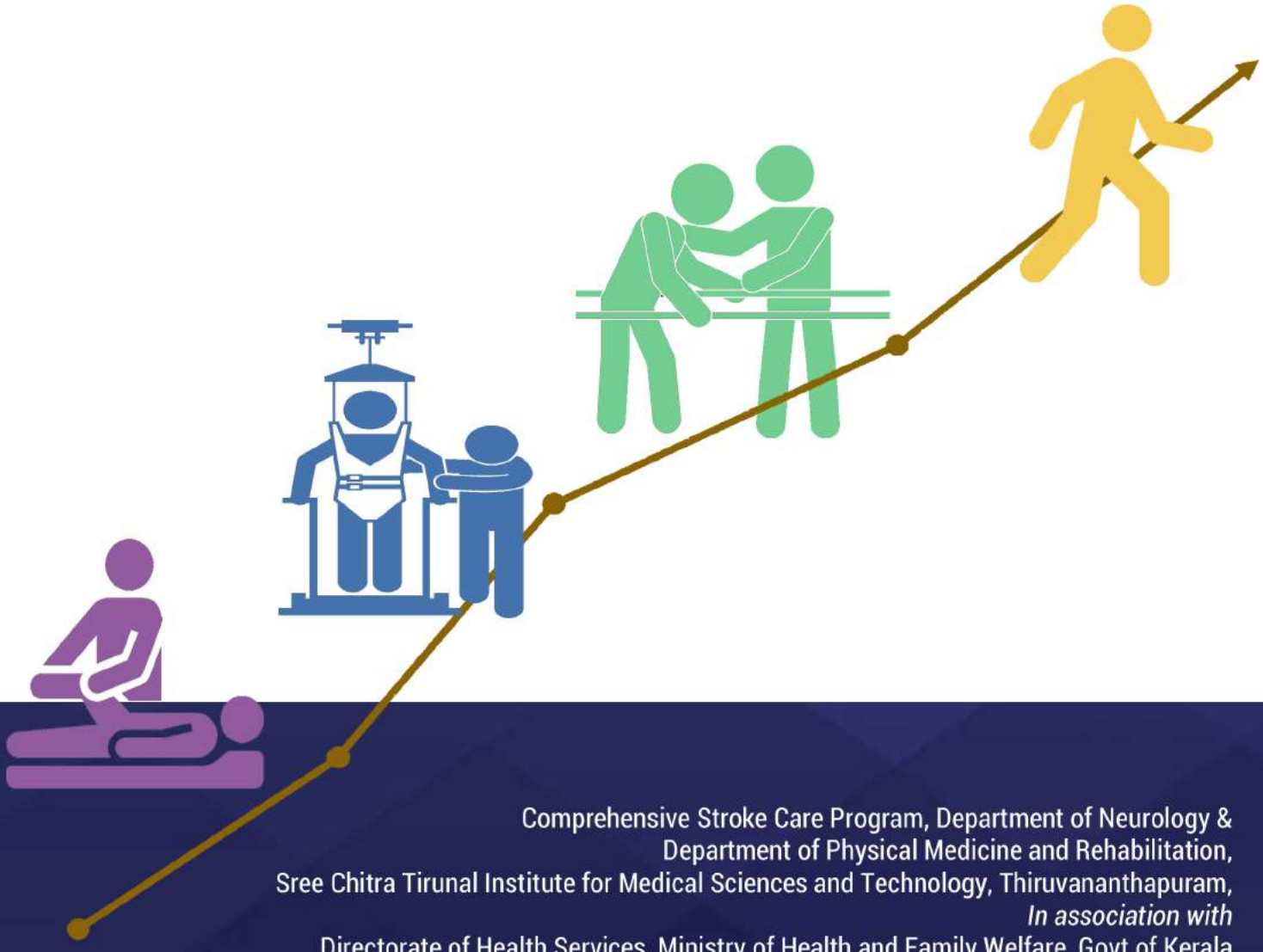
Sree Chitra Tirunal Institute for Medical Sciences and Technology
Thiruvananthapuram, Kerala

HANDBOOK ON
STROKE REHABILITATION
FOR PHYSIOTHERAPISTS



Comprehensive Stroke Care Program, Department of Neurology &
Department of Physical Medicine and Rehabilitation,
Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram,
In association with
Directorate of Health Services, Ministry of Health and Family Welfare, Govt of Kerala

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY
THIRUVANANTHAPURAM, KERALA

Handbook on Stroke Rehabilitation for Physiotherapists

Comprehensive Stroke Care Program, Department of Neurology and
Department of Physical Medicine & Rehabilitation (SCTIMST)

In association with
Directorate of Health Services, Ministry of Health and Family Welfare,
Government of Kerala

Editorial board

Dr. P.N. Sylaja, MD, DM, FRCP Edin, FESO

Professor of Neurology,

In-Charge, Comprehensive Stroke Care Program,

Department of Neurology,

Sree Chitra Tirunal Institute for Medical Sciences and Technology.

Dr. Nitha.J, MBBS, MD

Assistant Professor

Department of Physical Medicine and Rehabilitation

Sree Chitra Tirunal Institute for Medical Sciences and Technology.

Mr. Sivasambath.S, BPT

Research Co-ordinator & Physiotherapist

Comprehensive Stroke Care Program

Sree Chitra Tirunal Institute for Medical Sciences and Technology.

Contributors

Dr. Arun.K, MBBS, DNB, DM, PDF, Wellcome DBT fellow, Neurologist, SCTIMST.

Mr. Sivasambath.S, BPT, Research Co-ordinator & Physiotherapist, SCTIMST.

Mr. Amal.M.G, BPT, Physiotherapist, SCTIMST.

Mrs. Jijimol George, BPT, MPT, Physiotherapist, SCTIMST.

Mr. Paul Jose, BPT, MPT, Physiotherapist, SCTIMST.

Mr. Parthan T.S, BPT, MPT, Physiotherapist.

Message

Stroke is a global health problem and is a leading cause of adult disability. Due to the increased prevalence of risk factors such as hypertension, diabetes, tobacco use, unhealthy diet, physical inactivity, and obesity, stroke is becoming a major cause of premature death and disability in developing countries. A systematic review showed that 24-49% is disabled 2 years after stroke.

The stroke rehabilitation starts in the acute phase of stroke and is an ongoing process and ideally the rehabilitation should always be delivered through a multi disciplinary team involving physiotherapists, occupational therapists, speech therapists, psychologist and a stroke nurse.

In a country like India, where there is lack of rehabilitation centers, most of the stroke survivors do not get any form of rehabilitation. Caregiver based rehabilitation and community rehabilitation should be targeted for effective long term rehabilitation.

This program organized with the support of the Directorate of Health Services, Ministry of Health and Family Welfare, Government of Kerala aims to give stroke specific rehabilitation training especially to the physiotherapists working in government sector.

Dr. P.N Sylaja, MD, DM, FRCP Edin, FESO
Professor of Neurology,
In-Charge, Comprehensive Stroke Care Program,
Department of Neurology,
Sree Chitra Tirunal Institute for Medical Sciences and Technology.

Foreword

Neuro-rehabilitation following stroke has become an integral part of comprehensive stroke management. A common query amongst physicians as well as the patients is, "Is Rehabilitation so important in stroke care?" Even though we attain reperfusion in many of the stroke patients, with thrombolysis and mechanical thrombectomy; a vast majority of them, still end up with significant residual paralysis. Functional impairment of cognition, memory, executive functions, vision, communication, behavioural and emotional aspects, self-care, ambulation, etc., results in dependency in performing daily activities, decreased mobility and limited social interactions. This in turn may affect their self-esteem and motivation, causing depression to set in and they may become withdrawn from family and community. Rehabilitation aims to prevent this sequel by supporting, motivating, promoting recovery and guiding stroke patients to maximize their independence in functional activities and thereby improving their quality of life and attaining community reintegration along with secondary prevention of stroke.

Though institutes of eminence in stroke rehabilitation are present worldwide, the Indian scenario is quite dismal with limited institutions. In addition to numerous barriers faced by the differently abled, the concentration of rehabilitation centers in urban centers is a major hindrance in ensuring availability & accessibility to quality treatment. The limited resources at our disposal further constrain the establishment of an effective & sustainable stroke rehabilitation process in India. Encouraging and empowering health personnel's for community based rehabilitation is an effective strategy for bridging this gap. The family along with the patient needs to be involved in the rehabilitation to eventually empower them to be self-dependent.

The health professionals especially physiotherapists play a pivotal role in providing home based accessible, affordable quality health care. This book aims to provide an insight in to comprehensive stroke rehabilitation protocol, which can be helpful for physiotherapists in community based rehabilitation. The book also provides a quick reference on the medical and interventional management of stroke as well as different aspects of rehabilitation. The steps of rehabilitation from patient assessment to the recent technological advances have been well highlighted. The practical aspects of multidisciplinary stroke care that is being followed in Sree Chitra Tirunal Institute for Medical Sciences and Technology is well documented across this volume. As Rehabilitative Medicine Professionals, let us strive to bridge, to a certain degree, the unmet need for stroke rehabilitation & I believe that the book lays down the path to comprehensive stroke management.

Dr. Nitha.J, MBBS, MD

Assistant Professor,

Department of Physical Medicine and Rehabilitation,

Sree Chitra Triunal Institute for Medical Sciences and Technology.

Acknowledgement

It is my pleasure to bring out this **"Handbook on Stroke Rehabilitation for Physiotherapists".** First and foremost, I would like to convey my heartfelt gratitude to our mentor, **Dr. Sylaja P.N**., Professor of Neurology and In-charge of the Comprehensive Stroke Care Program at SCTIMST, for the inspiration and inception of this book. I would like to thank **Dr. Nitha J**, Assistant Professor of Physical Medicine and Rehabilitation at SCTIMST for her guidance in developing this book.

I am especially indebted to **Dr. Saritha R. L.**, Director of Health Services, Kerala for providing funding and support for this program. My sincere gratitude to **Dr. Bipin Gopal**, State Nodal Officer of the Non-Communicable Diseases Control Program of Kerala, who is the key person behind this endeavour.

My heartfelt thanks to **Dr. Biju Soman**, Additional Professor of the Achutha Menon Center for Health Science Studies at SCTIMST for his valuable suggestions in improving stroke care in the community setting. I am extremely grateful to **Dr. Arun K**, Neurologist and Wellcome Trust/DBT India Alliance Fellow at SCTIMST, for his contributions in acute management of stroke which is conveyed in lucid writing. I thank **Dr. Vishnu Renjith**, Research Associate at SCTIMST, for his contributions in designing the cover page and guiding us throughout the process of developing this handbook.

I would especially like to thank our physiotherapists, **Mr. Amal M.G.**, **Mrs. Jijimol George**, **Mr. Paul Jose** and **Mr. Parthan T.S.** also our colleagues **Soumya Krishnamoorthy**, **Vinod.K.K** and **Liji kumar.G** for their remarkable efforts and being instrumental in contributing to this valuable handbook on stroke rehabilitation. We would like to acknowledgement **Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram** for the facilities and support provided.

I believe that this handbook will provide its readers an updated knowledge on stroke rehabilitation. As physiotherapists, they would be able to deliver comprehensive rehabilitation services to stroke survivors in the community with utmost skills.

Mr. Sivasambath.S, BPT

Research Co-ordinator & Physiotherapist,

Comprehensive Stroke Care Program,

Sree Chitra Triunal Institute for Medical Sciences and Technology.

Contents

Management of Acute Stroke

Dr. Arun. K, Dr.P.N. Sylaja

It was then that it happened. To my shock and incredulity, I could not speak. That is, I could utter nothing intelligible. All that would come from my lips was the sound 'ab' which I repeated again and again.... Then as I watched it, the telephone handpiece slid slowly from my grasp, and I, in turn, slid slowly from my chair and landed on the floor behind the desk.... At 5:15 in that January dusk I had been a person; now at 6:45 I was a case. But I found it easy to accept my altered condition. I felt like a case.

-Eric Hodgins

The history of the world has undoubtedly been altered by stroke. Many important leaders in science, medicine, and politics have had their productivity cut prematurely short by stroke. In the United States, nearly three fourths of a million individuals have a stroke and 150,000 die from stroke each year with more or less similar statistics in the Indian population as well. At any one time, there are approximately 2 million stroke survivors living in the United States. Someone in the United States has a stroke every 45 seconds, and every 3.1 minutes someone dies of stroke. Stroke affects three times as many women as breast cancer and yet receives much less public attention. For a long time, stroke has been the third leading cause of death in most countries in the world, surpassed as a killer only by heart disease and cancer. Survivors of stroke are often unable to return to work or to assume their former effectiveness as spouses, parents, friends, and citizens with a great impact on the economic, social, and psychological life.

During the 19th and first half of the 20th century, nearly all acute stroke patients were cared for in the general wards with very few stroke specialists and no stroke nurses, and rehabilitation units were almost entirely outside the acute hospitals. During the last quarter of the 20th century, there was an explosive growth of interest in the knowledge about stroke. CT, MRI, ultrasound, and vascular imaging capabilities had made it clear that strokes are complex and composed of very diverse aetiologies and pathophysiologies. Advances in technology allowed better visualization of the anatomy and functional aspects of the brain and of vascular lesions during life. During the last few years of the 20th century, clinicians and investigators began using intravenous and intra-arterial thrombolysis as well as endovascular therapy. They also explored ways to extend the window of treatment by using modern brain and vascular imaging to identify the presence and extent of infarction and the presence and nature of occluded arteries.

Pathophysiology of stroke

There are two major categories of brain damage in stroke patients:

(1) Ischemia, which is a lack of blood flow depriving brain tissue of needed fuel and oxygen

(2) Haemorrhage, which is the release of blood into the brain and into extravascular spaces within the cranium.

Ischemia can be further subdivided into three different mechanisms: thrombosis, embolism, and decreased systemic perfusion (Figure 1). *Thrombosis* refers to an obstruction of blood flow due to a localized occlusive process. The lumen of the vessel is narrowed or occluded by an alteration in the vessel wall or by superimposed clot formation. The most common type of vascular pathology is atherosclerosis, in which fibrous and muscular tissues overgrow in the sub intima, and fatty materials form plaques that can encroach on the lumen. Next, platelets adhere to plaque crevices and form clumps that serve as nidi for the deposition of fibrin, thrombin, and clot. In *embolism,* material formed elsewhere within the vascular system lodges in an artery and blocks blood flow. Blockage can be transient or may persist for hours or days before moving distally. The material arises proximally, most commonly from the heart, from major arteries such as the aorta, carotid, and vertebral arteries and from systemic veins (Figure 2). Cardiac sources of embolism include the heart valves and clots or tumours within the atrial or ventricular cavities. Artery-to-artery emboli are composed of clots, platelet clumps, or fragments of plaques that break off from the proximal vessels. Clots originating in systemic veins travel to the brain through cardiac defects such as an atrial septal defect or a patent foramen ovale. In *decreased systemic perfusion,* diminished flow to brain tissue is caused by low systemic perfusion pressure. The most common causes are cardiac pump failure (most often due to myocardial infarction or arrhythmia) and systemic hypotension (due to blood loss or hypovolemia).

Haemorrhage can be further subdivided into four subtypes: subarachnoid, intracerebral, subdural, and epidural (Figure 3). In *subarachnoid haemorrhage*, blood leaks out of the vascular bed onto the brain's surface and is disseminated quickly via the spinal fluid pathways into the spaces around the brain which often originates from aneurysms, arteriovenous malformations, trauma and bleeding diatheses. The terms *intracerebral* and *parenchymal haemorrhage describe* bleeding directly into the brain substance, most often related to uncontrolled hypertension. *Subdural haemorrhages* arise from injured veins that are located between the dura mater and the arachnoid membranes. The bleeding is most often slow and accumulates during days, weeks, and even a few months. *Epidural haemorrhages* are caused by tearing of meningeal arteries, most often the middle meningeal artery. Blood accumulates rapidly over minutes to hours between the skull

and the dura mater. Both subdural and epidural haemorrhages cause symptoms and signs by compressing brain tissue and increasing intracranial pressure.

Stroke Subtypes

The TOAST classification system includes five categories: 1) large-artery atherosclerosis, 2) cardioembolism, 3) small-artery occlusion (lacune), 4) stroke of other determined aetiology, and 5) stroke of undetermined aetiology (Table 1). Diagnoses are based on clinical features and on data collected by tests such as brain imaging (CT/MRI), cardiac imaging (echocardiography, etc.), duplex imaging of extracranial arteries, arteriography, and laboratory assessments for a prothrombotic state which will help the physician to categorize a specific subtype with good degree of certainty.

Emergency management of Acute Stroke

Patients with suspected acute stroke should be triaged with the same priority as patients with acute myocardial infarction or serious trauma, regardless of the severity of neurological deficits (Table 2). The initial evaluation of a potential stroke patient is similar to that of other critically ill patients: immediate stabilization of the airway, breathing, and circulation (ABCs). This is followed by a brief history and the single most important piece of historical information is the time of symptom onset. For patients unable to provide this information or who awaken with stroke symptoms, the time of onset is defined as when the patient was last awake and symptom free or known to be "normal." The overall goal is not only to identify patients with possible stroke but also to exclude stroke mimics (Seizures, Hypoglycaemia, and Migraine with aura, hypertensive and Wernicke's encephalopathy). It is important to ask about risk factors for arteriosclerosis and cardiac disease, as well as any history of drug abuse, migraine, seizure, infection, trauma, or pregnancy. Historical data related to eligibility for therapeutic interventions in acute ischemic stroke are equally important. The initial neurological examination should be brief but thorough. Formal stroke scores or scales, such as the National Institute of health stroke scale **(**NIHSS) (Table 3) may be performed rapidly, have demonstrated utility, and may be administered by a broad spectrum of healthcare providers. Use of a standardized assessment and stroke scale helps quantify the degree of neurological deficits, facilitate communication, identify the location of vessel occlusion, provide early prognosis, help select patients for various interventions, and identify the potential for complications. In addition, the blood samples (Table 4) should be collected in the emergency department and the lab should be alerted.

Parenchymal brain imaging

Non enhanced CT (NECT) excludes parenchymal haemorrhage. NECT may demonstrate subtle visible parenchymal damage within 3 hours. Its widespread immediate availability, relative ease of interpretation, and acquisition speed make NECT the most common modality used in acute ischemic stroke imaging. Alberta stroke program early CT score (ASPECTS) is a 10-point quantitative score used for the detection of early ischemic changes in patients suspected of having acute large artery anterior circulation stroke (Figure 4).A normal CT scan is represented by an ASPECTS of 10. One point is subtracted for each of the 10 regions when any evidence of early ischemic change exists. Thus, the lower the ASPECTS, the larger the extent of the ischemic damage.

Acute Reperfusion therapies

There is incontrovertible evidence that IV thrombolysis with rtPA and endovascular thrombectomy with a retrievable stent improve neurologic outcomes in patients with acute ischemic stroke. Both treatments should be administered as quickly as possible after stroke onset, which can be combined, and are safe in appropriately selected candidates. IV thrombolysis and mechanical thrombectomy can produce reperfusion injury after recanalization. Reperfusion injury can manifest with haemorrhage and oedema. It is more severe when the area of established infarction is larger. Good patient selection and prompt treatment are crucial to avoid this complication.

1. **Intravenous thrombolysis**

IV thrombolysis with rtPA is proven to be effective in improving functional outcomes after an ischemic stroke up to 4.5 hours after symptom onset. IV thrombolysis should not be withheld because of advanced age, and mild but disabling deficits justify treatment. IV rtPA infused within 3 hours of symptom onset increases the chances of functional independence at 3 months by one-third. The benefit is time dependent and much stronger when the drug is administered within the first 90 minutes after symptom onset. The standard dose of IV rtPA for acute ischemic stroke is 0.9 mg/kg, with 10% administered as a bolus and the remainder infused over 1 hour. The total dose should not exceed 90 mg. Haemorrhage is the most dangerous complication after thrombolysis. The risk of symptomatic intracranial haemorrhage (sICH) is increased with old age, diabetes mellitus, severe hyperglycaemia, uncontrolled hypertension, and larger hypo density on baseline CT scan. While IV thrombolysis is the standard of care for eligible patients with acute ischemic stroke, this treatment has its limitations. In addition to the short time window and contraindication in patients with

increased bleeding risk, IV rtPA often fails to recanalize proximal artery occlusions caused by large clots. These are the most disabling strokes, and strong evidence now exists that these patients should be considered for endovascular therapy.

2. Mechanical thrombectomy

The dramatic benefit observed in six major randomised controlled trials using retrievable stents proved the importance of prompt intervention in patients' with large artery occlusion. These devices are deployed at the level of the occlusive clot, capture the clot in their mesh, and are then retrieved along with the clot (Figure 5 & 6). It is becoming increasingly clear that most interventions can be safely completed using conscious sedation. Delay in treatment need to be minimized, and consequently the time to reperfusion as well. In fact, those trials with shorter average time to reperfusion showed the greatest clinical benefit. The current guidelines recommend mechanical thrombectomy can be administered up to 6 hours, though recently published two major RCTs recommend it up to 24 hours of patient last seen normal.

Secondary prevention of stroke

Secondary stroke prevention is an individually based clinical approach aimed at reducing the risk of recurrent stroke and other vascular events in individuals who have already experienced a stroke or transient ischemic attack. Secondary prevention recommendations can be addressed in a variety of settings—acute care, stroke prevention clinics, and community-based care settings. A healthy lifestyle, which includes a healthy balanced diet, exercise, weight control, reduction and avoidance of alcohol and tobacco, reduces the risk of an initial stroke and the risk of a subsequent stroke for patients with a prior history of stroke. Numerous population-based studies have found that elevated blood pressure is a significant risk factor for first and recurrent stroke. While the optimal target blood pressure to prevent a first or recurrent stroke has not been formally established, the current treatment recommendation is to attain a blood pressure of consistently lower than 140/90 mm Hg for people who have had a cerebrovascular event. Patients who have had an ischemic stroke or transient ischemic attack should have their serum lipid levels assessed and aggressively managed. Lipid levels, including total cholesterol, total triglycerides, low-density lipoprotein (LDL) cholesterol, and high-density lipoprotein (HDL) cholesterol, should be measured on all patients presenting with stroke or transient ischemic attack. For individuals with stroke and acute coronary syndrome or established coronary disease, treatment to more aggressive targets (LDL-C <70mg/dl or >50% reduction) should be considered. Patients with ischemic stroke or transient ischemic attack should be screened for diabetes with either a fasting plasma glucose, or 2-

hour plasma glucose, or glycated haemoglobin (A1C). Glycaemic targets should be individualized; however, lowering A1C values to ≤7%/ fasting plasma glucose of 72-126mg/dl and 2-hours postprandial plasma glucose of up to 180mg/dl in both type 1 and type 2 diabetes and stroke or transient ischemic attack, provides strong benefits for the prevention of microvascular complications. All patients with ischemic stroke or transient ischemic attack should be prescribed antiplatelet therapy for secondary prevention of recurrent stroke. Patients with transient ischemic attack or ischemic stroke and non-valvular atrial fibrillation should receive oral anticoagulation. For patients with atrial fibrillation taking warfarin, careful dosing and consistent international normalized ratio (INR) monitoring is recommended to minimize adverse events; warfarin efficacy is dependent on maintaining therapeutic INR control (INR range 2.0–3.0; in the presence of mechanical valve, range is 2.5–3.5), and declines significantly when the international normalized ratio falls below 2.0. Patients with recent transient ischemic attack or non-disabling stroke and ipsilateral significant symptomatic carotid stenosis should have an evaluation by a clinician with stroke expertise and selected patients should be offered carotid endarterectomy (revascularization) as soon as possible. In patients with intracranial atherosclerotic disease, dual antiplatelet with aggressive management of all vascular risk factors including blood pressure, lipids, diabetes mellitus, and other at-risk lifestyle patterns are recommended. These secondary prevention strategies should be implemented as per the advice of a physician.

Conclusion

Stroke is a complex disease. Care should include: (1) rapid clinical evaluation and diagnosis, (2) rapid complete brain and vascular imaging studies and blood tests, (3) medical or surgical treatment (or both) of the process causing the acute stroke, (4) management of blood pressure, blood sugar and fluid balance, (5) atherosclerosis risk assessment and stroke prevention strategies, (6) early use of rehabilitation techniques, (7) surveillance and treatment to prevent common stroke complications, and (8) education for patients and their families regarding their specific problems and stroke in general. As patients with stroke often develop second and third strokes, all patients should be fully investigated for conditions that may cause future strokes. Consideration should be given to management of all of the risks found.

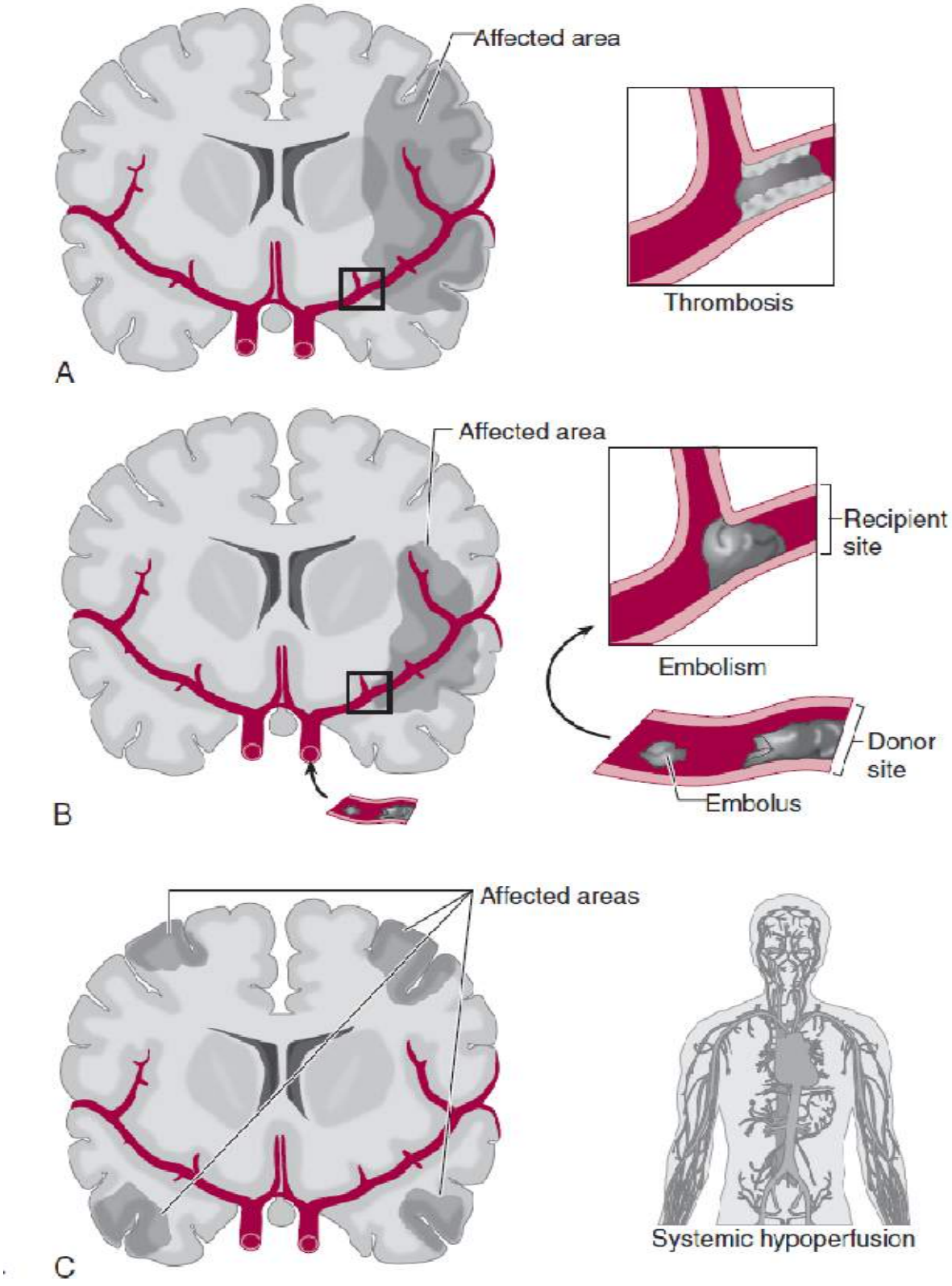


Figure 1.1: Illustrations of the three major causes of brain ischemia. (**A**) Thrombosis. The *insert* shows a thrombus in an atherosclerotic artery leading to a brain infarct, (**B**) Embolism. A thrombus that originated in a donor source embolized to the recipient site (shown in the insert) causing an embolic brain infarct, and (**C**) systemic hypoperfusion. Infarcts are in border-zone regions. (Courtesy: Caplan's Stroke-A clinical approach)

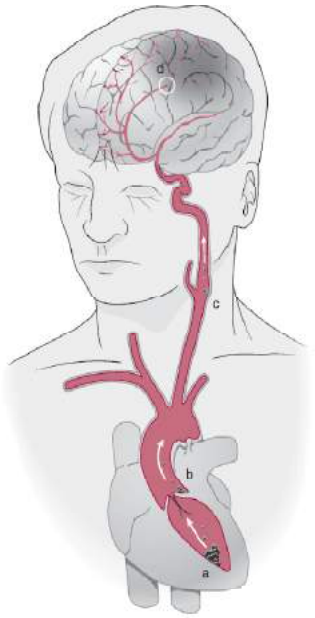


Figure1.2: Examples of potential sources of embolism: (**a**) cardiac mural thrombus; (**b**) vegetations on heart valve; (**c**) emboli from carotid plaque. (**d**) Shows infarcted cortex in area supplied by terminal middle cerebral artery due to embolism. (Courtesy: Caplan's Stroke-A clinical approach)

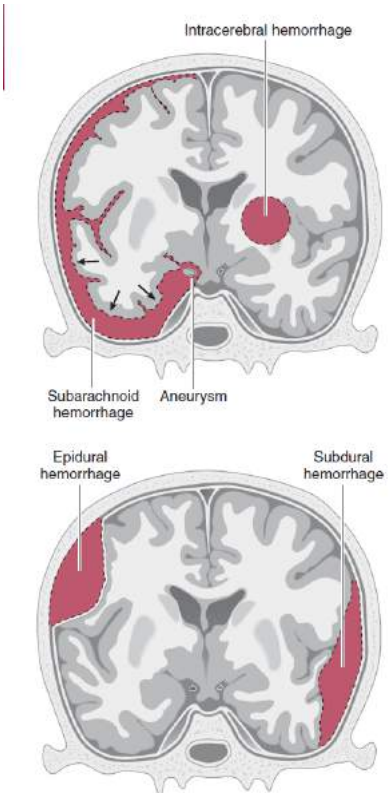


Figure 1. 3: Illustrations of main types of brain haemorrhages: Intracerebral, Subarachnoid, Subdural and Epidural. (Courtesy: Caplan's Stroke-A clinical approach)

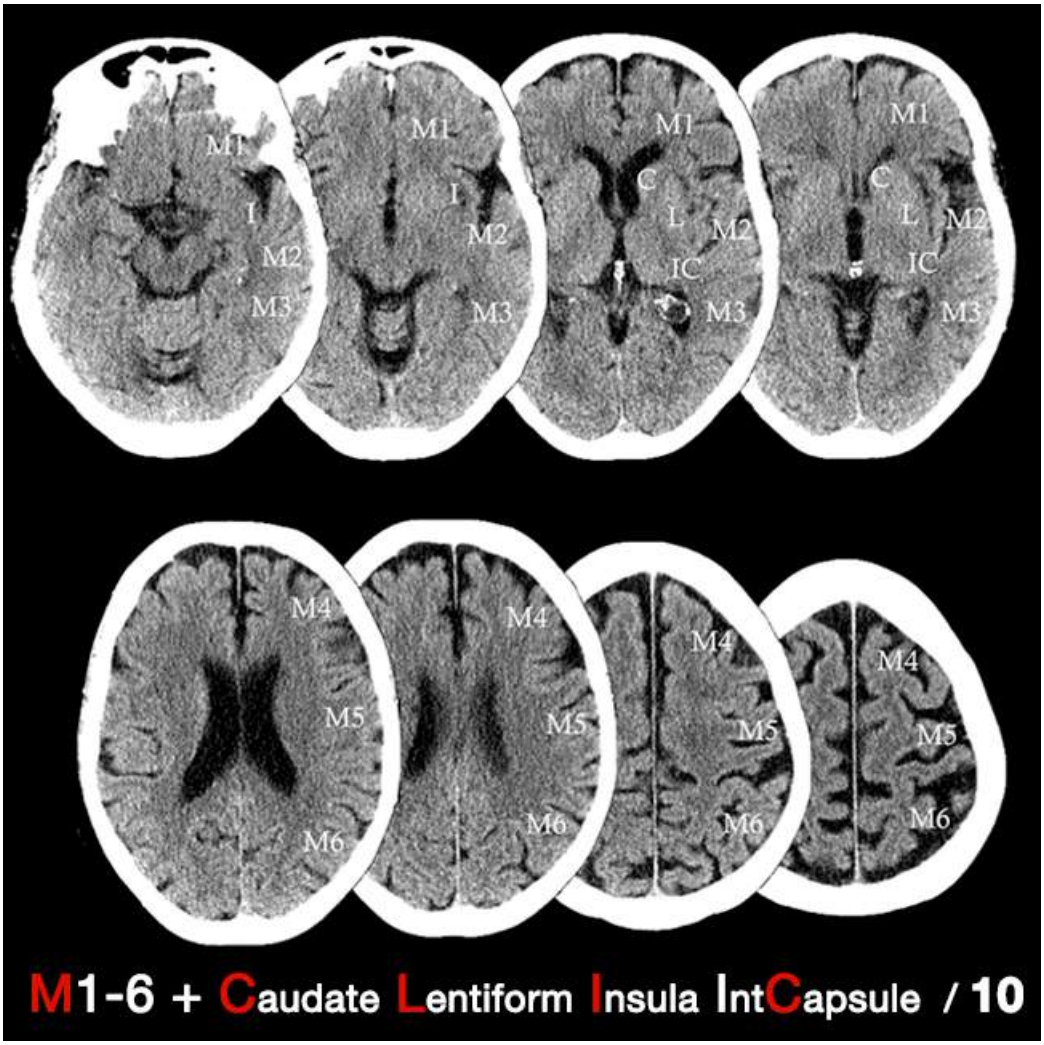


Figure 1.4: ASPECTS scoring at the ganglionic and supraganglionic level.

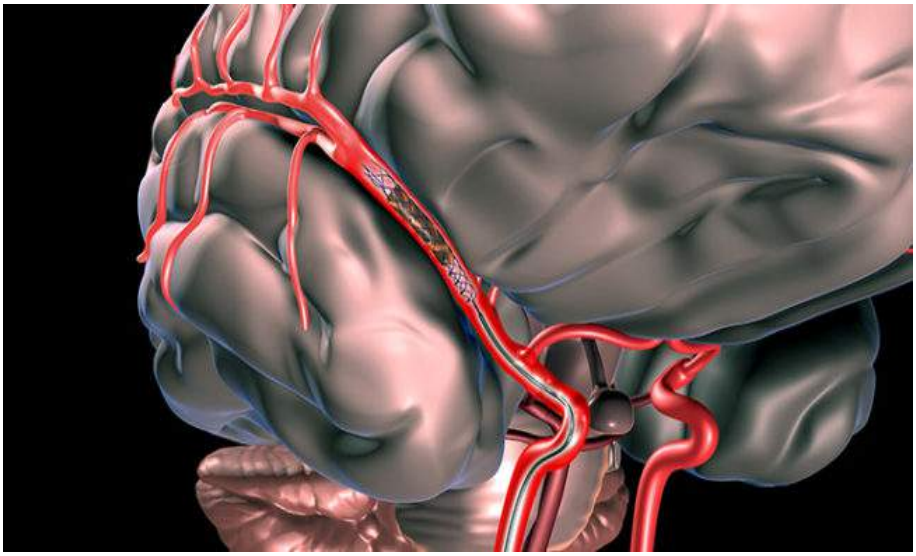


Figure 1.5: Illustration showing the clot retrieval from the middle cerebral artery using stent retriever.

Table 1: Stroke Subtypes: TOAST Classification.

Type of Infarct	Diagnosis
1. **Large-artery atherosclerosis**	Clinical evidence of cortical, subcortical, brain stem, or cerebellar dysfunction with *more than 50% lesion or occlusion in an extracranial or intracranial vessel* in the distribution of an infarct larger than 1.5 cm by CT or MRI. This diagnosis cannot be made if arterial studies show no evidence of pathology or if there is reasonable suggestion by history or studies that another mechanism is possible.
2. **Cardioembolism (high risk/medium risk)**	Clinical evidence of cortical, subcortical, brain stem, or cerebellar dysfunction with a lesion size larger than 1.5 cm on CT or MRI and the *presence of at least one high-risk (e.g., atrial fibrillation or mechanical heart valve) or medium-risk cardiac pathology (e.g., lone atrial fibrillation or patent foramen ovale*) on diagnostic studies, electrocardiogram, rhythm strip, 24-h cardiac monitoring, and transthoracic or transesophageal echocardiography. Evidence of transient ischemic attacks or strokes in more than one vascular territory or of systemic emboli supports the diagnosis. Finally, other categories (large artery, small artery) must be excluded
3. **Small-vessel occlusion (lacunar)**	A lacunar syndrome (pure motor, sensorimotor, pure sensory, ataxia hemiparesis, dysarthria clumsy hand) with normal CT or MRI or a *lesion smaller than 1.5 cm on CT or MRI in the territories supplied by small-vessel penetrators.* Large-artery and cardiac sources must be excluded.
4. **Stroke of other determined aetiologies**	Stroke caused *by non-atherosclerotic vasculopathies, hypercoagulable states, or hematologic disorders* and other rare causes of stroke after diagnostic testing.
5. **Stroke of Undetermined aetiology (cryptogenic)**	This diagnosis is made if two or more aetiologies of stroke are possible, *a complete evaluation reveals no possible source, or the patient had an incomplete evaluation*

Table 2: Emergency department based care (AHA/ASA 2013 Guidelines)	
Action	**Time**
Door to physician	≤10 minutes
Door to stroke team	≤15 minutes
Door to CT initiation	≤25 minutes
Door to CT interpretation	≤45 minutes
Door to drug (≥80% compliance)	≤60 minutes
Door to stroke unit admission	≤3 hours

Table 3: National Institute of health stroke scale (NIHSS)		
Tested Item	Title	Response and scores
IA	Level of consciousness	0—Alert 1—Drowsy 2—Obtunded 3—Coma/unresponsive
1B	Orientation questions (2)	0—Answers both correctly 1—Answers 1 correctly 2—Answers neither correctly
1C	Response to commands (2)	0—Performs both tasks correctly 1—Performs 1 task correctly 2—Performs neither
2	Gaze	0—Normal horizontal movements 1—Partial gaze palsy 2—Complete gaze palsy
3	Visual fields	0—No visual field defect 1—Partial hemianopia 2—Complete hemianopia 3—Bilateral hemianopia
4	Facial movement	0—Normal 1—Minor facial weakness 2—Partial facial weakness 3—Complete unilateral palsy
5	Motor function (arm) a. Left b. Right	0—No drift 1—Drift before 5 seconds 2—Falls before 10 seconds 3—No effort against gravity 4—No movement
6	Motor function (leg) a. Left b. Right	0—No drift 1—Drift before 5 seconds 2—Falls before 5 seconds

		3—No effort against gravity 4—No movement
7	Limb ataxia	0—No ataxia 1—Ataxia in 1 limb 2—Ataxia in 2 limbs
8	Sensory	0—No sensory loss 1—Mild sensory loss 2—Severe sensory loss
9	Language	0—Normal 1—Mild aphasia 2—Severe aphasia 3—Mute or global aphasia
10	Articulation	0—Normal 1—Mild dysarthria 2—Severe dysarthria
11	Extinction or inattention	0—Absent 1—Mild (loss 1 sensory modality lost) 2—Severe (loss 2 modalities lost)

Table 4: Immediate diagnostic tests in patients with acute stroke (ASA/AHA Guidelines 2013)

1. Noncontrast brain CT or brain MRI
2. Blood glucose
3. Oxygen saturation
4. Serum electrolytes/renal function tests
5. Complete blood count, including platelet count
6. Prothrombin time/INR
7. Activated partial thromboplastin time
8. ECG

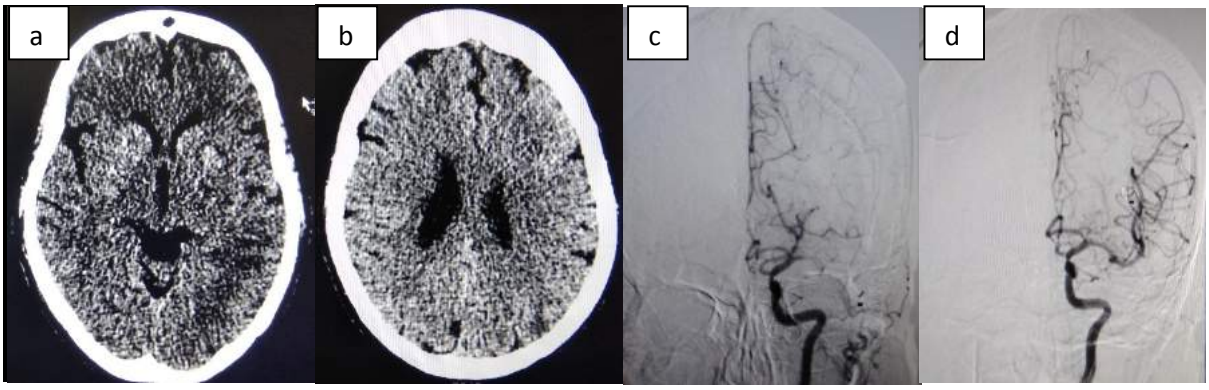


Figure 1.6: 65 year old female patient, diabetic and hypertensive, presented with right hemiparesis with an NIHSS of 15 within 2.5 hours after the stroke onset. Plain CT showed an ASPECTS of 6/10 **(a, b)** (lentiform, insula, M3, M2) with CT angiogram showing left MCA-M1 occlusion. DSA showed left MCA-M1 occlusion **(c)**. She was taken up for endovascular therapy with recanalization of left MCA **(d)**. She recovered and at discharge her NIHSS improved to 4.

Nurse's Role in Stroke Rehabilitation

Mr.Parthan T.S.

Stroke is a complex disease that requires the efforts and skills of all members of the multidiscilinary team to regain the functional independence of stroke survivors. Nurses play an important role in all phases of stroke patient care. Coordinated care of the acute ischemic stroke patient results in an improved outcome, decreased lengths of stay and decreased treatment costs. Stroke nurse's role is to facilitate and support acute stroke patients to receive the *right* care in the *right* place at the *right* time. Rehabilitation after the initial stage of stroke aims at attaining the stroke patient to their greatest potential and maximum independence. However the nurse's role is crucial in the acute management of stroke; the knowledge of rehabilitation will help them to deliver better care for the stroke survivors.

During acute management of stroke, nurses should manage the patient in such a way that the patient may need a long-term rehabilitation process to regain independent activities of daily living. In the acute stage, the patient will be medically managed in the intensive care unit and during this period, the patient needs to be positioned in bed, transferred from the bed to the wheelchair for investigations. The proper handling of the patient is required to prevent the complications such as the shoulder subluxation, falls etc. Nurses should be aware of the medical complications such as pressure ulcers, DVT, pulmonary embolism which may worsen the medical condition of the patient and adversely affect the rehabilitation. We, physiotherapists, should train the nurses about the shoulder and hip care during positioning, how to transfer from bed to the wheelchair and vice versa, how to sit, stand and prevent falls during activities.

1. **Positioning the patient**

- In the acute stage of stroke, correct positioning of the body is extremely important throughout the day.
- Rehabilitation nurses are responsible for the proper positioning of the patient's limbs in the most favourable positions during the early 'flaccid stages'.

Proper positioning has been shown to

1. Maintain skeletal alignment which promotes patient comfort and decreases fatigue.
2. Prevent the development of abnormal limb synergies and normalize tone.

3. Minimize or prevent pain and stiffness that are commonly present post-stroke.
4. Increase spatial awareness and protection of the weaker side of the body
5. Prevent complications including chest infections due to aspiration, pressure sores, limb oedema and contractures
6. Facilitate normal movement patterns which promote physical recovery and functional independence

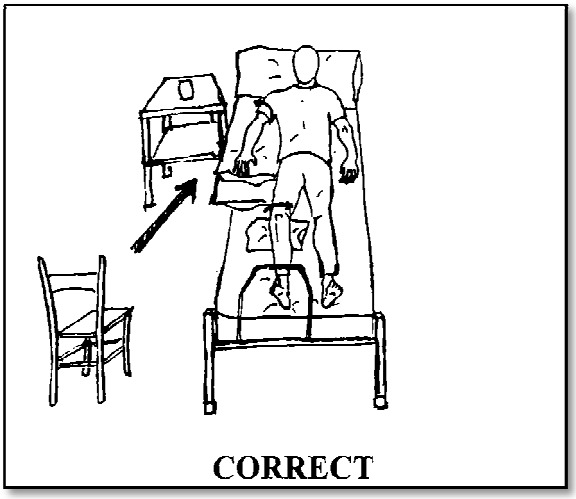


Figure 2.1 Proper positioning of Patient

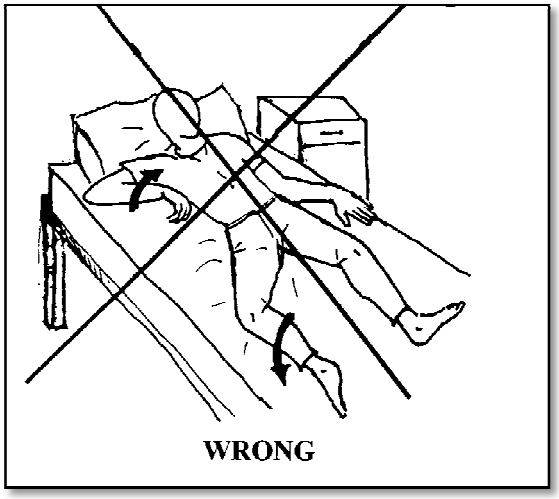


Figure 2.2 Poor positioning in bed leads to stiffness, limited range of motion of joints and muscular retractions.

Supine lying

The bed should be in such a height which promotes independence and safety for the patient, family members and healthcare workers during the rehabilitation.

→ Place a small pillow or towel roll under the patient's head or maintain the neck in neutral.

→ Head should not be positioned in hyper flexion with pillows (as it promotes facilitation of *Symmetric Tonic Neck Reflex {STNR}* leading to flexion synergy of upper limb).

→ Gently turn the head towards both sides periodically, but do not use force. (Helps to prevent the facilitation of *Asymmetric Tonic Neck Reflex {ATNR}* leading to flexion synergy of upper limb).

→ A folded towel roll under the shoulder to keep it lifted forward.

→ A pillow is placed under the weak arm which is kept straight at the elbow and if possible, the palms of the hand facing down with the thumb and fingers opened.

→ A small pillow is placed under the hip of the paretic side and should extend just to the knee to prevent retraction or a drooping backward of the pelvis. This will also help to relax the leg and prevent it from turning out at the hip.

→ The feet are placed in a neutral position with pillows or towel roll.

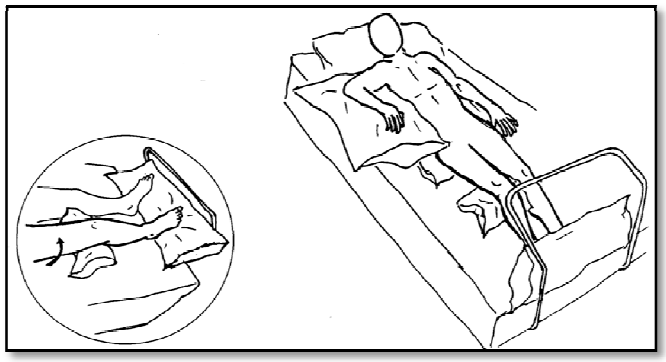


Figure 2.3 Positioning of foot

Side-lying on the unaffected side

This is a good position as it's easy to place the affected limbs In the anti-spasm pattern. It will also prevent bed sores on the affected side and facilitate breathing on the affected side.

→ One or two pillows are placed under the head.

→ The weaker shoulder is placed forward with the weaker arm keeping the elbow straight and supported on a pillow. Thumb and fingers opened.

→ To prevent the patient from rolling on to the back, the weaker leg should be placed forward with the knee bent and leg supported on a pillow in neutral rotation position.

→ A small pillow can be placed under the patient's waist to maintain the line of the spine.

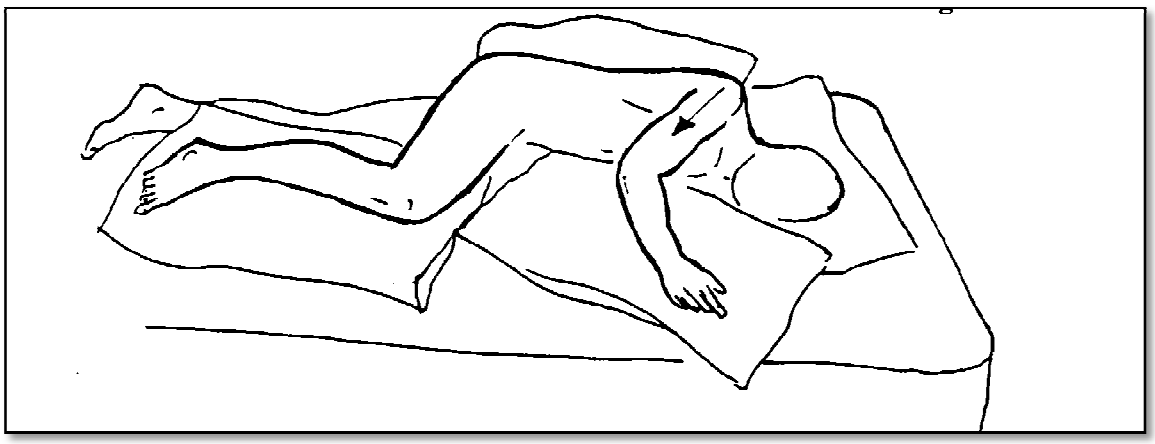


Figure 2.4 Lying on unaffected side

Side-lying on the affected side

→ One or two pillows are placed under the head.

→ The weaker shoulder is placed well forward positioned comfortably on a pillow so that the body weight is supported on the flat of the shoulder blade and not on the point of the shoulder.

→ The stronger leg is forward with the knee bent on one or two pillows, and the weaker leg is straight out.

→ Pillows are also placed at the back and in front of the body.

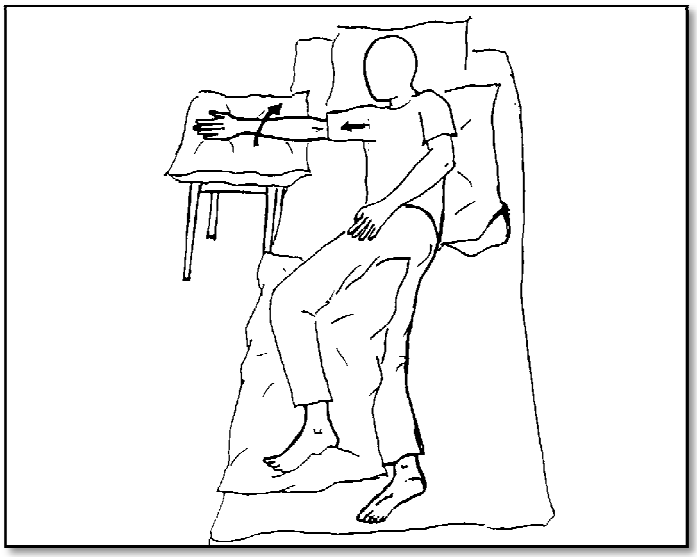


Figure 2.5 Lying on affected side

Sitting up in bed

→ Sitting up in bed is recommended only for short periods before the patient is allowed get out of the bed. (It is better to sit in a chair as soon as possible.)

→ The patient can sit upright, well supported by pillows behind the back, not the head.

→ Arms are placed forward on pillows on either side of the body and legs are extended comfortably. Weight-bearing is on both buttocks.

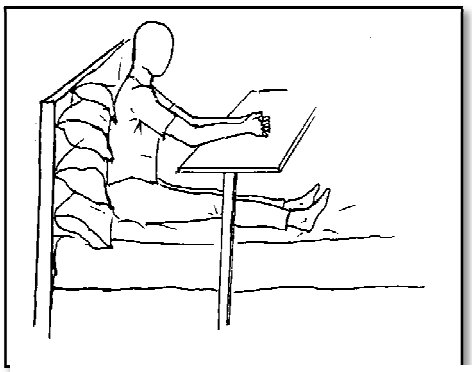


Figure 2.6 Proper sitting position

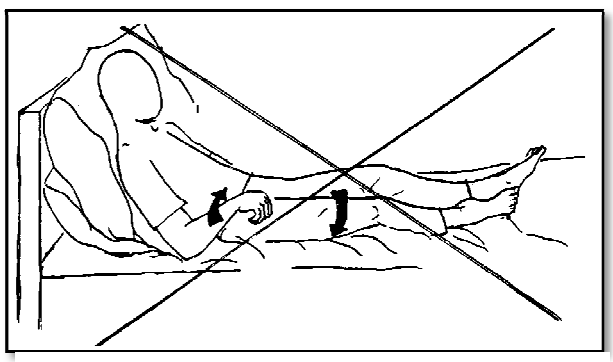


Figure 2.7 Poor sitting position

Sitting Up With the Legs Out of Bed

This position improves the chest expansion and makes breathing easier.

→ Reassure the patient by standing in front of him or sitting close to him at the affected side, as he may have some difficulties in controlling body's balance initially.

→ Three or four pillows should be placed behind the patient and by his side to support the arms.

→ The feet must be flat on the floor, with knee and ankle bent to 90*.

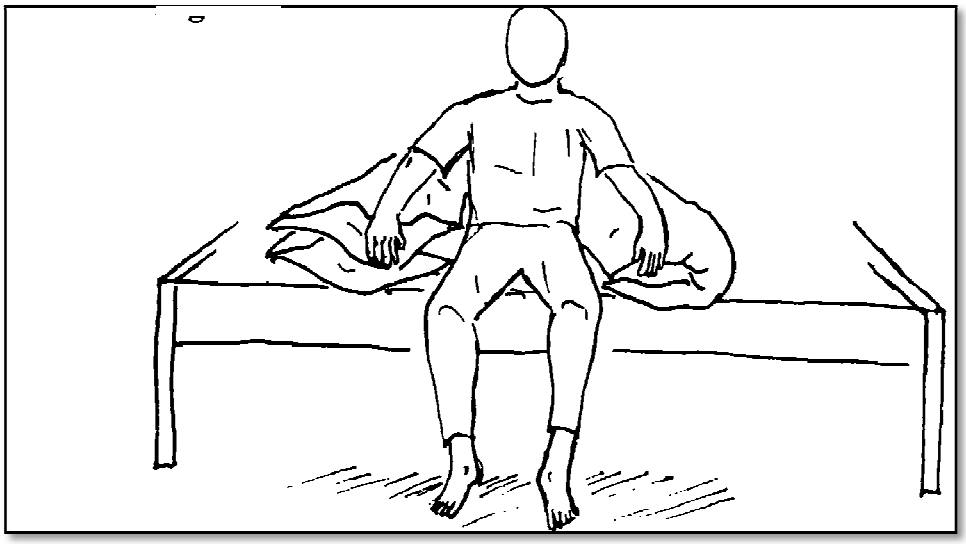


Figure 2.8 Sitting up with legs out of bed

Sitting on a chair/ wheelchair

Sitting out is essential to build up the tolerance, provide maximum stimulation and give a sense of normality.

→ Head over Pelvis

→ The arm should be protracted forward and supported

→ Hips and knee at 90 degrees flexion.

→ A slight extension of the lumbar region

→ Feet in the neutral position and well supported

→ Weight evenly distributed between both buttocks

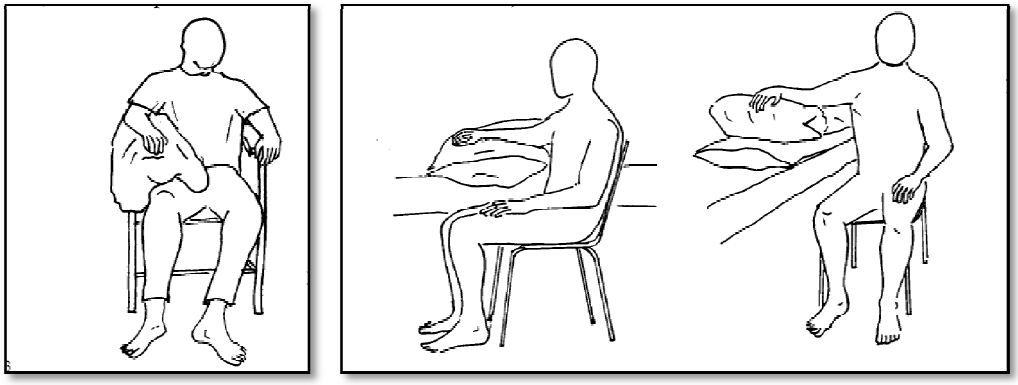


Figure 2.9 & 2.10 Sitting in chair with arm supported

Positioning the head end of the bed

→ Must be individualized for each patient

→ The traditional positioning ***at 25° to 30°*** elevation is often used for stroke patients with increased ICP and chronic respiratory conditions for maximum oxygenation.

→ This position also reduces the risk of aspiration or airway obstruction due to dysphagia.

2. **Bed mobility and transfer of patient**

→ Stroke patients should be mobilized early; when they are hemodynamically stable.

→ Early mobilization prevents or reduces the risk of secondary complications like pneumonia, DVT, and pulmonary embolism.

→ Immobility can also lead to contractures, muscular atrophy, and peripheral nerve palsies.

→ When repositioning or moving the patient, special care should be taken to avoid pulling on the affected arm and shoulder as it may cause Subluxation of the affected shoulder.

Passive and active assisted movements

→ Initially, Passive Range of Motion (PROM) exercises are given and later progress to active assisted ROM (AAROM) exercises in the intervals between physiotherapy sessions to maintain and improve joint range

→ The patient is also shown how to move around in the bed while protecting the affected arm, how to sit up and how to turn to the side-lying position.

Turning from supine to side lying

→ For the patient, it is easier to turn towards the affected side using normal limb power.

→ The affected arm is held at the wrist by the unaffected hand and rolls to the affected side.

→ For turning to the unaffected side, the weaker lower limb is brought to partial flexion with support from the caregiver, holding the weak arm at the wrist by the unaffected hand; patient attempts to turn over by swinging the arms and knee across the body.

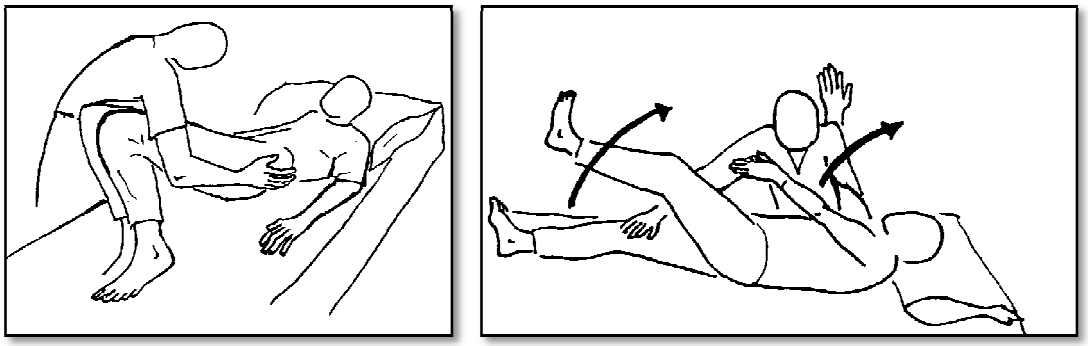


Figure 2.11 &2.12 Turning from supine to side lying

Side-lying to sitting up in bed

→ From side lying, place the unaffected hand to the bed and push up while lowering your legs to the floor. As he slowly rises his body lower the legs to assume an upright position.

Transfer from bed to chair

Lifting and transferring stroke patients require proper technique. Depending upon the level of disability the patient may require maximum assistance, medium assistance or minimal assistance for transfer activity. Proper transfer techniques reduce the risk of injury to the patient and caregiver

Steps in Maximum Assistance Transfer

→ Always tell the patient what you plan to do and encourage them to participate in the activity as much as he/she is able.

→ Never pull the weak arm during transfer; it can cause subluxation of the shoulder.

→ Use good body mechanics for lifting. Keep your back straight and bend your legs to avoid injuring your back.

→ Place the chair or wheelchair parallel to the bed and as close as possible and lock the wheelchair

→ Stand in front of the patient; Place your feet on either side of his/her affected or "weak" leg. Keep your body close to him/her. Wrap your arms around his/her upper body

→ Explain to the patient that you are going to help him/her stand up and encourage them to push with their sound leg.

→ Count "1-2-3". On "3" rock your weight back and help them to a standing position. Keep your back straight and legs bent, pivot and turn with your feet (not your back) so the patient is aligned to sit down on the chair. Slowly help him/her to sit down.

→ Make sure that he/she is sitting at the center of the chair.

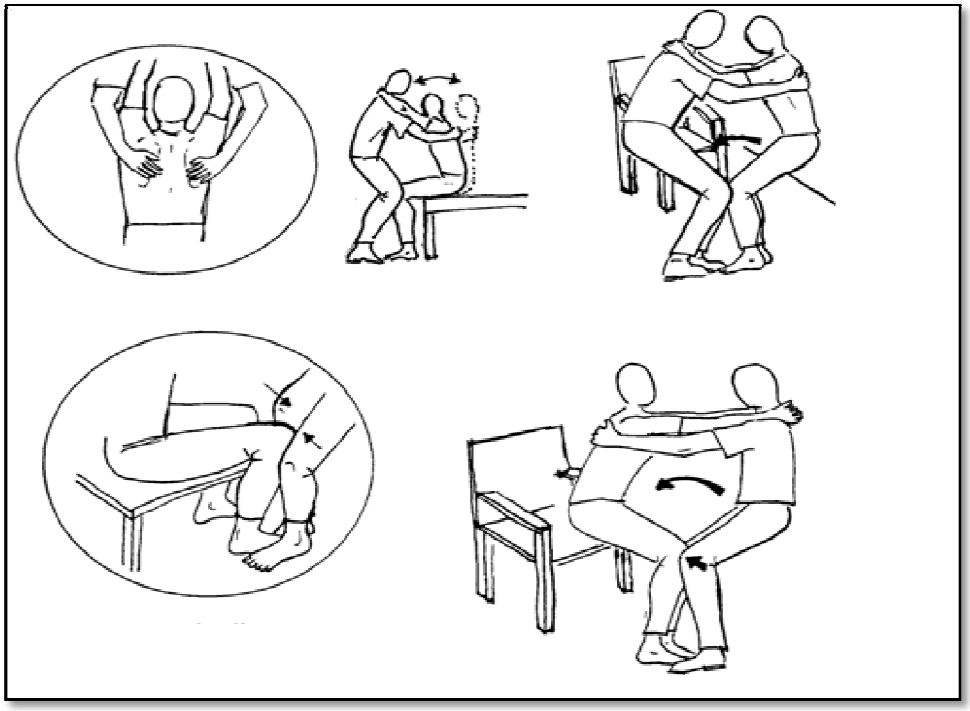


Figure 2.13 Steps in maximum assistance transfer

3. Fall prevention

Falls are a common cause of injury in stroke patients, with hip fractures being the most prevalent injury. Nurses must implement fall-prevention programs and educate the patient and family members about risks and fall precautions.

These may include

→ Identifying patients at risk (e.g. ataxic hemiplegia, vertigo, postural hypotension etc.)

→ Use of alarm systems calls buttons and use of special equipments (e.g., enclosure beds).

→ Place the patient's belongings near to him in order to prevent the patient from reaching for it.

→ Schedule voiding times to prevent falls that occur when a patient tries to go to the bathroom.

4. Prevention of secondary complications

Following stroke, the patients may have only limited mobility which leads to complications such as pressure ulcers, deep vein thrombosis (DVT), pneumonia, limb contractures, shoulder pain and depression.

a. Pressure ulcers

→ The skin must be kept clean and dry, and special mattresses should be used wherever indicated.

→ Frequent turning should be instituted in bedridden patients to prevent skin breakdown or pressure ulcers.

→ Patients should not be left in the same position for more than 2 hours.

→ Patients should be examined for skin breakdown over major pressure areas like heels, sacrum, and lateral malleoli when repositioned and after sitting.

→ When moving a patient in or out of the bed, special care should be taken to avoid excessive friction or pressure.

b. Pulmonary Embolism and Deep Vein Thrombosis

→ After the stroke, safe ambulation should be started as soon as possible.

→ Pneumatic compression devices and compression stockings can be used to prevent pulmonary embolism.

→ Regular passive ankle and foot movement and elevation of foot helps in the prevention of DVT.

c. Detection of Dysphagia and Prevention of Aspiration Pneumonia

→ Stroke patients should be kept NPO until the swallow screen has been performed.

→ The nurse should follow the speech-language pathologist's recommendations based on swallow assessment.

→ Implementation of safe swallowing techniques, respiratory therapy and deep breathing exercises will decrease the risk of pneumonia.

d. Shoulder pain and Limb contractures

→ Range-of-motion exercises and physical therapy to avoid limb contracture, shoulder pain

→ Range-of-motion exercises and proper positioning techniques can prevent joint contractures and atrophy.

→ Special care should be taken to avoid pulling on the affected arm to prevent subluxation of the affected shoulder.

→ Use of assistive devices like shoulder support and ankle foot orthosis helps to maintain joint integrity and prevent pain /contractures.

e. Depression

→ Depression is common after stroke or may get worsened in someone who had a history of depression before the stroke.

→ Depression has a negative impact on rehabilitation, as the patient may not show any interest in rehabilitation activities.

→ Early detection and providing reassurance and emotional support to patients and their family members along with antidepressant medication; psychological treatment including counselling helps in the better outcome.

f. Bowel and bladder care

→ Urinary incontinence interferes with rehabilitation and the nurse must initiate a bladder-training program incorporated into the daily plan of care.

→ Training the Valsalva Manoeuvre and Pelvic Bridging Exercise helps in better bowel and bladder hygiene.

→ High fluid intake during the day and decreased fluid intake in the night should be encouraged.

→ The patient should be offered a commode, bedpan, or urinal every 2 hours during daytime and every 4 hours at night.

g. Nutritional compromise and hydration

→ Stroke may compromise the patient's ability to self-feed resulting in malnourishment which is associated with higher complications and poorer functional outcomes

→ Patients with dysphagia should feed either by intravenous infusion or through nasogastric or percutaneous endoscopic gastrostomy tubes to avoid nutritional compromise.

→ Adequate hydration should be maintained to avoid fall in BP during rehabilitation sessions.

Assessment of functional outcomes in stroke

Mr.Paul Jose

Assessment is a systematic method of collecting data, tracking progress or decline in a patient and documentation. Data collected from assessment are analyzed and that information is used to plan the rehabilitation measures.

The common assessment scales that are used in stroke

Fugl Meyer Scale - functional assessment.

Barthel Index- Activities of daily living assessment

Berg Balance scale- Balance assessment.

Shoulder subluxation grading assessment.

Modified Ashworth scale - MAS- Spasticity grading.

Modified Rankin Scale- mRS – Disability assessment.

Fugl Meyer Assessment of Physical Performance

The Fugl-Meyer Scale is a widely used and highly recommended stroke-specific, performance-based measure of impairment. Measures impairment on a 3-point ordinal scale: 0=cannot perform, 1=performs partially and 2=performs fully.

Higher the score, the lesser the impairment.

The total possible score is **226**.

Scores are divided among **five domains** namely

-Motor function (UE max score: 66, LE max score: 34)

- Sensation (Max score 24)
- Balance (Max score 14)
- Joint ROM (Max score 44)

-Joint Pain (Max score 44)

Exclusion

- DVT
- Inability of the patient to attain starting position for the procedure or maintain it for 30 minutes.

- Disoriented or inability to follow instructions adequately.
- If a patient subsequently fails two or three consecutive items the assessment can be stopped with the knowledge that the patient will fail with the remaining items.

General rules:

- Assessment should be performed in a quiet area when the patient is maximally alert.
- The subject should perform the movement with non-affected extremity first.
- Repeat each movement 3 times on the affected side and score best performance. If full score is attained on trials 1 or 2, do not have to repeat 3 times.
- Do not assist subject, however verbal encouragement is permitted.
- Test the wrist and hand function independently of the arm. Assistance can be provided to the arm at the elbow and just proximal to the wrist in order to position the arm during the hand tests.
- Assessment can be done at the initial rehabilitation baseline, 1, 2, and 4 weeks after rehabilitation treatment, and 3, 4, 5, and 6 months after stroke.
- A change of score between 4 and 7 points in chronic stroke, and 9 to 10 points in sub acute stroke is considered to be clinically significant.

Barthel Index

Barthel index is a self report measure of functional disability which is focused on bodily oriented personal care.

1. The index should be used as a record of what a patient does and not as a record of what a patient could do.
2. The main aim is to establish degree of independence from any help, physical or verbal, however minor and for whatever reason.

3. The need for supervision renders the patient not independent.

4. A patient's performance should be established using the best available evidence. Asking the patient, friends/relatives and nurses are the usual sources, but direct observation and common sense are also important. However direct testing is not needed. Higher the score lesser the degree of dependence.

5. Use of aids to be independent is allowed.

Scale consist of 10 activities

Feeding
Bathing
Grooming
Dressing
Bowels
Bladder
Toilet use
Transfers
Mobility
Stairs

Minimal score: 0, Maximal score 100

A score of 0 –20 suggests total dependence, 21– 60 severe dependence, 61–90 moderate dependence and 91–99 slight dependence.

Berg Balance Scale (BBS)

The **Berg balance scale** is used to objectively determine a patient's ability (or inability) to safely balance during a series of predetermined tasks. It is a 14 item list with each item consisting of a five-point ordinal scale ranging from 0 to 4, with 0 indicating the lowest level of function and 4 the highest level of function and takes approximately 20 minutes to complete. It does not include the assessment of gait.

Higher the score, the better the balance

Equipment Needed:

- A ruler
- 2 standard chairs (one with arm rests, one without)
- A footstool or step
- 15 ft walkway
- Stopwatch or wristwatch

- A score of 56 indicates functional balance
- A score of < 45 indicates individuals may be at greater risk of falling

A difference of five to seven points is necessary to conclude with 90% certainty that patients receiving rehabilitation following stroke have undergone a real change in BBS performance when assessed in a between-rater situation.

Assessment of Glenohumeral Subluxation in Poststroke Hemiplegia

This scale is a 6 point grading system (0 to 5) which assess the width between the acromion and head of humerus with the help of the index finger.

Grade 0 is no subluxation and grade 5 is 2 and a half finger breadth space between the head of humerus and acromion process.

Modified Ashworth scale (MAS)

The **Modified Ashworth scale** (**MAS**) measures resistance during passive movement and is used as a simple measure of spasticity. There are 6 grades ranging from 0 to 4 (0, 1, 1+, 2, 3, 4). The patient should be distracted as we assess spasticity or else volitional movement may influence the assessment. Check for spontaneous movements which may also affect the assessment. Higher the score, greater the spasticity.

The Modified Ashworth scale (MAS) measures resistance during passive soft-tissue stretching and is used as a simple measure of spasticity. Scoring (based on Bohannon and Smith, 1987):

- 0: No increase in muscle tone
- 1: Slight increase in muscle tone, manifested by a catch and release or by minimal resistance at the end of the range of motion when the affected part(s) is moved in flexion or extension
- 1+: Slight increase in muscle tone, manifested by a catch, followed by minimal resistance throughout the remainder (less than half) of the ROM
- 2: More marked increase in muscle tone through most of the ROM, but affected part(s) easily moved
- 3: Considerable increase in muscle tone, passive movement difficult
- 4: Affected part(s) rigid in flexion or extension

Modified Rankin Scale

The mRS is used to evaluate the degree of disability in stroke patients.

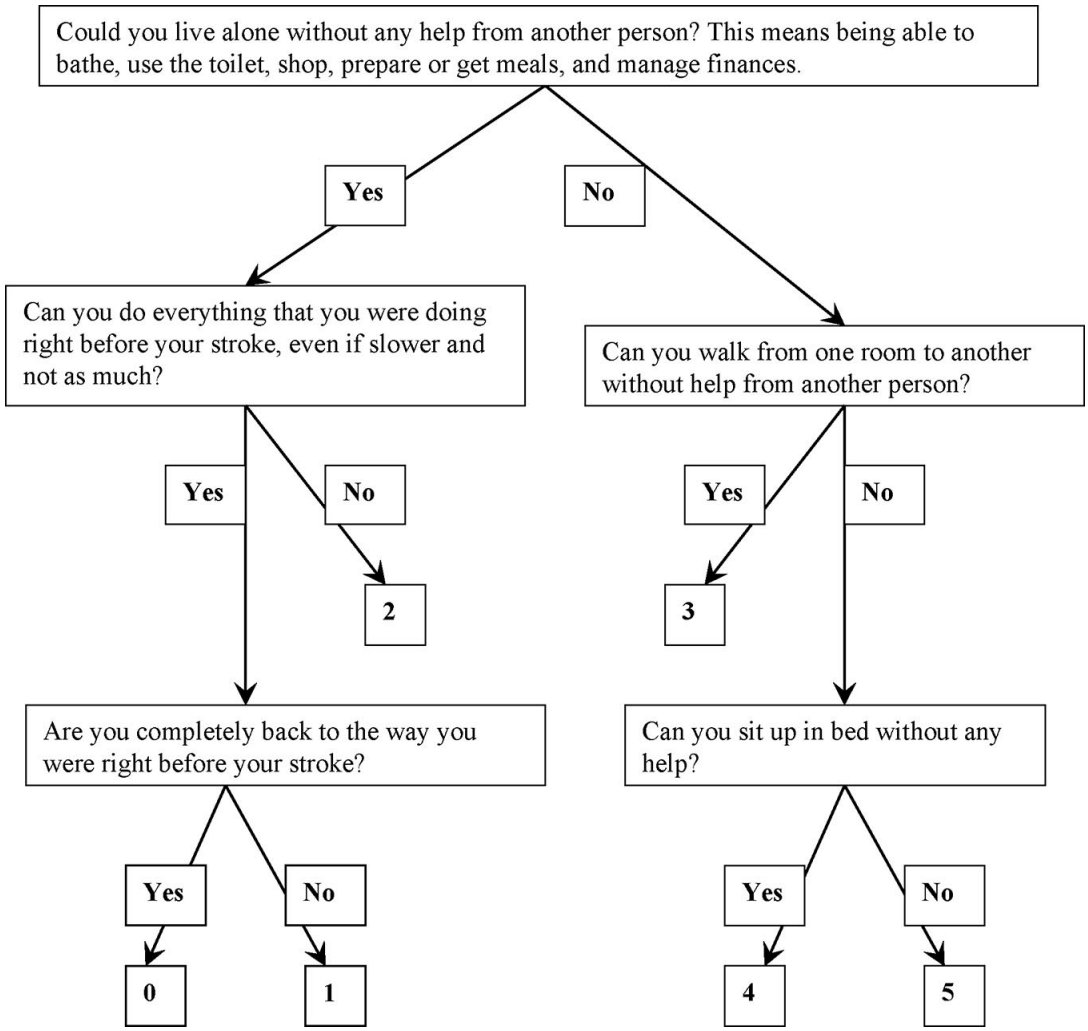
It assess the level of independence with reference to pre-stroke activities rather than observation of task-based performance.

Higher the grade/score, greater is the level of dependence.

Administration: 15 minutes to complete.

The scale runs from 0-6, running from perfect health without symptoms to death.

Each grade has to be assigned according to the structured questionnaire and each question has to be marked under 2 columns- now and before stroke.



Steps in stroke rehabilitation

Mr. Amal M G

Introduction

Stroke Rehabilitation is a goal oriented, progressive process which enable a person with physical impairment to achieve their optimal physical, social and functional level. Patients require rehabilitation for deficits related to spasticity, upper and lower limb dysfunction, shoulder pain, gait and dysphagia.

Most recovery occurs within the first three months post stroke, but recovery may occur even later. Initiation of rehabilitation at the earliest helps to improve outcomes and allow individuals to be engaged in their own work and social life.

Stroke rehabilitation team

Physiotherapy treatment begins as soon as the patient is medically stable Rehabilitation team helps patients in recovering from deficits using a variety of interventions. The rehabilitation team members include the following health professionals:

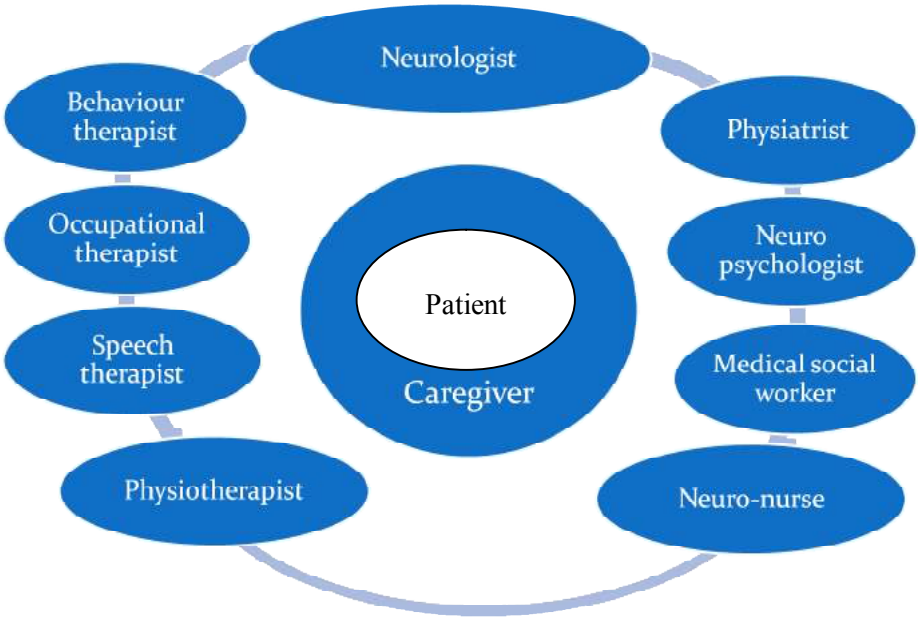


Figure 4.1. Rehabilitation team

According to the AHA/ASA guidelines caregiver is considered as a team member. Multidisciplinary stroke care reduces mortality rates, enhances recovery and increases independence in ADLs.

Rehabilitation Interventions in the Hospital Setting aim at

- Prevention of pressure sores and contractures
- Prevention of Deep Vein Thrombosis
- Neurogenic Bowel and Bladder Management
- Positioning to prevent activation of abnormal reflexes

Management of the upper extremity following stroke

Specific therapies

Selection of specific therapies will differ between patients depending on severity of the impairment.

- **Range of motion exercises (ROM):** passive, active assisted and active ROM exercises should be provided for upper limb in a variety of safe positions within the patient's visual field. Improper execution of ROM exercises may injure soft tissues guarding the joints.

Figure 4.2 Scapular rotation during ROM exercises

- Suitable patients should be encouraged to engage in **mental imagery** to enhance sensorimotor recovery.
- **Functional Electrical Stimulation** (FES) to the wrist and forearm muscles may be considered to improve function and reduce motor impairment. FES to shoulder muscles in flaccid stage helps prevent subluxation of glenohumeral joint
- **Constraint-induced movement therapy** (CIMT) may be considered for patients with at least 20 degrees of active wrist extension and 10 degrees of active finger extension. Sensory and cognitive deficits of selected patients should be minimal.

- **Mirror therapy** should be used as an adjunct to conventional physical therapy. It may help to improve upper limb motor function and ADLs.
- The role of sensory stimulation (TENS, acupuncture, muscle stimulation, biofeedback) in improving upper limb motor function is uncertain.
- **Virtual reality**: both immersive technologies such as head mounted or robotic interfaces and non-immersive technologies such as gaming devices can be used to provide, repetition, intensity, feedback and task-oriented training
- **Supplementary training** is aimed at functional use of the a□ected limb between therapy sessions, during hospitalization and at home.
- **Strength training** may be considered for persons with mild to moderate upper extremity function. Tone or pain in the limb is not aggravated with strength training.
- **Bilateral arm training** is not superior to unilateral arm training in improving upper limb motor function.

Adaptive devices

- Adaptive devices may be considered to improve safety of patients for whom new functional tasks cannot be learned.
- Need for special equipments should be reassessed at regular intervals with the aim of achieving independent function example: wheelchair trays.
- Functional dynamic orthoses may be considered to facilitate repetitive task-specific training
- Repetitive Transcranial Magnetic Stimulation (rTMS) and Transcranial Direct Current stimulation (tDCS) may be used as an adjunct to upper limb therapy.

Shoulder Pain following Stroke

Within the first year post stroke, about 29 percent of adult stroke patients reported shoulder pain. Causes of shoulder pain include hemiplegia itself, injury to soft tissue around the joint or other orthopedic conditions. Shoulder pain may inhibit patient from participating in rehabilitation, leading to poor functional recovery. Shoulder pain may lead to depression, sleeplessness and reduce quality of life.

Prevention of Shoulder Pain and Subluxation in hemiplegia

Joint safety strategies should be used during the flaccid stage of recovery to prevent shoulder pain. These include:

- Positioning the arm during rest.
- Protecting the arm during mobility.
- Supporting the arm while in wheelchair, by using an arm trough.
- **Cuff slings** may be used in flaccid stage. Arm slings which restrict shoulder and elbow movements should not be used. Use of such slings restrict arm swing during gait.
- For patients with a flaccid arm **electrical stimulation** may be considered.
- **Overhead pulleys** should not be used

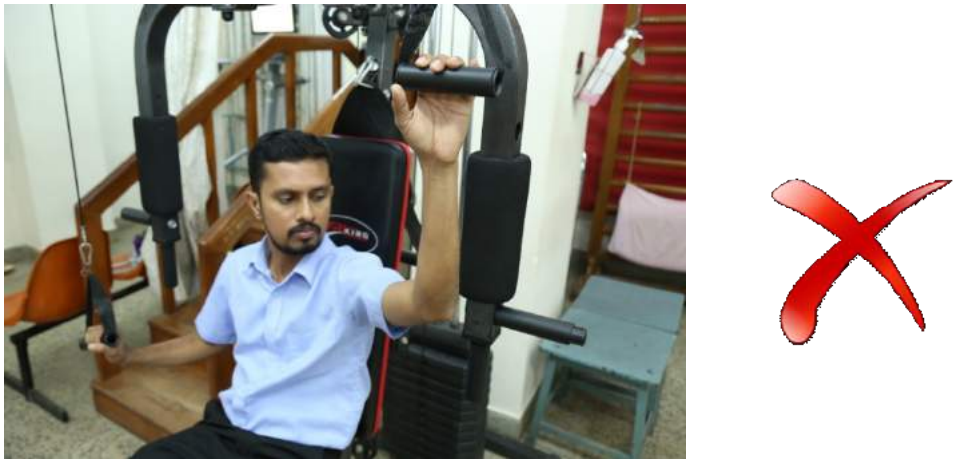


Figure 4.3. Don't use shoulder Pulley

- Movements beyond 90 degrees of shoulder flexion or abduction should not be initiated, unless the scapula is laterally rotated and the humerus is externally rotated.

Figure 4.4. Don't move beyond 90 degrees of shoulder flexion or abduction during flaccid stage

- Healthcare professionals, patients and family should be educated to correctly handle the affected arm; For example, supporting the arm during assisted moves such as transfers; **avoid pulling on the a□ected arm**.

Figure 4.5. & 4.6 Don't pull the affected limb while transfer

Treatment of Hemiplegic Shoulder Pain

- Treatment of shoulder pain related to reduced range of motion includes **gentle stretching and mobilization**, and strategies to increase external rotation and abduction of humerus.
- **Active range of motion** should be increased gradually in conjunction with strengthening weak muscles in the shoulder girdle.

Hand Edema

The following interventions may be considered:

- Active, active-assisted, or passive range of motion exercises in conjunction with arm elevation.
- Retrograde massage.
- Grade 1–2 mobilizations for hand and finger joints.

Complex Regional Pain Syndrome (CRPS)

Prevention: Active, active-assisted, or passive range of motion exercises should be used to prevent CRPS.

Treatment: ROM exercises and joint mobilization techniques.

Lower limb gait training

- **Strength training** may be considered for persons with mild to moderate lower limb function after subacute phase of recovery. Strength training does not a□ect tone or pain.
- **Task and goal-oriented training** that is repetitive and progressive should be used to improve performance of lower-extremity tasks such as walking distance, speed and sit to stand.
- **Treadmill-based gait training (**with or without body weight support) is used to enhance walking speed, and distance walked when over ground training is not available.
- **Electromechanical assisted gait training devices may** be considered for patients who would not otherwise practice walking. They should not be used as a substitute for conventional gait therapy. Example: robotic assisted gait training.
- **Rhythmic Auditory Stimulation** (RAS) may be used to improve gait parameters in patients including gait velocity, cadence, stride length and gait symmetry.
- **Virtual reality** training (non-immersive technologies) may be considered as an adjunct to conventional gait training.
- **Mental Practice** may be used as an adjunct to lower extremity motor retraining.
- **Biofeedback** may be used as an adjunct to improve gait and balance.

Balance

For patients with balance disorders post stroke, balance training should be provided.

- Voluntary and reactive balance control should be assessed and treated.
- Seated balance training
- Weight transfer in sitting from hip to hip
- Pelvic movements forwards and backwards
- Pelvic hiking
- Swizz ball training.
- Tai Chi, aquatic therapy, structured, progressive, therapist-supervised home exercise program, cycling training, and partial body weight support treadmill training may be considered.

Figure 4.7 Weight transfer in sitting from hip to hip

Figure 4.8 Pelvic hiking

Figure 4.9 Pelvic movements forwards and backwards

Figure 4.10. Swizz ball training.

Lower limb spasticity

- Anti spastic positioning, range of motion exercises and/or stretching.
- Ankle Foot Orthosis used at night and during assisted standing may be considered.
- Strength training in the leg should be considered even in the presence of spasticity.

Fall prevention and management

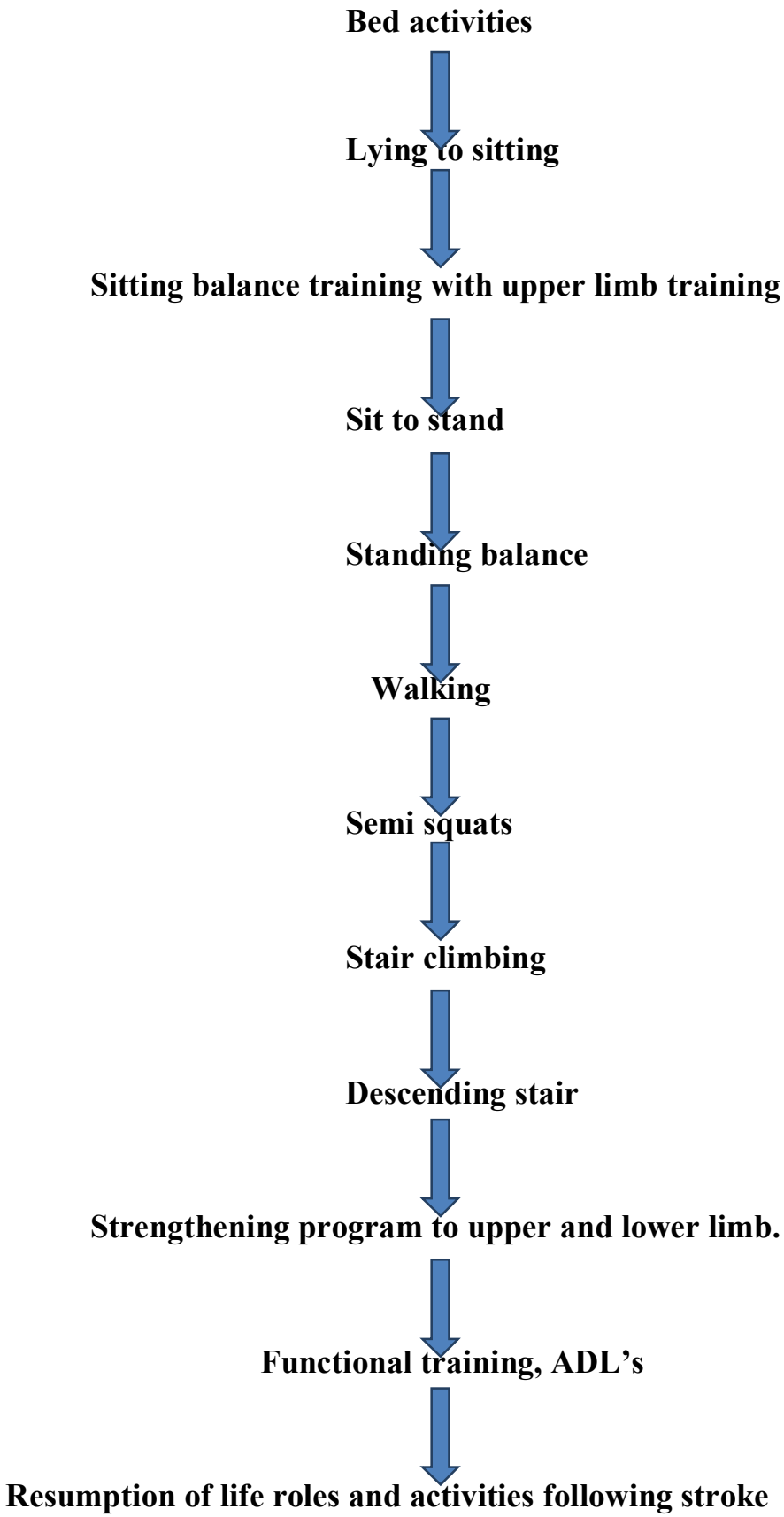
Risk of fall is high following stroke due to muscle weakness, impaired balance, vision, cognition and sensation. The patient, family, and caregiver should be made aware of their risk for falls. The patient and family should be trained to enable them safely transfer and mobilize the patient. The patient and family should be educated regarding gait aids, footwear, transfers, and wheelchair use considering the community environment.

The rehabilitation program

An individualized rehabilitation plan should be developed early post stroke for achieving optimal outcomes. The patients abilities must be assessed and treatment planned according to the findings. The goal of rehabilitation is to obtain the maximum physical and psychological independence. The person should develop an optimal functional independence to carry out his activities of daily living.

For example:- if a patient is able to perform sit to stand but, unable to sit from lying position, then the treatment should focus more on lying to sitting. Else, the patient will be dependent to caregivers

Progressions in stroke physical therapy care



Shoulder care and Functional Electrical Stimulation

Mr. Amal M G

Shoulder care in hemiplegia

If a patient has pain while moving, he will remain immobile and If he has pain at rest, he usually withdraws from any active rehabilitation.

The incidence of shoulder pain during the first year post stroke is 1% to 22%. Shoulder subluxation and motor weakness is usually associated with shoulder pain, the more important predictive factor being motor weakness. Spasticity may contribute to the genesis of shoulder pain in some patients, although a causal relationship has not been confirmed. Common predictors of shoulder pain include spasticity, old age, left hemiplegia, reduced touch and proprioception in the painful limb, limitation of passive shoulder abduction and external rotation and a positive Neer impingement sign.

Shoulder is a highly mobile joint providing a vast range of movement in order to perform countless tasks of day-to-day life. In favour of mobility, stability has been sacrificed in human shoulder. A patient with adducted, internally rotated and painful shoulder will not only resist movements of upper limb but also withdraw from gait training.

Patients with painful shoulder

Remains dependent in the activities of daily life because, he cannot concentrate on learning new skills.

- Has impeded balance both in sitting and standing, making him afraid to move. Constant pain in the long run can make him/her depressed.
- Is not able to co-operate fully in the exercise sessions as his/her sleep is disturbed due to pain, making them even more depressed.
- Muscle activity is inhibited due to pain, making it difficult to train active movements.

Factors Predisposing to Subluxation

Compared with hip joint, glenoid fossa is relatively shallow that only one third of the humeral head is accommodated in the fossa. This instability is compensated by strong musculature and ligaments around the joint.

- In the normal scapular orientation, glenoid fossa faces upwards, forwards and laterally. Upward slope of the glenoid fossa prevents the humeral head from slipping down as the humeral head would need to move laterally to slip downwards. When the glenohumeral joint is adducted, the superior capsule and the coracohumeral ligament become taut and prevent the humeral head to displace laterally, also known as the **locking mechanism of the shoulder**. The horizontal tension of the capsule is reinforced by supraspinatus.
- In stroke there may be winging of scapula which shows resistance to passive correction because, mild increase of tone in some muscles become marked due to unopposed hypotonic antagonist. Mild increase of tone in pectoralis minor may be responsible for the winging and downward rotation of scapula producing a relative abduction of humerus. The capsule becomes lax in this position allowing humerus to slide down in the fossa leading to subluxation.

Treatment of the subluxed shoulder

1. Restoring the natural alignment of glenoid fossa by correcting the position of scapula.

2. Stimulating the stabilising muscles of the shoulder using **FES.**

3. Maintaining full pain free range of passive movements without injuring the soft tissue surrounding the joint.

4. To protect the weak shoulder from being injured during routine procedures **using cuff sling**, **positioning** and **educating all health workers and family** who handles the patient.

Causes of Post stroke Shoulder Pain

- Capsulitis
- Subluxation
- Impingement syndrome
- Rotator cuff injury
- Bicipital tendonitis
- Complex regional pain syndrome type 1
- Brachial plexopathy
- Axillary neuropathy
- Suprascapular neuropathy
- Myofascial pain
- Spasticity
- Soft tissue contracture

Activities Which Cause Painful Trauma

- Passive range of motion exercises without scapular movement and humeral external rotation.
- Helping the patient to transfer from bed to wheelchair/chair by pulling on his arm. Lifting the patient from behind incorrectly
- Lifting the upper limb from the hand during nursing activities.
- Overhead pulley exercise.
- Vigorous active arm elevation exercise.

Figure 5.1 Avoid vigorous arm elevation while shoulder in internal rotation

Treatment of shoulder pain

- Motor retraining, proper ROM exercise, positioning.
- Lap trays for patients using wheelchair might be useful to reduce shoulder pain and subluxation.
- Aggressive range of motion exercise of the shoulder complex is harmful.
- The use of cuff slings.

Figure 5.2 Use cuff sling

- Avoid overhead pulley exercises.
- Various surface electrical stimulations like TENS and NMES have been evaluated for the treatment but, their efficacy for pain prevention and treatment remains inconclusive.

Functional Electrical Stimulation

Functional Electrical Stimulation (FES) is a treatment that provide practice of normal movement patterns by electrically stimulating muscles; that are not possible voluntarily. FES may facilitate motor restoration of stroke survivors by repetitive movement training. Studies have suggested that Neuromuscular Electrical Stimulation (NMES) reduces spasticity and enhances the muscle strength of a weak limb.

In 1967 the term **Functional Electrical Stimulation** was first coined by **'**Moe and Post'.

- FES is a subcategory of Neuromuscular Electrical Stimulation(NMES).

NMES may be delivered using:

- **Surface electrodes** placed over motor points or over superficial nerves.
- **Intramuscular electrodes** implanted in the muscle.

2 types of FES commonly used are:

- Bed side FES : with 2 channels and 10 regular stimulation patterns and can be used for a single patient at a time.
- Digital FES consists of 8 channels and 100 stimulation patterns, and can be used for multiple patients at a time.

Uses of FES

- Improve muscle tone
- Improve muscle strength
- Reduce spasticity
- Improve limb blood flow
- Reduce limb oedema
- Prevent disuse atrophy

Contraindications of FES

- Patients with pacemakers, defibrillators and medical implants
- Cancerous lesion of upper or lower limbs

- Over any open wounds or metal implants
- Pregnancy
- Uncontrolled seizures

Advantages of FES in stroke patients

- FES enhances the sense of movements, muscle strength and increases muscle tone
- Prevents atrophy of muscles and shoulder subluxation.
- FES helps in alleviating pain and oedema.
- FES helps to learn functional movement patterns.

Therapeutic FES with voluntary training, produces changes in corticomotor excitability.

FES Parameters

Duration of therapy - 30 min. daily

Output current: 0- 99 mA, Frequency: 20 – 100 HZ, pulse width: 50 – 999 μs.

Output waveform: Monophasic rectangular pulse, Biphasic rectangular pulse.

FES is a promising therapy in future stroke rehabilitation. Neuroprosthetics are now used to restore a function lost due to an impaired nervous system. They can either be implanted or worn externally, example include intramuscular stimulation system, implanted bladder voiding systems.

Usual electrode placement for functional training and prevention of complications following stroke

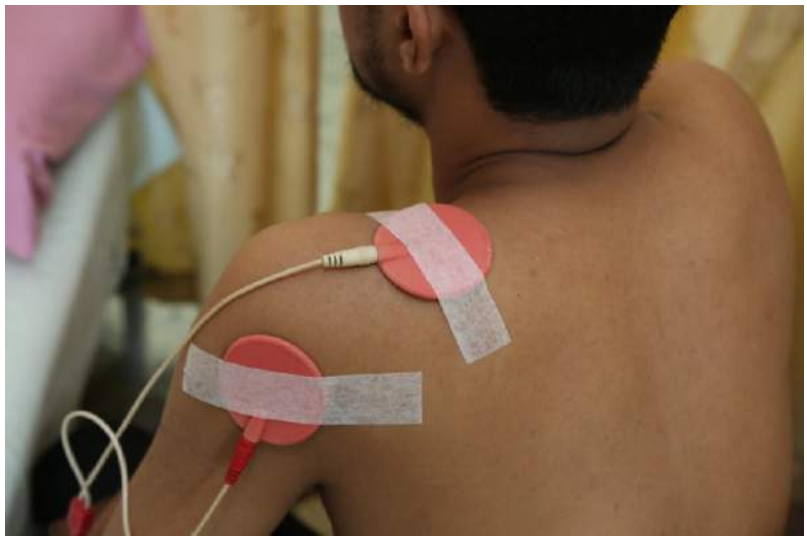


Figure 5.3 To prevent shoulder subluxation- Supraspinatus, Posterior deltoid

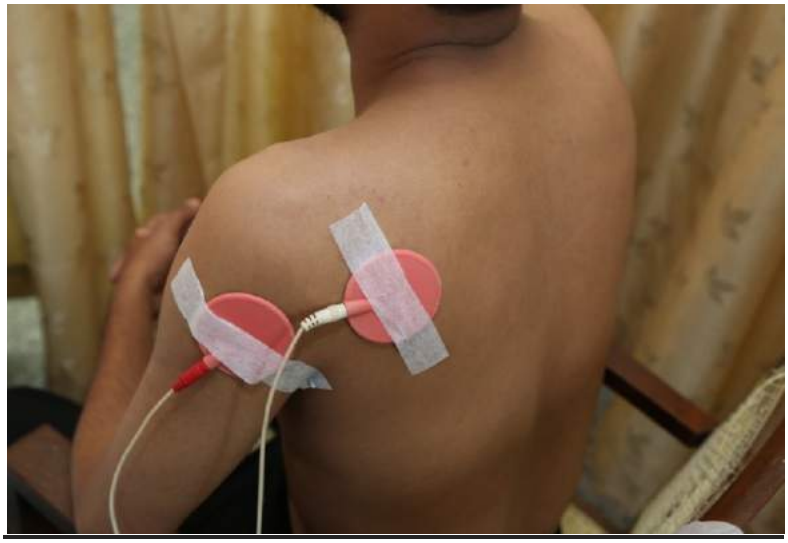


Figure 5.4 To prevent shoulder subluxation- Infra spinatus, Posterior deltoid

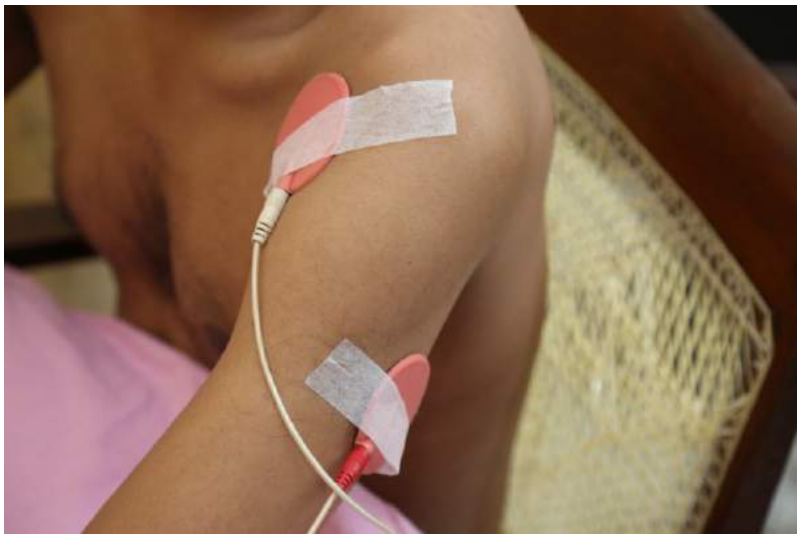


Figure 5.5 Training reaching- Triceps, Anterior deltoid

Soft skills for physiotherapists

Mr. Sivasambath.S

Soft skills are **also known as "people skills"**. They are either a natural talent, taught or learned through practical experience. An individual's beliefs and attitudes contribute to develop soft skills and are reflected by their behaviors.

The personality of a person is determined by 4 Qs:-

Physical quotient – physical body awareness and skillful use

Intelligence quotient- mathematics and verbal intelligence

Emotional quotient- managing ourselves and relationships well

Spiritual quotient- acting with inner wisdom guided by compassion.

The perfect interaction of all the above values determines the quality of one's personality. The interpersonal relationships are well developed and maintained by the intelligence and emotional trait. The knowledge of ourselves and the people around us helps to deliver good communication skills and inter personal relationships. The soft skills like communication skills, time management, problem solving, responsibility, self motivation are essential to develop leadership quality, work among the team and managements skills.

The physiotherapist should have a good academic background in his area of interest like neurological rehabilitation, cardiac rehabilitation, orthopedic rehabilitation, geriatric rehabilitation etc. The **willingness to learn** the interdisciplinary areas will help to assess the patient in a needful manner and deliver the optimal therapy for the individual patient.

Soft skills differentiate between adequate candidates and ideal candidates. Particularly with graduate schemes, recruiters will be looking for people who can become leaders and leadership, itself, depends on several key soft skills.

The therapist may have strong technical skills, but often that is not enough to get a job or maintain it afterwards. We must also have excellent communication and creative problem-solving skills. Physiotherapy requires strong adaptability, communication skills, patience, and giving friendly, recognisable directives to patients. During the physiotherapy sessions, the care giver or

patient may repeatedly ask the same questions, although they get answered from other members of rehabilitation team. Developing soft skills will help physiotherapists to understand the real intention of the questions and answer the queries in a gentle and understandable manner. The queries asked in the field of other team members should be answered carefully, it's best to say that, "I am not the right person to answer this query and you may get help from the respective team member".

Critical Thinking

Critical thinking is the ability to analyse and evaluate a situation in order to make a judgement or suggest an action. In physiotherapy, the analysis involves the client's body movements, the judgements are the diagnosis of the issue or limitations, and the actions are the suggested treatment plan. However the importance of critical thinking in physiotherapy does not stop there. Physiotherapists also need to analyse their client. For a treatment plan to be effective, the client has to actually perform the exercises they are told to do, but as we know, not everyone is willing to take advice and some others are picky about what they will do. A successful physiotherapist will analyse the client and choose a plan that the client will actually want to follow. This may mean a set of exercises that can be done while sitting for someone who is office-bound all day. Critical thinking can be both an inherent and a trained skill.

Communication Skills

The ability to communicate effectively with colleagues, team members, patients and caregivers is very important while delivering the rehabilitation. There are many factors to have efficient communication. Few of them are –Thinking, listening, speaking and nonverbal.

Figure:6.1

Thinking is the process which develops the idea internally in one's mind about a matter.The communication is a reflection of what a person thinks. If the thinking process is not correct, the listener may misinterpret what you may have intended on communicating to them.

Listening is the essential component in preparing the communication. When speaking to a stroke patient or the caregiver, the therapist must listen to them to grasp their social economic background, beliefs and attitude. The proper understanding will help us to determine what to speak, how to speak and when to speak.

Speaking is the ultimate output from a person with series of words which makes meaningful ideas to the listener. The tone of the speaker and selection of words are essential components of speech.

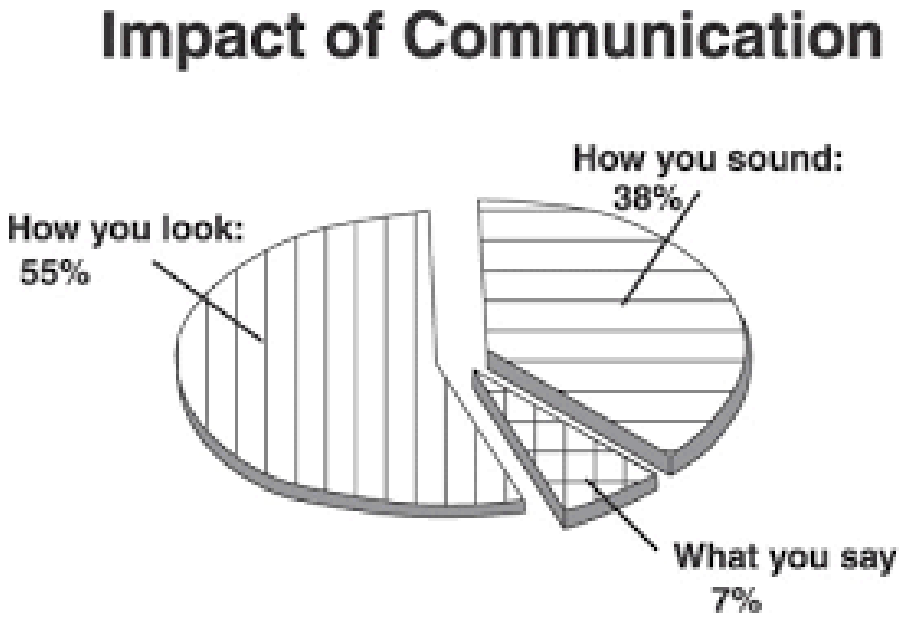


Figure 6.2

Nonverbal communication

Nonverbal communication is the communication skill that usually receives little thought because it happens automatically.

Interpersonal Skills

The interpersonal skills are just as important as communication skills for physiotherapists. First, you need to know how to work with other physiotherapists and medical professionals. This means having professional manner being social with colleagues, and knowing how to manage stress. Second, you need to know how to work with clients. This includes adapting your techniques according to the client's needs and understanding your client, and making them feel comfortable.

Empathy

As a physiotherapist, you need to empathize with the clients in three areas. First, to be able to empathise with what they have been through to have the condition they are seeking help for. Second, with how they feel physically and third, with how they feel emotionally. Only when a physiotherapist can empathize with the patients in all of these areas, can they truly begin to understand what their clients are going through. With that understanding, you can then adapt the treatment, within reason, to respect the clients and their experiences.

Management / Organizational Skills

For managing clients, physiotherapists do not stop working after providing treatment, instead they must develop and maintain client files. These files include information on what was assessed, what treatment was provided, what the goals were for the session or overall, what results were seen, what follow-up was suggested etc. Not only do these records help with consistency of care for a patient, but they prove professional and regulatory compliance. Without the ability to manage client records, a physiotherapist may struggle to keep track of client care and could put themselves into a legal situation, and their actions could be questioned.

Care giver training and education

Mr. Sivasambath.S

"Take time to take care of yourself. If you don't, you will not be of service to the survivor."
Janet Scott
(Caregiver for over 15 years)

Post stroke rehabilitation helps to improve stroke survivor's independence in activities of daily living. This includes mobility, speech, cognitive, self-care and social skills. Following the doctor's direction, rehabilitation specialists provide a treatment program specifically suited to the stroke survivor's needs. Caregiver is the key member of the rehabilitation team, who gathers information from the health professionals along with the patient and delivers care to the patient in the right manner. Caregiver should be educated about the healthcare team and their respective services.

Stroke recovery can be a difficult and confusing process for the survivor and the caregiver. The primary caregiver of a stroke survivor plays an integral part in the recovery process. The role of caregiver is rewarding, as well as challenging. As they adjust to these life changes, they will have many questions and concerns, which they may ask physiotherapists repeatedly even though they received answers from the other members of the multidisciplinary team.

Post-stroke emergency

The patient may have one or more risk factors and will be on medications. The symptoms of hypoglycaemia, postural hypotension should be taught to the caregivers. The methods to manage the emergency before rushing to nearby hospital should be explained.

In case of an emergency, be prepared to provide the healthcare professionals with necessary information and documents. Store them in a safe location.

- List of key contacts (physicians, family members, etc.)
- List of medications, including doses and frequencies
- Copy of patient's health insurance card

During discharge planning

The physiotherapist may be performing needful therapy during the hospital stay. Once the patient is planned for discharge, the therapist in the team should identify the ideal caregiver and discuss the rehabilitation plan.

During home visits

Most of the patients will be adopting home based rehabilitation after the acute stage medical management. Physiotherapist is the key person in the rehabilitation team who frequently visits stroke survivor's home to deliver therapy. Meanwhile he should have a view on patient's overall medical condition and advice the caregiver as required. During home visits, physiotherapist should remember the following points.

Day 1 of home visit

1. Read the discharge summary carefully in detail
    - Diagnosis
    - Date and time of event
    - Onset details
    - Course in the hospital
    - Investigations
    - Cardiac details
    - Risk factors
    - Advice
        - Medicines
        - Need of physiotherapy
        - Swallowing status
        - Others if any
2. Discuss with the patient and relative about the onset and course in the hospital.
3. Assess the patient

   The therapist can use specific scales of assessment and record it, so that the patient and caregiver can realise that the therapist is delivering care in a scientific manner. As a part of this, the therapist can give book mentioning the medical records, physical condition, goals, etc. and periodically update it.
4. Identify a care giver who may stay with the patient for at least a month.
5. Plan the treatment protocol specific

6. Perform the needful therapy as planned.
7. Train the care giver to handle the patient upon his present stage of illness.
8. to the patient and his environment.
9. Educate the need and role of rehabilitation and stages of recovery.
10. Goal setting

At the end of the session, remember to have a social chat and reinforce the goals with the family members.

Day 2 of home visit

1. Start the session with a social chat.
2. Ask the care giver and/or patient, whether they could do the exercises prescribed.
3. Whether any hurdles or any limitation to perform each exercise. In this regard we can use the book to review and add comments on each performance.
4. Plan and reschedule the exercise program as per the convenience of the caregiver and patient.
5. Perform the needful exercise
6. End with providing them an assurance on recovery.

Consequent days

1. Perform therapy as per plan.
2. Spend at least few minutes to reinforce the plan, goal setting, and responsibilities.
3. Try to find, if there is any new hurdles in the process of rehabilitation and explain the solution for the same in the possible manner.

Points to remember during home visits

- Maintain punctuality, inform the expected time of arrival an hour prior, so that the caregiver and patient may be mentally and physically ready for therapy.

Figure 7.1

- If you are unable to visit a particular day due to some personal reasons, inform them.

- You must provide the contact number and pick the phone or reply accurately. For instance they may be calling for an emergency opinion and therapist may think they may be calling for visit.
- Do not entertain phone calls, messaging, what's App chats during the treatment session.

Figure 7.2 

- Have a positive approach to all patients irrespective of their disability.
- Advice the caregiver to participate throughout the session. They may think that the time of therapy is their leisure time.

Advances in stroke rehabilitation

Mrs. Jijimol George

Following stroke, regaining of motor function is often not adequate. There are now multiple technologies that seem promising for promoting recovery of the paretic limb, and they are often guided by new understandings of biological principles, many relating to brain plasticity. Mentioned below are the excerpts relating to the recent advances in stroke rehabilitation.

Recent technologies include

1. Virtual Reality
2. Robot Assisted Therapy
3. Body Weight Support Treadmill Training
4. Supported Ambulation System
5. Motorized Movement Therapy
6. Balance Training With Visual Feedback
7. Functional Electrical Stimulation(FES)
8. Adjustable Stairs With Parallel Bar

Virtual reality

Virtual reality is a computer based technology that allows user to interact with multisensory stimulated environment and receive "real time" feedback on performance. It allows repeated task oriented training for the upper and lower limbs that helps the brain "re-program' itself and form new neural connections that stimulates recovery of motor skills in patients following stroke. Specifically, by using virtual reality it is possible to drive and control exercises for neuro rehabilitation within a functional, purposeful, and motivating context.

Types

a) **Immersive**
Here the virtual environment is delivered by wearing equipments by the user (like goggles, head mounted displays) or the user is situated within a virtual environment (through the use of, special gloves and large concave screen projections). This fully immersive system gives the user a sense of immersion.
Eg: - Glasstrom, IREX, and PlayStation EyeMotion.

Figure 8.1 Immersive type of Virtual Reality

b)Non immersive

It is two dimensional and is delivered through a computer screen. Here the user can control what is happening on the screen by using devices such as joystick, mouse or sensor.

Eg: Virtual Teacher, Cyberglobe, Virtual Reality Motion, Pneumoglobe, and Nintendo-Wii.

Figure 8.2 Non immersive Virtual Reality using gloves

Figure 8.3 Non immersive Virtual reality R using sensor

Robot Assisted Therapy (RAT)

Recent stroke rehabilitation evidence suggests that an intensive, task oriented training and accurate sensorimotor feedback (eg: kinetic and kinematic) will facilitate neuroplastic changes and associated motor learning and functional recovery in stroke patients. To restore gait and hand functions in hemiparetic patients innovative robot assisted gait and hand training paradigms have recently been adopted to provide an ample number of repetitions with precise feedback

Robotic training provides several potential advantages in stroke rehabilitation, like good repeatability, precisely controllable assistance or resistance during movements, and objective and quantifiable measures of patients performance.

Principle:-High dosage high intensity training with kinematic and kinetic sensorimotor feedback triggering neuroplasticity for functional recovery

Types

1. **End effector:-** Works by applying mechanical forces to the distal segment of limbs.

Eg: Gait trainer GT1, G-E-O-System,

Limitations

- Limited control of proximal joint which would result in abnormal movement pattern.
- It's not portable.

2. **Exoskeleton:-** Have robot axes aligned with anatomical axes of the wearer providing direct control of individual joint with minimal abnormal postural movement. It is portable as its worn by the patient. Eg: Walkbot, Lokomat, ARMin, MIME, Arm guide,Bi-Manu-Track etc

Limitations

Requires various modifications in different patients as they need an optimal joint adaptation to work correctly.

Robot assisted therapy for gait training

This device provide patient with either full or partial guidance of the lower limbs during the phases of gait cycle. As compared to the body weight supported treadmill walking these devices

can provide automated gait training on a treadmill or elliptical like device and requires no hands on supervision by the therapist

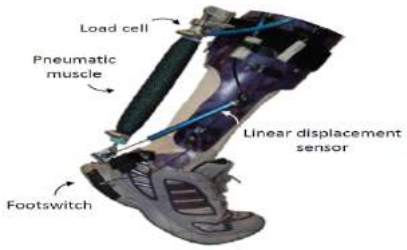


Figure 8.4 End effector for lower limb

Figure 8.5 Exoskeleton for lower limb

Robot assisted therapy for arm training

The human hands are very complex and versatile. Studies have shown that the relationship between the distal hand function and the ability to perform ADL is stronger than the other limbs . The impairment in hand function would definitely impact the quality of patients' life, which means more demand is needed on the hand motor recovery. Robotics is used to support rehabilitation by assisting in the repetitive labor-intensive manual therapy that are normally administered by therapists. This decreases the time demands on therapists as during exercises the patient's limbs gets moved by the assistance of robotic devices, thereby increasing the therapy sessions for each patient and increasing the number of patients undergoing therapy simultaneously. Thus the use of robotics which increases the amount of motor repetitions can aid in recovery.

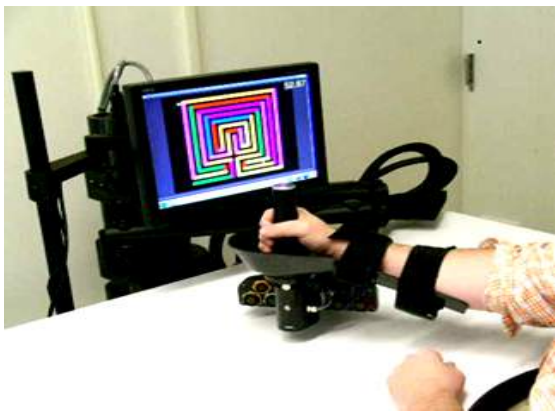


Figure 8.6 End effector for upper limb

Figure 8.7 Exoskeleton for Upper Limb

Body Weight Support Treadmill Training (BWSTT)

Gait training on a treadmill with some body weight support is a method of treating walking impairment. It has been shown that higher intensities of walking practice results in better outcome after stroke

Body weight supported treadmill training (BWSTT) is a task-oriented technique for gait restoration. In BWSTT patient will walk on a treadmill with their body weight partially supported. It is useful for persons who have active movement but insufficient strength to carry their entire body weight. Early initiation of gait training and higher intensities of walking practice can lead to improved strength, endurance, balance and gait performance. BWSTT facilitates changes in corticomotor excitability and allows the patients with stroke to practice almost normal gait patterns and avoid developing compensatory walking habits.

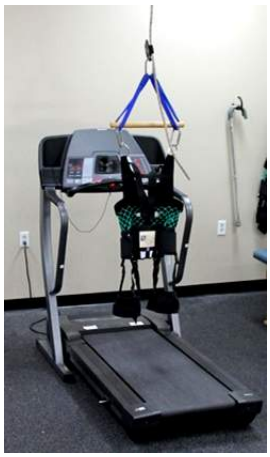


Figure 8.8 Over head suspension unit **Figure 8.9**Body weight supported treadmill training device

Principle Supervised , repetitive task related practice of walking result in better gait training

Application

Patient with limited motor control wear a chest harness connected to an overhead lift to reduce the need to fully load the paretic leg. The body weight support provides enough assistance to facilitate walking whereas the treadmill induces rhythmic stepping which increases the number of steps taken, although here the paretic leg requires physical assistance by therapist.

Supported ambulation system

It involves an overhead ceiling track and suspension system that provides a safe ambulation environment for both therapist and patient. Here the patients can fully focus on their tasks of gait and balance without fear of falling allowing the therapist to focus on assisting, rather than supporting.

Figure 8.10 Gait training using Overhead track and Harness system

This is used over ground, stairs and parallel bars to support patients with impaired mobility and balance. It motivates patient to move forward achieving their key goals like:-improving the muscle tone, increasing coordination and agility, and building greater balance. Here the therapist control how much weights the patient bear to eliminate delays due to weight-bearing restrictions. As a result, patient can more successfully focus on rehabilitation tasks.

Motorized movement therapy

The repetitive movements can stimulate the brain's ability to reorganize itself resulting in healthy brain areas acquiring the functions of the affected areas. The controlled, smooth motion of the motorized unit allows exactly this kind of repetitive movement training. Here the patient can do the training on movement therapy device from a wheelchair or a chair with or without motor-assistance. The motorized movement therapy can help stroke patients to relearn the lost movement patterns and thereby improving Upper and lower limb functions. The leg and arm training can also help with reducing spasticity, improving the overall strength and endurance and also assist coordination.

Figure 8.11 Motorised movement therapy

Operation modes

1. **Passive therapy - Get moved and relaxed passively by the motor.**
2. **Assistive therapy - Train actively with motor assistance.**
3. **Active therapy – Train activity with own muscle strength against finely adjustable resistance levels.**

Balance training with visual feedback

To maintain balance in activities of daily living (ADL), posture control is essential, while motor, sensory and higher brain cognitive functions all contribute to postural control. After stroke, patients lose motor, sensory and higher brain cognitive functions to various degrees which leads to diminished balance. The Balance Trainer is a system designed to provide visual presentation and clues of a client's real-time center ofgravity(COG) accurately

Figure 8.12 Balance trainer with digital monitor and printer providing feedback on performance

During the process of weight or posture shifting, the position and movement tracks of COG can be monitored; thus a client can recognize such information by visual feedback to adopt adequate strategies to keep posture control as steady as possible. It provides objective measurement of the basic components of balance control including the COG, posture alignment, limits of stability (LOS), and rhythmic weight shifts.

Functional Electrical Stimulation (FES)

Functional electrical stimulation (FES) is generally referred to as the artificial electrical stimulation of a muscle that has diminished nervous control, with the aim of providing a muscular contraction and producing a functionally useful movement. FES aims to generate functional movements that mimic normal voluntary movements and to restore functions that have been lost after the impairment. This passive modality is also referred to as neuromuscular electrical stimulation. Functional electrical stimulation (FES) enables therapists to combine NMES with task-specific training.

Principle

Uses bursts of short electrical pulses to generate muscle contractions by stimulating motor-neurons or reflex pathways. The repeated movement training will strengthen the network patterns and lead to enhanced synaptic connections and neural plasticity.

Upper extremity rehabilitation

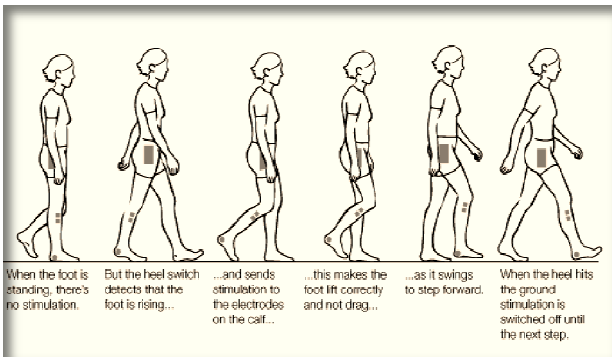
FES can be delivered through a neuroprosthesis (devices that use electrodes to interface with the nervous system and aim to restore function that has been lost)that allows a patient with limited or no movement to perform functional tasks over and over again. This noninvasive neuroprosthesis, provides reproducible, synchronized electrical stimulation of the flexor and extensor muscles of the affected arm so that the patient can perform a variety of functional tasks.

Figure 8.13 Upper limb Neuroprosthesis for functional training

Lower extremity rehabilitation

Here a neuroprosthesis like a Foot Drop System is used for individuals suffering from the effects of stroke. This includes an electronic orthosis, a control unit and a gait sensor. The active unit wraps around the leg just below the knee, with stimulating electrodes over the peroneal nerve and the anterior tibialis muscle . The sensor consists of a lightweight pad that is placed under the patient's

heel and is connected to a small sending unit. When the patient takes there leg forward and pressure comes off the heel switch, a signal is sent to the stimulating electrodes, causing dorsiflexion of the ankle. As the leg swings further through the gait cycle and the heel strikes the ground, heel switch contact causes stimulation to cease, and the foot returns normally to the ground. Using this Patients quickly develop a more normal gait pattern and they have the ability to walk further and more frequently, and, most importantly, are more likely to avoid falls.



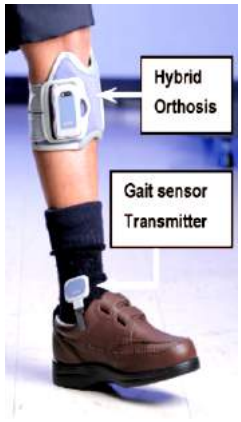


Figure 8.14 Gait cycle using FES **Figure 8.15** Lower limb Neuro prosthesis for gait training

Adjustable stairs with parallel bar

A device used to train the progressive use of stair-climbing skills to regain mobility and independence. It is designed to help patients gain the confidence, balance and ability to climb steps as a part of the rehabilitation process.

Figure 8.16 Adjustable Dynamic stair with parallel bar

Comprehensive Stroke Care Program, Department of Neurology
Sree Chitra Tirunal Institute for Medical Sciences & Technology, Trivandrum
Thiruvananthapuram - 695 011, Kerala, India.
Email: strokesct@sctimst.ac.in