overcome limitations of conventional therapies. Repetitive transcranial magnetic stimulation (rTMS) arises as a promising tool in this context. This systematic review aims to provide a state of the art on the application of rTMS in stroke patients and to assess its effectiveness in clinical rehabilitation of motor function. Studies included in this review were identified by searching PubMed and ISI Web of Science. The search terms were (rTMS OR "repetitive transcranial magnetic stimulation") AND (stroke OR "cerebrovascular accident" OR CVA) AND (rehab OR rehabilitation OR recover*). The retrieved records were assessed for eligibility and the most relevant features extracted to a summary table. Seventy out of 691 records were deemed eligible, according to the selection criteria. The majority of the articles report rTMS showing potential in improving motor function, although some negative reports, all from randomized controlled trials, contradict this claim. Future studies are needed because there is a possibility that a bias for non-publication of negative results may be present. rTMS has been shown to be a promising tool for stroke rehabilitation, in spite of the lack of standard operational procedures and harmonization. Efforts should be devoted to provide a greater understanding of the underlying mechanisms and protocol standardization.

J Stroke Cerebrovasc Dis. 2018 Jan;27(1):1-31.

Neurotechnology-aided interventions for upper limb motor rehabilitation in severe chronic stroke

Martina Coscia [1], Maximilian J Wessel [2 3], Ujwal Chaudary [1], José Del R Millán [4], Silvestro Micera [5 6], Adrian Guggisberg [7], Philippe Vuadens [8], John Donoghue [1 9], Niels Birbaumer [1 10], Friedhelm C Hummel [2 3 7]

Upper limb motor deficits in severe stroke survivors often remain unresolved over extended time periods. Novel neurotechnologies have the potential to significantly support upper limb motor restoration in severely impaired stroke individuals. Here, we review recent controlled clinical studies and reviews focusing on the mechanisms of action and effectiveness of single and combined technology-aided interventions for upper limb motor rehabilitation after stroke, including robotics, muscular electrical stimulation, brain stimulation and brain computer/machine interfaces. We aim at identifying possible guidance for the optimal use of these new technologies to enhance upper limb motor recovery especially in severe chronic stroke patients. We found that the current literature does not provide enough evidence to support strict guidelines, because of the variability of the procedures for each intervention and of the heterogeneity of the stroke population. The present results confirm that neurotechnology-aided upper limb rehabilitation is promising for severe chronic stroke patients, but the combination of interventions often lacks understanding of single intervention mechanisms of action, which may not reflect the summation of single intervention's effectiveness. Stroke rehabilitation is a long and complex process, and one single intervention administrated in a short time interval cannot have a large impact for motor recovery, especially in severely impaired patients. To design personalized interventions combining or proposing different interventions in sequence, it is necessary to have an excellent understanding of the mechanisms determining the effectiveness of a single treatment in this heterogeneous population of stroke patients. We encourage the identification of objective biomarkers for stroke recovery for patients' stratification and to tailor treatments. Furthermore, the advantage of longitudinal personalized trial designs compared to classical double-blind placebo-controlled clinical trials as the basis for precise personalized stroke rehabilitation medicine is discussed. Finally, we also promote the necessary conceptual change from 'one-suits-all' treatments within in-patient clinical rehabilitation set-ups towards personalized home-based treatment strategies, by adopting novel technologies merging rehabilitation and motor assistance, including implantable ones.

Brain. 2019 Aug 1;142(8):2182-2197.

In the News…

The 8th European Stroke Organization Conference

Much of the progress made in reducing death & disability due to stroke has been because of better acute management & secondary prevention of ischemic stroke. Results from several trials testing the above mentioned approaches, were presented at the 8th European Stroke Organization Conference, which was held in early May, in Lyon, France.

ESOC plenary highlights announced before the meeting included presentations of results from several acute ischaemic stroke clinical trials on the use of Tenecteplase, viz:-

- NOR-TEST 2 part A, a phase 3 trial aiming to show non-inferiority of tenecteplase versus alteplase for moderate or severe ischaemic stroke.
- TASTE-A, comparing prehospital tenecteplase with alteplase
- AcT, NCT03889249
- TWIST, NCT03181360

Among the other highlights of this conference were presentations of results from other acute stroke trials, viz:-

- ParaNASPP- acute triage by paramedics, NCT04137874.
- ACTIMIS - Glenzocimab in combination with reperfusion, NCT03803007.
- ATTENTION - endovascular treatment for acute basilar artery occlusion, NCT04751708.
- AMETIS - sedation *vs* general anaesthesia in large vessel occlusion thrombectomy, NCT03229148.

Secondary analyses due to be presented in this conference included:-

- ENCHANTED - blood pressure lowering in patients with ischaemic stroke eligible for thrombolysis, NCT01422616.
- RACECAT - direct transfer to an endovascular centre *vs* the closest stroke centre for patients with suspected large vessel occlusion, NCT02795962.

There were also presentations in areas that have seen fewer clinical trials but that remain priorities for patients, including intracerebral haemorrhage and difficulties encountered by stroke survivors.

A recent stroke priority setting exercise by the James Lind Alliance involved surveys and workshops for more than 1400 stroke survivors, carers, and health-care professionals. The top three priorities for prevention, diagnosis, and treatment were primary prevention, early diagnosis, and treatment of intracerebral haemorrhage; the top three priorities for rehabilitation and long-term care were assessment and reduction of psychological effects, cognitive dysfunction, and communication problems.

(https://www.thelancet.com/journals/laneur/article/PIIS1474-4422(22)00178-8/fulltext)

Virtual Reality Based Games for Stroke Rehabilitation

Many stroke patients have difficulty in using their hands for activities of daily living, but using rehabilitation measures neuroplasticity can help to change this disability.

To help patients practice and improve their performances in a range of hand rehabilitation exercises, Cogitat and VR production studio Unit 9 with support from UK Research and Innovation (UKRI) are exploring the potential for VR based games powered by a brain-computer interface that enables a virtual hand to perform the movements that the patient is attempting to make.

The concept for the games is motivated partly by research in neuroscience suggesting that the experience of seeing a motor task performed helps you develop the motor skills needed to perform that task yourself by stimulating so-called mirror neurons – brain cells that are activated both by witnessing and performing motor tasks.

Getting the best results in rehabilitation requires patients to carry out exercises frequently for an extended period of time. While the proposed VR rehabilitation games could be used as part of physiotherapy sessions at clinics, they also have the potential advantage of helping patients to carry out exercises at home. Game elements such as the opportunity to compete online with other players or to try to beat one's own past performances could make the exercises more enjoyable.

(https://www.imperial.ac.uk/news/235375/mind-controlled-vr-games-could-stroke-rehabilitation/)\

Return to Work After a Severe stroke

New research cites that about one third of people who had a large vessel (severe) ischemic stroke, treated with mechanical clot removal, resumed work three months after stroke treatment. However, women were about half as likely to return to work after a severe stroke compared to men, according to the study published in ***Stroke***, the peer-reviewed, flagship journal of the American Stroke Association, a division of the American Heart Association.

A stroke due to a blockage in a large blood vessel is an indicator of a severe stroke and the potential for continuing loss of function, which makes it less likely people will return to work. According to the American Heart Association, while ischemic stroke accounts for 87% of strokes in the United States, large vessel occlusions only account for approximately 24% - 46% of ischemic strokes.

"Returning to work after a severe stroke is a sign of successful rehabilitation. Resuming pre-stroke levels of daily living and activities is highly associated with a better quality of life," said Marianne Hahn, M.D., lead study author and a clinician scientist in the department of neurology at Johannes Gutenberg University in Mainz, Germany. "In contrast to most return-to-work studies, we included a large cohort of only people treated with mechanical clot removal; they are a subgroup of stroke patients at high risk for severe, persisting deficits." Researchers examined data from the German Stroke Registry - Endovascular Treatment Study Group. The analysis included more than 600 men and women (28% women), ages 18- to 64-years-old who had a large vessel ischemic stroke between 2015 and 2019.

All study participants were employed prior to their stroke and were treated with mechanical thrombectomy. More than half of the study participants also received intravenous thrombolysis.

(https://newsroom.heart.org/news/women-were-less-likely-to-return-to-work-after-a-severe-stroke-new-study-finds)

Outpatient Stroke Prevention Clinic at Ahmedabad

Zydus Hospitals has initiated 'Zydus Stroke Prevention Clinic', an outpatient clinic for individuals who have symptoms of a stroke or transient ischemic attack (TIA), or who are at risk of having a stroke or TIA.

According to the Indian Stroke Association, the incidence of stroke has increased by 100 percent in the last decade. As per a certain estimate, 18 lakh people suffer from stroke in India every year. Stroke contributes to around 30 percent of the overall morbidity in India. One Indian suffers from a stroke every 20 seconds. Stroke risk in India: 1 in 5 in a lifetime.

"This is the time for hospitals to focus more on preventive aspects of stroke. Common people must know their personal risk factors: high blood pressure, diabetes, high blood cholesterol," said Dr Arvind Sharma, secretary of Indian Stroke Association. Sharma, also a Senior Neurologist and HOD of Neurology department, Zydus Hospital, said, "Only 9 to 12 percent of stroke patients get acute stroke treatment, rest 85 – 90 percent need treatment and stroke rehabilitation."

Stroke care rehabilitation advancement in the form of robotics for active and passive robotic physiotherapy is very task specific and is the future for stroke therapy and recovery.

(https://ahmedabadmirror.com/zydus-hospital-starts-stroke-prevention-clinic-in-the-city/81831227.html)

3D Printed Gloves for Stroke Rehabilitation

Aiming to help stroke victims, researchers in the Department of Physics at the Indian Institute of Science (IISc.) have developed a soft, wearable device that exploits the fundamental properties of light to sense a patient's limb or finger movements. The customisable, 3D printed gloves can be remotely controlled, opening up the possibility of tele-consultation by physiotherapists.

"We wanted to develop something affordable, and available to a person at all times at their convenience. The product should be easy to use and must provide feedback," said Aveek Bid, Associate Professor in the Department of Physics, whose team has developed the device.

The researchers say that the device has been tested for stability for over 10 months, and no loss of sensitivity or accuracy was detected. The device has been entirely designed and manufactured in India, and is expected to cost less than ₹1,000. A patent has been filed, and the researchers hope to launch the device in the market soon.

Prof. Bid explained that quantifiable feedback – for example, the units of pressure applied while squeezing a ball or the degree of bending of a leg with a knee injury – is crucial for doctors to monitor the patient, even remotely. Such feedback can also motivate patients to perform better in every consecutive session.

Another challenge is that physiotherapy often requires daily hospital visits. Home visits by professionals or sophisticated devices to monitor patients remotely, although ideal, are not readily available, and are expensive. To address these challenges, the team developed a mechanism by which customisable wearables, like hand gloves, can be designed, 3D printed, and controlled remotely.

"The idea behind the device is that you wear something like a glove, the physiotherapist controls the device from a remote location through the internet, and makes your hands and fingers move," according to Prof. Bid.

The device can sense various hand and finger movements, and precisely detect parameters like pressure, bending angle and shape.

The technology that drives the device is based on the fundamental properties of light: refraction and reflection. Any movement in the finger or arm of the patient causes the flexible material to deform. The deformation alters the path of light, and thereby its properties. The device translates this change in light properties to a quantifiable unit. Since light travels across the entire length of the device, movement along any part of the patient's finger or arm can be accurately measured.

"The device is highly sensitive – enough to respond to the touch of a butterfly," said team member Abhijit Chandra Roy, DST-Inspire Faculty in the Department of Physics and the brain behind the project. "In addition, while existing devices can only detect the bending of a finger, the new device can even measure the degree of bending at every joint of the finger."

It can be customised to fit each patient's arm and fingers. The device can capture and store data, and transmit it over the internet, facilitating remote monitoring by clinicians or physiotherapists.

(https://www.thehindu.com/news/cities/bangalore/3d-printed-gloves-offer-possibility-of-tele-consultation-by-physiotherapists-for-stroke-patients/article65381108.ece)

Gabapentin Helps in Fastracking Stroke Repair in Mice

Adult mice given the drug gabapentin regained skilled control of their forelimbs and had improvements in their structural and functional neuroplasticity, according to a study published May 23 in the journal *Brain*. "These observations highlight the strong potential for repurposing gabapentinoids as a promising treatment strategy for stroke repair," wrote first author Andrea Tedeschi, PhD, assistant professor in the department of neuroscience at The Ohio State University, and colleagues.

To test the treatment, the researchers first induced a photothrombotic cortical stroke in adult mice, after which they administered gabapentin or saline as a control within either one hour or one day. Treatment with the drug or saline continued for six weeks.

Gabapentin had no effect on vascular occlusion, hemodynamic changes, or survival of corticospinal neurons within the ipsilateral sensory-motor cortex during the acute stage of the stroke.However, the group used a combination of tract tracing, electrical stimulation, and functional connectivity mapping to find significant neuroplasticity in the contralateral side of the brain.

Corticospinal axons originating from that side extended many collaterals, formed new synaptic contacts, and better integrated within spinal circuits that control forelimb muscles. At the same time, maladaptive plasticity in the mice treated with gabapentin was dampened by reducing the excitability of spinal motor circuitry, the paper reported.

The recovery of skilled upper extremity function persisted after the six-week treatment ended.

The paper noted that gabapentinoids are already being studied for promoting

neurological recovery after severe traumatic brain injuries."As gabapentinoids are clinically approved drugs prescribed for a wide range of neurological disorders, our findings highlight the strong potential for repurposing GBP as a promising treatment strategy for stroke repair," the study concluded.

https://journals.lww.com/neurotodayonline/blog/breakingnews/pages/post.aspx?PostID=1247

Portable MRI for Stroke Detection

Low-field portable MRI (pMRI) captured images of infarcts in 90 percent of patients with ischemic stroke, as part of a small proof-of-concept study published April 22 in *Science Advances*.

The low-field pMRI captured images of lesions as small as 4 mm and stroke volume measurements were consistent with the images captured by conventional high-field MRI studies. The results suggest that with further study and refinement, low field pMRI could be a novel neuroimaging solution to problems associated with standard MRI—especially the need for lead-shielding around the point of care and specialized technicians to operate the device.

"Portable MRI is feasible and provides moderate image quality,' said co-author W. Taylor Kimberly, MD, PhD, chief of neurocritical care at Massachusetts General Hospital, in comments to *Neurology Today*.

"This technology provides a new option for neuroimaging in a clinical setting and has the potential to enhance access to MRI in a variety of settings. Given the portability and ease of operation, the device has the potential to be used in areas beyond the ICU, including low-resource environments, in the pre-hospital setting, and in the emergency department."

https://journals.lww.com/neurotodayonline/Fulltext/2022/05190/Can_Low_field_Portable_MRI_Widen_Access_to_Rapid.12.aspx

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Olives Reduce Stroke Risk

While it is well known and established that eating a balanced diet of fruit and vegetables is crucial, people occasionally forget about dietary accoutrements, also known as snacks.

Over consumption of treats such as biscuits, pastries, pies, and chocolate can lead to increased cholesterol levels, raised blood pressure, and the risk of a stroke. According to data published in the journal Lipids in Health and Disease, olives have been found to reduce the risk of stroke. This is because they contain high levels of monounsaturated fats. These fats have been found to reduce the overall risk of stroke, mortality, and cardiovascular disease. Monounsaturated fats can also reduce levels of harmful LDL cholesterol

https://www.express.co.uk/life-style/health/1614660/stroke-risk-olives-reduce-risk

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Fecal Bacteria & Stroke Recovery

Presented at the European Stroke Organisation Conference (ESOC 2022), researchers told of the association between faecal matter and stroke recovery. Dr Miquel Lledós, the lead author of the paper, explained the method and findings. In this study we took faecal samples – the first samples taken after the event – from 89 humans who had suffered an ischaemic stroke.

"Comparing with a control group, we were able to identify multiple groups of bacteria that were associated with a higher risk of

ischaemic stroke. The influence of the gut microbiome (the trillions of bacteria and other microorganisms that live in the gut) is a modifiable risk factor," he said.

The gut microbiome is "associated with the risk of stroke and with post-stroke neurological outcomes".

Data demonstrates that Fusobacterium and Lactobacillus were associated with ischaemic stroke risk. Negativibacillus and Lentisphaeria were associated with a more severe stroke, six to 24 hours following a stroke. Furthermore, Acidaminococcus bacteria (found in faeces) was related to poor functional outcomes at three months.

Dr Lledós added: "The discovery opens the exciting prospect that, in the future, we may be able to prevent strokes or improve neurological recovery by examining the gut microbiota."

"In other pathologies, clinical trials are being carried out where researchers replace the intestinal flora through dietary changes or faecal transplantation from healthy individuals, and this should be studied further in the stroke field."

https://www.express.co.uk/life-style/health/1604048/stroke-neurological-recovery-poop-bacteria-study

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Kinarm Robotic Device & Motor Learning After a Stroke

"When the nervous system functions well, things look elegant," says Dr. Tyler Cluff, PhD, assistant professor in the Faculty of Kinesiology at the University of Calgary. "We don't have to put a lot of conscious thought or effort into movement, how we learn new motor skills or adapt them for different contexts. When there's an injury, illness or a disorder that impacts the health and function of the nervous system, even the simplest task like eating with a spoon can be challenging."

For more than a decade, Cluff has been studying how people learn motor skills. He knows that reaching for that spoon relies on distributed circuits throughout the brain. Now, he is co-leading a clinical project at UCalgary with Dr. Sean Dukelow, MD, PhD, a physiatrist, member of the Hotchkiss Brain Institute, and medical director of stroke rehabilitation for the Calgary Stroke Program.

The goal is to collect a large dataset that can inform on how healthy people of all ages and sexes learn motor skills. This dataset will provide a basis to understand how stroke influences motor learning during the time that many people are participating in rehabilitation.

The research is done using a robot device called the Kinarm. Patients sit in the robotic exoskeleton and, using their arms, interact with a two-dimensional virtual-reality environment as data is collected. The Kinarm was developed to assess sensory, motor and cognitive function by Dr. Stephen Scott, PhD, at Queen's University. It was designed so that new tasks and analyses can be developed and applied to evolve the Kinarm's assessment capabilities.

Both Cluff and Dukelow worked with Scott in Ontario before coming to UCalgary, where they use the Kinarm in their research through the Human Performance Lab and Neuro Robot Lab. Cluff designed the specific assessment tool being used for this clinical trial.

The UCalgary study aims to recruit 150 healthy people, as well as 150 individuals recovering from stroke.Study participants watch a screen in front of them and complete tasks such as hitting balls as they go by, crossing out lines or reaching to targets. The

Kinarm challenges them by introducing errors. The nervous system typically responds by trying to correct the errors.

All the while, the exoskeleton is measuring how quickly and how well the person responds to those challenges. After a series of activities, the researchers can begin to create a profile of how the brain learns those skills and where there are impairments.

The 150 healthy controls in the study provide the foundation. "Once we understand the range of what healthy behaviour looks like, we can flag impairment. We can identify the problem, and, in the long term, we hope to develop new strategies that help people recover," says Cluff.

For stroke patients, their brain profile includes accounting for lesions on their brain where it was damaged when normal blood flow was interrupted. "What we're depending on (for rehabilitation) is rewiring around that dead tissue in the brain," says Dukelow. "A lot of literature has been around repetition in helping that rewiring process, but no one really knows how much is required and it's probably different for every patient."

This clinical trial is in its first phase of collecting a large dataset to map the brain as it relates to learning motor skills. It's the beginning of a long-term project that will equip doctors with the knowledge and data they need to zero in on personalized strategies to help patients maximize rehabilitation after stroke.

https://ucalgary.ca/news/exoskeleton-robot-helps-researchers-shed-new-light-learning-and-stroke-recovery

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Neuromodulation for Post Stroke Recovery

As a principal investigator for the pivotal VNS-REHAB study, which supported_the first US Food and Drug Administration (FDA) premarket approval of a vagus nerve stimulation (VNS) system for stroke rehabilitation therapy last year**,** Jesse Dawson (Glasgow, UK) is playing a key role in evaluating the potential held by neuromodulation for post-stroke recovery. Here, Dawson outlines the promising future proffered by this technology, and others.

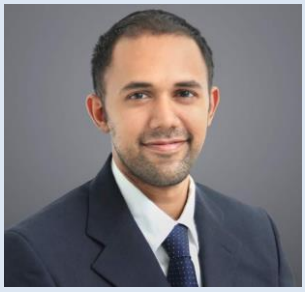
In recent years, randomised controlled trials of VNS paired with rehabilitation, transcranial magnetic stimulation (TMS), transcranial direct current stimulation (tDCS), pharyngeal electrical stimulation and sphenopalatine ganglion stimulation in people with stroke have been reported.

The use of VNS paired with rehabilitation has recently been approved by the US FDA for the treatment of chronic upper-limb deficits after ischaemic stroke. A recent randomised, phase 3 trial showed that this technique led to improvements in upper-extremity impairment and function in people with moderate-to-severe arm weakness an average of three years after ischaemic stroke. A clinically meaningful response—defined as an improvement greater than or equal to six points on the Fugl-Meyer assessment, upper limb (FMA-UE)—was seen in approximately half of people treated with VNS compared to approximately a quarter of people treated with rehabilitation alone.

https://neuronewsinternational.com/neuromodulation-therapies-post-stroke-recovery/

The Afterglow…

HBOT in Stroke- A EBM Literature Review for Referring Clinicians



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He completed Primary certification in Hyperbaric and Underwater Medicine in 2013, from National Baromedical services, Columbia, South Carolina, USA. He also completed his training in Spasticity Surgery and Rehabilitation in 2014, from Tokyo Women's University, Shinjiku, Tokyo, Japan.
He was the Chief Editor of the Kerala Journal of PMR from 2019 to 2022. His areas of interest include Spasticity, HBOT, Neurorehabilitation & Pain rehabilitation.

Clinicians starting an HBOT service may face obstacles when getting started. Purchase and infrastructure aside getting cases may be challenge, especially if others have to refer to you. The following is designed to facilitate overcoming hose hurdles.

I heard its bad for you.

We breathe oxygen all the time. Regardless O2 toxicity is described and this happens at 3 Absolute Atmospheres (ATA). Most treatment protocols stop at 2.5 ATA. Another possible harm comes from exposure for more than 30 minutes. This is called O2 toxicity, and is why we have air breaks during treatment. There is a systematic review on hyperoxemia in stroke that shows a poorer outcome in recipients. They state 'Studies of chronic pulmonary disease or hyperbaric oxygenation were excluded.'[1]

I heard its not useful

You are correct. There are a few studies from the last poorly designed studies from 2 decades ago that do show this. The reason for this because of design flaws. One study didn't differentiate stroke by mechanism, size, or location. Its primary measure was a 100 point neurological exam. Patients were taken 6 hours after event with subsequent dives every 8 hours, for a total of 15 dives. Many treatment group patients declined for unspecified reasons. The secondary measure of outcome was quantification of the volume of hypodensity due to infarction, as seen on a computed tomogram (CT scan) performed 4 months after onset. Considering mechanism of action this is a bit late to note changes effected by it. A treatment pressure of 1.5ATA was used, which is now known to be suboptimal, instead of 2 ATA.[2,3] On the other hand, there are enough recent well designed studies that show otherwise. Three randomised controlled trials (106 participants) showed there were no significant differences in mortality rate at six months in those receiving HBOT compared to the control group (relative risk 0.61, 95% confidence interval (CI) 0.17 to 2.2, P value 0.45). Two of 15 scale measures of disability and functional indicated an improvement

following HBOT, both at one year follow up: the mean Trouillas Disability Scale was lower with HBOT (mean difference (MD) 2.2 points reduction with HBOT, 95% CI 0.15 to 4.3, P value 0.04) and the mean Orgogozo Scale was higher (MD 27.9 points, 95% CI 4.0 to 51.8, P value 0.02)[4]

I heard the effects fade once you stop.

Multidisciplinary medical rehabilitation run by a Physiatrist is superior to any one or two of a therapy. The goal is not more HBOT, but to get to a state where they can keep what they've gained. This means translating the gains into function. While therapists can do this, it is often limited to their specific domain and does not directly get a person back to whom they were before.

How many sessions do I need?

International studies show all use forty sessions. We see changes within 5-10 sessions.

When do we stop?

When the patient is conscious and able to make gains without it, or doesn't change after 10 sessions.

Is it quackery?

There is a really well designed cross-over sham RCT that quantifies changes post stroke not only with quality of life scales, but also with Single Photon Emission CT and cortical blood flow.[5] Take some time to read it.

How do we know it is working?

The simplest test is a clinical exam, the next step up is a CT or MRI.

Whom not and why?

Albumin <3, >TID suction, low Ejection fraction, fluid retention, my anecdote of pulmonary edema.[6]

What if we don't and say we do? (i.e. use your name for marketing but withhold patients who come for it)

In general deception is not a good practice, especially when someone's well being is at stake. We reap the rewards of our actions.

Can this cure my stroke?

Sorry, you won't grow a new brain. What's dead is gone, but you can perfuse the areas around the stroke improving recovery potential overall and reducing the spread of the stroke.

I heard regular oxygen was enough?

A systematic review with a total of 11 prospective RCT studies (6366 patients) with acute stroke looked at this. It had a normobaric O2(NBO) group, 3207 vs a control group of 3159. NBO decreased Barthel Index scores between 3 and 7 months, and increased death rates at 3, 6 months, and 1 year, whereas, modified Rankin Scale scores between 3 and 6 months were unchanged.[7]

We know it works in acute ischemic stroke[8], how about in Intracranial hemorrhage?

HBO can reduce the brain water content (BWC) (-0.982, 95% CI, -1.148 to -0.817; P < 0.01; 57 comparisons), and improve Neurobehavioural outcome (NO) (-0.767, 95% CI, -1.376 to -0.159; P < 0.01; eight comparisons). HBO was most effective in reducing BWC when given 72 h after ICH.[9]

What else is it good for post-stroke?

HBOT significantly reduced depression measured on the Hamilton Depression (HAMD) test.[10] HBOT induces significant improvements in all cognitive domains even in the late chronic stage.[11] It can improve neural plasticity up to 3 years from stroke.[12]

Its so expensive

No one plans to have a stroke and the acute care can create a big financial burden for the family. The real question is if a bigger initial bill will reduce a larger lifelong expense. The studies above all show this.

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Hemiplegic Shoulder Pain

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Stroke is the 3rd leading cause of death in the United States. It has a considerable impact on the economic, social and health care sectors. Impairments from stroke vary widely, but one of the most common factor affecting the quality of life is hemiplegic shoulder pain (HSP).HSP is a challenge to patients and health care providers as it reduces participation in rehabilitation, discourages motion, hinders recovery and affects function, thus becoming a poor predictor of functional recovery. HSP is commonly reported in 70% of stroke patients (range 16% to 84%). Though HSP is widely recognised and discussed, the evidence in literature is inconsistent in conclusions.

The causes of HSP are multifactorial, have both mechanical and neurogenic causes, generated peripherally in the limb or centrally within the brain. No patient is exactly the same, so a one size fits all treatment is not effective. It's presence is strongly associated with a long hospital stay and a lower Barthel's score at 12 wks. Resolution of upper limb functions within 5 weeks predicts good long term function.

Risk factors of HSP

Age by itself is not clearly a risk factor, but older age groups are likely to have pre-existing abnormalities that affect the impairment and functional outcome. Additional risk factors for developing shoulder pain within first 6 months after stroke include impaired voluntary motor control, diminished proprioception, tactile extinction, abnormal sensation, spasticity of elbow flexor muscles, restricted range of motion for both-shoulder abduction and external rotation, trophic changes, type 2 diabetes mellitus, adhesive capsulitis and complex regional pain syndrome.

In addition to new impairments following stroke pre-existing musculoskeletal disorders, whether symptomatic or not may contribute to shoulder pain. These include long head of biceps injury, supraspinatus tear/tendonitis and rotator cuff disorders. Rotator cuff disorders are the most common cause of pain.

Shoulder Anatomy

It is a complex ball and socket joint that allows multidirectional reach, this agility comes at the cost of stability. Extensive movement is due to the shallow glenoid cavity, only 25% of the humeral head comes in contact with glenoid cavity. Stability of

the joint depends on static stabilisers and dynamic stabilisers. Primary static stabilisers are the superior, middle and inferior glenohumeral ligaments. Primary dynamic stabilisers are the rotator cuff muscles whose attachments form a cuff around the humeral head. Functional movement requires the coordination of dynamic stabilisers. Glenohumeral joint receives passive support from cartilaginous labrum, glenohumeral ligaments and joint capsule. Deltoid and rotator cuff muscles act on the humerus. Scapula is primarily controlled by trapezius, Serratus and Latissimus. Rotator cuff muscles compresses the humeral head in the glenoid fossa, stabilises the joint, and provides counter balance to the opposing forces on the humerus. Impairment of rotator cuff leads to superior subluxation of the humeral head and impingement of supraspinatus between greater tubercle and acromion.

Mechanisms of injury

The aetiology is likely multifactorial; relating to the disruption of biomechanical balance caused by stroke induced weakness, spasticity, sensory loss and stability. Ryerson and Levit identified 4 sources of pain in HSP. 1) Instability can cause sharp pain with passive or active movement. 2) Abnormal pain sensitivity can arise from inappropriate CNS modulation of pain, which can vary from diffuse and achy to sharp and lancinating pain. 3) Atrophic or spastic muscle can result in a pulling pain with movement.4) CRPS is characterised by reduced ROM, dysesthesia and trophic changes. The classification of HSP is more accurately based on aetiology rather than symptoms alone.

The factors affecting HSP can be divided into 2 categories-**neurological and mechanical factors**.

Neurological causes

UMN factors – paralysis, spasticity, central post stroke pain, central sensitisation of pain.

LMN factors – peripheral neuropathy, brachial plexus injury, complex regional pain syndrome.

Mechanical factors

Shoulder subluxation, rotator cuff injury, glenohumeral joint disorders, adhesive capsulitis, myofascial pain and direct trauma.

Weakness of the shoulder disrupts the stabilisers of the shoulder joint. Weakness of the muscles of the head and trunk is common after stroke and this disrupts the cervicothoracic posture creating a flexed and stooped posture, which can lead to anterior subluxation of the shoulder and further exacerbate rotator cuff impingement and traction on the joint capsule.

Spasticity results in typical flexor posturing of the upper limb. Overactivity of the pectoralis and subscapularis results in humeral flexion, adduction and internal rotation. Combined with increased activity of teres major and latissimus dorsi spasticity inhibits active and passive abduction, extension and external rotation. The result is inability to attain range for ADL and predisposition to mechanical injury. 85% of spastic hemiplegics experienced pain compared to 15% of flaccid hemiplegics. Preserve joint range in patients with spasticity and prevent contracture in those with flaccidity to reduce incidence of HSP.

Brachial plexus and peripheral nerve injury- Injury to the plexus may be traumatic and atraumatic. In the setting of hemiplegia traction injury caused by

improper handling of the flaccid hemiplegic limb during transfers and repositioning is the cause. The upper trunk of the brachial plexus is most susceptible to injury. The most common isolated peripheral nerve injury in HSP is Axillary neuropathy, thought to be subsequent to downward displacement of the humeral head in shoulder subluxation. If a plexus or nerve is injured it may contribute to a cycle of pain, weakness, and progressive subluxation.

Complex regional pain syndrome- Pain is out of proportional to the pathologic condition. Incidence is as high as 23% in patients with hemiplegia. CRPS can inhibit mobility by both pain that discourages motion and the associated adhesive capsulitis that restricts it.

Central post stroke pain (CPSP) and sensitisation- Sensory disturbance and neglect can alter a patient's proprioception and perception of pain, predisposing the shoulder to injury. CPSP can lead to pain in the shoulder and elsewhere. Also termed Thalamic pain syndrome, a lesion of the spinothalamic tract may result in abnormal pain reorganisation resulting in improper generation of pain in the absence of injury. Sensitisation involves alteration in serotonin and norepinephrine levels.

Shoulder subluxation- Common source of mechanical pain in HSP. During the stage of flaccidity post stroke, joint stability decreases and this predisposes to traction injury. Paralysed shoulder musculature fails to provide dynamic stability at the joint. Downward displacement of humeral head is most common during the flaccid stage, whereas the spastic stage often leads to anterior displacement, posterior displacement, or internal rotation. AP and oblique X-rays help in diagnosis. Association between shoulder subluxation and HSP remains controversial.

Rotator cuff injury-Incidence of rotator cuff tears in hemiplegic patients ranges from 33%to 40% when compared to 20% to 40% in the general population. Abnormal positioning, improper handling and muscle imbalance by weakness and spasticity cause impingement and tearing. Treatment is usually conservative.

Adhesive capsulitis- A painful shoulder develops adhesive capsulitis because of pain inhibiting mobility, leading to subsequent disuse atrophy and contracture. Increased immobilisation from spasticity can increase the likelihood of developing adhesions.

Myofascial pain- very few studies are available regarding myofascial pain and HSP.

Diagnosis

There are no clear criteria for the diagnosis of HSP.

History- Pre-existing shoulder pain, use of analgesics, limited functional use of the arm, prior trauma, surgery.

Physical examination- Observation (for asymmetry, deformity and erythema), ROM (passive and active), palpation, sensation, reflexes, strength and special tests. Demonstrate AROM before PROM. Decreased PROM may be due to contracture or anatomic block. Pain is most often the limiting factor in AROM followed by weakness. Palpation for muscle bulk, abnormal contour or masses, or areas of tenderness. Test dermatomes and myotomes from C5 to T1, sensations C5 to T1 and reflexes to localise a neurologic lesion and assess whether it is central or peripheral. Assess spasticity with the Ashworth scale.

Electrodiagnosis for peripheral nerve lesions ,limited use in HSP.

Sympathetic Nerve block in suspected cases of CRPS. Helps in reducing symptoms mediated by the sympathetic nervous system, which includes alterations in skin colour and temperature. May produce temporary Horner's syndrome.

Specialised tests-Neer, Hawkins and Jobe (``empty can") test for subacromial impingement. Apprehension and Sulcus test for glenohumeral instability. Hand Behind Back (HBB) and Hand Behind Neck (HBN) are simple bedside screening tests to diagnose HSP. HBB combines internal rotation and extension and HBN combines external rotation and abduction. Differences or pain in passive or active external rotation of the shoulder can indicate the onset of HSP.

Diagnostic Imaging

Radiography- An AP view will rule out a fracture /subluxation. AP in external rotation will better visualise greater tuberosity and associated soft tissues, and may help reveal calcific rotator tendinopathy. AP with humerus in internal rotation may reveal a Hill- Sachs lesion. Scapular Y view helps evaluate cuff impingement, and axillary view for instability.

Conventional X-ray Arthrography- can help diagnose adhesive capsulitis and rotator cuff tears, but is rarely used now. Joint volume less than 10 ml, irregular capsule margins and a diminished axillary recess suggest adhesive capsulitis. A rotator cuff injury will be demonstrated by contrast leakage from glenohumeral joint to the subdeltoid bursa and it is highly sensitive.

MRI-will help diagnose Adhesive capsulitis, labral tears and rotator cuff injury. MRI findings in stroke survivors with shoulder pain shows synovial capsule thickening/enhancement, and enhancement in rotator cuff interval.

Ultrasonography- The primary advantages are excellent visualisation of soft tissues, dynamic assessment and lack of ionising radiation. It easily identifies rotator cuff tendinopathy, impingement, acromioclavicular joint arthritis and bicipital tendinitis. Hypoechoic echotexture and increased vascularity within the rotator interval are seen in adhesive capsulitis. An advantage of ultrasound is that serial assessments are available at low cost without the danger of ionising radiation.

Management

There are many available modalities **pharmacologic** and **nonpharmacologic.**

Prevention through positioning- In the flaccid stage there is risk of injury. Care should be taken while transferring patients . Caretaker awareness of potential injuries caused by poor handling can reduce injury. A commonly suggested position of shoulder is abduction, external rotation and flexion. There is no consensus on which position is ideal and no one has been proved to be better in studies.

Strapping and slings-Maintains shoulder in anatomical position and reduces subluxation. Strapping from onset until the patient regains muscle tone may prevent the incidence or delay HSP. Taping perpendicular to muscle inhibits activity, and taping parallel to a muscle promotes activity. The exact mechanism is not clear and it also requires a trained care provider. Shoulder slings and troughs help minimise shoulder stress and subluxation. If incorrectly positioned or not alternated with therapeutic exercises, it may lead to contractures and pain. Slings are used

when a patient is upright or walking and it supports and protects the flaccid arm and can maintain abduction. Many slings hold the arm in flexion, adduction and internal rotation, their use must be balanced with ROM exercises.

Physical therapy- Is an essential component of post stroke rehabilitation and has a major role in the prevention and treatment of HSP. PROM exercises as soon as the patient is medically stable and care should be taken during passive abduction as this may aggravate cuff injury. Performing PROM exercises within pain free range reduces reports of shoulder pain by 53%. Overhead pulley exercises increase cuff injury risk. Heat and cold therapy are used to decrease pain, increase mobility and reduce inflammation.

Rehabilitation methods include the Bobath and Brunnstrom approaches, and task-specific motor training. Neither proved superior. When comparing CPM and self ROM, CPM was associated with greater shoulder stability, but there was no significant improvement in motor impairment, disability, pain, or tone.

Management of Neurologic factors

TENS- works based on the principle of gate-control theory of pain. TENS can be delivered with low intensity (just enough stimulation to be sensed on the skin) or high intensity (noticeable muscle contraction or near painful skin sensation). Studies have shown that high intensity TENS may reduce HSP in comparison to placebo.

Functional electrical stimulation (FES) - Several studies have shown that FES reduces HSP and shoulder subluxation, and improves functional strength and ability. FES is most often directed at the supraspinatus and posterior deltoid muscle because of their role in maintaining dynamic shoulder stability. Research shows that FES is more effective in acute hemiplegia when compared to chronic.

Intramuscular electrical stimulation(IES)- delivers the stimulation directly to the targeted muscles via a percutaneous electrode.. Advantages include more direct stimulation and reduced pain.

EMG biofeedback and relaxation exercises- has been shown to provide more physiological control of pain. Also there was improvement in range and also improved tone.

Botulinum toxin- A presynaptic inhibitor for focal reduction of spasticity. A study by Lim et al showed that botox reduced pain and increased ROM when compared to intra articular steroids. Botox injected into the pectoralis and biceps produced significant improvement in Ashworth score for shoulder adduction and elbow flexion in an RCT of stroke patients with HSP.

Sympathetic blocks for CRPS- There are 3 major components to be addressed: pain management, rehabilitation, and psychological therapy. The basic concept is to reduce pain, prevent further injury, and increase mobility. Sympathetic blocks (often to the stellate ganglion) are used to interrupt abnormal sympathetic activity when pharmacotherapy fails. Rehabilitation should use modalities for pain and edema control, isometric and stress loading exercises, PROM in the pain free range and concurrent psychotherapy.

Pharmacotherapy

Simple analgesics- Acetaminophen taken before therapies may be useful. Topical agents such as Lidocaine can be useful and carry less side effects.

NSAIDS- may be used, provided there are no contraindications. Many patients with stroke will be on antiplatelet drugs and often have comorbidities like cardiac and renal illnesses. NSAIDS can interfere with anti-platelet treatment , provide an unwanted anticoagulant effect and further impair kidney function. Topical NSAIDS may be used.

Tricyclic antidepressants- have pain relieving properties and also aids with sleep.

Selective Serotonin Reuptake Inhibitors- helpful in neuropathic pain.

Antispasticity medications- help facilitate better participation in therapy. Its use can be limited due to sedation.

Oral corticosteroids- small studies have shown reduction in HSP with short term use of oral corticosteroids.

Lidocaine injection- 1% lidocaine (10 ml) injected into the subacromial bursa will produce pain relief and increase ROM in cases with bursitis.

Corticosteroid injections- into the glenohumeral joint or subacromial bursa decreased inflammation from rotator cuff tear, bicipital tendinitis, subacromial bursitis or adhesive capsulitis. If coupled with therapeutic exercises it can reduce pain and improve ROM for 2 to 4 weeks.

Suprascapular nerve block- Anaesthetic medication may be coupled with corticosteroid to improve range and decrease shoulder pain . Since there is no sensory component the risk of neuropathic pain is lower. The effect of the block varies from 3 to 9 months. It is potentially superior to corticosteroid at one month.

Surgical procedures are reserved only for severe shoulder stiffness or pain, most typically in the setting of adhesive capsulitis, not improving by all conservative measures. Operations include release of muscle contractures, repair of rotator cuff tear and scapular mobilisation. Very little research has been done in this area.

Approach to the treatment of hemiplegic shoulder pain

Step 1- identify neurogenic factors.

Step 2- identify mechanical factors.

Step 3- Prevention through positioning.

Step 4- symptom control and rehabilitation.

Step 5- Pathology based interventions.

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Gait in Stroke

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Cerebro vascular accident (CVA) or stroke is a global health problem and is a leading cause of disability[1]. Post-stroke hemiplegia is characterized by loss of control of one half of the body, cognitive deficits and various other forms of impairments leading to inability to perform activities of daily living (ADL).

Gait deviations following post-stroke hemiplegia depends on the location, severity and extent of brain injury, the duration of stroke and the rehabilitative interventions that have been implemented. About 52 to 85% of hemiplegic patients regain their ability to walk, but their gait differs from that of normal healthy subjects[2]. Reduced walking velocity and impaired balance decrease the ambulation potential and increase the risk of falls and fractures, and compromise health-related quality of life[3].

Kinematics of Hemiplegic Gait

The gait kinematics in hemiplegic patients differs from normal individuals in both stance and swing phases of gait. For proper interpretation of a hemiplegic gait one should be familiarized with normal human gait.

During the stance phase, hemiplegic patients may exhibit a variable hip range of motion. This may include a normal hip range of motion[4], reduced hip flexion at initial contact or increased hip flexion than normal at initial contact[5,6,7]. Sometimes the hip may remain flexed at toe-off [8].

Knee joints also exhibit a difference in the pattern of range of motion from normal during stance phase. Some patients exhibits increased knee flexion, especially at initial contact[4] while others exhibit reduction in knee flexion during early part of stance phase followed by a knee hyperextension in late stance and delayed movement into knee flexion in preparation for swing[4]. A third group of patients exhibits excessive knee hyperextension throughout the stance phase of the gait cycle[4].

The ankle joint also exhibit significant variation in the kinematics during stance phase. On the affected side the initial contact is typically made with the foot flat[9,10] or toe due to a plantar flexed ankle[7,8]. The ankle has been found to exhibit reduced dorsiflexion in midstance[6], or increased plantarflexion in stance phase of the gait[6,8].

The swing phase patterns of hip, knee, and ankle motions on the hemiplegic side is characterized by reduced flexion at the hip[4,8] and upward tilt of the hip, absent or reduced knee flexion[6,8], and reduced dorsiflexion or continuous plantarflexion at the ankle[4].

Due to these variations, the hemiplegic gait has been characterized by a stiff knee during swing phase[6]. The limited hip and knee flexion and reduced ankle dorsiflexion causes a relative increase in the limb length which results in reduced floor clearance on by the affected side during swing phase. As a result the patient adopts compensatory patterns in thehemiplegic gait such as dragging of the toes or circumduction of the leg[4,6,8] or upward tilt of the hip called hip hiking[10].

The reduction of knee flexion during swing phase is not only limited to the involved lower extremity, but also seen in the uninvolved lower extremity if the impairment is severe[11]. There are alterations in the upper extremity kinematics in patients with hemiplegia with a reduction in the arm movements[10] with the shoulders remaining relatively fixed in extension and the elbow remaining flexed[4].

There is forward flexion of the trunk during stance, in order to shift the center of gravity forward produced by recurvatum of the knee[12]. Another compensatory strategy adopted by the patient is the forward trunk leaning at push-off phase of the paralysed lower extremity which is a compensation for weak musculature on the paretic leg and this forward trunk leaning is not evident during push-off of the uninvolved leg[13]. It has also been observed that there is lateral shift of the trunk over the uninvolved side during stance phase to assist in weight shifting during swing of the paralyzed lower extremity[12].

Hence it can be concluded that typical abnormal movement patterns in hemiplegia are reduction of knee flexion during both phases of gait cycle (spastic paretic stiff-legged gait), during stance the knee can go into hyperextension also called dynamic recurvatum, and excessive ankle plantar flexion or equinus during either phase of gait. Ankle equinus during swing phase may be due to ankle dorsiflexor weakness, plantar-flexor spasticity, or ankle plantar flexion contracture. The plantar flexor spasticity or contracture can lead to the development of dynamic knee recurvatum. During ambulation patients have to adopt certain compensatory maneuvers to overcome these abnormalities like hip circumduction, hip hiking, and contralateral vaulting to avoid toe drag in a stiff knee gait[14].

Winters et al. in 1987 divided gait in spastic hemiplegia into four based on sagittal plane kinematics[15].

Type 1 hemiplegia

Type 1 hemiplegia is a gait pattern in which there is a 'drop foot'. The drop is evident during the swing phase of gait. The drop is due to the inability to selectively control the ankle dorsiflexors during swing phase of the gait cycle. Since there is no plantarflexion contracture the ankle dorsiflexion is relatively normal during stance phase. This gait deviation is usually rare following hemiplegia. It usually results from calf lengthening procedure in gastro-soleus spasticity and can be managed by using a posterior leaf spring AFO.

Type 2 hemiplegia

Type 2 hemiplegia is of two types:

2a- Equinus plus neutral knee and extended hip

2b- Equinus plus recurvatum knee and extended hip

Type 2 hemiplegia is the most common type observed in clinical practice. True equinus may develop during stance phase of gait because of plantar flexor spasticity and/or contracture of the gastrosoleus muscles. During swing phase there is a drop foot due weakness of ankle dorsiflexors. In case of mild spasticity of the plantarflexors the knee will remain neutral. But with severe spasticity the ankle remains plantarflexed throughout entire part of stance phase. This can lead over action of the plantarflexion-knee extension couple and the knee may adopt a position of extension or recurvatum.

This can be managed by reducing the gastrosoleus spasticity by intramuscular botulinum toxin injection. Orthotic support in the form of a hinged or posterior leaf spring AFO may be required. In fixed equinus contracture develops, lengthening of the gastrocnemius and soleus may be required. If the knee is fully extended or in recurvatum, then a hinged AFO with a plantarflexion stop is the orthosis of choice.

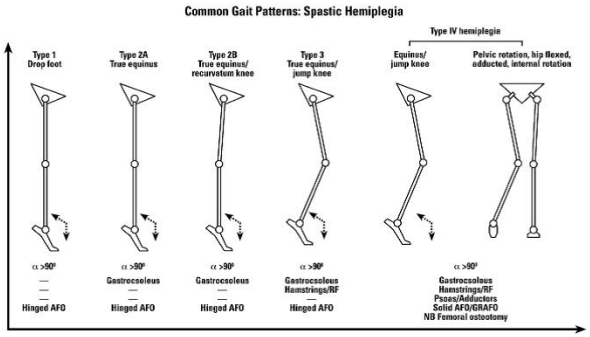
Type 3 hemiplegia

Type 3 hemiplegia is characterized by gastrosoleus spasticity or contracture, impaired ankle dorsiflexion in swing phase and a flexed, `stiff knee gait' as the result of co-contraction of hamstring/quadriceps.

This gait pattern can be managed by botulinum toxin injections for gastrosoleus spasticity or tendon lengthening for gastrosoleus contracture. For the stiff knee lengthening of the medial hamstrings with rectus femoris muscle transfer to the semitendinosus. According to the integrity of plantarflexion, knee-extension couple' a solid or hinged AFO may also be used.

Type 4 hemiplegia

In Type 4 hemiplegia there is marked involvement of the proximal musculature. In the sagittal plane there is equinus at ankle, a flexed stiff knee, a flexed hip and an anterior pelvic tilt. In the transverse plane there is internal rotation and in the coronal plane there adduction at the hip. For the distal problems the management is similar to Type 2 and Type 3 hemiplegia. The adducted and internally rotated hip will usually require lengthening of the adductors and an external rotation osteotomy of the femur.



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Role of Orthotics in Stroke Rehabilitation: What's New??

Kavitha Panchal. BPO(AIIPMR), CPO (Dubai Health Authority) Gold Medalist. Senior Prosthetist and Orthotist, Hope Prosthetic and Orthotic Rehabilitation Center, Kakkanad.

www.hoperehab.co.in

Stroke

Stroke is the fourth leading cause of death in the United States.About 19 Billion USD is spent annually in the US for care of stroke patients.

Treatment mainly involves Medical Management and Rehabilitation.

Rehabilitative management is multi factorial i.e the treatment plan is made with many different objectives in mind. Prevention of deformity; Improvement of function such as walking , transfers, balance, grasp etc… many such parameters are worked upon.

Orthotic management of stroke patients address many such Objectives.

Mrs. Kavitha Panchal is the Managing Director of Hope Prosthetic & Orthotic Rehabilitation Center, located in Kakkanad, Kochi. She is a Gold Medalist Prosthetist and Orthotist from the prestigious All India Institute of Physical Medicine and Rehabilitation. She has more than 17 years of experience and has served as a P&O in an MNC in Mumbai, as a P&O in Sheikh Rashid Hospital, Dubai UAE, as a Senior P&O in Gujarat before starting her own Center HOPE in early 2021.

Role of Orthoses

- Minimise Contracture
- Improve Joint Position
- Increase joint Stability
- Maximize Functional Movement
- Prevent/ Compensate for limb deformities.

Lower Limb Orthotics

SMO :A supra malleolar orthosis can be given when minimal orthotic is required to help correct over pronation which is commonly seen in stroke patients. Along with strategically placed corrective straps, this orthosis eliminates the necessity of prescribing an AFO and over bracing the patient.

Ankle Foot Orthoses: Foot drop is most commonly seen in stroke patients and an AFO caters to the problem very well. A variety of designs in both Static and Dynamic AFO are available.

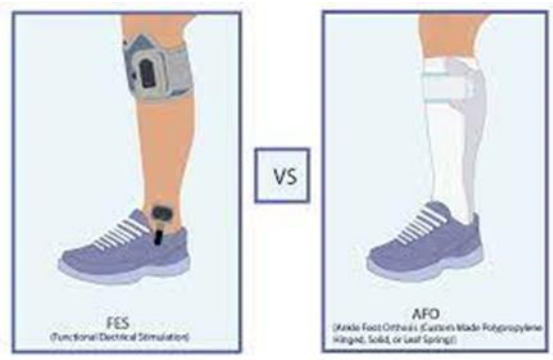
AFO with Flexure joints: Some Dynamic AFOs provide better freedom of movement by replacing the missing action eg. an AFO with dorsiflexion assist (Flexure Joints) provide the missing dorsiflexion at the beginning of swing phase of the Gait and the PlantarFlexion stop provided in the posterior aspect prevents the plantar flexion at the same time.

AFO with Ultraflex Ankle joint: These Joints provide adjustable tension to stretch Tendo Achilles tightness . This joint can also be locked at various positions. The tone reducing footplate,static controls and submaximal assist allow for conservative management of spasticityto improve muscle length and balance and to correct postural deformity. This ankle-footdesign minimizes pressure to ease related co-morbidities from poor skin integrity,neuropathies or vascular disease. The addition of an SMO keeps the footStable and securely in place

Carbon Fiber AFO: This AFO provides a strong, lightweight solution for patients with varying degrees of drop foot secondary to a variety of neurological conditions. The energy storing properties of carbon fiber make it an ideal material for this dynamic ankle foot orthosis because it provides real energy return. Best for those people leading busy lives, this AFO ensures a more efficient walk for the user. Carbon fiber design provides excellent strength-to-weight ratio and dynamic motion.The tapered carbon heel stores energy and manages forces at heel strike. Full-length toe lever provides full support while foot is loaded.

Functional Electric Stimulation:FES is a technique that uses low energy electrical pulses to artificially generate body movements in individuals who have been paralyzed due to the injury to the central nervous system. FES can be used to generate muscle contraction in otherwise paralyzed limbs to produce functions such as grasping and walking.

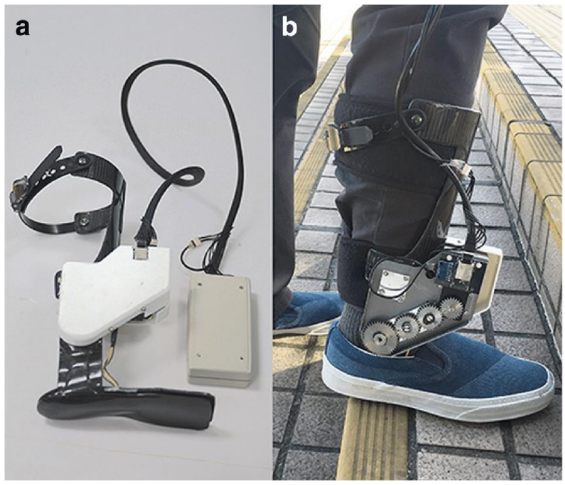
FES is being actively used to help patients with Peroneal Nerve Palsy to eliminate foot drop. Electrodes are placed on quadriceps muscles and Peroneal nerves. At the moment just before the heel off phase of gait, the stimulator delivers a stimulus to the common peroneal nerve which results in the contraction of the Tibialis Anterior, ExtensorDigitorum longus, ExtensorHallucis longus, and Peroneus Tertius thereby bringing about dorsiflexion and subsequently uninterrupted swing.



Robot Assisted AFO: Robot-assisted ankle-foot-orthosis (AFO) can provide immediate powered ankle assistance in post-stroke gait training. The research team at Department of Biomedical Engineering at The Chinese university of Hong Kong, has developed a novel lightweight portable robot-assisted AFO which is

capable of detecting walking intentions using sensor feedback of wearer's gait pattern. This study aims to investigate the therapeutic effects of robot-assisted gait training with ankle dorsiflexion assistance.After 20-session robot-assisted gait training with ankle dorsiflexion assistance, the active ankle assistance in

Robotic Group induced changes in gait pattern with improved gait independency , motor recovery, walking speed, and greater confidence in affected side loading response, with heel strike instead of flat foot touch-down at initial contact. Robot-assisted gait training with ankle dorsiflexion assistance could improve gait independency and helpstroke patients developing confidence in weight acceptance, but future development of robot-assisted AFO shouldconsider more lightweight and custom-fit design.



Knee Orthoses:

CHECK Brace: Hyperextension of the knee joint is very commonly seen in Stroke Patients. With its Four point pressure mechanism, the CHECK Brace is very effective in controlling hyperextension of the Knee. Soft upper and lower suspension sleeves and popliteal interface combine with adjustable straps to hold the frame in position as the straps are adjusted to provide a "stop" to control ability of the knee to hyper-extend.Longer uprights (when compared to the Swedish knee Cage) reduce the amount of pressure required on the femur

and tibia to control hyperextension, making the orthosis better tolerated by the patient.Dual axis joints allow for full knee flexion and allow each of the four uprights to move independently over each other, from extension to flexion, enabling the orthosis to follow the natural movement of the leg and prevent downward migration.Low profile hinges with slim uprights that are easily shaped to fit the contours of the leg to create an orthosis that becomes virtually unnoticeable under clothing.Made of synthetic leather laminated with polyurethane foam and brushed polyester tricot. These unique pads provide a soft interface between soft tissue and the orthosis. D-loops are available for patients with limited use of their hands to make the application of the device easier. Straps are attached to the suspension sleeves - eliminating confusion of which strap goes where. After initial fitting, wearer just closes or opens one side only of the front straps for simple application and removal.

Knee Ankle Foot Orthoses (KAFO):

Robotic Leg Orthosis: The Tibion Bionic Leg is a wear-able RKO that provides mechanized-assistance to patient-initiated active movement The RLO has a flexible plantar pressure-sensing shoe insert; loose-fitting plastic ankle straps attaching the shoe insert without providing ankle support, leg and thigh uprights, single-axis knee joint with angle sensors; textile straps secured with zippers, Velcro and adjusting knobs; onboard actuator motors with control panel housing; and rechargeable lithium battery. The RLO uses plantar pressure, angle and actuator torque sensors to determine the assistance level and timing needed during activity. Plantar pressure sensors detect gait phase based on sequence and timing of heel-toe weight-bearing. Angle sensors determine knee motion angles. Actuator torque sensors determine knee torque. A proprietary formula incorporating amount and distribution of forces, in the context of an internal gait-prediction algorithm, defines knee state and function thus determining which knee extension assistance mode is applied. During stance phase, stair ascent or sit-to-stand movements, the knee actuator actively assists concentric extension. At toe-off, during swing phase or in non-weight bearing, the actuator decouples to allow free knee swing. At heel strike, stair descent or stand-to-sit, the knee actuator resists knee flexion by providing an eccentric knee extension torque.

Using the Tibion Bionic Leg, a wearable robotic knee orthosis, for transfer training with a man after stroke.

Microprocessor powered lower limb Orthotics:

The microprocessor-controlled leg orthosis like the C-BRACE from Ottobock,opens up entirely new possibilities for freedom of movement. The new sensor technology makes the entire gait pattern even more dynamic and responsive by computerized controlling of both stance phase and swing phase.

This Orthotic give real time response for ease of walking. Modes can also be changed for e.g., from walking mode to cycling mode, through an app installed in the user's smartphone.

Hip Knee Ankle Foot Orthoses (HKAFO):

Reciprocating Gait Orthosis (RGO): The term Reciprocating Gait Orthosis refers to a unique form of HKAFO . This device is generally a right and left KAFO connected to a pelvic section with a reciprocating mechanism. This type of device is used with people who suffer from paralysis of the lower trunk, hips, and lower extremities.

The KAFO sections control the lower extremities and maintain them in proper walking alignment. The purpose of the reciprocating pelvic section is to control the hips and lower trunk and prevent simultaneous hip flexion. Extension of one hip causes the simultaneous or reciprocal flexion of the other hip, thereby enabling patient to take a step. The Patient uses upper trunk, shoulder, and arm muscles to operate the device with the assistance of either crutches or a walker. This device is usually limited to use in therapy or household walking.

The mechanical design of the hip joints in the RGO allows flexion of one hip which causes simultaneous extension in the opposite hip. These rotations were motorized in this new design by adding powered actuators to the existing components of the RGO

Upper Extremity Orthotics:

MyoPro Arm Hand Orthosis

A breakthrough in modern medical robotics, MyoPro is a powered arm and hand orthosis (brace) designed to help restore function to the wearer's paralyzed or weakened upper extremities, helping individuals perform actions and daily activities that might otherwise be impossible. The MyoPro may also facilitate rehabilitation including muscle re-education and increasing range of motion.

Originally developed at MIT with Harvard Medical School, the MyoPro arm and hand orthosis device works by reading the faint nerve signals (myoelectric signals) from the surface of the skin (fully non-invasive, with no implants) then activating small motors to move the limb as the user intends (no electrical stimulation).

The user is completely controlling their own hand, wrist, elbow, and arm; the robotic arm brace amplifies weak muscle signals to help move the upper limb. It has been called "power steering for the patient's arm."

While there are many prosthetic products for those who have lost their arms, hands or legs, and while there are orthotic products to support weak legs, MyoPro is the only wearable orthotic robotic device on the market to help restore function for those who still have their arms and hands but are unable to use them.

SyreBro Robotic Glove:

Syrebo™ stroke therapy product is an innovative pnenumatic flexible rehabilitation robot. It combines the most advanced flexible robotics technology and neuroscience theory, integrating hand function rehabilitation training, evaluation and clinical research. It is widely used in various hospitals such as rehabilitation, neurology, stroke center, geriatrics and pediatrics, orthopedics, brain tumors and other departments. It can fully cover the patient's full-cycle hand function rehabilitation training from the paresis period to the rehabilitation period.

Passive training: In the passive training mode, even if the patient's hand cannot move due to high muscle tension or stiffness, the rehabilitation glove can drive the affected hand to execute flexion and extension exercises. The patient can simultaneously see the 3D model of this hand on the screen.The syrebo rehabilitation robot can intelligently adjust the speed and intensity of flexion and extension of the gloves, which can meet the training requirements of patients at different stages of rehabilitation.

Task-oriented training: Due to the innate ability of our brain Neuroplasticity, patients can relearn their hand motor functions via functional task training.With the help of rehab glove and on-screen 3d animation,users can interact with real objects, which could further enhance patients' learning process and re-educate patients to use hand during the Activities of Daily Living (ADLs).

Assistance training: Syrebo rehabilitation glove are able to capture the patient's weak active movement, then helps him amplify the movement, assists the patient to complete the whole active movement. It can induce plastic changes in the neural network and strengthen the patient's awareness of active participation.

Innovative mirror training: Under the exercise of the Mirror Training, with help of syrebo robotic glove, the healthy hand drives the affected hand, two hands move synchronously. The simultaneous visual effects and proprioceptive feedback (feeling and seeing hand) are able to stimulate patient's neuroplasticity. Hand Mirror Training is scientifically well-grounded and effective method for hand rehabilitation.

Active game training: Multi interactive hand & brain combined games, enhance the immersion of hand rehabilitation, increase the enthusiasm and initiative of patients, make training more interesting.Patients can also adjust the difficulty of the game according to their hand movements.

A plethora of orthotic innovations are happening all around the globe. Inspite of many limitations and challenges these orthoses are bettering the lives of many Stroke patients.

Members in Action

On 26th May 2022, **Dr. V.K Sreekala** delivered a talk on "Approach to Low Back Pain", at the monthly academic meet at Sree Gokulam Medical College. It is a common academic forum which is attended by Faculty and PG students from all specialties.

She (Dr. Sreekala) also presented a paper on " Low back pain in post natal women" In the National conference in March 2022, IAPMRCON 2022 held at New Delhi. The title was "Mind your muscles, Ladies! ". She delivered Oration 2022 in the state conference on 23rd April, Rehabcon 2022 held at Thiruvananthapuram.

REHABCON 2022

15th Annual State Conference of Kerala Chapter of Indian Association of Physical Medicine and Rehabilitation was jointly organized by Department of PMR, Govt. Medical College, Thiruvananthapuram and Kerala Chapter of IAPMR at Hotel Residency Tower, Thiruvananthapuram on 23rd and 24th April 2022. Theme of the conference was “Interventional Physiatrist: Need of the Hour”. 137 delegates attended the conference. *Organizing Chairman* was **Dr.Suresh Kumar.P.S**. and *Organizing Secretary*-**Dr.Selvan.P.** Conference was inaugurated by **Dr.Sara Varghese**, *Principal, Govt. Medical College, Thiruvananthapuram*. *Chapter president* **Dr.P.C.Muralidharan** presided over the inaugural function, **Dr.Selvan.P**, presented Secretary’s report. Stalwarts of PMR,

Dr.S.Hariharan, Dr.George Joseph.N and Dr.Churchin Ben were honored.

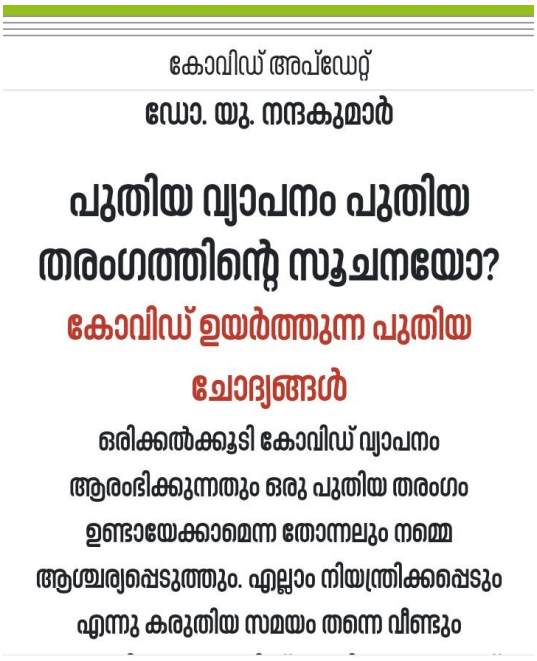
Dr.Laxmi Mohan, Dr.Unnikrishnan Ramachandran, Dr.Sasikumar.N, Dr.Padmakumar.G, Dr.Sreejith.K, Dr.Shehadad, Dr.Jijo Varghese, Dr.Shiby.T.G., Dr.Nitin.A.Menon and **Dr.Ravi Sankaran** were the invited faculties. They did deliberations on interventional pain management covering the various aspects. Obtained 3 Hours of CME credit hours from the Kerala State Medical Council.

Oration was done by **Dr.V.K.Sreekala** on the first day of conference. 12 free paper platform presentations were done by Junior Residents and the top 3 presentations were awarded with cash prizes. 2 free paper presentations were done by Junior Physiatrists and a cash prize was awarded for the best paper. There were10 E-Poster presentations and cash prizes were awarded for the top 3 posters.

PMR Quiz competition was conducted by **Dr.Nitha.J** and **Dr.Karthikeyan Ramachandran.**

General Body meeting was conducted on 23rd evening at 5'O clock. New office bearers of the Association took charge in the meeting. Preconference workshop of hands-on technique on Musculoskeletal Ultrasound Scan was conducted on 22/04/2022 at Dept. of PMR, Govt. Medical College, Thiruvananthapuram and Anatomy Dissection Hall.

Dr. U. Nandakumaran Nair, *Professor and HOD of PMR at Kollam Medicity*, wrote an article in Madhyamam, about how skepticism regarding the efficacy of vaccines peaked during the Covid pandemic. He wrote in length about how vaccines have been pivotal in the human races fight against various diseases. The effectiveness of Covid vaccines was particularly highlighted in this succinct article.



Dr. U. Nandakumaran Nair, contributed another article on trends seen in Covid cases in India, to *True Copy Webzine*. He mentioned how Indian Covid data on April 29th, as analyzed by New York Times showed 199% increase in cases. The number of Covid related deaths also increased considerably. This trend definitely points to the possibility of a new emerging strain of the virus, & makes us question the efficacy of herd immunity….

രോഗം മാറ്റാൻ വ്യായാമം

കുട്ടികൾക്ക് പാക്കേജ്

ഓടിച്ചാടി കളിച്ചു നടക്കുന്ന കുട്ടികൾക്കെന്തിനാണ് വ്യായാമം എന്നു കരുതരുത്. അസ്ഥി-പേശികളെ ബലപ്പെടുത്താനും മാനസിക ഉന്മേഷം നേടാനും കൃത്യമായ വ്യായാമങ്ങൾ തന്നെ വേണം

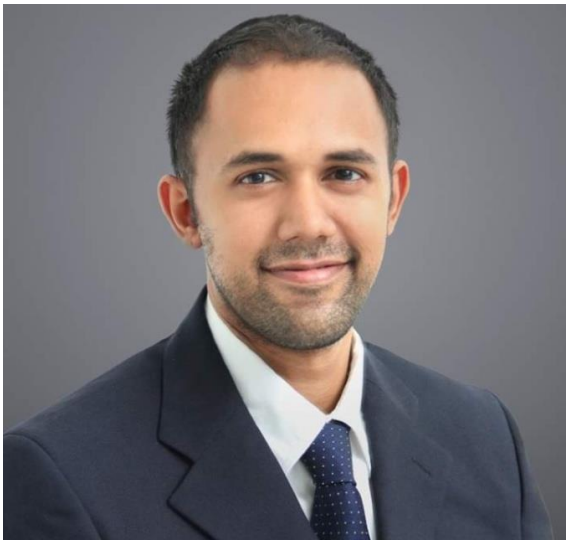
വ്യായാമപദ്ധതി എങ്ങനെ ?

എത്രനേരം ചെയ്യാം?

99

Dr. T.K Vasudevan, *Professor & HOD, of the PMR Department at Sree Narayana Institute of Medical Sciences(SNIMS)*, wrote an article in Manorama Arogyam. The article addressed the necessity of exercise in children. Sir also highlighted that in today's world where children are glued to TV or mobile screens & video games, it is better that they keep aside time for scheduled exercise.

Dr. Sooraj Rajagopal, *Associate Professor of PMR at Govt. Medical College, Kozhikode***,** presented an interactive lecture on Importance of Exercises in Hemophilia, as part of the Hemophilia Day Celebration. This session was held at Hotel Sea Shells Savoury,Calicut on the 25th of May 2022.



He sleeps at nine & wakes up at three,

Then toils hard in the wards & the OPD.

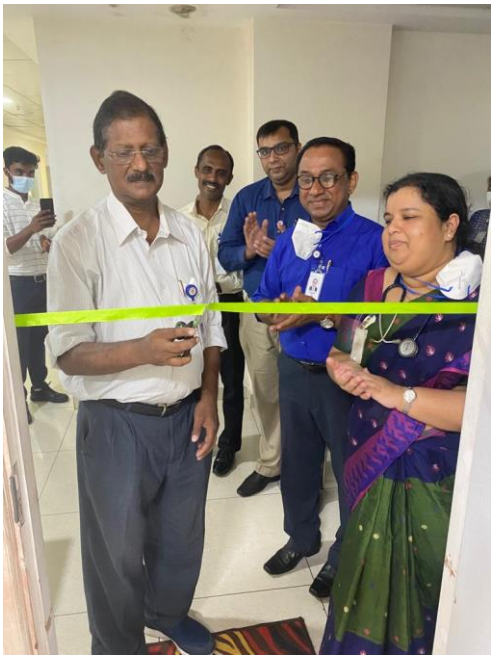
Our beacon of hope is now officially the HOD….

Dr. Ravi Sankaran is now the HOD of PMR at Amrita Institute of Medical Sciences.

Dr Ravi also gave a talk to IMA Kochi at Utopia Dystopia Binale at Hilite Platino in July 6.

The inaugural ceremony of 'The Alzheimer's And Related Disorders Society of India-Kozhikode Chapter' was conducted on July 26th, at IMA Hall, Kozhikode. **Dr. V.T Sudheera** has been appointed the President of this Chapter. The august function was attended by **Dr. V.R Rajendran,** *Past Principal of Government Medical College, Kozhikode*, **Dr. P.C Muralidharan**, *President of Kerala Chapter of IAPMR*. **Dr. Beena Philip**, *the Mayor of Kozhikode* was the Chief Guest & **Mr. P.V Chandran** was the Guest of Honour.

Dr. Sooraj Rajagopal, *Associate Professor of PMR at Government Medical College, Kozhikode,* attended an IEDC Medical Camp, for children with special needs, on 23rd July. This camp was conducted by Samagra Shiksha Kerala, Kozhikode, BRC Mavoor.



Dr. Roshin Mary Varkey, *Associate Professor & HOD of PMR Department*, at Believer's Church Medical College Hospital (BCMCH), played a crucial role in the Inauguration of Prosthesis and Orthosis Clinic along with the General Surgery Department in BCMCH in association with Ottobock.

Initiation of Child Developmental Clinic (Day Care Program) by PMR department was done along with Departments of Paediatrics and Neonatology in BCMCH.

Assessment and Electric Wheelchair Prescription as part of distribution of free wheelchairs for disabled children by BCMCH, was coordinated by the PMR Department.

Birthday Celebrations with children of CDC, was attended by **Dr. Roshin Mary Varkey**, and she received beautiful birthday cards, hand made by them with the help of developmental and occupational therapists

Dr. Anand Raja, *Consultant Physiatrist at SUT Hospital & Research Centre, Thiruvananthapuram,* discussed the rehabilitation of chronic low back pain on the live phone-in programs "Hello Doctor" aired on Kairali News & 'Dr.Q' aired on News18 Keralam.

DNB Gold Medalists

Dr. Midhun A.
June 2019

Dr. Asha Mohan
June 2021

Dr. Neethu R.
December 2020

Dr. Reni Benny
June 2020

As part of the 21st convocation of the National Board of Examinations in Medical Sciences, the list of gold medalists in the various DNB specialities was released. As you're all aware DNB exams are held in June & December each year. It's a matter of great pride that the gold medals for the June & December exams in 2019, 2020 & 2021 were bagged by Physiatrists based in Kerala. The Physiatrists who bagged gold medals & the sessions they bagged gold medals in are as shown above.

Dr Nitha J, *Consultant Physiatrist, at KIMS Health, Thiruvananthapuram*– authored a chapter on *"Role of Rehabilitation in Equipping Differently abled-Children with Assistive devices for inclusive education" in a book titled -"Assistive technologies for differently abled students".* IGI Global is the publisher who brought this book out, & it is available for online purchase on Amazon.

The PMR Department of KIMS Trivandrum conducted a camp to provide free prosthetics to 60 patients. This camp received publicity in the local press.

Dr. Soumya Thankappan, *Senior Resident of PMR, at SNIMS,* presented a talk on 'Differential Diagnoses of Knee Pain' in the Physiatrists from Private sector group.

FREE PM& R CAMP

Pushpagiri Medical College, Department of Physical Medicine and Rehabilitation in association with Freedom Trust, Chennai organised a free Rehabilitation Camp for distributing mobility devices, assistive devices, orthoses and prostheses free of cost to the differently abled on June 6th 2022. Through this initiative around 103 persons suffering from various disabilities including amputations of the upper and lower limb, paraplegia due to Spinal Cord Injury,

disability due to Stroke and Traumatic brain injury, Spina Bifida, Polio etc, were assessed by Rehabilitation Physicians (Physiatrists) and provided free equipment based on their specific locomotor disability, functional status and felt needs.

Welcome address was given by **Dr Abraham Varghese,** *Medical Director, Pushpagiri Medical College Hospital*. Presidential address was given by **Dr Tomy Philip**, *Principal, Pushpagiri Institute of Medical Sciences and Research Centre*.The program was inaugurated by **Dr R Bindu**, *Hon Minister for Higher Education and Social Justice*, who also distributed few free equipment to some of the beneficiaries**. Smt Sheela Varghese**, *Chairperson, Thiruvalla Municipality* honoured the differently abled staff of Pushpagiri Hospital.

Dr S. Sunder, *founder* of Freedom Trust and author of Textbook of Rehabilitation Medicine was honoured by the Hon Minister **Dr R. Bindu**. The distinguished dignitaries who spoke were **Mr Vikas Gupta**, *Branch head-Cochin Savex Technologies*, **Sri Joseph M Puthussery** *Ex-MLA*, **Adv R. Sanal Kumar** *Vice chairman Kerala State Co-operative Employees Welfare Board* , **Sri Jiji Vattasseril** , *Ward councilor*, **Dr Jimi Jose**, *Assistant Professor, Department of PM&R,* Pushpagiri Medical College delivered the vote of thanks.

A hands on workshop was conducted on Musculoskeletal Rehabilitation an Hemophilia Joint Health Score by **Dr. Nittu Devassy Panjikaran**, *Assistant Professor of PMR at Amrita Medical College.*

On the 26th of May, **Dr.Nittu Devassy Panjikaran**, *Assistant Professor of Physical medicine and Rehabilitation* along with Hematology department conducted Prathidhi. The program was a camp and patient oriented awareness program on the recent advances in carrier detection, genetic councelling and Yttrium therapy for Hemophilia Patients.

Intrathecal Baclofen Pump for Spasticity (Including Spastic Hemiplegia as in Stroke)

Dr R Ramnarayan, Sr Consultant Restorative neurosurgeon, Chennai.

DrMuralidharan, Associate Professor, Department of Physical medicine and Rehabilitation, Medical College, Kozhikode.

Introduction

Spasticity is defined as a motor disorder characterized by a velocity dependent increase in the tonic stretch reflexes with exaggerated tendon jerks as a component of upper motor neuron involvement. It is a disordered sensorimotor control resulting from a upper motor lesion presenting as an intermittent or sustained involuntary activations of muscles.

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He is a specialist in surgery for Movement

Lesions of the upper motor neuron cause a variety of positive and negative features. Among these spasticity is considered a positive feature. All muscles need some tone to maintain function, for example, activation of antigravity muscles to maintain sitting or standing postures. In an individual with spasticity, there is a velocity-dependent increase in muscle tone to passive movement. This creates an inability to stretch muscles or coordinate movements effectively (1).

Causes of spasticity

- Stroke
- Cerebral Palsy
- Spinal cord injury
- Multiple Sclerosis
- Hypoxic Brain Injury
- Traumatic Brain Injury
- Parkinson's Disease
- Motor neurone disease
- Spinal cord compression
- Metastasis / tumour

Pathophysiology of spasticity. Spasticity is the velocity-dependent increase in muscle tone due to the exaggeration of stretch reflex. The central lesion causing the upper motor neuron system disrupts the balance of supraspinal inhibitory and excitatory inputs directed to the spinal cord, leading to a state of disinhibition of the stretch reflex. Also some sort of plastic changes that occur in the spinal cord and brain also is a cause of spasticity. An important plastic change in the spinal cord could be the progressive reduction of postactivation depression due to limb immobilization. Secondary soft tissue changes in the paretic limbs also tend to enhance muscle resistance to passive

displacements. Due to this reason, early limb mobilisation in patients with upper motor lesion is essential to prevent and treat both spasticity and intrinsic hypertonia (2).

Spasticity can have an impact on an individual's function, affecting upper and lower limbs, as well as trunk. If this is not managed effectively, it can lead to fixed deformity contractures (changes to soft tissue), which affect skin care, comfort and hygiene, as well as complications for daily tasks (3).

The management of spasticity needs to be carefully considered. It affects approximately 35% of those with stroke, more than 90% with CP, about 50% of TBI patients, 40% of SCI patients and between 37% and 78% of MS patients (4).

Clinical assessment.

On physical exam, the clinician will notice that spasticity varies with the speed of movement; meaning the faster the muscle is moved or stretched, the greater the resistance to stretch or passive elongation is felt. Additional physical exam findings include clonus, spastic co-contractions, and spastic dystonia. Clonus is defined as an alternating muscle contraction and relaxation of the agonist and antagonist muscles. Spastic co-contractions are abnormal antagonist contractions that present during voluntary agonist effort. Spastic dystonia is a muscle contraction that is present at rest, leading to a constant clinical posture that is highly sensitive to stretch. Spasticity is frequently graded using the modified Ashworth scale, which is graded 0 to 4. Other commonly used scales include the Tardieu scale and Penn spasm frequency scale (5).

Modified Ashworth Scale

Gr 0 – no increase in muscle tone

Gr 1 – Slight increase in muscle tone manifested by a catch and release or minimal resistance at the end of the range of motion when the affected part(s) is moved in flexion or extension
Gr 1+ – Slight increase in muscle tone manifested by a catch, followed by minimal resistance throughout the reminder (less than half) of the range of motion.

Gr 2 – More marked increase in muscle tone through most of the ROM, but affected part(s) easily moved
Gr 3 – Considerable increase in muscle tone, passive movement difficult

Gr 4 – Affected part(s) rigid in flexion or extension

When evaluating a patient with new spasticity, a detailed history and progression of the symptoms, including any motor weakness, altered sensation, pain, bladder and/or bowel dysfunction, and sexual dysfunction and including family history, travel history, diet, and any compromised immunity is a must. The physical exam should include a neurological evaluation of muscle tone, motor power, reflexes, and sensation.

For a patient with worsening of chronic spasticity, evaluate for any triggers, disease progression, and the possibility of a new disease. Triggers may include skin, visceral, drug-related, or device-related issues. Skin issues may present as ulcers, ingrown toenails, boils, and infections. Visceral issues include constipation, urinary tract infections, or calculi. Rapid withdrawal of antispasmodic agents can lead to worsening spasticity. Lastly, poor seating, an ill-fitting orthotic, or failure of an intrathecal baclofen

pump can all be device-related triggers. Spasticity also can be worsened by other noxious stimuli such as infections, injuries, deep vein thromboses (DVT), or stress (6).

Management of spasticity

Several treatment options exist for spasticity and patients usually undergo more than one treatment method at a time. These methods have been shown to effectively alleviate symptoms and improve quality of daily life. They can be classified as either nonsurgical or surgical methods.

Non-Surgical Treatments

a. **Physical therapy:** stretching and strengthening exercises focusing on large muscle groups to improve range of motion and mobility.
b. **Occupational therapy:** exercises that focus on small muscle groups to improve strength and coordination allowing for improved performance of daily tasks. Speech therapy can also be done by patients whose spasticity has affected their speech.
c. **Casting or bracing:** prevents involuntary spasms and reduces tightening of the muscles.
d. **Oral Medications:** oral medications are used in combination with other therapies or medications, such as physical or occupational therapy. Oral medications are only used if symptoms interfere with daily functioning or sleep. Common medications include:
    - Baclofen
    - Benzodiazepines
    - Dantrolene sodium
    - Imidazolines
    - Gabapentin
e. **Botulinum Toxin (Botox) Injections**: Botox injections can be used to paralyze the spastic muscle preventing it from contracting. In small amounts, Botox is injected into carefully selected sites determined based on the pattern of spasticity. Botox injections can last up to 12-16 weeks, but, due to the plasticity of the nervous system, new nerve endings will form and the muscle will no longer be inhibited by the Botox. Additionally, while Botox can be very helpful, there are a limited number of injections that can be administered.

Surgery

a. **Intrathecal Baclofen (ITB) Pump:** A pump can be surgically placed in a patient's abdomen and will release a steady dose of baclofen directly to the spinal fluid. This allows for a significant reduction in spasticity and pain with fewer side effects compared to taking baclofen orally. ITB pump therapy should only be considered in extreme cases of spasticity and has been found to be most effective in treating spasticity in the lower and upper extremities.
b. **Selective Dorsal Rhizotomy (SDR)**: Spasticity can be caused by an imbalance in electrical signals to antagonist muscles. SDR rebalances the electrical signals sent to the spinal cord by cutting selective nerve roots. This is only done in severe spasticity of the legs but not effective when the upper limbs are affected. With proper and precise indication of the problematic nerve roots, cutting these roots will decrease muscle stiffness, while maintaining other

functions. SDR is most commonly used in patients with cerebral palsy. However the side effect profile can be devastating (7).

Intrathecal baclofen (ITB) pump is an FDA approved procedure for severe spasticity (1996). This device allows for direct delivery of baclofen into the cerebrospinal fluid (CSF) in the intrathecal space. This allows a patient to receive a high concentration of the medication directly to the spine while decreasing the CNS risks associated with high oral doses of baclofen, with a ratio of 100:1 for the baclofen concentration at the spinal cord level when administered intrathecally versus orally (8). The components include a pump and reservoir implanted subcutaneously within the abdominal wall and a catheter placed into the intrathecal space. A programmable battery-powered pump stores and delivers the baclofen via an electronic schedule. The pump is refilled on an intermittent basis via transcutaneous injection. The frequency of refill depends on the infusion rate and the size of the pump reservoir. The dose can be adjusted via the electronic programmer at any time. The pump also has a programmable alarm system to alert the patient, caregiver, and clinician when the reservoir is running out of medication or when there has been a pump malfunction.

ITB pump is indicated for patients with generalized spasticity that either cannot tolerate or lack response (9) to more conservative agents (oral, nerve blocks, etc.). Once again, the clinician must be careful to evaluate the utility of a patient's spasticity to their daily function. Before implanting an ITB pump, the patient must undergo trials through a single intrathecal bolus or continuous infusion through a percutaneous catheter. Multiple trials of increasing doses may be performed to establish clinical benefit. If the patient demonstrates a significant decrease in tone or spasms, he or she may be a good candidate for pump placement. The initial pump infusion dosing is typically calculated by doubling the initially clinically effective dose and using this for the initial 24-hour infusion dose. An ITB pump requires strict compliance, as it needs regular monitoring and refilling, and withdrawal can be lethal.

In a study, Ertzgaard, Campo and Calabrese (10) looked at both oral and intrathecal baclofen for spasticity to determine whether there is a rationale for the use of intrathecal baclofen. Oral baclofen may be effective in many patients with spasticity regardless of the underlying disease or severity. However, adverse effects, such as muscle weakness, nausea, somnolence and paraesthesia, are common with oral baclofen, affecting between 25% and 75% of patients, and limiting its usefulness. Intrathecal baclofen may be an effective alternative as the drug is delivered directly into the cerebrospinal fluid, thus bypassing the blood-brain barrier and thereby optimizing the efficacy of baclofen while minimizing drug-related side-effects. Intrathecal baclofen is a viable option in patients who experience intolerable side-effects or who fail to respond to the maximum recommended dose of oral baclofen.

Another study (11) looked at the risks and benefits by providing surgical intervention rate, safety, and elective device replacement rate data in intrathecal baclofen therapy. A total of 1743 patients treated with ITB for severe spasticity were analysed. Discontinuation from the registry was largely due to study site closure and patient relocation; exit due to an adverse event was limited to 0.3%.After 10 years, 87.2% of

adult and 76.3% of paediatric patients continued with ITB. Overall, 99.1% of pumps reaching end of battery life were replaced at the time of explant.For spinal and cerebral spasticity in paediatric and adult patients, discontinuation rates due to an adverse event were low (0.3%), and there was high acceptance (99.1%) of surgical intervention for therapy continuation. Patient/caregiver willingness to accept surgical and other risks for therapy continuation was extremely high.

Intrathecal baclofen pump for post stroke spasticity

The incidence of post stroke spasticity was recently reviewed in an article (12). The pooled prevalence of spasticity after stroke was 25.3% and that after the first-ever stroke was 26.7%. The incidence of spasticity after the first-ever stroke with paresis was 39.5%. The prevalence of disabling or severe spasticity (MAS ≥ 3) in stroke patients with paresis was 9.4% and severe spasticity was 10.3%. Moderate to severe paresis, haemorrhagic stroke and sensory disorder were risk factors for post stroke spasticity. Post stroke spasticity usually occurs within the first few days or weeks (13). However, the onset of spasticity is highly variable. It primarily affects the elbow (79% of patients), the wrist (66%) and the ankle (66%). Severe spasticity (Modified Ashworth Scale; MAS 3), though, was observed more frequently in the upper limb muscles.

Creamer et al (14) conducted the 'Spasticity In Stroke-Randomised Study' (SISTERS), a randomised, controlled, open-label, multicentre phase IV study to evaluate the efficacy and safety of ITB therapy versus conventional medical management (CMM) with oral antispastic medications for treatment of post stroke spasticity. Patients with chronic stroke with spasticity in ≥2 extremities and an Ashworth Scale score ≥3 in at least two affected muscle groups in the lower extremities were randomised to ITB or CMM. Both treatment arms received physiotherapy throughout. The primary outcome was the change in the average Ashworth score in the leg of the affected body side from baseline to month 6. Of 60 patients randomised to ITB (n=31) or CMM (n=29), 48 patients (24 per arm) completed the study. The primary analysis showed a significant effect of ITB therapy over CMM. These data support the use of ITB therapy as an alternative to CMM for treatment of generalised post stroke spasticity in adults.

Ramnarayan, Rajuraman and Marimuthu (15) published their retrospective analysis of both reductions in Modified Ashworth score as well as Stroke specific quality of life in 10 patients. All the ten patients who underwent surgery had benefit of reduction of MAS score three months after surgery. In three patients the reduction was significant (>50%) to become normal. The upper limb spasticity also had improved in 6 patients. The Stroke specific Quality of life score (SSQOL) also showed improvement in six patients (60%).

Creamer et al (16) also reported the results for secondary outcomes: pain via the Numeric Pain Rating Scale, health-related quality of life (QoL) by the EuroQol-5 dimensional 3 level utility score and health status visual analog scale score, stroke-specific QoL, and patient satisfaction from the SISTERS study. The authors found significant treatment effects in favour of ITB over CMM for changes from baseline to month 6 in Numeric Pain Rating Scale scores for actual pain as well as EuroQol-5 dimensional 3 level utility scores. ITB patients showed greater numeric

improvements from baseline during follow-up. More ITB patients than CMM patients (73% versus 48%) were satisfied with the spasticity reduction at 6 months.

Bensmail and coauthors (17) tried to the cost-effectiveness of intrathecal baclofen (ITB) therapy compared with conventional medical treatments for patients with disabling spasticity. The study suggested that including ITB as a first option strategy in the management of function of severely impaired patients with disabling spasticity results in a higher success rate. In addition, the ITB therapy revealed a lower cost and an overall more favourable cost-effectiveness ratio compared with conventional medical management.

How we do it

In our practice we routinely do intrathecal baclofen pump surgery.

The main indications include:

a) patients with severe spasticity (gr 3 and 4 Modified Ashworth score) of both cerebral and spinal origin.

b) patients have tried comprehensive non operative methods (including different therapies) for a minimum of 6 months and still no improvement.

c) patients with severe flexor spasms, clonus and pain.

d) in patients with complete spinal cord especially those with autonomic symptoms, it is better to do the procedure early.

We also do the same surgery for other neurological conditions like patients in persistent vegetative state and those with cerebellar signs due to Multiple sclerosis and spinocerebellar degeneration.

Once the correct patient is selected, we always do a trial intrathecal baclofen injection to confirm good response Figure one shows a chart developed in our centre for the same and which is self-explanatory. The trial involves a lumbar puncture which introduces 50µg of baclofen into the CSF (25µg in children). The Modified Ashworth score is done just before the procedure and hourly for four hours after the procedure (Figure 1). The changes expected are more than 25% reduction in spasticity by 2 hours after injection and back to pre-procedure state by 4 to 6 hours and absence of side effects. These patients will benefit from a permanent intrathecal baclofen pump insertion.

The pump is inserted under general anaesthesia. A subcutaneous lower abdominal pouch is made to fit the pump. The pump catheter is then tunnelled subcutaneously to reach the L3 L4 spinal levels. A lumbar puncture is made and after good flow of CSF is confirmed, the catheter is inserted into the intrathecal space and delivered up. The wounds are then closed

The patient is explained that it requires a few weeks of adjustment to get the correct dose as the dosage is highly individual. It then becomes easy for the physiatrists to work with the patient and make him mobile.

There are two types of pumps. The electronic programmable type has the advantage of flexibility of dosing and frequent change of doses for fine-tuning the patient's optimal dose. The mechanical constant flow type has the advantages of being gas driven and not needing battery replacement and not needing a programmer to refill, thus allowing geographically removed patients to benefit from ITB. Also the gas driven pump is cheaper but requires refilling every second month. Also very minute changes in

concentration are not possible unlike the battery operated pump.

Concluding, intrathecal baclofen pump is a very effective and safe procedure for cases of severe spasticity.

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Case Report: Phenol Neurolysis for Management of Upper Limb Spasticity in Early Recovering Stroke

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This case describes a 48year old male who suffered cerebrovascular accidents with left hemiplegia. The patient gradually recovered but developed debilitating spasticity mainly in left elbow flexors, forearm pronators and wrist palmar flexors, abnormal positioning of shoulder girdle complex, and shoulder pain. Phenol (3%) was injected to left brachialis, pronators under guidance of electrical stimulation at 12 weeks after initial injury. After 2 weeks, re-evaluated the patients and given one more dose of phenol (3%) to FCR muscle under electrical stimulation. After injection, elbow flexor and forearm pronator and wrist palmar flexor spasticity and shoulder pain was immediately reduced and abnormal positions of shoulder girdle complex and elbow joint gradually returned to functional limits over 6 weeks. This case suggests that phenol neurolysis for spasticity management in early recovery could yield functional recovery.

Discussion:

Spasticity in persons with stroke is commonly seen in clinical practice. Common clinical presentations in the upper extremity include shoulder adduction and internal rotation, elbow flexion, forearm pronation, wrist and finger flexion and clenched fist. Spasticity is one of the most physically debilitating conditions that interfere with functional improvements. It predisposes to other complications such as peripheral muscular changes, contractures and joints deformities. These abnormalities evolve over time and interact each other and produce a dynamic

picture of varying clinical presentations after an upper motor neuron lesion. Effective management of spasticity could improve rehabilitation after stroke.

There is a spectrum of treatment option. They include therapy (range of motion, stretching) physical modalities (splinting and casting, electrical stimulation), oral systemic medications, local interventions (botulinum toxin injections, phenol neurolysis), intrathecal baclofen therapy

and neuro- orthopaedic surgical correction.

Phenol is a chemical composite agent. It denatures protein readily and may cause denervation when injected near neural structures. Phenol's effect may be a combination of both neurotoxicity and ischemia. When used for the treatment of acquired muscle spasticity, phenol nerve injection can provide a temporary motor nerve blockade lasting weeks or months, which may improve physical functioning and gait. It can also be used for persistent and intractable pain conditions also.

Contraindications include patient refusal, active infection, tumour involvement at the needle entry site and bleeding disorder.

It should be given under ultrasound, fluoroscopy or electrical stimulation to motor points. Phenol is given in a concentration of 2% to 3% for Neurolysis. Concentrations greater than 5% produce demyelination.

Common Complications of phenol include pain on injection, bleeding and infection.

Case Report on New Onset of Stroke in COVID-19

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Dr. Sooraj Rajagopal (Associate Professor), Dept of PMR, Government Medical College, Kozhikode

Abstract:

SARS COVID-19 is associated with increased risk of thromboembolic complications. The aim of this study was to identify different types of stroke seen in COVID-19. A cross sectional study was conducted among 3780 patients admitted in Kozhikode Medical College between January to July 2021. 122 new onset stroke cases were noted. Among them 96(78%) were ischaemic and 26(22%) were haemorrhagic. Also 64% anterior circulatory stroke, 18% posterior circulatory stroke, 10.5% global hypoxic injury and 8% had multiple infarct. At the time of admission 90 had raised D-dimer and 83 had raised ferritin values. Comorbidities like DM, HTN, CAD were found in 86% of patients. Steroid has been started after the onset of severe symptoms for 98 patients. Newer biologicals were tried in 18. 15 patients were severely dehydrated at the time of admission. 100 patients who developed stroke were already under LMWH.

Masna Majeed did her MBBS in the 55th batch from Kozhikode Medical College. She is a second year Junior Resident in the Department of PMR, at Kozhikode Medical College. She won the gold medal for paper presentation in the IAPMR National Midterm CME.

Background:

The pandemic SARS COVID-19, emerged in Wuhan at the end of 2019, it presents with a large variety of clinical manifestations ranging from asymptomatic carrier state to severe respiratory distress.

Also newer data suggests that COVID-19 results in a unique profoundly prothrombotic milieu leading to both arterial and venous thrombosis.

Thrombotic complications in patients with COVID-19 most commonly present as venous thromboembolism and ischaemic complications related to thrombosis of extremity, cerebral, coronary and visceral arteries.

During my COVID postings I found many interesting cases of stroke following SARS COVID-19 infection. These were found in relatively young patients without higher cerebrovascular risk factors.

Case Presentation:

Among COVID positive patients admitted in Medical College Hospital, Kozhikode between January - July 2021, there were 2556 Category C patients, 86% had comorbidities like DM, HTN, CAD, CKD, COPD, DLP. Patients with history of higher cerebrovascular risk were excluded from the study.

95% of Category C population developed stroke 6-9 days after the onset of respiratory symptoms. 78% of cases were reported from males. Also 65% of cases were in 45-55 age group.

Investigations:

Low platelet count: 76%

Neutrophil/lymphocyte >3.3: 64%

CRP >80: 92%

D-dimer/S.ferritin/ LDH highly elevated: 80%

Imaging:

Ischaemic: 78%

Deep white matter ischaemia: 30%

Multiple infarcts: 18%

Posterior circulation : 8%

MCA stem occlusion: 16%

Thalamic infarct: 4%

Gangliocapsular infarct: 12%

Corona radiata: 2%

ACA occlusion:5%

Haemorrhagic: 22%

Intracerebral: 44%

SAH:8%

Intraventricular: 6%

Haemorrhagic transformation: 42%

Treatment:

100 patients who developed stroke were already under prophylactic LMWH

Steroids had been started after the onset of severe symptoms in 98 patients

Newer biologicals were tried among 18

36 required mechanical ventilation

64 reqired NIV

18 required hfnc

2 required O2 facemask at high flow

1 required nasal prongs

1 patient was on room air

Prone lying, pursed lip breathing, resisted breathing exercises were done by 6 patients

None of the study population received thrombolytic treatment , due to optimal therapeutic window, due to patient condition and resource limitation.

Discussion:

Among 2556 category C and 678 category B admitted, 122 (3.7%) had new onset stroke

46-55 age group had maximum incidence

Ishaemic stroke (78%) is more than haemorrhagic(22%)

In our study, incidence of stroke is usually seen 6-9 days after the onset of respiratory symptoms

In a study conducted by Zilan wang et al said that COVID 19 induced pro coagulant state, cytokine storm were risk factors for ischaemic stroke

In our study, all of the stroke patients had elevated D-dimer

A study by Jeffry et al said that elevated D-dimer independently associated with

incidence of critical illness, thrombosis and all cause mortality

Out of 122 stroke patients, 22% had haemorrhagic stroke. Of which, intracerebral haemorrhage is commonest type.

Stroke increases morbidity and mortality.Anticipation of complication and providing awareness about its prevention is important

185 patients lack care giver support which might affect their oral intake and also increase anxiety.

Most of the study population have other vascular risk factors, which cannot be overlooked.

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Young Recurrent Stroke With Dilated Cardiomyopathy and Verbal Auditory Agnosia – Rehab Challenge...

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Introduction

Stroke is the one of the leading causes of long term disability. Acute stroke rehabilitation is important to reduce the extent of disability and improve timely functional recovery. The evaluation of risk factors of stroke and their proper management is important to prevent recurrent stroke .Recurrent stroke is defined as any recurrent stroke occurring >24 hours after the onset of the incident stroke, irrespective of vascular territory. Dilated cardiomyopathy usually occurs in young adults, the heart muscles become dilated and stretched leading to reduced pumping effect and finally heart failure. A structured cardiac rehabilitation (CR) program can improve the patients' quality of life, the exercise capacity and the activities of daily living. Verbal auditory agnosia or pure word deafness has a selective deficit in the recognition of verbal sounds with preserved hearing and comprehension of non speech sounds like music. It usually occurs due to lesion in either the bilateral or unilateral temporal lobe especially the supratemporal gyrus, Heschl's gyrus, known as the primary auditory cortex.

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Case report

28 year old software engineer with recurrent stroke left MCA infarct and right hemi paresis, which recovered and then developed right MCA infarct one week later. He underwent mechanical thrombectomy with history of hemorrhagic transformation and dense left hemiplegia. He was detected to have dilated cardiomyopathy with severe LV dysfunction (EF-14%), LV clot, LBBB and ventricular dysynchrony and underwent cardiac resynchronization therapy defibrillator (CRT-D) from a tertiary care centre. The patient presented to our department with weakness of left upper limb and lowerlimb, speech difficulty, emotional disturbances and dependence in ADL of 8 months duration. On detailed evaluation, he had dense left hemiplegia with grade O power in left upperlimb and lowerlimb,left shoulder subluxation, right UMN facial palsy ,verbal auditory agnosia and post stroke depression with modified rankin scale(MRS) of 5/6 , modified barthel index scoring was 8/100 with total dependency and

had auditory verbal agnosia which is impairment in the comprehension of speech in the presence of an intact hearing mechanism and ability to comprehend non speech auditory information like music.

He was initiated on comprehensive multidisciplinary rehabilitation measures with physical therapy, occupational therapy and speech therapy after obtaining cardiology fitness. The goal was to improve his functional mobility, ADL independence, communication and endurance. Inpatient rehabilitation was provided in the initial 2 weeks to monitor the cardiac status and plan was to improve the functional mobility, bowel and bladder rehabilitation, psychosocial support and cardiac rehab measures to improve endurance and effort tolerance. He was provided with a customised double shoulder support for shoulder subluxation in view of the CRT-D machine in the left deltopectoral groove. After achieving the short term goal, he was given rehab interventions as outpatient for a period of 4 weeks. Even though there was no improvement in power of left upper limb and lower limb, he started ambulating independently with forearm crutch and knee orthosis and ankle foot orthosis in left lower limb under supervision with MRS of 3/6. He became moderately dependent in ADL with modified barthel index score of 68/100 and his auditory comprehension improved, and he now communicates verbally and by writing notes. The post stroke depression was treated with medications and psychological counselling and emotional support. The cardiac parameters after 6 weeks of rehabilitation showed improvement in the ejection fraction to 21% and moderate effort tolerance.

Conclusion:

A well structured comprehensive multidisciplinary stroke rehabilitation programme will improve the functional outcome in patients with co mobordities like dilated cardiomyopathy. The team work of the doctors, therapists, patient and the caregivers was the key in achieving the functional improvement of this patient. As physiatrists we need to take up the challenges in the rehabilitation of stroke patients with multiple co morbidities.

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Fledgling Physiatrists..

These are the young Physiatrists who recently cleared their MD exams in PMR…***Congratulations!!!***

Dr. Aneesh Nalinakshan[1]

Dr. Aswini V.R[1]

Dr. Lakshmi S. S[1]

Dr. Sonu Mohan M.S[1]

Dr. Cinju K.C[2]

Dr. P. Archana[2]

Dr. Nirav Joshi Ganapatram[3]

1. **From Govt. Medical College, Kozhikode**
2. **From Govt. Medical College, Thiruvananthapuram**
3. **From Amrita Institute of Medical Sciences, Kochi**

Took the Road to Rome and Reached Athens

Dr. Unnikrishnan Ramachandran, **Consultant Physiatrist, Saraswathy Hospital ,Trivandrum**.

I would like to present here two cases where patients who came with apparently straightforward musculoskeletal diagnoses unexpectedly took me to completely unplanned paths, ending up with totally different medical conditions needing urgent attention.

Case 1.

A 54 year old gentleman Mr.S was referred to me by a diabetologist for intractable shoulder pain of a few months duration. He was an obese person (BMI 39) with poorly controlled diabetes for many years, and started on regular medications recently and slowly getting his blood sugar lower. He also was hypertensive. The shoulder issue as expected turned out to be Periarthritis with effusion around the biceps. His wife also had similar complaints, a milder periarthritis, but significantly interfering with sleep. Since Mr.S was not well controlled diabetes wise, I explained to him that we need better blood sugar values, and injected his wife SSNB , who got good relief. He was on strict diet as advised by the diabetologist yet weight was not reducing. So I advised him on the need to walk atleast 45 minutes daily and he said that he is unable to manage more than 100 steps and would feel breathless. I thought that it was probably due to the morbid obesity, but decided to auscultate his chest which was clear, but I was shocked to hear a loud murmur over the aortic area. On questioning again he said he had mild aortic valve disease seen 5 years earlier and was advised just observation and thought it was too insignificant to mention. Since I was planning a SSNB for him, I asked my cardiology friend about safety of bupivacaine in aortic stenosis and vaso vagal shock (Obese people are more prone for vasovagal attacks while injecting) He almost jumped over the phone and told me not to inject and send the patient for evaluation. It turned out to be a very severe AS with impending cardiac failure. I thanked my stars when the cardiologist told me that vasovagal syncope in a severe AS carries a near 90% mortality and our usual measures like leg elevation , IV fluids etc will not help as the hypotension is difficult to correct. I have been injecting since so many years without this important piece of information. Never too late to learn. This person underwent detailed investigation and they diagnosed severe AS with a significant block in the left coronary requiring a bypass procedure. In short, a person who came for injection of periarthritis shoulder, ended up being a candidate for urgent Aortic Valve replacement and Bypass surgery.

Syncope: The Underestimated Threat in Severe Aortic Stenosis Georg Goliasch [1], Andreas A Kammerlander JACC Cardiovasc Imaging. 2019 Feb;12(2):225-232.

Syncope in Patients With Severe Aortic Stenosis: More Than Just an Obstruction Issue Jaume Francisco-Pascual [1], Eduard RodenasCan J Cardiol. 2021 Feb;37(2):284-291.

Case 2

A 45 year old gentleman Mr.K was referred again by the diabetologist to me for pain and swelling of the right ankle of few days duration, interfering with his ambulation and wanted to rule out septic arthritis. He was a recently detected diabetic started on OHAs. It was a unilateral ankle swelling , with relatively pain free passive ankle ROM with no significant joint tenderness. His swelling was subcutaneous and severely tender with local warmth mostly above the ankle. So I diagnosed it as lymphangitis/ cellulitis and started him on symptomatic treatment. Routine blood work up showed a high CRP 45 with normal WBC counts and ESR. Because he mentioned that two months prior, his FBS was normal, I enquired about history of covid, which he denied. But remembered an episode of rhinitis and feeling unwell , with tiredness for a few days 2 to 3 weeks back. Suspecting post covid I sent blood forD dimer which came as 1600. I duly sent the patient for a physician work up who diagnosed it as post covid and started him on anticoagulant Rivaroxaban. Was a stroke or MI prevented ? One never knows. (Covid is reportedly a reason for sudden rise of blood sugar in previously normal or controlled DM..or is it the steroid that was regularly used earlier)

There was definitely an element of luck or chance in both these cases. Being a physiatrist I feel fortunate that by our training we are conditioned to look a little broader than others, and more functionally in every case, and not the highly specialty centric tunnel vision that is the norm now a days. The idea of presenting it here is to highlight the fact that although at some level we are all guilty of conditioned presumptive diagnoses, we should keep our eyes and ears open for alternate possibilities , spend time with the patient and get a good history to connect the dots.

Links

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After Retirement Had One Year Association with SUT Royal Ulloor as Consultant Physiatrist
From 2020 onwards working as Consultant in Vijaya Anssi Spine Center at Statue Trivandrum. Now last month onwards working as Authorised Medical Officer at VSSC Pattom Polyclinic Trivandrum.
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2. Ip and ward consultations
3. Physiotherapy
4. Nerve conduction studies
5. Interventional procedures
6. Medical board for disability certification
7. House visits with palliative team.
8. Implementation of e health services.
9. Provides rehabilitation aids free of cost to BPL patients when available.
10. Health education to increase awareness of Physical Medicine and Rehabilitation

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Amputee rehab
Cerebral palsy rehab
Chronic pain management

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Pulmonary Rehabilitation
Pelvic floor rehabilitation
Pediatric rehabilitation
Geriatric Rehabilitation
Musculoskeletal Pain rehabilitation
Cancer rehabilitation
Interventional Pain Management
We provide Digital Therapeutics using FDA approved Jogo device - which comprises an AI driven mobile app and wearable sensors
We have IP rehabilitation care , Home care and Telerehabilitation services

---

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Beyond the Horizon...Course Suggestion..

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Continuing medical education is very important in modern medical world. Everyday new inventions are happening across the world. We should update our knowledge to keep up with the newer developments in the field.

Physical medicine and rehabilitation was considered as an end speciality in the past. But now the situation is changing very fast. Lot of new advanced courses are available for Physiatrists. Online and offline courses are there within and outside India. For this issue we will discuss one such course:-

Post-Doctoral Fellowship in Neuro Rehabilitation: After completing residency there are certain options for higher studies, exclusively for a Physiatrist. Post-Doctoral Fellowship in Neuro Rehabilitation by NIMHANS, Bangalore is one of the pioneer projects in our country.

Department of Neuro Rehabilitation in NIMHANS, runs outpatient and inpatient services, with average outpatient number more than 8000, and inpatient numbers more than 200 per year. Department works closely in association with Department of Neurology, and running neuromuscular clinic. Urodynamic laboratory- for research and management of patients with neurogenic bladder, Gait Analysis laboratory, Balance Assessment & training, Gait training including Body weight support treadmill training, Hand Robot, Computer-based cognitive assessment & training, Virtual reality rehabilitation are major Specialities among services. The department is involved in a lot of research activities. Most of the research work has been published in leading International & Indian journals (Pubmed Indexed).

Post Doctoral Fellowship in Neuro Rehabilitation started in 2012- 2013, with regular intake of two candidates. The candidates who have completed MD/DNB (Physical Medicine & Rehabilitation) are eligible to apply for this course. Course duration is for One year, course is included in Institute stipendary category. NIMHANS used to conduct a National level entrance exam for the admission. Exam notification usually comes in April, after selection courses begins in month of July. Selected candidates are invited for Certificate Verification and Interview .There is no reservation of seats (for applicants belonging to OBC/SC/ST Categories) in Ph.D. Programs, Postdoctoral Fellowship and Super Speciality courses. For postgraduate medical and Superspeciality courses - age should not be more than 32 years for MBBS degree holders and 37 for PG medical degree holders. Candidates who are awaiting the results may also appear for the entrance test, subject to production of proof of having

passed the examination on or before the date of admission to the course.

For details you can visit www.nimhans.ac.in , also contact PMR Department, NIMHANS, or call 080-26995143.

Book Review

Vasundhara Ghosal
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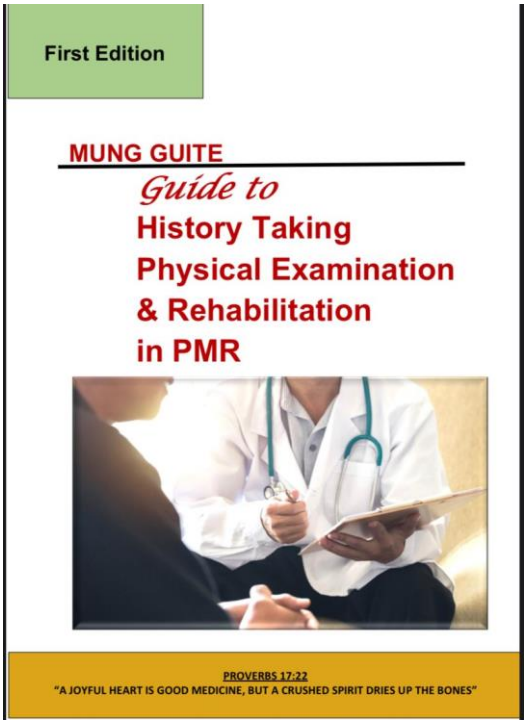
Guide to History taking, Physical Examination and Rehabilitation in PMR by Thongsuanmung Guite, 1st Edition



This book is a detailed work suited for all budding physiatrists and a practical guide for post-graduation students on how to take proper history of individual cases and important points of examination of most long and short cases in detail. There was shortage of books of Clinical Examination in Physical Medicine and Rehabilitation and this book is a good attempt in filling this gap.

The salient features that make this book unique are its simple language, short to the point presentation and crisp format with charts, properly mentioned negative history, inclusion of necessary investigations and basic treatment protocol.

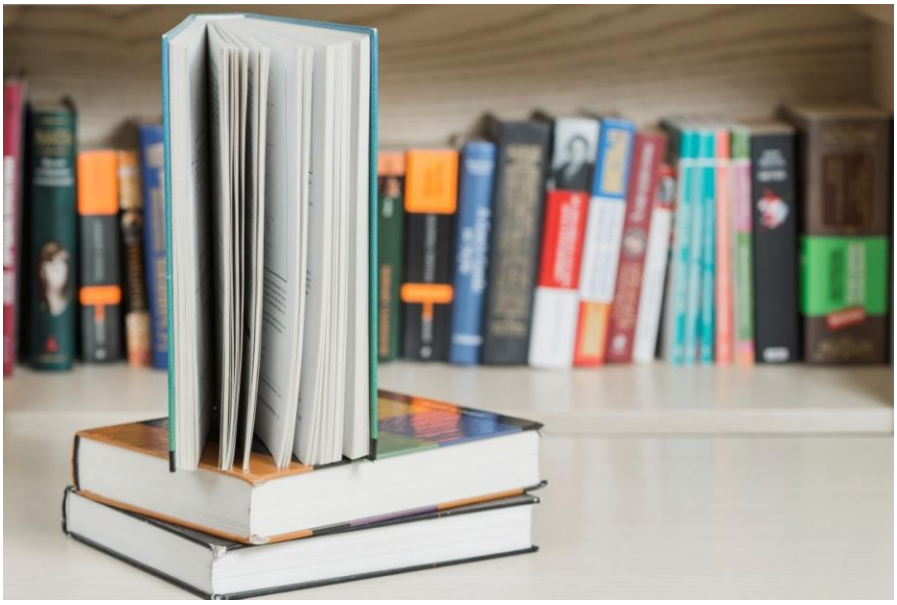
Addition of Disability assessment makes it a good & informative read. Difficult chapters like gait are very lucidly written that improves understanding. The expected or probable viva questions after every chapter makes it very helpful for students to prepare cases for the Practical Examination

I am hopeful that the book will keep getting regularly updated and the future edition(s) will also include more long cases and brief salient portions on orthoses and prosthesis and instruments related to Physical Medicine and rehabilitation. Best wishes for the book. I hope it reaches it's destined audience & benefits them in all ways possible….

Quiz 1

1. Strokes seen at the border zone of two vascular territories ("border zone" or "watershed" infarct) are more frequently seen due to _____.
   (a) Amyloid angiopathy (b) Hypertension (c) Hypotension (d)Aneurysm rupture
2. During the initial management, if the patient received fibrinolytic therapy, blood pressures should be maintained below 185 mm Hg systolic and ____mm Hg diastolic.
   (a) 110 (b) 120 (c) 140 (d) 130
3. In the acute period it is desirable to maintain blood glucose levels between_____?
   (a) 90- 100mg% (b) 140- 180mg% (c) 180-200mg% (d) 200- 210mg%
4. Fiorelli classification is used for _____
   (a) Chest infection post stroke (b) DVT following stroke (c) Silent aspiration (d) Intracranial Hemorrhage
5. Approximately half of all strokes that recur within 90 days occur within the first ___ weeks, thus highlighting the importance of aggressive measures and close monitoring during the acute inpatient rehabilitation period.
   (a) 8 (b) 6 (c) 3 (d) 2
6. Large-artery narrowing after aneurysmal SAH is visible in up to 50% of cases, usually occurring 7 to 10 days after the aneurysm's rupture and resolving spontaneously after ___days.
   (a) 16 (b) 17 (c) 21 (d) 37
7. Guidelines support the use of prophylactic-dose heparin products during acute and rehabilitation hospitalizations, to prevent DVT, up to the time that a patient regains mobility . It is common practice to use ambulation of ___ feet as the threshold to discontinue prophylactic anticoagulation.
   (a) 100 (b) 150 (c) 180 (d) 200
8. Amytriptyline and _____ have support as first-line agents in Central pain in a stroke patient.
   (a) Lamotrigine (b) Pregabalin (c) Oxcarbamazepine (d) Paracetamol
9. To prevent contractures, guidelines recommend positioning the hemiplegic shoulder in the maximum _____ tolerated for 30 minutes a day
   (a) Internal rotation (b) External rotation (c) Adduction (d) Flexion
10. Braden scale is used to assess_____
    (a) Balance (b) Spasticity (c) Muscle power (d) Pressure injury risk

Trivia…



The term “lacune” was adopted in the 1800s to describe infarctions from cerebral small vessels, but their underlying pathophysiological basis remained obscure until the 1960s when Charles Miller Fisher performed several autopsy studies of stroke patients. He observed that the vessels displayed segmental arteriolar disorganization that was associated with vessel enlargement, hemorrhage, and fibrinoid deposition. He coined the term “lipohyalinosis” to describe the microvascular mechanism that engenders small subcortical infarcts in the absence of a compelling embolic source. Since Fisher’s early descriptions of lipohyalinosis and lacunar stroke, there have been many advancements in the understanding of this pathological phenomenon*.

* https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7416422/

Key

1. (c)

   Ischemic strokes from thrombosis or stenosis may occur in any large-vessel vascular territories. Lacunar strokes are most often associated with hypertension. Strokes seen at the border zone of two vascular territories ("border zone" or "watershed" infarct) are more frequently seen due to hypotension. They are commonly associated with cardiac surgeries due to hypoperfusion that occurs during the procedure, or they may occur from microemboli, as may be seen from a cardiac etiology.

   Intracerebral hemorrhage (ICH) accounts for nearly 50% of stroke-related morbidity and mortality. These hemorrhagic strokes occur from a variety of underlying causes, hypertension being one common cause. The most common areas for a hemorrhagic stroke due to hypertension are the basal ganglia, thalamus, cerebellum, and pons.

   Lobar hemorrhages from amyloid angiopathy are more often seen in those aged 60 years and older. Some estimate that cerebral amyloid angiopathy accounts for up to 15% of ICHs in this age group.

   Although not considered "strokes," nontraumatic hemorrhages may also result from other causes. An AVM or aneurysm may rupture and cause an ICH. Subdural hematomas (SDHs) arise from the rupture of bridging veins due to their vulnerability to shear injury. Subarachnoid hemorrhages (SAHs) are located between the arachnoid and pia mater, tracking down the sulci and following the contours of the brain. The most common cause of a SAH is rupture of a berry aneurysm; the most frequent locations for a ruptured aneurysm are the anterior cerebral artery (ACA).

2. (a)

   Hypertension is more commonly seen than hypotension. "Permissive hypertension" is reasonable, but significant elevations, particularly if a fibrinolytic therapy is being used, should be corrected. Overcorrection must be avoided, as arterial hypotension is associated with a worse outcome. If the patient received fibrinolytic therapy, blood pressures should be maintained below 185 mm Hg systolic and 110 mm Hg diastolic. If no fibrinolytic therapy was used, the blood pressure may be allowed to go to 220 mm Hg systolic and 120 mm Hg diastolic. If the blood pressure must be managed, an appropriate goal is a decrease of 15% gradually over 24 hours. For patients with hypertensive lacunar infarcts and those with diabetes, it is recommended that their systolic blood pressure is maintained below 130 mm Hg.

   Although there is no clearly defined goal for blood pressure control poststroke, a Cochrane review by Zonneveld et al. did find a trend for "intensive blood pressure lowering in reducing the risk for recurrent stroke and major vascular events."

   In addition to blood pressure control, the patient's oxygen saturation should be maintained at 94% or higher. Hypovolemia should be rapidly treated and maintenance intravenous fluids should be run.

3. (b)

Hyperglycemia should also be treated, as it has been associated with worse outcomes. Very tight control is inadvisable, as the patient could become hypoglycemic, particularly in the postacute period when he or she may have a lower caloric intake than usual and is increasing physical activity during therapy. A goal of 140 to 180 mg/dL in the acute period is reasonable.

4. (d)
   Fiorelli claasification is used to assess Intracranial hemorrhage, as shown in the table below..

Hemorrhage Classification	**Radiographic Appearance**
Hemorrhage infarction type 1 (HI1)	Small hyperdense petechiae
Hemorrhage infarction type 2 (HI2)	More confluent hyperdensity throughout the infarct zone; without mass effect
Parenchymal hematoma type 1 (PH1)	Homogeneous hyperdensity occupying <30% of the infarct zone; some mass effect
Parenchymal hematoma type 2 (PH2)	Homogeneous hyperdensity occupying >30% of the infarct zone; significant mass effect; or any homogenous hyperdensity located beyond the borders of the infarct zone

5. (d)
   Because of more aggressive medical treatment specifically to reduce secondary strokes, the rate of recurrence of stroke after ischemic stroke and/or TIAs has dropped to about 3% to 4% per year. The rate of recurrence is highest in the first 30 days following the initial stroke/TIA. Approximately half of all strokes that recur within 90 days occur within the first 2 weeks, thus highlighting the importance of aggressive measures and close monitoring during the acute inpatient rehabilitation period. The most important risk factor to target for secondary stroke prevention is hypertension. In most cases antihypertensives should be restarted 24 hours poststroke in any patient who was taking them prior to the stroke.
6. (c)
   Vasospasm may contribute to a secondary ischemic injury and lead to further morbidity and mortality. Guidelines suggest oral nimodipine (IA) and euvolemia with normal circulating blood volume (IB) for all patients with aneurysmal SAH to decrease the risk of vasospasm. Transcranial Doppler and perfusion imaging with CT may be used for monitoring.
7. (b)
   In terms of VTE prevention, a process on admission should be implemented to ensure appropriate prophylaxis. Given the still notable risk for deep venous thrombosis (DVT) and PE in immobile patients, even in those appropriately treated with

pharmacologic or mechanical prophylaxis, a low threshold for repeat assessment for DVT and PE should be maintained even in the situation of appropriate prophylaxis. Illustrating this, Samama noted a relative risk reduction of 63% with low molecular weight heparin (LMWH) compared with placebo in a population of acutely ill medical patients. This study demonstrated a DVT rate of 14.9% in individuals without prophylaxis and a rate of 5.5% in those on LMWH.

After ICH, prophylactic-dose heparin products are recommended to be begun in 2 to 4 days in most cases (IIbC). In both ischemic stroke and ICH, LMWH is generally preferred over UFH (IIaA and IIbC, respectively). If anticoagulation is contraindicated, intermittent pneumatic compression is preferable to no prophylaxis (IIbB and IIbC, respectively). In both ischemic stroke and ICH, elastic compression stockings are not recommended (IIIB and IIIC, respectively).

8. (a)

   Classically seen in Déjèrine-Roussy syndrome related to thalamic stroke, neuropathic pain may occur after a stroke in a variety of locations. Appropriate care includes a thorough assessment of etiology, and other causes of pain should be excluded.

   Pregabalin, gabapentin, carbamazepine, and phenytoin may be considered as second-line agents.

9. (b)

   Contractures may frequently develop after stroke and can restrict eventual function and cause potential pain and skin breakdown. Resting the hand and wearing wrist orthoses as well as regular stretching or serial casting may be helpful for reducing elbow and wrist contractures. Surgical release of elbow flexor muscles can be considered for elbow pain and contractures. Ankle splints may also be helpful for preventing ankle plantarflexion contracture.

10. (d)

    Appropriate skin management requires regular assessments with use of standardized measures such as the Braden scale. Regular interventions—including nutritional assessment, skin hygiene maintenance, turning and weight-shift schedules, and the appropriate use of pressure-relieving mattresses and wheelchair cushions—are also recommended, along with ongoing family education.

Quiz 2

1. In the hospitalized stroke patient with poor oral intake, feeding via nasogastric tube should be started within __ days.
   (a) 4 (b) 5 (c) 7 (d) 9
2. Although detrusor hyperreflexia is the most common subtype of incontinence after cortical and internal capsule ischemic stroke, there is a relatively higher incidence of detrusor areflexia in patients with cerebellar infarction and _____
   (a) Thalamic infarction (b) Hemorrhagic stroke (c) Pontine infarction (d) Subthalamic infarction
3. Scores of ___ or greater, in Barthel Index, have been used as a measure of complete independence in stroke outcome research.
   (a) 60 (b) 70 (c) 80 (d) 95
4. For upper extremity recovery following initial ischemic stroke, 80% of patients achieve maximum recovery at 3 weeks and 95% achieve maximum recovery at __ weeks.
   (a) 9 (b) 10 (c) 12 (d) 13
5. The ____ score—an ordinal scale based on ICH volume and location, age, GCS score, and preexisting cognitive status—was shown to predict outcome.
   (a) GOS (b) FUNC (c) MRS (d) BI
6. Anosognosia, a lack of ability to recognize the deficits resulting from the stroke, is common among individuals with ____lesions and may include a lack of awareness of hemiplegia, a lack of insight regarding their need for continued hospitalization, and, in severe cases, an inability to recognize their hemiplegic limb(s) as their own.
   (a) Right frontal (b) Left frontal (c) Right parietal (d) Left Parietal
7. _____ apraxia may be detected when a person is unable to carry out a task on command such as “comb your hair” or “wave goodbye,” even though there is no paralysis.
   (a) Ideomotor (b) Constructional (c) Oculomotor (d) Dressing
8. Emotional lability occurs in as many as 20% of patients poststroke and is more common in patients with _____ lesions.
   (a) Left hemisphere (b) Interhemispheric (c) Pontine (d) Right hemisphere
9. For ischemic stroke, the Copenhagen Stroke Study provides guidance on time frames for duration of recovery. According to this study, severely impaired patients require approximately ___ months for recovery.
   (a) 4 (b) 5 (c) 6 (d) 7
10. With large vessel infarctions, due either to thrombosis or embolism, prognosis is related to the volume of the lesion. Outcome is poorest when the lesion involves more than ___ % of intracranial volume.
    (a) 5 (b) 7 (c) 9 (d)10

Recovering From…

This is how a patient who is recovering from aphasia feels like…

"When I read a new word-that is one I knew before the stroke- I knew what it meant intuitively. But although the new word was not lost it was not available to me. Concepts…would fade away like moonshine the moment I tried to pin them down with speech. It was a sensation so fleeting that I hardly knew it was there. The lack of speech ate right into my dealings with the outside world. It made me vulnerable, timid, defensive and shy. I hated being like that. I used to have opinions and laugh. People would say to me "You must feel very frustrated." No, "frustration" definitely is not the word. I was aware of the fragmentation of my brain-the emotions, the body language and thoughts that were all cut off and out of my reach. To paraphrase Wordsworth, mine was a grief "too deep for tears."

Speechless is a 170-paged autobiographical book written in 1994 by Jennifer Gordon, a patient recovered from a stroke*.

* https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5552754/

Key

1. (c)
   Early dysphagia screening is important to decrease the risk of aspiration, malnutrition, and dehydration. Beyond the bedside swallow assessment, an instrumental assessment is probably indicated. In one review, incidence of dysphagia after stroke differed as follows: cursory screening techniques identified an incidence of 37% to 45%; skilled screening identified a rate of 51% to 55%; and instrumental testing, often via videofluoroscopy, identified an incidence of 64% to 78%. The presumption is that there is a higher sensitivity with a more intensive evaluation. The incorporation of the principles of neuroplasticity (IIaB) and behavioral interventions (IIbA) is recommended for dysphagia treatment, but the use of drugs, NMES, transcranial direct current stimulation (tDCS), and transcranial magnetic stimulation is not recommended in the most recent guidelines (IIIA).

   In the hospitalized patient with poor oral intake, feeding via nasogastric tube should be started within 7 days (IA); this should be advanced to a percutaneous G-tube in those unable to advance from tube feeding within 2 to 3 weeks following stroke (IB). Supplements may be necessary in some to prevent or treat malnutrition (IIaB). Assessment for calcium and vitamin D supplementation should be encouraged in those in long-term care facilities (IA).
   The level of evidence is shown inside the brackets.
2. (b)
   Bladder incontinence is one of the most important predictors of poorer functional outcomes, institutionalization, and mortality. During acute hospitalization, all patients with stroke should provide a urologic history and be assessed for any concern regarding urinary retention through bladder scanning or intermittent catheterizations after attempted voiding (IB). If present, a Foley catheter should be removed within 24 hours after admission (IB). Prompted voiding, through a timed voiding schedule, may be helpful in the hospital or at home, and pelvic floor muscle training may be helpful after discharge to home (IIaB).
3. (d)
   Common and historically well-established instruments to measure disability following stroke include the Barthel Index (BI), the Modified Rankin Scale (MRS), and the Glasgow Outcome Scale (GOS). When measured on admission to rehabilitation, scores on the BI less than 40 tend to predict lack of independence in motor skills and difficulty with other basic skills, whereas scores over 60 tend to demonstrate a transition from dependence to assisted independence. Scores of 95 or greater have been used as a measure of complete independence in stroke outcome research.
   The MRS is a simple 0 to 6 ordinal scale that divides subjects into general functional categories.

Although originally intended for brain injury, the GOS is used in some studies of stroke recovery and has more recently been expanded into the Glasgow Outcome Scale–Extended (GOS–E).

4. (a)
   Additionally, the presence of voluntary finger extension and shoulder abduction can help to guide prognosis; 98% of those with these abilities within 72 hours after stroke achieving some manual dexterity, as demonstrated by an action research arm test (ARAT) score of ≥10.
   Among those still lacking voluntary finger extension and shoulder abduction within 72 hours, only 25% achieve manual dexterity. In those patients with a continued lack of voluntary finger extension and shoulder abduction at 9 days, eventual manual dexterity was achieved by only 14% of patients. Proprioceptive loss is also associated with decreased long-term recovery of upper extremity functioning and independence in daily living, although the difference in recovery between patients with and without proprioceptive impairment on admission to rehabilitation could not be demonstrated earlier on at 6 weeks out from stroke.
5. (b)
   The FUNC score—an ordinal scale based on ICH volume and location, age, GCS score, and preexisting cognitive status—was shown to predict outcome. In a prospective study, no patients with a score below 5 regained functional independence, whereas greater than 80% of those with a maximal score of 11 regained functional independence. Notably, 26% of the overall sample regained functional independence.
6. (c)
7. (a)
   Here's a list of Apraxias & agnosias & the inability/inabilities caused by them…

   - *Constructional apraxia/visuospatial agnosia* (there's a considerable overlap in the signs of these two syndromes) → Inability to construct or copy figures.
   - *Dressing apraxia*→ Difficulty dressing and undressing.
   - *Agraphia*→ Inability to write.
   - *Alexia*→ Inability to read.
   - *Dyscalculia*→ Inability to calculate.
   - *Topographical disorientation*→ Getting lost, inability to learn new routes.
   - *Autotopagnosia*→ Inability to name, recognize or point to parts of own or someone else's body.
   - *Hemisomatognosia*→ Part of body felt to be absent.
   - *Prosopagnosia*→ Inability to recognize faces.
   - *Finger agnosia*→ Inability to name/number fingers
   - *Simultagnosia*→ Inability to recognize complex pictures

8. (d)
   Individuals with emotional lability often are unable to control or suppress their emotional response to common environmental stimuli and may cry or laugh very easily even though the stroke survivor recognizes that this response is inappropriate. Emotional lability (sometimes termed "emotional incontinence") is often mistaken for depression. Education of the stroke survivor and his or her family is particularly important, and many individuals find they can tolerate these symptoms reasonably well as long as they understand their cause.
9. (a)
   For ischemic stroke, the Copenhagen Stroke Study provides guidance on time frames for duration of recovery, with mildly impaired patients requiring on average 2 months, moderately impaired patients requiring 3 months, severely impaired patients requiring 4 months, and the most severely impaired patients requiring 5 months.
   In terms of predicting ambulation, sitting balance combined with ability to recruit the hemiparetic leg is a predictive marker for independent ambulation at 6 months. Of those who are able to maintain sitting balance and recruit activation in the hemiparetic leg within 72 hours from stroke, 98% were independent in ambulation at 6 months, whereas patients unable to maintain sitting balance or activate the hemiparetic leg within 72 hours had a 27% chance of independent ambulation. Those still unable to maintain sitting balance and recruit the hemiparetic leg by day 9 had only a 10% likelihood of independent ambulation at 6 months.
10. (d)