Significant contributions to Stroke Care Delivery systems in India.

The STROKE ACTION PLAN FOR INDIA

ON-GOING MAJOR NATIONAL PROJECTS UNDER THE AEGIS OF GOVT. OF INDIA

I. SMART INDIA PROGRAM

SMART-India App was created, with a primary purpose of providing a low-cost tele-stroke services of a neurologist and physiotherapist to physicians in district hospitals.

This project currently running amongst 22 district level hospitals across India is being spearheaded by me under the AIIMS-ICMR aegis, Govt. of India. This implementation research is designed to estimate the value and utility of using the SMART APP device by the physicians in charge of the emergency services in acute stroke care.

II. IMPETUS

IMPETUS is an implementation research project that aims to investigate the feasibility of implementing a uniform stroke care pathway in medical colleges of India and improving stroke care. The study will be conducted in selected medical colleges across the country and is intended to examine the changes in a select set of stroke care related indicators over time within the sites exposed to the same implementation strategy.

III. CARE-DAT

CARE-DAT stands for Centre for Advanced Research and Excellence in Disability and Assistive Technology, was launched to study the role of assistive technologies in optimizing functional recovery post stroke with special emphasis on hand function and its validation of sustenance and long-term clinical impact.

This innovative research and development program is running between AIIMS (I am the PI and the over all coordinator) and Indian Institute of Technology, Biomedical Engineering division in Delhi to develop low cost assistive devices for stroke recovery and for "life after stroke".
One such innovation is the "robotic arm" which is now patented and will cost less than Rs. 1500 which is around 20 dollars!

I. Acute Stroke Care:

I have pioneered the work on " thrombolysis program in acute ischemic stroke in India. I initiated and implemented the country's first public sector acute stroke thrombolysis program in AIIMS, New Delhi in the year 2002. At that time, the international guidelines for stroke management had mandatory requirement of obtaining blood platelet count, PT and INR prior to administering IV rTPA(Alteplase). This made it impossible for any patient managing to arrive into the emergency triage within 3 hours of stroke onset since obtaining these investigations with in the extremely narrow therapeutic time window was impossible. She redefined the relevance of these investigations prior to thrombolysis (which further delayed and increased cost of treatment) and due to her work, it is no longer mandatory to perform these tests if patients could be identified with appropriate clinical and radiological criteria. (**Ref: Padma MV et al. Neurology India, 55(1): 46-49, 2007).**

Subsequently, this protocol was adopted by most developing countries which have a resource crunch. Many public and private sector hospitals across India

could implement the stroke treatment protocols with IV thrombolysis without the need for coagulations studies because of her experience.

In the year 2018, the international guidelines, including ASA/AHA have also adopted these same modifications. Currently, it is not mandatory to get these tests done before acute thrombolysis for stroke.

For my contribution to the field of stroke management in India, I have been the National Coordinator for the SITS-NEW registry, the SITE-SEARS registry, and has been on the board fort the National Commission on the Non – communicable Diseases, Diabetes and Stroke (NPCDCS) in designing National Stroke Registry, with the Public Health Foundation of India for designing programs for primary, secondary and tertiary care and prevention of stroke in the country.

I am the author of the National Stroke Guidelines for India from Ministry of Health and Family Welfare as well as for the Indian Stroke Association. The updated version of these guidelines from the Ministry of Health and Family Welfare has been published in January 2020.

I am the architect of the STWs (Standard Treatment Flow) for Stroke Management across the primary, secondary and tertiary care centers across India, published by ICMR.

I am the resource person for Government of India for the PBSR (Population Based Stroke Registry) and HBSR (Hospital Based Stroke Registry) from ICMR.

I am also the resource person and the expert for training and monitoring of the first of its kind MSU(Mobile Stroke Units) program for Stroke care in North East in India spearheaded by ICMR.

I have conducted with the support of NCD divisions of individual states, physician training programs in Himachal Pradesh (I am the official mentor for the development of Neurosciences in Himachal Pradesh), UP, Rajasthan,

Punjab, Delhi, Kerala, Telangana, Tamil Nadu, Chattisgarh, West Bengal, Manipur, Assam, Orissa, Ladakh, Madhya Pradesh.

I have been the expert for Stroke Awareness Programs and dissemination of information amongst school children, colleges and lay public in the out reach areas of Ladakh and Himachal Pradesh under the aegis of DST, along with the KAP studies for which she has been awarded the National Award in category A from the Science and Technology Communications of Govt. of India.

I have been the architect of the novel Low Cost Innovative Establishment of Stroke Care Pathways across India. I established the Acute Stroke Treatment and stroke chain of survival algorithms across India using the no -cost WhattsapTelestroke Models.

I launched the H.P Telestroke Project in May 2014. This was without any added infrastructure requirement or any new man power. The district level hospitals equipped with CT facilities were in the network. The emergency services manned by physician/surgeons were given training with standard SOPS developed by me. Remote monitoring and help was provided through whattsap. Within one month of launching the first ever thrombolysis of an acute stroke patient was performed by an orthopedician on emergency duty in the district hospital. Till date more than 300 have been thrombolysed in the state in the district level hospitals now designated as primary stroke centers. This facility is available without in house neurologists.

I have published this data and currently, world over the low cost technique of using whatssap is being used in the developing countries in various ways in the stroke care pathways.

I have developed and launched successfully stroke physicians programs at the district level health delivery systems, involving the emergency physicians for acute stroke care protocols. Till date all district level hospitals in Himachal Pradesh and selected districts across different states in India are running this program.

Currently this program is active in states of Punjab, Rajasthan, Maharashtra, Gujarat, Telangana, Andhra , Kerala, Assam, and other states using the local state government help and with central monitoring. This includes both public and private sector hub and spoke models. From government sector, this program is now available promptly and free of cost to the traditionally underprivileged sections and to all irrespective of social and economic barriers across the country.

Refs:

1. Sudhir Sharma, **PadmaMV**, Amit Bhardwaj, Ashish Sharma, NishitSawal, Suresh Thakur. Telestroke in resource-poor developing country model. Neurology India Vol. 64(5):934-940; 2016
2. **Padma MV**, Paulin Sudhan, Dheeraj Khurana, Rohit Bhatia, Subash Kaul, P. N. Sylaja, MajazMoonis and Jeyaraj Durai Pandian. Telestroke a viable option to improve stroke care in India.International Journal of Stroke Special Issue: World Stroke Day Edition.vol9;A100;133-134;2014

Currently this model is well established and accepted by Government of India and is being implemented in various states.

II. **Stroke Units:**

I have also launched successfully in several district hospitals, the Stroke Unit concept just by mo0difying the existing CCUs under the NCD program of Government of India. This has been done at no additional cost.

As President of Indian Stroke AssociationI launched the first ever Stroke Summer School where young physicians and neurologist are given the training

and mandatory skills to initiate stroke services in their local clinical practice.

III. Work on Stem Cells in Stroke:

I have done pioneering work on stem cells therapy in chronic stroke from India. The following publications bear testimony to her work.

Clinical Trials on Autologous Bone Marrow Derived Stem Cells Therapy in Chronic Stroke:

This research dealt with the safety and efficacy of intravenous autologous bone marrow derived mononuclear and culture expanded mesenchymal stem cells in stroke. Adult patients were recruited with the inclusion criteria as: 3 months to 2 years after stroke, power of hand muscles of at least 2; Brunnstrom stage 2-5; NIHSS of 4-15, conscious and cooperative. This was an unblinded, non randomized case control study. Patients were assessed for strength, tone (modified Ashworth), Fugel Meyer (FM) scale for upper limb, Edinburgh handedness inventory, modified Barthel Index (mBI) and functional MRI including DTI was performed at baseline, 8 and 24 weeks of stem cell infusion. Prior to stem cell therapy, patients were screened and educated about stem cells and bone marrow aspiration technique. Forty stroke patients were recruited with the above inclusion criteria. Twenty were given stem cells followed by 8 weeks of physiotherapy, serving as experimental/stem cell group and 20 patients were administered physiotherapy regime alone. 50 -60 million cells in 250 ml of saline was infused intravenously over 2-3 hours. The baseline clinical and radiological scores between the experimental and control groups were statistically insignificant. The safety profile was normal with no mortality or cell related adverse reactions in stem cell patients. On comparison between experimental and control groups, ,mBI was statistically significant on follow up at 24 weeks ($p = 0.05$). Laterality Index (LI) of BA 4 and BA 6 was insignificant at 8 and 24 weeks follow up, as also in the FA ratio, fiber length

and fiber number ratio between the two groups. An increased number of cluster activation in Brodmann areas BA 4, BA 6 was observed post stem cell infusion indicating neural plasticity. The study concluded that autologous intravenous stem cell therapy is safe and feasible. Stem cells may act as "scaffolds" for neural transplantation and may aid in repair mechanism.

Publications:

1. Bhasin A, **Padma MV**, Bhatia R, Mohanty S, Kumaran, S.Stem cell therapy – A clinical trial in Stroke. ***Clinical Neurology and Neurosurgery. Nov 23 S0303 – 8467; 2012***. (E pub ahead of print). **Citation index38**

2. AshuBhasin, **Padma MV,** S. Senthil Kumaran , Sujata Mohanty Rohit Bhatia Sushmita Bose Shailesh Gaikwad Ajay Garg, Balram Airan .Autologous MesenchymalStemCells in Chronic Stroke***Cerebrovascular Diseases Extra; Vol.1(1): 93 – 104; 2011.***Citation index 23

3. Bhasin A, **Padma MV**, Mohanty S, Kumaran SS, Bhatia R. Autologous intravenous stem cell therapy in chronic ischemic stroke. ***Journal of Stem Cell and Regenerative Medicine. 8(3): 181-189; 2012.***

4. Bhasin A, **Padma MV,** Kumaran SS, Bhatia R, Mohanty S. Neural interface of mirror therapy in chronic stroke; a functional imaging study. ***Neurology India; 60(2): 570 – 576; 2012***.**Citation index8.**

5. AshuBhasin**, Padma MV**, Sujata Mohanty, S Vivekanandhan, Sakshi Sharma, Senthil Kumaran, Rohit Bhatia. Paracrine Mechanisms of Intravenous Bone Marrow Derived Mononuclear Stem Cells in

Chronic Ischemic Stroke. Journal Of Cerebrovascular Disease, Vol6(3):107:119; 2016

6. AshuBhasin, **Padma MV.** Safety and feasibility of autologous mesenchymal stem cells in chronic stroke. A four year follows up. Journal of Stem Cell & Regenerative Medicine.Vol.13(1):1-6;2017
7. M. Gourie Devi, Alka Sharma , Sujata Mohanty , Neeraj Jain , Kusum Verma**,PadmaMV**, Pramod Pal , H. S. Chabbra , Satish Khadilkar , Sudesh Prabhakar,Gagandeep Singh. Report: Stem Cell applications in neurological practice, an expert group consensus appraisal. Annals Of Indian Academy Of Neurology.Vol 19(3):367-373;2016
8. **Padma MV**, Neha Kuthiala. Restorative Therapies after Stroke: Drugs, Devices, and Robotics.Annals of the National Academy of Medical Sciences (India) 2019;55(03):124-131 DOI: 10.1055/s-0039-1698495.

IV. Stroke Rehabilitation:

I have done immense work on low cost and high yield rehabilitative techniques to improve disability after stroke. In collaboration with IIT Delhi I have developed the robotic arm for post stroke paralyzed upper limb which is currently patented and is in the industry for full fledged commercial production.

I. CIMT and Electrical Stimulation in Chronic Stroke Rehabilitation:

The study was designed as a randomized clinical trial approved by the IRB at AIIMS, New Delhi. Patients, aged 18-70 years, diagnosed with chronic ischemic stroke within 3 months – 2 years of index event, with an MRC power grade > 2 for wrist and hand muscles, and NIHSS of 4 – 20 were recruited from

Stroke Clinic. Of 205 patients screened, 126 were recruited. Patients were assigned to the groups via alternate allocation to Neuromuscular Electrical Stimulation (NMES group = 63) and Constraint Induced Movement Therapy (CIMT group = 63). In the CIMT group, the unaffected arm was restrained for 4-6 hours a day and were instructed to practice active, assisted strengthening and motor control training with the affected arm. In NMES, wrist and finger extensors were stimulated with a pair of vacuum electrodes. The electric current had a pulse width of 250-300 microseconds and a frequency of 50 Hz with amplitude set at the minimum level required to initiate joint extension. The initial contraction period was 5 seconds and the initial rest period was 10 seconds. Both groups received 8 weeks of treatment on a daily basis and assessed at baseline, 2 and 4 months after therapy with mRS, BI, FMS and the Motor Assessment Scale. At 2 months follow up, there was no difference in between the two groups in the mRS ($p=0.9$), BI ($p=0.2$), FMA ($p=0.3$) and the MAS ($p=1.0$). However, the CIMT group performed better than the NMES groups in the mRS ($p<0.001$), BI ($p< 0.001$), FMS ($p=0.03$) and the MAS ($p=0.02$) at the 4 months follow up. CIMT works on the principle of reversing learned non-use. A subconscious effort to use the affected limb might have persisted while the subjects performed their daily activities at home. This may have played a role in the persistence of efficacy of CIMT over a longer period of time. In contrast, NMES is purely a hospital based intervention and may not have had a "carry-over" effect which was demonstrable in the CIMT group.

Publication:

1. Vishal Taimni, Aashrai SV Gudlavalleti, AshuBhasin**, MV Padma Srivastava.** Comparison of Constraint induced movement therapy and neuromuscular electrical stimulation on clinical outcomes in chronic stroke. ***Indian Journal of Physiotherapy and Occupational Therapy. 2014***.

2. **Padma MV**.Is it possible to facilitate neural plasticity for enhancing post chronic stroke recovery?***Neurology India. Vol.63 (3):310-1;2015*.

II. Mirror Therapy in Stroke Rehabilitation:

The aim of the study is to evaluate the effectiveness of mirror therapy by a computer assisted (laptop) webcam system in rehabilitating stroke patients. It also studied cortical re-organization when the patients were subjected to physiotherapy regime. Twenty chronic stroke patients (3 moths – 2 years of index event), underwent clinical and radiological examination at baseline, 8 and 24 weeks. 10 healthy control subjects also had functional imaging for comparison. Blood oxygenation dependent (BOLD) data were acquired using the echo planar imaging (EPI) sequence using 1.5T MR scanner (Avanto;Siemens Medical Solutions, Erlangen, Germany) with a standard head coil. Block design with alternate baseline and activation cycles was used with a total of 90 whole brain EPI measurements (timed repetition (TR) = 4520 ms, timed echo (TE) = 44 ms, slices = 31, slice thickness = 4 mm). All patients received physiotherapy by the same therapist for the paretic limbs. The treatment regime was administered for 5 days in a week for 8 weeks for 60-90mminutes. The treatment incorporated bilateral hand exercises in such a way that the patient observed his unaffected hand on the laptop screen to the subject. This resulted in the facilitation and movement of the paretic hand. The mean FM scale score at 24 weeks was 35.65 ± 8.5 with statistically significant improvement between 8 and 24 weeks (t= - 8.929, p= 0.0001) and between baseline and 24 weeks (t= -16.37, p = 0.0001). The mean mBI at baseline and 8 weeks was 46.95± 10.04 and 58 ± 9.3 respectively (p< 0.05). Repeated measures of ANOVA were applied to calculate the difference between 0 (baseline), 8 and 24 weeks which was found to be statistically significant. Increased number of cluster activation in the ipsilateral and contra-lateral

hemisphere was observed. There was a consistent increase in the cluster activation of the motor and pre-motor Brodman areas post-therapy ($P< 0.05$). The observations in this study suggest that there was an increase it the activation of primary motor area BA 4 post-therapy explaining the "restitution" principle of neural plasticity. The treatment regimen in this study was based on the principles of virtual reality (VR) and motor imagery. A shift in the position of the BA 4, 6 was also observed suggesting that physiotherapy in the form of motor imagery promotes a focussed activation of the injured brain, augmenting recovery. The brain areas involved are pre-motor cortex, dorsolateral and pre-frontal cortex, and the primary hand motor area as evident by the results in this study.

Publication:

1. AshuBhasin, M.V.Padma Srivastava, R Bhatia, S Mohanty. Neural interface of mirror therapy in chronic stroke: a functional imaging study. Neurology India 2012; 60(12): 570 – 576.

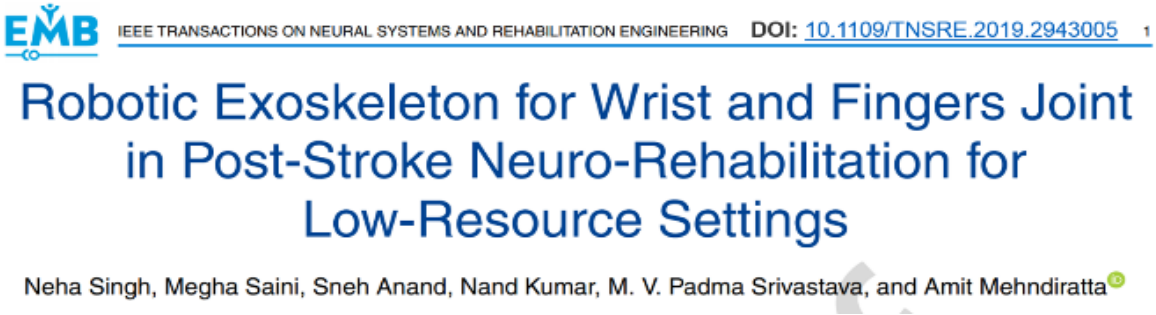
III. Study on role of intensive physiotherapy and rTMS on growth factors as biomarkers for stroke recovery:

This ongoing research examines the upregulation of growth factors (VEGF) after acute ischemic stroke and its correlation with clinical recovery as measured by stroke outcome scales. It also examines the effects of recurrent Transcranial Magnetic Stimulation (rTMS) (1Hz) and correlate the expression of VEGF in the groups receiving rTMS and physiotherapy versus the group receiving physiotherapy regime alone. Of the 87 patients enrolled in this on going study, 19 were randomized to receive rTMS and 16 sham rTMS. All received physiotherapy. rTMS group received total 750 pulses @ 110% motor threshold (MT) with inter train interval of 45 seconds. Total duration per

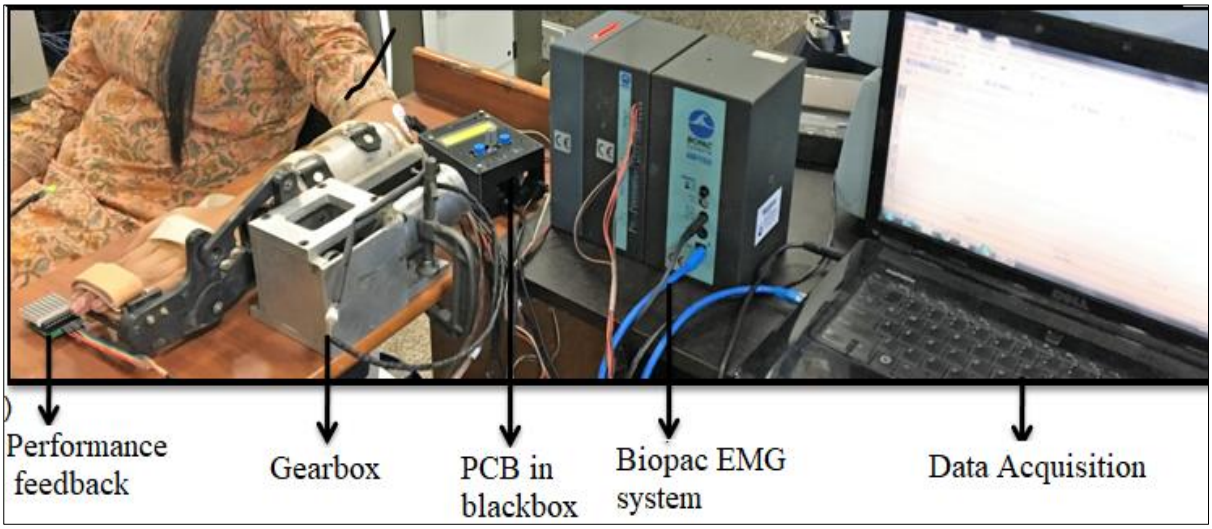
session was for 45 minutes. Between group analysis showed statistically significant improvement in the Study group with NIHSS, mBI, FMA lower limb post rTMS ($p < 0.05$) as compared to control group. No significant improvement in rTMS parameters MT ($p = 0.15$), latency period ($p=0.11$) and MEP ($p = 0.9$) was observed between groups. Serum VEGF of 20 patients was found to be statistically significantly elevated in the study group with a mean of 483.6±280.3 pg/ml as compared to controls ($p= 0.04$).

1. H.Sharma,V.Y.Vishnu,N.Kumar, V.Sreenivas, M.R.Rajeswari, R.Bhatia, R.Sharma, **Padma MV** , Efficacy of Low-Frequency Repetitive Transcranial Magnetic Stimulation in Ischemic Stroke: A Double-Blind Randomized Controlled TrialArchives of Rehabilitation Research and Clinical TranslationVolume 2, Issue 1, March 2020, 100039 https://doi.org/10.1016/j.arrct.2020.100039
2. Bhasin A, **Padma MV**, Vivekanandhan S, Moganty R, Talwar T, Sharma S, Kuthiala N, Kumaran S, Bhatia R. Vascular Endothelial Growth Factor as Predictive Biomarker for Stroke Severity and Outcome; An Evaluation of a New Clinical Module in Acute Ischemic Stroke. Neurol India. 2019 Sep-Oct;67(5):1280-1285. doi: 10.4103/0028-3886.271241.

IV. Robotic-hand exoskeleton, focusing especially on improving ADL through improving range of motion of wrist and MCP joints: Joint venture with IIT, Delhi. The robotic hand focused on synchronized movement:



Robotic Exoskeleton for Wrist & Fingers Joint in Post-Stroke Neuro-Rehabilitationfor Low-Resource Settings



SN Comprehensive Clinical Medicine
https://doi.org/10.1007/s42399-019-00113-1

MEDICINE

Time-Frequency Analysis of Motor-Evoked Potential in Patients with Stroke *vs* Healthy Subjects: a Transcranial Magnetic Stimulation Study

Neha Singh[1] · Megha Saini[1] · Nand Kumar[2] · K. K. Deepak[3] · Sneh Anand[1,4] · M. V. Padma Srivastava[5] · Amit Mehndiratta[1,4]

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Neural interface of mirror therapy in chronic stroke patients: A functional magnetic resonance imaging study

Ashu Bhasin, M. V. Padma Srivastava[1], Senthil S. Kumaran[1,2], Rohit Bhatia[1], Sujata Mohanty[2,3]

Figure 1: Mirror therapy using web cam. Patient is right hemiparetic. The camera captures the motion of the unaffected upper limb (left) in a right hemiparetic subject. The left hand is observed as a mirror image as right hand (affected) on the laptop screen. The subject performs bilateral task with the visual feedback

My current work with the CARE facility sanctioned by ICMR:

Role of Assistive Technologies in Optimizing Functional Recovery Post Stroke with special emphasis on Hand Function;

Validation of sustenance and long-term clinical impact

A. To optimize the robotic hand exoskeleton for upper limb (distal joints) rehabilitation in stroke patients.

B. To design a piezoelectric hand glove (robotic glove) with machine interface for hand biomechanics and functional recovery.

C. To optimize the protocol for non-invasive brain stimulation (tDCS) along with robotic glove for upper limb rehabilitation.

D. To integrate internet of things (IOT) module for tele-rehabilitation monitoring in remote settings.

E. Vertical I : Design and optimization of robotic exoskeleton & its clinical validation on large sample.

F. Vertical II : Development and design of piezoelectric hand glove (robotic) followed by clinical testing

G. Vertical III: To study the combined effect of transcranial direct current stimulation with piezoelectric hand glove on upper limb function.

H. Vertical IV : Tele rehabilitation for ensuring compliance and sustainability

- **Effect of Dual-Task Exercise in Conjunction With Fluoxetine & Transcranial Direct Current Stimulation (tDCS) On Postural Stability And Gait In Stroke Patients:**

  The motor impairment related to postural control and gait is very common in stroke patients. Due to impairment of postural stability and gait, stroke patients have difficulty in performing their activities of daily living. Various approaches to stroke rehabilitation have been studied to improve the walking ability of people with stroke. Previous studies and published literature on combination therapy in stroke can help in the development of new neurorehabilitation therapeutic tool for post stroke motor recovery. This study has been planned to see the effects of combination therapy of Fluoxetine, tDCS and Dual- task

Training on post stroke impairments of posture and gait. The effectiveness of drug, device and exercise will be measured using various clinical and functional outcome scales.The result of current study may help in the development of new neurorehabilitation intervention to improve functional motor recovery of stroke patients in the country.

- **Understanding and facilitation of neural plasticity for enhancing post stroke recovery using low-cost non-invasive brain stimulation techniques**

- **Elucidating the science of yoga as a therapeutic intervention in post stroke recovery: study of brain using the technique of magnetic resonance.**

  Inspite of the advances in understanding the pathophysiology and pathogenesis of stroke, there are unfortunately only limited number of options available in allopathic medicine to fight stroke. In this context, yoga as an adjunct therapeutic intervention will be advantageous because of its cost-effective nature and its known beneficial effects on mind and body. Not much work has been reported on use of yoga in stroke management in young patients. The current study will focus on yoga intervention in post stroke recovery. The science behind how yoga works in recovery will be evaluated using functional, biochemical and structural biomarkers. The technique used will be Magnetic Resonance (MR). Studies will involve MR Imaging (MRI), functional MRI (fMRI) and MR Spectroscopy (MRS). Biochemical parameters will also be assessed.

PUBLICATIONS FOR STROKE REHABILITATION

1. Smartphone-based Telestroke vs Stroke physician led acute stroke management (SMART INDIA): A protocol for a cluster randomised trial

   Vishnu VY, Bhatia R, Khurana D, Ray S, Sharma S, Kulkarni GK, Rao GN, Mailankody P, Garuda BR, Bharadwaj A, Angra M, Ferriera T, Sharma A, Wilson VP, Kuthiala N, Sharma S, Bhasin A, Mukherjee A, Agarwal A, Murali S, Nilima N, **Srivastava MVP.**
   Ann Indian Acad Neurol. 2022 May-Jun;25(3):422-27

2. Correlation of DTI-Derived Measures to Therapy-Mediated Recovery after Stroke: Preliminary Findings.
   Bhasin A, **Srivastava MVP**, Kumaran SS.
   Neurol India. Sep-Oct 2021;69(5):1210-1216.

3. Post stroke rehabilitation of distal upper limb with new perspective technologies: Virtual reality and repetitive transcranial magnetic stimulation – a mini review.
   Banduni O, Saini M, Singh N, Nath D, Kumarana SS, Kumar N, **Srivastava MVP**, Mehnidiratta A.
   Journal of Clinical Medicine 12, 2944. 2023.

4. Feasibility of combining functional near-infrared spectroscopy with electroencephalography to identify chronic stroke responders to cerebellar transcranial direct current stimulation- a computational modeling and portable neuroimaging methodological study

   Rezaee Z, Ranjan S, Solanki D, Bhattacharya M, **Srivastava MVP**, Lahiri U, Datta A.

   Cerebellum. 2021 Dec; 20(6):853-871

5. Design and validation of virtual reality task for neuro-rehabilitation of distal upper extremities.
   Nath D, Singh N, Saini M, **Srivastava MVP**, Mehndiratta A.
   Int J Environ Res Public Health. 2022 Jan 27;19(3):1442

6. Restorative Therapies after Stroke: Drugs, Devices, and Robotics.

Srivastava MVP, Kuthiala N.
Annals of the National Academy of Medical Sciences (India) 2019;55(03):124-131

7. Efficacy of Low-Frequency Repetitive Transcranial Magnetic Stimulation in Ischemic Stroke: A Double-Blind Randomized Controlled Trial.
   Sharma H, Vishnu VY, Kumar N, Sreenivas V, Rajeswari MR, Bhatia R, Sharma R, **Srivastava MVP**.
   Archives of Rehabilitation Research and Clinical Translation Volume 2, Issue1, March 2020, 100039

8. Functional Recovery After Bone Marrow Derived Stem Cells in Stroke- A fMRI & Growth Factor Correlation.
   Bhasin A, **Srivastava MVP**, Mohanty S, Kumaran S.
   J of Stem cell reports 2020; 2(101):1-9.

9. Evidence of neuroplasticity with robotic hand exoskeleton for post-stroke rehabilitation: a randomized controlled trial

   Singh N, Saini M, Kumar N, **Srivastava MVP**, Mehndiratta A.
   J Neuroeng Rehabil. 2021 May 6;18(1):76

10. rTMS and CIMT for neurofunctional recovery in chronic stroke.
    Kuthiala N, Bhasin A, Sharma R, **Srivastava MVP**, Kumaran S, Sharma S, Kumar N.
    International Journal of Neurorehabilitation. 2020; Vol 7: 6.

11. Application of Stem Cells in Stroke: A Multifactorial Approach.
    Singh M, Kumar P, Bhasin A, **Srivastava MP**, Mohanty S.
    Front Neurosc2020;vol 14: article 473: 1-10.

12. A Robotic Exoskeleton for Wrist and Fingers Joint in Post-Stroke Neuro-Rehabilitation for Low-Resource Settings.
    Singh N, Saini M, Anand S, Kumar N, **Srivastava MVP**, Mehndiratta MMM.
    IEEE Trans Neural Syst Rehabil Eng. 2019 Dec;27(12):2369-2377.

13. Vascular Endothelial Growth Factor as Predictive Biomarker for Stroke Severity and Outcome; An Evaluation of a New Clinical Module in Acute Ischemic Stroke.
    Bhasin A, **Srivastava MVP**, Vivekanandhan S, Moganty R, Talwar T, Sharma S, Kuthiala N, Kumaran S, Bhatia R.
    Neurol India. 2019 Sep-Oct;67(5):1280-1285.

14. Safety and feasibility of autologous mesenchymal stem cells in chronic stroke. A four year follows up.

Bhasin A, **Srivastava MVP.**
Journal of Stem Cell & Regenerative Medicine.Vol.13(1):1-6;2017

15. Telestroke in resource-poor developing country model.
Sharma S, **Srivastava MVP**, Bhardwaj A, Sharma A, Sawal N, Thakur S.
Neurology India Vol. 64(5):934-940; 2016

16. Does Vascular Endothelial Growth factor (VEGF) expression in combination with Physiotherapy with/without repetitive Transcranial Magnetic Stimulation (rTMS) play the role in acute stroke recovery?
Sharma H, **Srivastava MVP**, Bhatia R, Kumar N, Moganty R.
Brain Stimulation 8(2):324 · March 2015

17. Comparison of Constraint Induced Movement Therapy and Neuromuscular Electrical Simulation on Clinical Outcomes in Chronic Stroke.
Aashrai SV, Vishal A, **Srivastava MVP**.
Indian Journal of Physiotherapy & Occupational Therapy Vol 9(2):182;2015

18. Telestroke a viable option to improve stroke care in India.
Srivastava MVP, Sudhan P, Khurana D, Bhatia R, Kaul S, Sylaja PN, Moonis M, Pandian JD.
International Journal of Stroke Special Issue: World Stroke Day Edition. vol9;A100;133-134;2014

19. Stem cell therapy – A clinical trial in Stroke.
Bhasin A, **Srivastava MVP**, Bhatia R, Mohanty S, Kumaran, S.
Clinical Neurology and Neurosurgery.Vol.115 (7) 1003– 1008; 2013.

20. Autologous intravenous bone marrow mononuclear cell therapy for patients with subacute ischaemic stroke: a pilot study.
Prasad K, Mohanty S, Bhatia R, **Srivastava MVP**, Garg A, Srivastava A, Goyal V, Tripathi M, Kumar A, Bal C, Vij A, Mishra NK.
Indian J Med Res. 2012 Aug;136(2):221-8.

21. Autologous intravenous stem cell therapy in chronic ischemic stroke.
Bhasin A, **SrivastavaMVP**, Mohanty S, Kumaran SS, Bhatia R.
Journal of Stem Cell and RegenerativeMedicine.Vol.8 (3):181-189;2012.

22. Neural interface of mirror therapy in chronic stroke; a functional imaging study.
Bhasin A, **SrivastavaMVP**, Kumaran SS, Bhatia R, Moahnty S.
Neurology India;Vol.60(2):570–576; 2012.

23. Autologous mesenchymal stem cell transplanatation in chronic stroke.
Bhasin A, **Srivastava MVP**, Kumaran SS, Mohanty S, Bhatia R, Bose S, Gaikwad S, Garg A, Airan B.
Cerebrovascular Disease Vol.1(1): 93 – 104; 2011

24. Design and validation of virtual reality task for neuro-rehabilitation of distal upper extremities.
Nath D, Singh N, Saini M, **Srivastava MVP**, Mehndiratta A.

Int J Environ Res Public Health. 2022 Jan 27;19(3):1442

RECENT PUBLICATIONS IN STROKE

1. Primary CNS vasculitis (PCNSV): A cohort study

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