World Stroke Organization

IMPF

FICCI 100 YEARS OF BUILDING TOMORROW

3rd National Stroke Summit 2026

National Stroke Action Plan India

LET'S TOGETHER PUT #STROKE PE ROK

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Abbreviations

NCD	Non communicable disease
IVT	Intravenous thrombolysis
EVT	Endovascular thrombectomy
SU	Stroke Unit
NIHSS	National Institutes of Health Stroke Scale
mRS	modified Rankin Scale
CT	Computed tomography
MRI	Magnetic Resonance Imaging
CTA	Computed Tomography Angiography
WSO	World Stroke Organization
NABH	National Accreditation Board for Hospitals & Healthcare Providers
CHW	Community Health Workers
ANM	Auxiliary nurse midwife
PHD	Prehospital delay
EMS	Emergency Medical Services
EMT	Emergency Medical Technicians
RHTC	Rural Health Training Centre
NPCDCS	National Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases & Stroke
NRHM	National Rural Health Mission

Abbreviations

NGO	Non-Governmental Organization
PHC	Primary Health Centre
EMR	Electronic Medical Record
LMIC	Low- and Middle-Income Countries
MSU	Mobile Stroke Unit
AIS	Acute Ischemic Stroke
Rt-PA	recombinant tissue-type plasminogen activator
DNT	Door to needle time
MEVO	Medium Vessel Occlusion
ICH	Intracerebral Hemorrhage
SAH	Subarachnoid Hemorrhage
PM-JAY	Pradhan Mantri Jan Arogya Yojana
NCDIR	National Centre for Disease Informatics and Research
PT	Physiotherapy
PPP	Public Private Partnership
DALY	Disability-Adjusted Life Year

National Stroke Action Plan- India

Background

Stroke is a leading cause of death and disability in India. It accounts for 41% mortality and 72% disability adjusted life years lost among non-communicable diseases (NCDs).[1]

The high burden of stroke can be attributed to multiple risk factors; including hypertension, diabetes, tobacco use, dyslipidaemia and lifestyle changes associated with rapid urbanization and socioeconomic transitions.[2]

Management of stroke in Indian conditions is challenging due to the limited access to stroke therapies such as intravenous thrombolysis (IVT) and endovascular thrombectomy (EVT).



There is a substantial shortage of trained personnel with only 0.15 neuro-interventionists per million population combined with a poorly developed stroke action awareness and prehospital care system.[1]



The number of average stroke centers per million population capable of providing intravenous thrombolysis is estimated to be 0.41, and those capable of endovascular thrombectomy is 0.26.[1]



Access within one hour to a center capable of IVT is available to one-fourth of Indians whereas only about one-fifth of Indians have access to an EVT center. This is crucial in stroke management where time is of the essence and chances of a good outcome diminish with each passing minute.[1]

Purpose

The 'Stroke Action Plan- India' provides a road map with focus on consolidating national health policy to address current policy gaps along with strengthening of existing health programmes in management of stroke.

Objectives

The stroke action plan sets out clear objectives to be achieved by 2030, in alignment with the vision of the National Program for Prevention and Control of Non-Communicable Diseases (NP-NCD 2023-2030), by Ministry of Health & Family Welfare.

The objectives of National stroke action plan are:

- To reduce the absolute number of strokes in India by 10%.
- To treat 90% or more of all patients with stroke in India, in a dedicated stroke unit, as the first level of care.
- To have national plans for stroke, encompassing the entire chain of care, from primary prevention to life after stroke.
- To fully implement national strategies for multisector public health interventions, to promote and facilitate a healthy lifestyle, and reduce environmental (including air pollution) and socioeconomic factors that increase the risk of stroke.

Stroke Action Plan: Strategic areas of focus

I. Organization of Stroke Care Services

II. Prehospital stroke care and Triage

III. Management of Acute Stroke

IV. Primary and Secondary Prevention of Stroke

V. Rehabilitation after Stroke

VI. Research on Stroke

Stroke Action Plan: Strategic areas of focus
I. Organization of Stroke Care Services

The organization of stroke services is fundamental to ensuring quality care across the spectrum from prevention via acute therapy to long-term care.

Stroke Unit (SU)

Stroke units serve as a foundational step in building capacity for reperfusion treatments. Acute stroke care, skilled nursing care and specialist rehabilitation are all core aspects of a comprehensive stroke unit, and treatment in such facilities has been shown to reduce mortality and disability. India reports only around 500 – 600 stroke units (SUs) in a population of 1.4 billion, predominantly in urban areas, underscoring the severely limited access to specialized stroke care.[3]

1.Establishment of Essential Stroke Center

As per the criteria of essential services we need to focus on primary stroke care units in all district hospitals in India, so that patients will have access to acute stroke care. These units should have 24-hour imaging facility and the capability of giving thrombolysis. The units can be managed even by physicians with the support of neurologists.[3],[4]

The minimum standards for Essential Stroke Center should follow these requirements:-[5],[6],[7]

a. Infrastructure

The minimum infrastructure requirement in the stroke unit shall be as follows:

- A dedicated area within the hospital for the Stroke unit.
- Admission facility with minimum four beds - fully dedicated to the Stroke unit.
- The following diagnostic services should be available on 24/7 with the capacity to complete and interpret initial tests within 15 minutes of being ordered.



o ECG
o CT scan
o Transthoracic echocardiography
o RBS, CBC, INR, S. Creatinine
o Facility for doing vascular imaging like CT or MR angiography

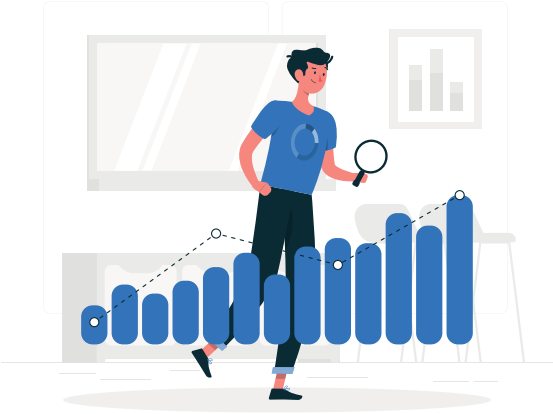
- The Essential Stroke Care Units should have facilities for providing 24-hour continuous monitoring of vital parameters (ECG, blood pressure, O2-saturation, and temperature).
- Facility should be able to do intravenous thrombolysis
- There should be facilities for physiological and neurological monitoring of patients

b. Quality measures

The Centre shall strive to be compliant with minimum key indicators for clinical structure, process and outcomes

- **Door to Physician ≤10 min**
- **Door to stroke team ≤15 min**
- **Door to CT/MRI initiation ≤20 min**
- **Door to IV Alteplase bolus ≤60 min**
- **Door to puncture time < 90 min**
- **Deep vein thromboembolism prophylaxis**
- **Swallow assessment of all stroke patients irrespective of the stroke severity**
- **The patient should be discharged on antithrombotic therapy**
- **Anticoagulation for all cardioembolic strokes**
- **Provision of thrombolytic therapy within four and half hours**
- **Provision of antithrombotic therapy by day 2**
- **The patient should be discharged on statin medication**
- **Advice on handling of stroke patients shall be given to the care givers**
- **Rehabilitation assessment should be done before discharge**





c. Performance measures

The centre shall use the following performance measures to evaluate patient outcomes:

- **NIHSS score during admission**
- **mRS at 90 days**
- **ICH score for IC bleeds**
- **INR reversal attained by what time**
- **Discharge planning**
- **Median time to treatment with a procoagulant reversal agent**
- **Assess hemorrhagic complications after IVT and EVT within 24 hours if any**

2. Establishment of advanced stroke centers

These centers need to be available in medical colleges and other private hospitals. They should have facilities for mechanical thrombectomy and neurosurgical facilities. The Essential stroke centers need to be linked to these centers for advanced care [4,5]

Advanced stroke centers have specific minimum standards to ensure optimal patient care. Here are some key requirements: [6,7,8]

a Staffing Requirements

- **Stroke Team:** A multidisciplinary team including vascular neurologists, neurointerventionalists, neurosurgeons, emergency physicians, and rehabilitation specialists.
- **Nursing Staff:** Registered nurses with stroke-specific training, with a ratio of 1 RN to 2 patients,
- **Therapists:** Physical, occupational, and speech therapists with stroke-specific training and expertise.

b. Facility Requirements

- **Dedicated Stroke Unit:** A designated unit with monitored beds and staff trained in stroke care.
- **Neurocritical Care Unit:** Availability of neurocritical care services and beds.
- **Advanced Imaging:** Availability of advanced imaging modalities like CT, MRI, and CTA 24/7.
- **Interventional Neuroradiology:** Availability of interventional neuroradiology services like mechanical thrombectomy (cath lab provision) , neurosurgical facilities and equipment.

c. Process Requirements

- **Stroke-Specific Education:** Regular stroke-specific education for staff, including nurses and therapists.
- **Standardized Stroke Scales:** Use of standardized stroke scales like NIHSS for assessing stroke severity.
- **Quality Improvement:** Regular quality improvement initiatives and data collection to monitor outcomes.
- **Multidisciplinary Rounds:** Regular multidisciplinary rounds to discuss patient care and outcomes.

3. Stroke unit protocols



All these units should have protocols for acute revascularization therapies, dysphagia evaluation (specify), physiological and neurological monitoring and evaluation of these patients and discharge planning. All patient data need to be captured in a database to see that all quality and performance measures are adhered too in the stroke unit.[7],[8],[9]

Written protocol and documentation system[5],[7],[8]

- All stroke units should have customized treatment protocol, and an electronic medical record system should be in place.
- All the information should be maintained in a centralized database.

4. Training of health care professionals

This is important for improving the quality of stroke care in the unit. Nurses training programs need to be conducted biannually ensuring the nursing team is well versed with stroke unit care. The rehabilitation team should also be given focused training on stroke rehabilitation, especially early rehabilitation, shoulder care and involvement of the care giver in the rehabilitation.[5],[8],[9]

Human Resource of stroke units

- A team comprising of Neurologist/ trained Physician, sufficient Nurse (minimum patient : nurse ratio of 2: 1 should be available on 24 /7 basis.
- Periodical training sessions (separately for physicians, nurses, speech therapists, physiotherapists) exclusively for - stroke care for human resources should be made mandatory.
- There is a need to have a full-time physiotherapist, part-time speech therapist and social worker.

Training of human resources of stroke units

- Staff including nurse, physiotherapist and speech therapist should be trained for managing stroke patients.
- Refresher training should be given at regular intervals.
- Updated handbooks on treatment guidelines should be given annually.

5. Stroke unit certification

This should be done for all stroke units in the country, including primary and advanced stroke units. WSO has started the stroke unit certification process with NABH and that needs to be done. [5],[9]

6. Discharge planning

A multidisciplinary meeting is important before patient discharge which will help in discharge planning for the patient and transition of care. The discharge planning includes stroke education, advice on medication adherence, control of risk factors, rehabilitation advice and caregiver education, and physical activity and diet advice.[7],[8]
A documented discharge process should be present, and a discharge / treatment summary should be provided to all patients. Dietary advice should be given at the time of discharge to the caregivers. The importance of physiotherapy should be advised to the patient as well as caregivers. A well-trained nurse should educate the patients on post stroke care at home-Home modification, diet, physiotherapy, hygiene, medication and follow-up. Printed education materials on antiplatelet, anticoagulation use, risk factor monitoring, lifestyle and behavioral modification should be given at the time of discharge.[7],[8]

Certify stroke centers through a national training and accreditation program (WSO NABH)

To standardize and elevate stroke care quality across India, a structured certification program for stroke-ready centers should be established through a national training and accreditation framework. This program would set clear criteria for infrastructure, personnel, protocols, and patient outcomes to define what constitutes a stroke-ready center, in alignment with global best practices and national health priorities.[4,8,9]

Facilities would undergo training and evaluation through a centralized platform offering simulation-based learning, standardized care pathways, and evidence-based guidelines.[4,8]

The NABH-WSO Stroke Certification Program, launched in 2022, aims to improve stroke care in India by aligning hospitals with global standards. It offers two certification levels: Primary and Advanced Stroke Care Centres. Standards focus on patient care, medication management, safety, and organizational practices. Hospitals must meet specific criteria and undergo assessment to qualify. The program includes training and self-assessment tools to support implementation. This initiative by NABH and the World Stroke Organization enhances stroke treatment quality, ensuring better outcomes and standardized care across the country, and serves as a model. (More info: nabh.co.)[4,8,9]

Actionable points:



Develop a Centralized Training Platform



Mandate Accreditation for Stroke Units



Monitor Outcomes & Quality Metrics

II. Prehospital stroke care and Triage

The effectiveness of advanced interventions largely depends on the timely recognition of stroke symptoms and immediate seeking of medical attention. The mean time to reach the hospital after stroke onset is around 14.6 hours.[10]

Prehospital delay (PHD) is identified as one of the major challenges to thrombolysis and early overall treatment.[11] (Figure1)[12].

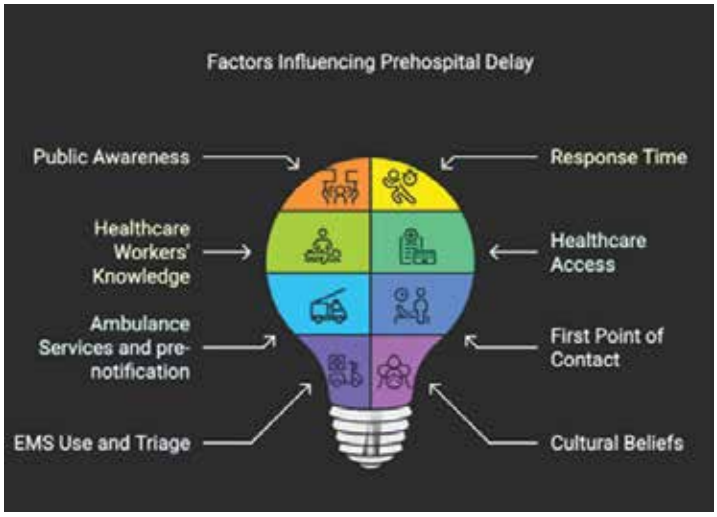


Figure 1

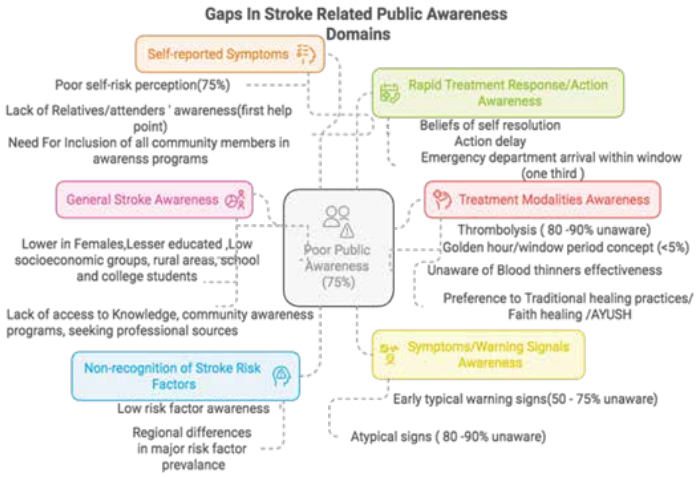


Figure 2

Public awareness about stroke- One of the biggest barriers of immediate thrombolysis therapy is non-recognition of stroke risk factors, warning signs and treatment response among patients at risk, relatives and the public causing 3/4th of the delayed arrival[11],[13]. 90% patients fail to be eligible for thrombolysis due to inadequate knowledge of stroke symptoms and early treatment options available[14] (Figure 2)[15].

Health care workers Knowledge (Figure 3)-[16] Successful implementation of acute stroke care would only be possible with a highly informed team of health workers[17] . As per the WHO, the number of neurologists per 100,000 population is 0.07 in South-East Asia[18]. Most patients are catered by GPs, physicians and CHWs with limited knowledge.

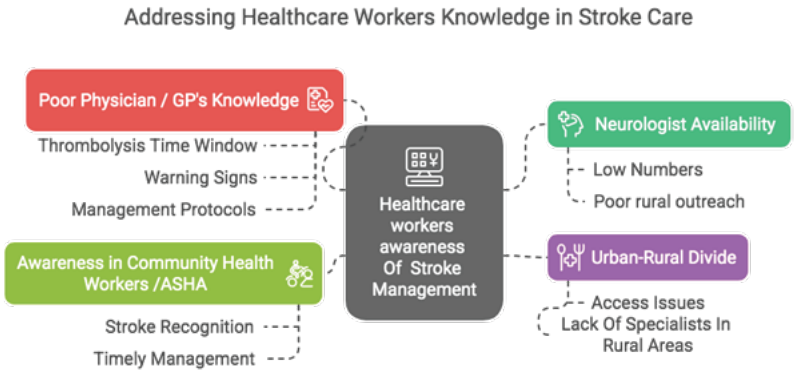


Figure 3

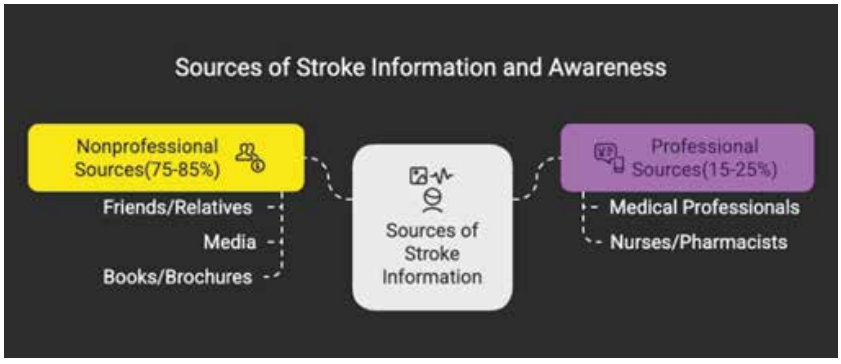


Figure 4

Information sources- Knowledge about stroke from medical professionals though less; showed better stroke awareness and response,[18],[19]. (Figure 4)[20]

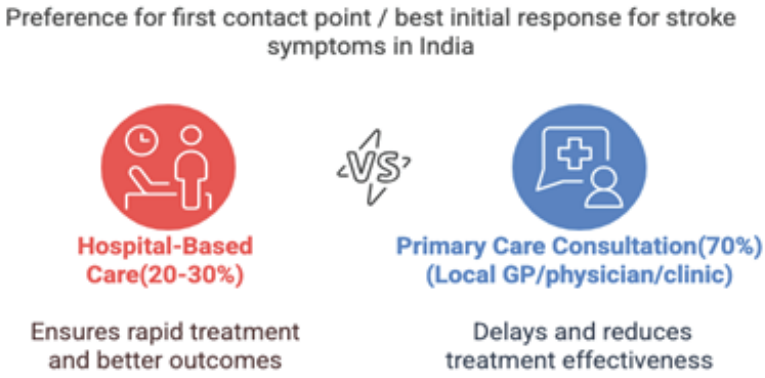


Figure 5

First point of contact- Most people are unaware of the benefits of rapid hospital-based care following stroke and highlights the need to educate all members of the general population[21]. Distance from hospital, contact with a local doctor and low threat perception of stroke symptoms are associated with delayed arrival[22]. (Figure 5)[23]

Emergency Medical Services (EMS) (Figure -6)[24]

Use of EMS has been clearly shown to be crucial in reducing PHD and early hospital arrival. Even in urban areas of India, only 15% receive prehospital care with lack of trained EMS providers.[25]

Visiting family doctor or primary care centre first, referral from another hospital and private transport to hospital are associated with delayed arrival[26]

Ambulance services- Study showed 44.1% patients were not aware regarding ambulance services in their region[13]. Knowledge regarding stroke helplines, ambulance services and need to rush to hospital emergency department is found to be low.[11]



Figure 6

Triage

Good neurological care at primary care level supported by efficient secondary and tertiary care facilities is the goal[27]. EMS-triage personnel training to identify IVT eligible patients and thrombectomy-eligibility with appropriate triage is essential[28]. Most Indian states have little/no trained EMS personnel, lack of defined pathways, no national emergency numbers with low preparedness[29,30]. Only a minority of the ambulances are physician staffed or had Basic Life Support (BLS)-trained personnel[31]. 98% of EMTs transferred the patients to the nearest hospital regardless of available specialized services.[32]

Recommendations/Strategies to improve various domains of PHD/Action plan

A multifaceted approach to address the stroke burden tailored to regional risk factors and healthcare infrastructure variations and targeted strategies.[14,21]

Stroke management in community spanning primary, secondary and tertiary healthcare system levels imply a need to involve community health workers in stroke and NCD control[27].

1. Community engagement with focus on special populations

a. Stroke awareness campaigns - Focus on women, low education groups, low-income groups and rural areas. BP and diabetes screening among women, Education on tobacco/alcohol risks, healthy cooking and lifestyle tips in community kitchens or self-help groups[18],[19].

b. Creating "Stroke Awareness Kiosks" with audiovisual depiction during festivals or at social gatherings, places of worship and public meetings.

c. Younger generation awareness- through educational interventions in schools and colleges[18] Incorporate stroke education in curriculum- Stroke basics, signs by visuals and cartoons, animations Promoting healthy lifestyles, health awareness quizzes and competitions, collaboration of health professionals talks on important days, involving family meetups. Adaptation of FAST HEROES campaign[33]

d. Stroke survivors and their family members –educating the public on a better response to acute stroke by sharing the first hand experiences on podcasts, interviews and public gatherings and can be incentivized /provided medical support in return.

2. Community health workers (CHWs) education

a. Identify and involve local influencers- Village health workers (ASHA, ANMs), Anganwadi workers, self-help groups, women panchayat leaders, nurses and CHWs. - Pragmatic and cost-effective strategy for public stroke awareness, vascular risk factor control, liaising with stroke care centers, and ensuring follow-up[17]

b. Focus on educational level and representation of local CHWs

- Capacity building by regular short term interactive training programs for ASHA workers and CHWs.[17]
- Certification courses and salary grading as per the training and milestones achieved.
- Promotions and felicitation for improved motivation (indicators, every 100 people screened for BP and sugar, every 50 strokes detected and triaged).

c. Conduct initial trust-building meetings-

- Use familiar spaces like temples, Anganwadi centers, or village gatherings.
- WhatsApp groups of SHGs or village health volunteers to circulate videos and audio messages.

d. Educational interventions by interns and social workers posted in RHTC – Camps, short training sessions and certifying their contributions

3. Collaborate with Government Programs, stroke foundations - Integration with NPCD-CS, NRHM and local NGOs

- Creation of special block for public stroke awareness about the early and rapid response.
- Registry for stroke risk factors, integration of screening for cardiac and stroke risk factor control (due to common shared risk factors).

4. Mass media campaigns- Leveraging Technology for effective reach

- Use of culturally Relevant Education Tools
  Visual aids- Posters, flashcards, and flipbooks showing stroke symptoms (FAST, BEFAST graphics)- Audio messages in local dialects- Recordings by local women or health workers, shared via mobile speakers or local FM, WhatsApp groups.
  Street plays/ puppet shows- Leverage local folk theatre to dramatize stroke signs and emergency response.
  Demonstrations and Role-plays- Teach FAST method (Face, Arms, Speech, Time) using role-play.[34],[35]
  Mock drills- Practice what to do when stroke symptoms appear.
  Health vans with TV screens- Play stroke awareness videos in local languages.
  Distribute picture-based leaflets with minimal text.
- Use of celebrity campaigning or real-life stories through TV advertisements, newspapers, books, magazines, radio broadcasting
- IVR systems (Interactive Voice Response) for stroke info via simple phone calls.

5. Screening camps and public health initiatives

Regular Awareness Camps[21,36]

- Monthly health and stroke awareness sessions with screening programmes: Include blood pressure and sugar checks along with education.
- Tie-up with Primary Health Centers (PHCs) for regular support.
- Educate family decision-makers to support timely care. Public health initiatives to curb the unfavorable attitudes and practices[13,14]

- **Reduce tobacco use/alcohol consumption**
- **Healthy diet/Nutrition**
- **Regular physical activity**
- **Sleep hygiene**
- **Environmental health interventions-Air pollution control measures**

6. Integrating non-neurologists and traditional healers

- To train primary care physicians, general practitioners and paramedical staff by short term intensive training for 6-8 weeks by neurologists[27].
- "Saving the Brain Initiative" in East Delhi – a hub and spoke model with a central hub hospital providing expertise and resources to spoke centers (peripheral centers) for treatment and referral aimed to increase the thrombolysis rates[37].
- Initiatives involving collaboration between hospitals, general physicians and community members to improve stroke care at all levels[13].
- Integrate the traditional healers and first line contacts to guide the patients into the rapid response emergency treatments in initial phase.

7. Information Resources effective utilization

- Integration of "Stroke Care Resource Manual" and interactive training sessions among ASHA and ANMs for stroke education[36]
- WHO STEP wise approach to stroke surveillance tool- information on socio-demographics, warning symptoms, the golden period, risk factors and response to acute stroke[19]
- Diagnostic algorithms for stroke pathway, use of stroke scales and treatment protocols
- World Stroke Academy, Angels Initiative and Global Stroke Alliance virtual platforms providing free, high-quality training.[38]

8. Emergency Response Training

- Create locally adapted emergency response plans- Who to call, where to go. (SOPs as per the local health needs, affordability and existing stroke services).
- EMS standard training protocols- Paramedic training for prenotification[39]
- Public private partnerships- Partner with local transport owners- Ensure quick access to hospitals.
- Local healthcare providers education- about thrombolysis ready centers, encourage drip-and-ship, and contact EMS for rapid reach to nearest stroke ready centre
- Stroke education programs to impart knowledge- Stroke helplines, importance of ambulance services and need to reach hospital emergency department

9. Ambulance services availability

- 108 and 112 ambulance services to be trained and allocated to every region as per population census.
- Public private partnerships- To collaborate with government ambulances, Red health to improve reach and access to all the areas and mapping of nearby hospitals.
- EMS operators to be trained periodically for Immediate response.
- Separate corridor for ambulance- for swift transfer
- Establish a dedicated nation-wide hotline/ helpline number for operation of emergency medical services.

10. EMT training and certification

- For community awareness, first-aid, resuscitation protocols, fluid therapy, hypoglycaemia management, and hemodynamic monitoring[40]
- Create education modules- NIHSS and modified Rankin scale certification programs to all stroke personnel
- Use of BLS certified EMTs to train in acute stroke response team.
- Training with standardized protocols, clear pathways and stroke maps can enable a swift arrival to the target hospital
- Utilization of EMRI green health services, a GVK enterprise helping 9000 EMR teams to be trained by Angels initiative to improve EMT response.
- Dhulikhel Hospital EMS(DEMS), a pre-hospital EMS(Kathmandu) where EMS dispatchers/ambulance staff, paramedics/first responders were trained with scenario-based skill assessments is a resource-efficient, innovative and cost-effective LMIC strategy to be adopted.[41]

11. Screening tools

- A simple screening checklist can be an efficient and sensitive tool.
- Prehospital screening and assessment tools such as Cincinnati Pre-hospital Stroke Scale (CPSS) can expedite EMS transport.[42]
- Clinical stroke severity scales such as Face-Arm-Speech-Time (FAST) and Balance-Eyes-Face-Arm-Speech-Time (BEFAST) are simplest pre-hospital triage tools for basic EMT training.[43]

12. Telemedicine

- Upgrading the existing emergency medical services with adequate number of ambulances equipped with telecommunications system mounted for prenotification and efficient triage.
- Mobile telemedicine/Modern digital communication could be a cheaper alternative in areas without neurologists.[38]
- Smartphone apps to enable telemedicine in ambulances can improve communication between EMTs and neurologists/stroke specialists[30]
- Smart India trial and tele stroke networks established in Himachal Pradesh can be taken as a prototype for expanding telestroke services.[44],[45]
- Intermittent/mock training can help evolve tele stroke.
- Mobile stroke unit(MSU) can facilitate time-saving stroke triage decisions and provide telemedicine to EMTs[46]
- Funds for initiation, development, and maintenance of telestroke programs to be allocated in the National Health Plans.

13. Monitoring & Feedback

- Track awareness levels via feedback forms and questionaries
- Improving registry-based stroke detection and risk factor burden
- Gather feedback through ASHAs/CHWs about what works and what needs to be improved.
- World stroke day campaign and goals to be assigned every year and feedback meetings and monitoring for the fulfilment of the objectives.

14. Quality Indicators-

Public awareness- at least 70-80% improvement in following parameters

- Awareness of vascular risk factor knowledge
- Awareness of the FAST and BEFAST acronym for signs of acute stroke.
- Awareness of "golden time" concept for acute stroke and rapid response.
- Awareness of local helpline number to call the ambulance services.
- Awareness of treatment modalities like thrombolysis/EVT in window period.
- Awareness of first point of contact as hospital-based care for acute stroke cases.



Community health workers awareness

- Number of vascular risk factors detected and treated in the region
- Number of ASHA workers/CHWs certified for stroke training and education
- Number of non-neurologists, General physicians and traditional healers trained for stroke specific management
- Number of patients referred from local clinics or CHWs in golden period.

EMS and triage quality indicator

- Rapid response time- From ambulance call to EMS reaching the patient location
- Number of Patient reaching through EMT trained ambulances
- Number of patient pre-notified to the receiving hospital
- Number of EMS teams trained for FAST/BEFAST, NIHSS and mRS scales.
- Number of EMS teams certified and trained in acute stroke care like basic life support, dysphagia screening, sugar check, vitals and counselling.
- Number of EMS teams trained for FAST/BEFAST, NIHSS and mRS scales.
- Number of stroke thrombolysis by telemedicine networks
- Dispatch time to door time in the receiving hospital- Dispatch to door time.
- Number of patients reaching in window period for thrombolysis- Call to door time, Symptom onset / Last known well to door time.

III. Management of Acute Stroke

Intravenous thrombolysis

The first few hours after an ischemic stroke represents a critical window to salvage viable cerebral tissue and avoid potential brain damage. Intravenous thrombolysis[47](IVT) has emerged as a cornerstone in the management of acute ischemic stroke (AIS), significantly improving outcomes and decreasing post-stroke disability when administered timely. This treatment involves the intravenous administration of clot-dissolving medications, to restore blood flow to the affected brain area.

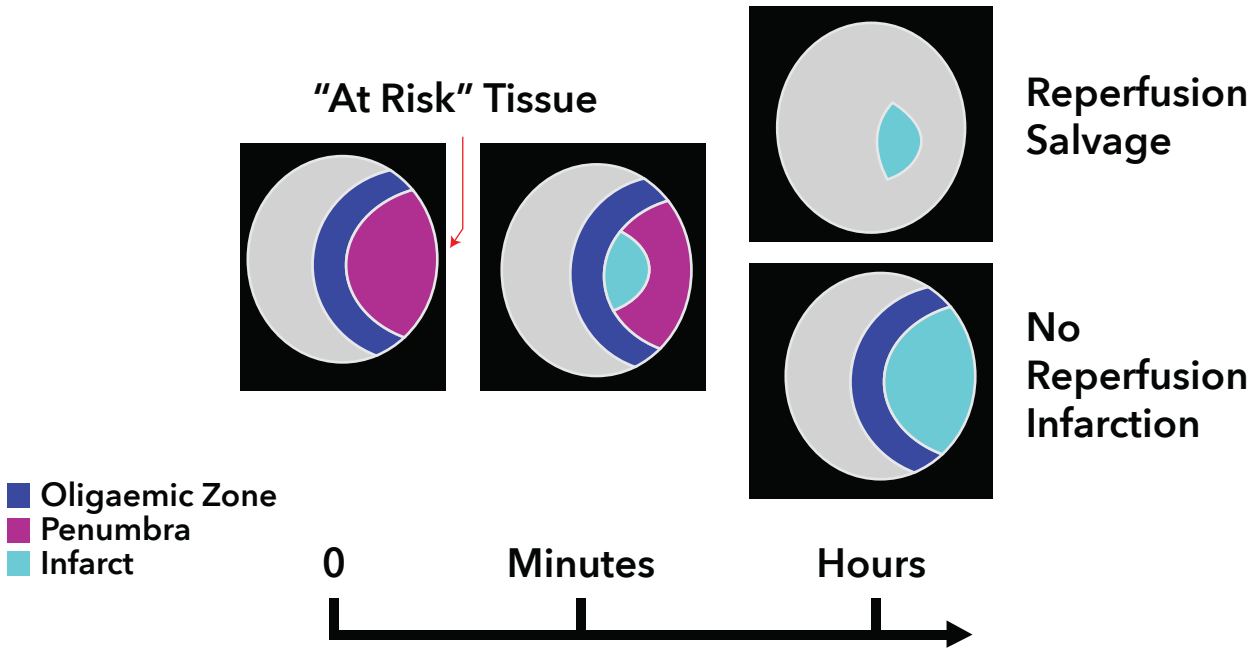


Figure 7

When a brain vessel is blocked, blood flow beyond the blockage is lost. This creates three main zones:

- **Core:** The central area with very low blood flow (CBF <10 ml/100g/min) where cells die within minutes–this tissue is irreversibly damaged.
- **Ischemic Penumbra:** Surrounding the core, this zone has slightly higher blood flow (CBF 10–22 ml/100g/min). Here, cells are dysfunctional but not yet dead, making the tissue potentially salvageable if blood flow is restored quickly. This is the main target for reperfusion therapies.
- **Oligemia:** Beyond the penumbra, this area has mildly reduced blood flow (CBF 22–60 ml/100g/min). Neurons here remain functional and usually recover without intervention.

The goal of acute stroke treatment is to restore blood flow and save the penumbra before it becomes part of the core[48]. The size and survival time of the penumbra depends on factors like vascular anatomy, collateral circulation, and blood pressure. Rapid intervention is crucial: "time is brain".

Alteplase remains the most widely used thrombolytic drug in stroke. It is a recombinant tissue plasminogen activator with established safety and efficacy in improving functional outcomes in ischemic stroke patients across multiple clinical trials[49]. More recently, Tenecteplase, which is a genetically engineered tissue plasminogen activator has also been recognized as a viable alternative, offering the advantage of a single bolus administration and potentially improved safety profiles compared to alteplase. The efficacy of thrombolysis is a function of time with earlier administration demonstrating better outcomes

1. Standardized Imaging and Eligibility Criteria

Objective: To establish a consistent, evidence-based approach to imaging and patient selection that enables timely, accurate diagnosis and appropriate treatment decisions in acute stroke care

a. Refine Non-Contrast CT (NCCT) Thresholds for Early Ischemic Change:

NCCT remains the primary imaging tool in most emergency settings due to its widespread availability. Validated tools like the Alberta Stroke Program Early CT Score (ASPECTS) should [50]be standardized to exclude extensive ischemia. Patients with ASPECTS ≤5 (indicating >1/3 middle cerebral artery territory involvement) face higher hemorrhage risks and poorer outcomes post-IVT, as shown in the ECASS III trial.

b. Mandate Advanced Imaging for Patients with Unclear Onset Times

A critical barrier to IVT eligibility is the "time last known well" uncertainty, which excludes ~20% of stroke patients globally. Advanced imaging with MRI based protocols such as MRI diffusion-weighted imaging (DWI) with FLAIR mismatch; CT perfusion or MR perfusion should be adopted in patients with unclear onset of symptoms, wake-up strokes or unwitnessed symptom onset. The DWI-FLAIR mismatch (visible acute ischemia on DWI but no parenchymal hyperintensity on FLAIR, demonstrated in WAKE-UP and EXTEND trials) as [51]well as perfusion mismatch (ischemic core <70 ml, mismatch ratio ≥1.8 demonstrated in DEFUSE-3 [52]and DAWN [53]trials) helps identify patients likely within 4.5 hours of stroke onset allowing for expanding treatment time windows in selected patients without increasing hemorrhagic risk.

c. Harmonize Eligibility Criteria Across Regions

Significant variability exists in IVT exclusion criteria, particularly for "relative contraindications" like recent surgery, anticoagulant use, or mild deficits.

- Non-evidence exclusions such as advanced age (>80 years), and comorbidities (diabetes, prior stroke) should not automatically disqualify patients, per AHA/ASA 2023 guidelines.
- Allow IVT in patients taking direct oral anticoagulants (DOACs) if last dose was >48 hours ago or if coagulation tests (e.g., anti-Xa levels) are normal.
- Replace time-consuming written consent with verbal assent in time-sensitive scenarios.

d. Implementation Strategy:

- Equip comprehensive stroke centers with advanced imaging such as MRI and CTP capabilities and train staff to interpret mismatch profiles.
- Develop cloud-based platforms for rapid perfusion analysis in resource-limited settings.
- Disparities in imaging access especially in remote/ rural areas should be addressed via feasible solutions including telestroke services.

Actionable steps:



Mandate ASPECTS scoring for all NCCT scans during acute stroke evaluations.



Establish rapid-transfer agreements for facilities without on-site MRI.



Establish telestroke hubs for remote imaging interpretation.



Train and equip stroke-ready hospitals to perform neuroimaging within 25 minutes of arrival.



Harmonized eligibility criteria with clear protocols based on onset, radiological features as well as indications for advanced imaging.

2. Reduce Door to Needle Times

Objective: To minimize the time interval between a stroke patient's arrival at the hospital and the initiation of intravenous thrombolytic therapy (rt-PA). Every 15-minute reduction in DNT lowers odds of in-hospital mortality by 5% and symptomatic intracranial hemorrhage by 3%.

a. Pre-Notification by Emergency Medical Services (EMS)

EMS prenotification is the cornerstone of rapid stroke care. Studies show hospitals receiving advance notice from EMS reduce median DNT by 15–20 minutes and lower in-hospital mortality by 13%[54]. Key steps include:

- Training of EMS personnel to use validated tools like BE- FAST (Balance, Eyes, Face, Arm, Speech, Time) for rapid identification.
- Implementation of direct communication protocols for EMS to transmit stroke alerts directly to stroke teams via radio or mobile apps, bypassing standard emergency department (ED) registration, along with real-time data sharing.

b. Rapid Triage Pathways Bypassing ED Delays

Streamlined workflows eliminate bottlenecks in traditional ED triage.
Direct-to-CT Pathways to be established redirecting suspected stroke patients via these routes.
Implementing the "Code Stroke" model with parallel processing of neurological assessments, IV access and blood draws during imaging transport.
Dedicated stroke team including stroke neurologist/ physician, radiologists, stroke nurse to respond to "code stroke" alerts within 10 minutes of intimation.

c. Thrombolytic Drug Storage in Imaging Areas

Proximity of alteplase to CT/MRI suites eliminates delays in post-imaging administration.
Thrombolytics can be stored in temperature-controlled cabinets near scanners, reducing medication preparation time from 10-15 minutes to <2 minutes.
Performance Feedback with monthly reports benchmarking DNT metrics against national standards (e.g., 80% ≤ 60-minute target) to drive continuous improvement

d. Training and Accountability Measures

Quarterly mock stroke codes identify workflow gaps, such as delays in lab result retrieval or consent processes. Publish reporting of hospital-level DNT compliance rates and thrombolysis outcomes to incentivize adherence.

Actionable steps:

- Train EMS to use BE-FAST for prenotification
- Store thrombolytics near imaging suites
- Establish direct-to-CT pathways with parallel workflows
- Track DNT metrics and conduct quarterly mock drills

ALGORITHM FOR ACUTE STROKE CARE IN THE EMERGENCY

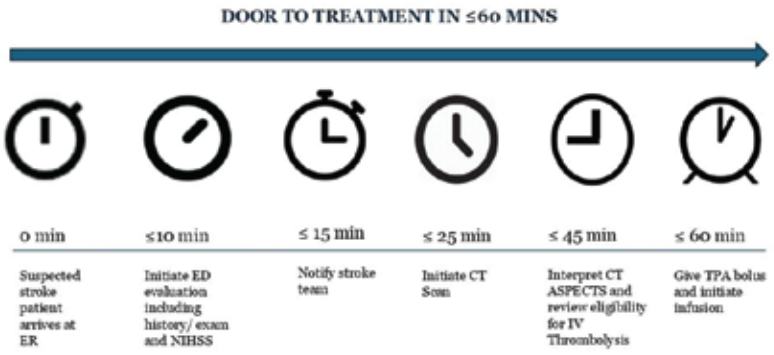


Figure 8

Summary of Key Timelines[55]

TIMELINE FROM ARRIVAL TO EMERGENCY DEPARTMENT

Arrival at ER (Initial assessment and IV access)	Within 10 minutes	• Immediate assessment: Airway, Breathing, Circulation (ABCs); provide oxygen if hypoxic. • Establish IV access and check glucose: Hypoglycemia can mimic stroke • Activate stroke team: Notify neurology/ stroke specialists immediately
Neurologic evaluation and imaging	Within 25-45 minutes	• Perform neurologic exam using NIHSS • Urgent brain imaging (non-contrast CT or MRI)-Rule out hemorrhage • Obtain ECG and labs
Decision making	Within 45 minutes	• Exclude hemorrhage • If hemorrhage detected: Initiate hemorrhagic stroke protocol; consult neurology/neurosurgery • No hemorrhage and ischemic stroke likely: Assess eligibility for IV Thrombolysis • Rule out contraindications for IVT
Consent and Thrombolysis decision	Within 60 minutes	• Obtain consent: Discuss risks/benefits with patient/family • Administer IV thrombolytic therapy (rtPA) • If eligible for EVT: Arrange transfer to interventional suite promptly*
Post-Treatment Monitoring	Within 6 hours (up to 24 h in selected cases	• Admit to stroke unit or ICU- Stroke unit measures • Prepare for secondary prevention and rehabilitation.

3. Implement Stroke Mapping To Identify The Nearest Stroke-ready Center

After reperfusion therapy rapid and informed decisions about ongoing stroke management are essential, particularly in areas with fragmented referral systems. Implementing a national stroke mapping system can transform patient care by enabling real-time identification of the nearest stroke-ready center based on a patient's location, treatment eligibility, and current resource availability. This system should be fully integrated with existing platforms like the Ayushman Bharat Digital Mission (ABDM) and emergency services, offering geolocation-based recommendations to emergency responders, ambulance teams, and first-contact providers.

The mapping system should categorize hospitals based on their stroke care capabilities-primary (IVT), comprehensive (IVT + EVT), and post-stroke rehabilitation, with real-time information on current bed availability, specialist availability, imaging services (CT/MRI), and tele-stroke connectivity. This data can be updated via cloud-based dashboards, ensuring decision-making is accurate and efficient. Piloting this model in high-burden states will help refine logistics and coordination protocols. Stroke mapping will reduce treatment delays, optimize resource allocation, and improve patient outcomes, especially in remote and underserved districts.

4. Strengthen Telestroke Networks And Access

Objective: To expand and optimize tele-stroke networks, ensuring equitable access to rapid stroke diagnosis and send specialist-guided stroke management across all regions, through standardized protocols, technology integration, and provider training.

a. Scale Hub-and-Spoke Tele-stroke Infrastructure Nationally

The Punjab Hub-and-Spoke Stroke Care[56] Model is an innovative public-private partnership (PPP) established through a memorandum of understanding (MOU) between the Government of Punjab, Christian Medical College (CMC) Ludhiana, and Medtronic India, designed to address the state's growing stroke burden through equitable and rapid access to advanced care. Central to this model is a hub-and-spoke framework, where CMC Ludhiana serves as the central hub, providing advanced stroke care treatments like mechanical thrombectomy, while networked government hospitals and medical colleges across Punjab act as spokes, delivering initial stabilization and thrombolysis. The partnership, formalized via a Memorandum of Understanding (MOU), ensures treatment for economically vulnerable patients, particularly targeting middle-class and low-income groups, with industry partners supplying critical devices like thrombectomy stents and CMC Ludhiana offering clinical expertise. The Punjab model exemplifies how local innovation can advance national objectives. By combining PPPs, technology, and standardized protocols, it offers a replicable framework that can be adopted in other states to achieve the National Stroke Action Plan's vision of universal, equitable stroke care.

The Kerala stroke care system employs a successful hub-and-spoke model involving 10 district hospitals as spokes, where neurologists provide timely thrombolysis for stroke patients. Patients needing advanced treatment like mechanical thrombectomy are referred to a comprehensive tertiary centre (the hub). Nurses across Kerala receive annual training in stroke unit care protocols, ensuring consistent, high-quality care statewide. By decentralizing thrombolysis to district hospitals while centralizing complex interventions at a comprehensive centre, the Kerala hub-and-spoke model balances accessibility with specialized expertise, creating a coordinated and efficient stroke care network.

Integrating tele-stroke into PM-JAY reimbursement frameworks can ensure financial sustainability, incentivizing private-sector participation and expand access to 300+ districts.

b. Physician training: [57]

Given the lack of specialist neurologists to cater to the entire population of India (1 neurologist per 1.25 million people), it is imperative to adopt alternative models of stroke care. Empowering and equipping physicians to recognize and manage stroke through structured training and certifications is vital to enable them to confidently handle stroke patients according to guidelines. Successful examples of physician-based stroke care have been established in various regions of the country. Tools like the SMART-India App and the ENIGMA app[58] can further district-level physicians by providing guidance on both acute stroke and stroke unit management.

c. Deploying Mobile Stroke Units (MSUs) in Underserved Regions

Deploying Mobile Stroke Units (MSUs) in underserved regions of India represents a transformative approach to bridging the critical gap in timely stroke care, particularly for remote districts located more than 100 kilometers from established stroke centers. Enabling on-site diagnosis and treatment, MSUs can reduce time to tPA administration or transport to a comprehensive stroke center by up to 33%. MSU is a success story in Tezpur and Dibrugarh launched by ICMR.

The Indian Council of Medical Research has played a pivotal role in the piloting MSU deployment and recognizing the importance of expanding stroke access, the Indian government has actively promoted the integration of MSUs within the national framework for stroke care. The success of India's first mobile stroke ambulance, operating on a telestroke model, has demonstrated substantial improvements in patient quality of life and a decrease in mortality in regions like Tezpur, Assam. PPP can be leveraged to offset the substantial costs associated with MSU procurement, staffing, and technological integration, making the model more sustainable and scalable for widespread adoption.

d. Train Rural Healthcare Workers via Immersive Technologies

Gaps in stroke care in rural regions in India can be addressed using a multi-pronged strategy leveraging immersive technologies, policy reforms, and financial incentives is critical. Targeted training for community Health Workers (CHWs) and ASHA workers[59] in stroke identification (e.g., BE-FAST criteria) and referral protocols, and structured training programs and workshops can significantly improve ASHAs' knowledge of symptoms, risk factors and lifestyle interventions. The Ayushman Bharat Digital Mission (ABDM) can scale this by offering standardized online courses with certifications, integrating modules on stroke triage, thrombolysis eligibility, and post-stroke rehabilitation. For instance, Kerala's CHWs showed improved stroke care practices through government-backed training under the National Program for NCD Prevention, while Punjab's ASHAs achieved 42–53% gains in stroke prevention knowledge via culturally tailored, hands-on sessions. Post-stroke follow-ups by ASHAs, proven effective in improving blood pressure control and medication adherence.

Actionable points:

1. **Replicate the Hub-and-Spoke Telestroke Model Nationwide**
2. **Integrate Telestroke Services into PM-JAY and Health Insurance Schemes**
3. **Train Non-Neurologist Physicians Using Digital Tools and Certification Programs**
4. **Deploy Mobile Stroke Units (MSUs) in Remote and Underserved Areas**
5. **Upskill ASHAs and Community Health Workers Using Immersive and Digital Learning Platforms**

5. Monitor Outcomes and Set National Benchmarks

Monitoring outcomes and setting national benchmarks help ensure that stroke care is standardized, effective, and continuously improving across different healthcare settings in the country. It provides a medium to measure performance against national standards, identify areas for improvement, and implement targeted interventions to enhance patient outcomes. Key components include:

- Establish achievable benchmarks for Key performance indicators including door to needle times ≤ 60 minutes for at least 90% of eligible patients.
- Aim to increase national thrombolysis rates from 2% to at least 10%
- Ensure dysphagia screening for ≥ 90% of stroke patients
- Track and document outcome measures including in-hospital and 30-day mortality rates for stroke patients, complication rates and functional outcomes using objective scales such as the mRS.
- Develop stroke center tracking with a live dashboard for the country

Endovascular Thrombectomy

Endovascular thrombectomy / Mechanical thrombectomy is an advanced treatment performed in specialized digital subtraction angiography (DSA) labs or endovascular suites by trained specialists (Neurointerventionists), where clots causing blockade of blood vessels inside the brain are removed by a stent retriever or aspirated using large bore catheter or a combination of both.[60]

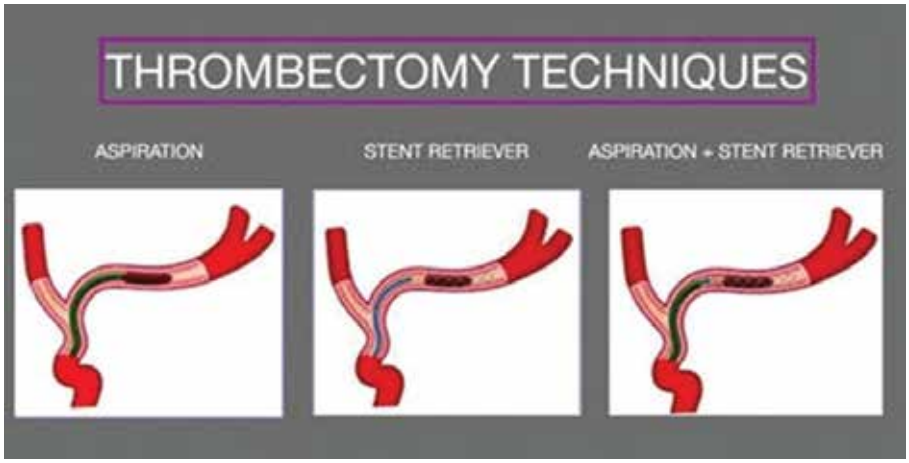


Figure 9

Figure caption: Representative images of various endovascular stroke thrombectomy techniques

In 2014–2015, five large international clinical research trials of acute ischemic stroke compared IV tissue plasminogen activator (tPA) as the standard of care with endovascular treatment (EVT) or mechanical thrombectomy (MT) in conjunction with IV tPA for large-vessel occlusion in select patients and were published. These studies individually and collectively demonstrated improved outcomes for patients who undergo acute endovascular treatment (EVT) for large-artery occlusions, and this was subsequently recommended by the American Heart Association/American Stroke Association[62]. In India, approximately 1.18 million patients experience stroke annually, with around 21 per cent being suitable for mechanical thrombectomy procedures. The current adoption rate of mechanical thrombectomy is less than 0.1 per cent in India, generally owing to a lack of awareness and access. Endovascular treatment for stroke in India demonstrates promising outcomes, with successful recanalization rates reported at around 90% and good functional outcomes at around 36%. However, access within one hour to an EVT centre was only available to 20.6 per cent of the Indian population[63]. The treatment costs about ₹3 lakh in government hospitals and at least ₹5-₹6 lakh in the private sector. This treatment is cost-effective as it helps people live better lives following a stroke[64]. The following are the recommendations with regards to EVT / MT.

1. System of Care Coordination for EVT

Objectives:

- Improve prehospital and hospital coordination for stroke management by prenotification.
- Reduce delays in EVT treatment through streamlined protocols.
- Wherever possible, to develop referral pathways between smaller hospitals (to be made stroke ready) and bigger hospitals (with DSA Cath lab and expertise for EVT)
- Ensure every 200 km has at least one EVT capable hub hospital and connect it with spokes (stroke ready smaller hospitals with IVT facilities)
- Classification of hospitals and treatment facilities based on availability of stroke specialists and interventionists as well as imaging modalities and intensive care
- All State and District administration should ensure that the referral pathways are developed in communication with all accredited private as well as public hospitals.

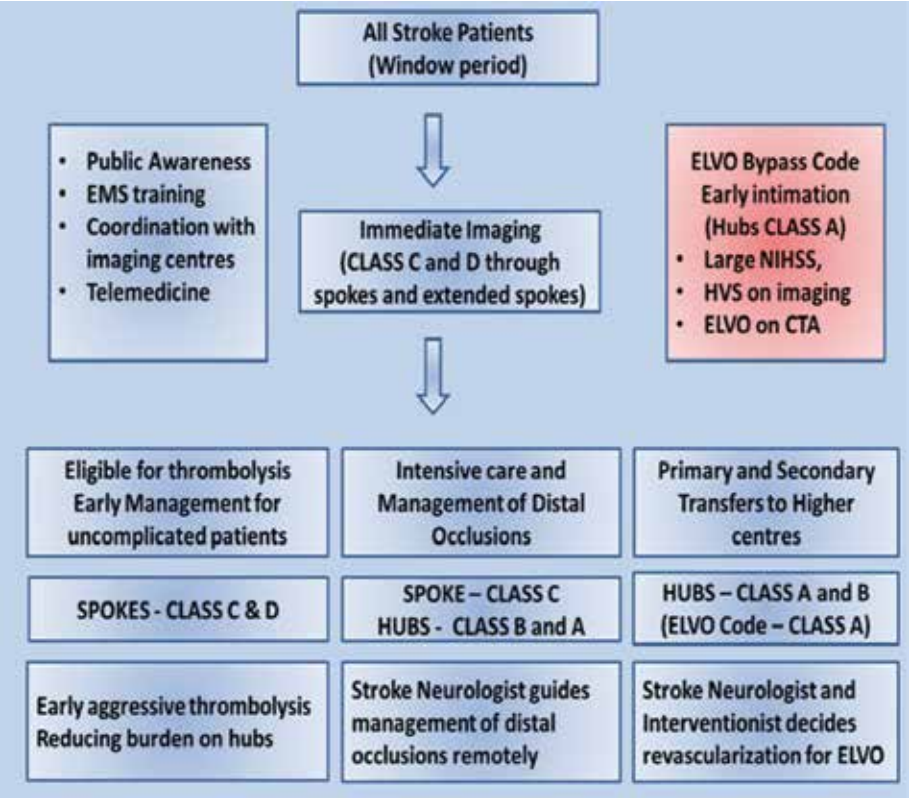


Figure 10

Figure Caption: Example of referral hub and spoke model for acute stroke revascularizations[65]. (Spokes are smaller hospitals lacking more intensive care or advanced imaging facilities while Hubs are comprehensive stroke centers with intervention facilities, ELVO – emergent large vessel occlusion. Some of the distal occlusions are now increasingly being considered for MT (MEVO).

Actions:

Emergency Medical Services (EMS) Coordination and prehospital notification

- Differentiate between Large Vessel Occlusion (LVO) and non-LVO stroke.
- Validated LVO triaging scales such as RACE to be used by EMS and in the ER
- Develop predictive tools for severe stroke cases requiring advanced care.
- Implement clinical risk stratification (NIHSS >10, cortical signs – aphasia, neglect, gaze preference, etc.)
- Establish prehospital pathways for EVT candidates.
- Optimize availability of Neurointerventions (Trip and Treat models).
- Minimize delays and ensure timely referrals to advanced stroke centres.
- Enhance seamless communication and transfer protocols between EMS, Emergency Departments (EDs), and stroke centres.

Rapid Neurovascular Imaging:

- Establish vascular imaging as the standard of care.
- Optimize imaging protocols and train medical personnel on CTA techniques.
- Protocols implementation and avoidance of redundant practices causing treatment delays such as estimation of serum creatinine, which is not needed before CTA for acute stroke (Neurons over Nephrons concept to be educated to all the physicians)
- Implement multiphasic CTA where feasible, considering local logistics.

Stroke Team Collaboration:

- Involve neurologists, neurointerventionists, radiologists, anaesthesiologists, and stroke unit staff in coordinated care.
- Ensure access to specialized stroke units for continued care and rehabilitation.
- Train nursing and critical care specialists on post-EVT management and complications handling in the stroke unit / ICU settings.
- Protocol for in-hospital stroke and referral pathways to be established

Figure caption: Example of acute care referral pathways in Stroke[66].

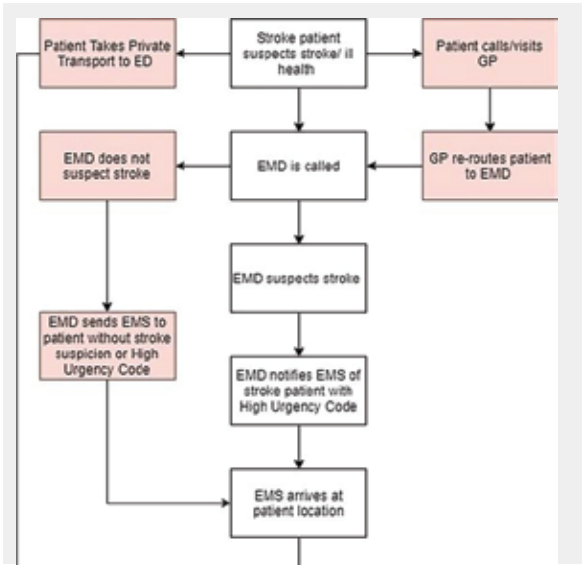


Figure 11 A

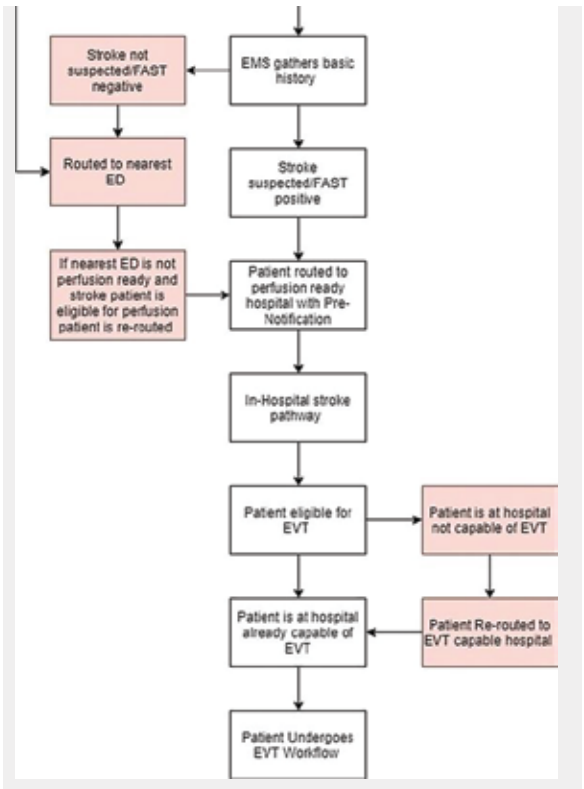


Figure 11 B

2. Patient Selection and Eligibility

Objectives:

- Ensure appropriate patient selection for EVT using standardized criteria.
- Maximize EVT benefits through proper screening and assessment.

Actions:

- Utilize non-contrast CT head and CT angiography to detect LVO.
- Follow established EVT inclusion criteria based on severity, imaging, and time, etc
- Drip and ship- Administer intravenous thrombolysis (IVT) to EVT eligible patients, as per guidelines
- Consider EVT as both a primary and adjunct therapy in suitable cases.

3. Timeliness and Time windows

Objectives:

- Minimize treatment delays to improve patient outcomes.
- Expand eligibility criteria for EVT where appropriate.

Actions:

- Reduce time from ED arrival to imaging and treatment initiation.
- Reinforce the importance of timely EVT within therapeutic windows.
- Consider extending EVT eligibility beyond the traditional 6-hour window for select patients as per evolving guidelines (especially after DAWN and DEFUSE-3 studies).

4. National Stroke Targets and Action Plan

Objectives:

- Standardize stroke care with measurable national targets.
- Implement structured frameworks for EVT adoption.

Actions:

- Establish acute stroke care benchmarks:
  - 30 minutes: Door-to-imaging time
  - 60 minutes: Door-to-needle time for IVT
  - 90 minutes: Door-to-puncture time for EVT
- puncture-to-recanalization less than 60 minutes and wherever possible 30 minutes
- Develop a national stroke action plan to facilitate implementation and infrastructure expansion including DSA labs, and personnel training (technicians and nursing, etc).

5. Ongoing Research and Training

Objectives:

- Promote continuous learning and innovation in stroke management.
- Enhance healthcare professional training for EVT.
- Adequate training and retraining of work force in EVT pathways including paramedical, nursing, radiographers and DSA/Cath lab technicians.
- Create sustainable pool of specialists across the neurosciences including neurology, neurosurgery and radiology backgrounds in neurointerventional training, from accredited centres and mentors specifically with regards to structured curriculum fulfilling a minimum number of angiographies and stroke interventions done by the candidate under supervised conditions and performances to be evaluated in training
- Engage stroke societies both national and international as well as industry/trade partners for funding of cerebrovascular neurointerventional training programs in India
- Ensure the presence of senior faculty trained adequately in Neurointervention therapy in the form of a faculty post in medical colleges in at least 10% of all medical institutions.

Actions:

- Stay updated with evolving guidelines and clinical evidence.
- Train neurointerventionists, neurologists, and emergency personnel.
- Implement quality improvement programs to monitor and optimize stroke care.

6. Targets for 2030

Objectives:

- Achieve ambitious stroke care benchmarks by 2030.
- Improve stroke treatment accessibility and outcomes nationwide.

Targets:

1. Treat 90% or more stroke patients in a stroke unit as the first level of care.
2. Ensure 95% of eligible patients have access to recanalization therapies.
3. Reduce onset-to-needle time (IVT) <120, onset-to-reperfusion time (EVT) <200 min
4. Achieve IVT rates above 15% and EVT rates above 5% in all states of India.
5. Lower first-month stroke-related mortality rates to <25% and increase good functional outcomes to >50% for ICH and SAH.
6. Private and public insurance coverage for majority of the EVT eligible population
7. 10% of medical colleges to have EVT facilities and trained personnel for the same
8. Cath labs/DSAs to have stroke intervention specific (digital subtraction, etc) features

7. Financial aspects

Objectives:

- Address cost challenges related to EVT implementation including hardware costs.
- Ensure financial sustainability for stroke intervention programs.

Actions:

- Evaluate cost-effective models for EVT infrastructure development.
- Advocate for funding from healthcare authorities and insurance providers with insurance coverage for mechanical thrombectomy.
- Encourage low cost technologies like funding for indigenous aspiration devices for improving affordability of MT for the economically underprivileged population.
- Explore public-private partnerships for affordable stroke treatment access.

Conclusion

By implementing these structured actions, we can enhance public awareness, improve stroke care coordination, and optimize EVT access. The outlined national targets and financial strategies will play a crucial role in achieving better stroke outcomes by 2030. EVT and IVT constitute acute care strategies to improve outcomes along with the other facets of stroke care.

Figure Caption: Example of an acute stroke management workflow[67]

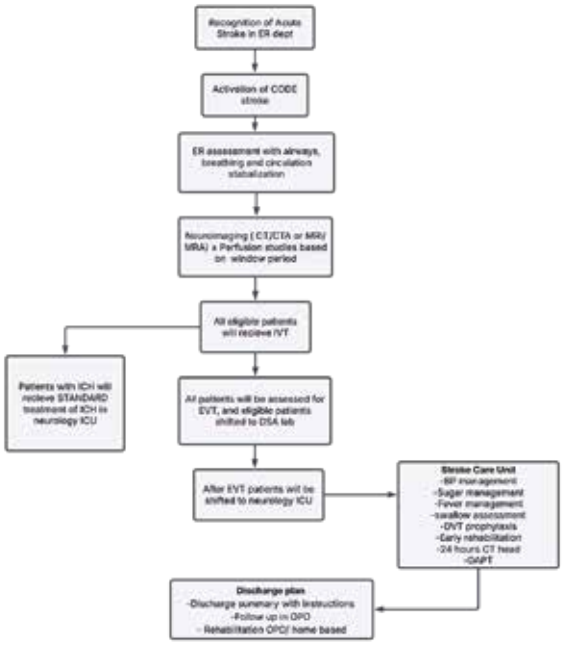


Figure 12

Insurance schemes

This entails adoption of Pradhan Mantri Jan Arogya Yojna (PM-JAY) Health Benefit Package HBP 2.2 at the state level, by actively integrating the comprehensive stroke care package outlined in HBP 2.2 into the state PM-JAY implementation. This will improve the thrombolysis rate and thrombectomy rates and reduce the stroke burden in the community.

IV. Primary and Secondary Prevention of Stroke

Primary Prevention

1. Identify High-Risk Areas & Mobilize Local Networks

Involve Local people - Village heads and teachers for training to spread stroke prevention messages. Appoint one "Stroke Prevention Champion" per village (e.g., an ASHA worker or active community member). The use of epidemiological mapping such as Stroke Surveillance Program by NCDIR Bangalore is crucial to identify high burden stroke areas.[68]

2. Mass Awareness Using Low-Cost Strategies

Leverage Local FM Radio & Community WhatsApp Groups: Run 30-second stroke prevention messages on regional radio. Use WhatsApp voice notes & short videos in community groups explaining stroke risk factors in simple terms[69].

3. Low Salt Initiative India

Encourage the use of salt substitutes.
Advocate for mandatory salt content labeling on all packaged foods.
Collaborate with FSSAI to introduce front-of-pack salt warning symbols.

4. Strengthening Health and Wellness Centers

Train One Stroke Care Coordinator at Every PHC
Identify one existing staff (nurse or health worker) per PHC and train them in basic stroke prevention & emergency response. Equip all Primary Health Centers (PHCs) and Community Health Centers (CHCs) with BP monitors, glucometers, and stroke risk assessment kits.
Give them a "Stroke Kit" with basic posters, checklists, and training materials[70].

5. Adopt a Village Model:

Each district hospital or medical college adopts one village and runs monthly stroke awareness activities. Gather PHC doctors, ASHA workers, and community heads every 3 months to discuss[71].

6. School-Based Awareness Programs

Introduce stroke awareness and healthy lifestyle education in middle and high school curricula.

7. Integrate Stroke Prevention into National Health Programs

Expand NPCDCS (National Programme for Prevention and Control of Non-Communicable Diseases) to include stroke-specific awareness and risk screening. Link stroke prevention with Ayushman Bharat for subsidized BP and diabetes medication[72].

8. Use of Stroke Risk Assessment Tools

Use the Stroke Riskometer App at community health camps and PHCs.
Start training the frontline workers to help individuals assess personal stroke risk.

9. Digital Health & Implementation Research

Initiate large-scale digital stroke care platforms.
Engage medical students in digital health education and community outreach for stroke[73].

Secondary prevention

1. Regular follow up, Monitoring and risk factor management

Ensure follow-up visits at PHCs or health & wellness clinics.

Ensure targets for:

- Blood Pressure < 130/80 mmHg
- HbA1c < 7%
- LDL cholesterol <70

  Lifestyle changes: low salt diet, physical activity, smoking cessation[74,75]

2. Anti-Coagulation & Atrial Fibrillation Management

Plan to set up Anticoagulation Clinics in PHC and wellness clinics.
Focus on warfarin/acitrom monitoring, patient counselling and INR testing.

3. Carotid Artery Disease

Screen stroke survivors for severe carotid stenosis and to establish a referral pathway for carotid endarterectomy or stenting in suitable cases.

4. Rehabilitation and Multidisciplinary Care

Ensure early triage to appropriate rehabilitation: which includes Physiotherapists, occupational therapists, speech and swallowing therapist. Psychiatric support for post-stroke depression and cognitive issues.

5. Support Groups and Caregiver Engagement

Create district-level or virtual stroke survivor support groups.
Educate caregivers on medication, mobility, diet, and provide emotional support.[76]

6. Digital Follow-Up and Awareness Teleconsultations, and mobile apps for regular follow-up.[77]

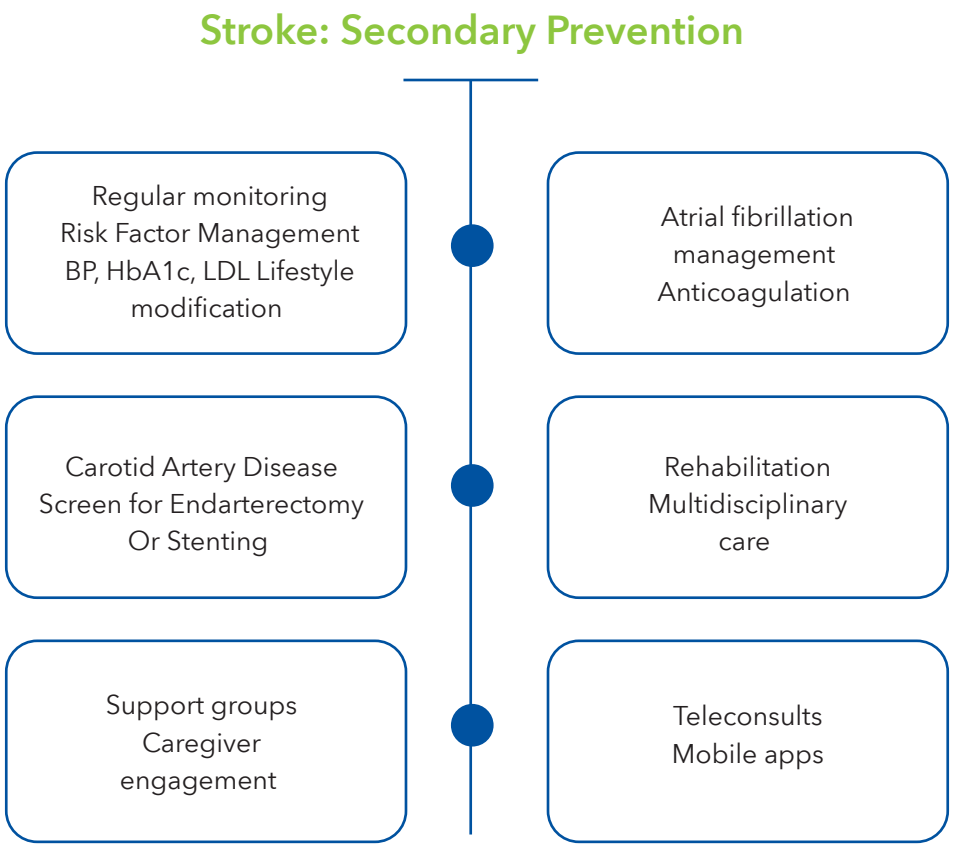


Figure 13

AYUSH in Primary and Secondary Stroke prevention

Integrating Ayurveda, Yoga, Unani, Siddha, and Homoeopathy (AYUSH) into preventive medicine enhances holistic health care by addressing lifestyle, mental well-being, and disease prevention. The integration of AYUSH with conventional approach results in a holistic framework for inclusive, collaborative healthcare landscape, which is vital for addressing India's increasing burden of non-communicable diseases (NCDs).[78]

Regular practice of yoga may ameliorate cholesterol levels, blood pressure, stress, Type 2 diabetes, and other risk factors associated with cardiovascular disease.[79]

Anderson et al. performed a meta-analysis and observed the effect of transcendental meditation on blood pressure, demonstrating a positive effect on these patients suggesting an overall reduced fatality due to stroke and coronary heart disease. [80]

V. Rehabilitation after Stroke

1. Strengthening Acute Stroke Care and Early Rehabilitation Initiation

Objective:

Improve early identification, treatment, and timely transition to rehabilitation.

Key Actions:

Systems and Processes

- Develop regional stroke units in tertiary/secondary hospitals for early thrombolysis and neuroprotection followed by early initiation of rehabilitation.
- Train healthcare staff (neurologists, physiatrists, PTs, nurses, psychologists) on early rehabilitation protocols.
- Promote use of National Stroke Clinical Practice Guidelines developed by the Ministry of Health and Family Welfare, India[81], at all healthcare levels.
- Implement telestroke services and task-shifting model of stroke rehabilitation delivery in remote areas for recognition, referral, and rehabilitation.
- Standardize documentation as per World Stroke Organization (WSO) key quality indicators[82],[83].
- Establish structured post-discharge follow-up protocols and pathways, with community support networks, patient support organizations and NGOs[84].

Clinical (Fig 14)

- Refer all suitable cases to rehabilitation team/PT within 48 hours of onset[85].
- Use standardized assessments (e.g., FMA, ARAT, 10MWT, mRS, swallow/speech/cognitive assessments)[86].
- Conduct swallow assessment within 24 hours and initiate treatment as needed.[85]
- Begin out-of-bed mobility within 24–48 hours to reduce complications.
- Address comprehensive rehabilitation areas: motor, pain, speech, swallow, diet, cognition, perception, vision, emotion, fatigue, and activity[81],[85]
- Implement National Stroke Clinical Practice Guidelines developed by the Ministry of health and Family Welfare, India, guidelines consistently across all levels.

Fig 14: Acute stroke rehabilitation essentials

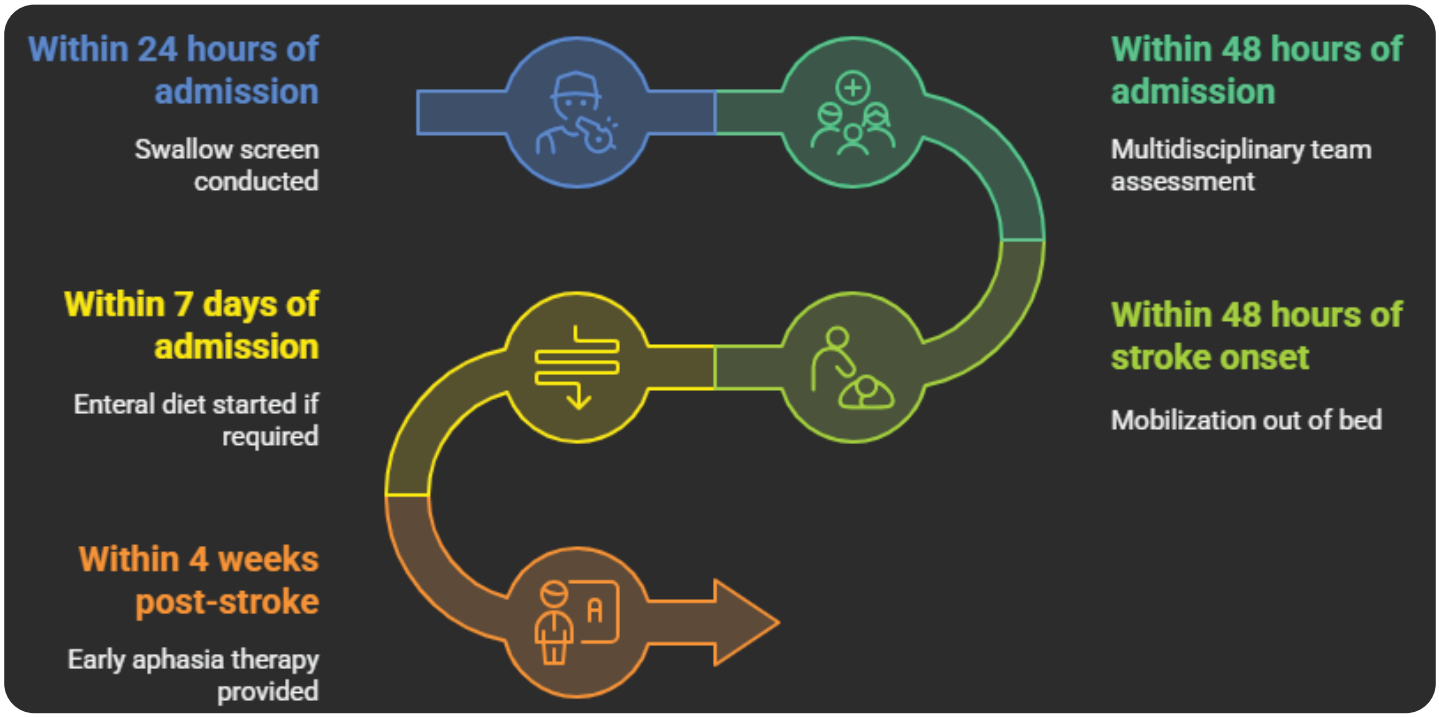


Figure 14

2. Establishing Multidisciplinary Stroke Rehabilitation systems

Objective:

Set up dedicated stroke rehabilitation units and/or across the healthcare system[87].

Key Actions:

Systems & Protocols

At PHCs:

- Train ASHAs/ANMs in basic rehab, swallowing, positioning, nutrition, incontinence care[84].
- Link PHCs to district hospitals; use schools/community centers for follow-up and secondary prevention.[84]
- Appoint a trained PT and rehab nurse to periodically oversee delivery of stroke rehabilitation with regular tele-monitoring

At District Hospitals:

- Establish stroke rehabilitation units with PT and speech therapy.
- Provide tele-rehabilitation support to PHCs and rural patients[84].
- Implement group therapy sessions where feasible for promoting physical activity, community reintegration of patients, secondary prevention and continued support[84].

At Tertiary Hospitals:

- Create full-fledged rehabilitation centers with multidisciplinary teams.
- Conduct interdisciplinary meetings and enable smooth transitions of care.
- Launch rehabilitation fellowship programs and train professionals on WSO quality standards and WHO stroke package of interventions
- Standardize documentation as per WSO indicators.

Clinical

- Mandatory implementation of national rehabilitation guidelines.
- Conduct stroke survivor support groups and secondary prevention sessions[84].
- Address comprehensive rehabilitation areas: motor, pain, speech, swallow, diet, cognition, perception, vision, emotion, fatigue, and activity.

3. Enhancing Home-Based and Community Rehabilitation

Objective:

Ensure continuity of care post-discharge.

Key Actions:

Systems

- Form mobile rehabilitation teams for in-home physiotherapy, speech, and psychological support.
- Train caregivers in rehabilitation techniques, fall prevention, assistive device use.
- Distribute rehabilitation kits (bands, splints, guides).
- Collaborate with NGOs for community rehabilitation camps.
- Empower stroke survivor self-help groups.
- Integrate yoga and alternative therapies to improve general well-being.

4. Improving Access to Rehabilitation via Insurance & Government Schemes

Objective:

Reduce financial burden on patients and families.

Key Actions:

- Expand Ayushman Bharat (PM-JAY) to cover comprehensive stroke rehabilitation[84].
- Provide subsidized assistive devices (wheelchairs, orthoses, communication aids) where needed[84].
- Offer transport support for patients/caregivers to rehabilitation centers.
- Incentivize private hospitals through PPP models to deliver affordable rehabilitation services.
- Map rehabilitation service availability vs stroke DALYs to identify region-specific needs; apply hub-spoke models for coverage.

5. Developing Stroke Rehabilitation Protocols

Objective:

Standardize rehabilitation across all healthcare facilities.

Key Actions:

- Implement National Clinical Guidelines contextually[84].
- Ensure implementation of evidence-based and measurable stroke rehabilitation delivery by rehabilitation professionals. (documentation and standardized assessments included)
- Standardize assessment tools (e.g., NIHSS, mRS, FMA, ARAT, 10MWT/6MWT, EQ-5D-5L)[86].
- Develop clinical pathways from hospital to home/community care.
- Adhere to WSO performance metrics for quality assurance[82,83].

6. Training and Capacity Building of Rehabilitation Professionals (Fig 15)

Objective:

Expand and enhance the workforce for stroke rehabilitation.

Key Actions:

- Include rehabilitation modules in MBBS, PT, OT, nursing curricula, etc.
- Launch CME programs for stroke rehabilitation.
- Create fellowship programs for specialized training.
- Train community health workers in identification, prevention, and basic rehabilitation. Such task-shifting models of stroke rehabilitation delivery should be implemented under the supervision of trained clinicians.

Fig 15: Improving stroke rehabilitation workforce

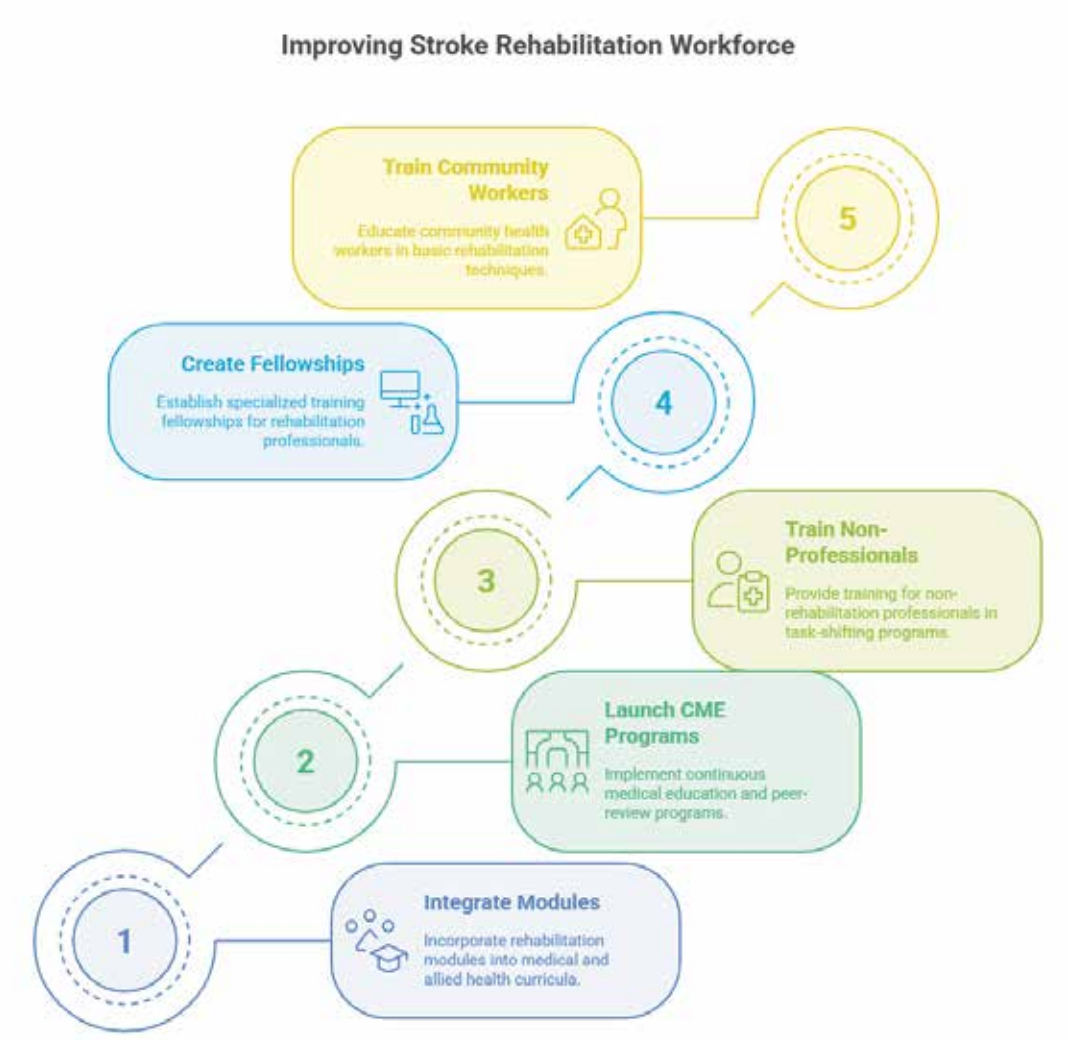


Figure 15

7. Leveraging Technology for Stroke Rehabilitation

Objective:

Use digital tools to improve access and quality.

Key Actions:

- Develop tele-rehabilitation platforms for remote therapy and follow-ups[84].
- Promote mobile apps for guided rehabilitation and self-management.[84]
- Utilize AI-based tools for personalized recovery plans.
- Introduce low-cost robotic rehabilitation devices in tertiary centers.

8. Addressing Psychological and Cognitive Rehabilitation Needs

Objective:

Promote emotional and cognitive well-being.

Key Actions:

- Train psychologists in evidence-based stroke rehab techniques.
- Provide therapy for memory, attention, perception, and problem-solving.
- Facilitate group counseling for survivors and caregivers.
- Introduce music therapy and mindfulness-based interventions.

9. Monitoring and Evaluating Stroke Rehabilitation Outcomes

Objective:

Ensure the quality, accountability, and outcome tracking of stroke rehab services.

Key Actions:

- Establish a National Stroke Rehabilitation Registry.
- Conduct regular audits and quality reviews.
- Use Patient-Reported Outcome Measures (PROMs) to track satisfaction and progress.
- Leverage big data and AI for real-world optimization of rehab protocols.

Fig 16: Achieving comprehensive and good-quality stroke rehabilitation standards with available resources

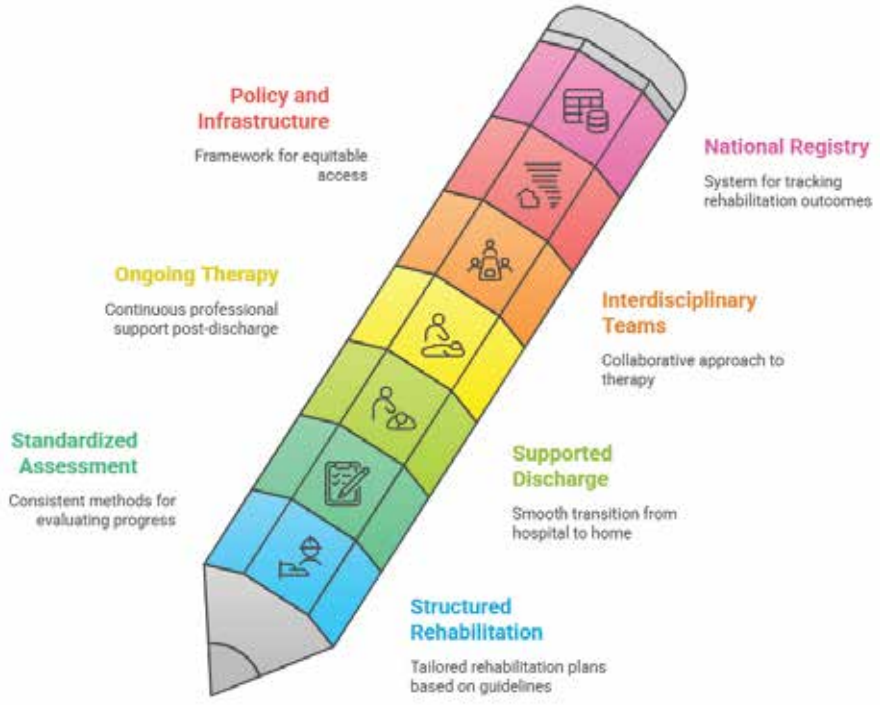


Figure 16

AYUSH in Rehabilitation after Stroke

Ayurveda offers unique rehabilitative measures for post-stroke recovery. Specific rehabilitation treatments for Pakshaghata or hemiparesis have been documented in Ayurvedic classics. The treatment involves applying medicinal oils to the body and exerting manual pressure (Abhyangam), which may assist to stimulate the circulatory system and keep inert muscles from atrophy. Besides Ayurvedic oil massages, the treatments such as Dhanyamla Dhara (pouring of medicated liquid over the affected body part), Ksheera Dhooma (medicated milk vapors applied over face and body from a safe distance, mild sudation therapy), Swedanam (fomentation), Nasyam (intranasal administration of medications), Virechanam (induced purgation), Shiro Vasti (keeping medicated oil over head in a well-shaped container), Sarvangadhara (pouring of medicated oil over the whole body in a systematic manner), Njavarakizhi (fomentation with rice and milk), and Vasti (medicated enema) are also used for recovery after stroke.[88]

RESTORE trial is the first ever randomised controlled trial of Ayurveda in stroke which evaluated the benefit of Ayurvedic Rehabilitation Therapy (ART) in stroke survivors, comparing it with physiotherapy (PT). [88]

It was an investigators-initiated, multi-center prospective, parallel arm randomized controlled trial with blinded outcome assessment across four comprehensive stroke centers in India.[88]

The trial had enrolment of 140 patients of which 70 were in the intervention (ART) and 70 in control (PT) group.[88]

The primary outcome of the RESTORE trial was the sensorimotor recovery of the upper extremity, measured using the Fugl-Meyer Assessment (FMA-UE). At 3 months, the physiotherapy (PT) group showed significantly better scores than the Ayurvedic Rehabilitation Therapy (ART) group (mean FMA-UE: 82.0 vs. 71.9; $p = 0.023$), but after adjusting for baseline differences and risk factors, this difference was no longer statistically significant ($p = 0.057$).[88]

Both groups showed improvement over time, but ART did not demonstrate superior efficacy in enhancing sensorimotor recovery.[88]

The secondary outcomes of the RESTORE trial assessed functional disability, postural balance, activities of daily living, and quality of life. [88]

While the physiotherapy (PT) group showed slightly better scores in Barthel Index (BI), Berg Balance Scale (BBS), and SF-36 physical component at 3 months, these differences were not statistically significant after adjusting for baseline variables. [88]

The RESTORE trial concluded that while Ayurvedic Rehabilitation Therapy (ART) was not superior to physiotherapy in stroke recovery, it was safe, well-tolerated, and needs more trials with different protocols of Ayurveda.[88]

Conclusion:

India's stroke rehabilitation landscape requires a unified, scalable, and inclusive model. This action plan supports a patient-centric, evidence-based, and multidisciplinary system integrating acute care, facility-based rehab, community/home services, and digital innovations. (Fig 16) Proper implementation will enhance recovery, reduce long-term disability, and ensure equity in stroke care.

VI. Research on Stroke

The Indian Stroke Clinical Trial Network (INSTRuCT) has been established as a Task Force Research Project under the aegis of the Indian Council of Medical Research. It has been created to conduct small and large clinical trials and research studies to advance acute stroke treatment, stroke prevention, and recovery and rehabilitation following a stroke. This network of several regional centers across India involves 59 hospitals and is designed to serve as the infrastructure and pipeline for exciting new potential treatments for patients with stroke and those at risk for stroke. It will also provide an educational platform for stroke physicians and clinical trial coordinators.

Objectives of INSTRuCT:

- To create a network for carrying out clinical trials for Stroke in India
- To conduct simple pharmacological and non-pharmacological stroke clinical trials in India

The goals identified for the next five years by INSTRuCT are:

- To develop a world-class health infrastructure for carrying out stroke trials in India
- To develop a portfolio of stroke trials in the areas of prevention, acute care, rehabilitation, and chronic care
- Work with professional, industry, academic and funding bodies (within and outside the country) to enhance and increase stroke clinical trials in India

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