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Editorial

STROKE BURDEN IN BANGLADESH AND IMAGING PRACTICES: A COMPREHENSIVE REVIEW

Hussain ME[1], Rashid MH[2],Mamun AA[3], Jobair AA[4], Islam MS[5]

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Abstract:

Stroke is a leading cause of disability and death worldwide, with a particularly high burden in low- and middle-income countries like Bangladesh. Factors contributing to the increasing prevalence of stroke in Bangladesh include hypertension, diabetes, smoking, and limited access to timely healthcare. Despite the effectiveness of the FAST (Face, Arms, Speech, Time) approach for early clinical recognition, delays in treatment persist, often leading to higher mortality and disability rates. This review explores the stroke burden in Bangladesh, highlighting key diagnostic and treatment challenges. It offers evidence-based imaging recommendations, adapted to local healthcare realities, and emphasizes the importance of timely interventions, including the use of the FAST approach and adherence to key performance indicators (KPIs). Strengthening public awareness, improving healthcare infrastructure, and expanding access to stroke imaging are key strategies to improve stroke outcomes in Bangladesh.

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Introduction:

Stroke is a leading public health concern in Bangladesh, significantly contributing to disability-adjusted life years (DALYs). Despite global advancements in stroke care, Bangladesh faces persistent challenges in managing stroke due to insufficient healthcare infrastructure, economic barriers, and low public awareness of stroke symptoms and emergency response. Additionally, the burden of stroke in Bangladesh is compounded by the country's high prevalence of risk factors, such as hypertension, diabetes, and smoking, which remain largely unmanaged in the general population. Rural-urban disparities in healthcare access and delayed diagnosis further exacerbate the issue. This review provides an in-depth analysis of stroke incidence, risk factors, and current imaging techniques used in Bangladesh, while offering actionable recommendations to improve diagnosis, early detection, and treatment outcomes. A focus on enhancing public awareness, increasing imaging access, and implementing international stroke care guidelines, including key performance indicators (KPIs), is essential for improving stroke outcomes in Bangladesh.

Methodology:

This systematic review was conducted by reviewing literature on stroke in Bangladesh using databases such as PubMed and Google Scholar. A total of **14 studies** published between 2019 and 2023 were included. The selection focused on studies addressing stroke incidence, risk factors, stroke imaging practices, clinical outcomes, and public awareness specific to Bangladesh. Studies were selected based on the following criteria: studies presenting primary data on stroke in Bangladesh, published in English, and peer-reviewed. Excluded studies were those that

1. Prof. Dr. M Emarat Hussain, Professor, Department of Radiology and Imaging, East West Medical College and Hospital.
2. Dr. Md. Humayun Rashid, Associate Professor, Department of Neurosurgery, East-West Medical College, Dhaka.
3. Dr. Kazi Abdullah Al Mamun, Professor & Head, Department of Neuromedicine, East West Medical College, Uttara, Dhaka.
4. Brig. Gen (Retd) Dr. Md. Abdullah Al Jobair, Director- Hospital, East West Medical College and Hospital.
5. Dr. Md. Shafiqul Alam, Associate Professor, Department of Radiology and Imaging, East West Medical College, Dhaka, Bangladesh.

Address of Correspondence: Prof. Dr. M Emarat Hussain, Professor, Department of Radiology and Imaging, East West Medical College and Hospital; Phone: +8801713179133; Email: drmehussain@gmail.com;

did not focus on stroke, were not conducted in Bangladesh, or lacked sufficient data related to stroke care in the country. This review followed the **PRISMA 2020 guidelines** for systematic reviews. Data were extracted from these studies and analyzed to provide a comprehensive overview of the current state of stroke care in Bangladesh, as well as the challenges and opportunities for improving diagnosis, treatment, and prevention.

Results:

Research consistently underscores the growing burden of stroke in Bangladesh. Rahman et al. (2020) estimated the prevalence at 1.6%, with ischemic stroke accounting for 80% of cases.[1] Alam et al. (2019) found that hypertension (65%) and diabetes (30%) are common risk factors for stroke in the country.[2] The World Health Organization (WHO) reports that stroke contributes to around 6% of all deaths annually in Bangladesh.[3] Additionally, Khan et al. (2022) observed a rise in stroke-related hospital admissions, particularly in individuals aged 50 and above.[4]

Despite the rising number of stroke cases, significant delays in seeking treatment persist, especially in rural areas. Siddique et al. (2021) reported a 25% longer delay in accessing imaging services in rural areas compared to urban centers, contributing to delayed diagnoses and treatment.[5] Moreover, Hasan et al. (2020) found that nearly 60% of stroke patients fail to receive thrombolytic therapy due to delays in reaching hospitals and obtaining imaging.[6]

Several risk factors contribute to the increasing stroke burden, including hypertension, smoking, and physical inactivity, as noted by Chowdhury et al. (2022).[7] Public awareness of stroke symptoms remains low, particularly in rural areas. Khan et al. (2020) noted that while the FAST (Face, Arms, Speech, Time) approach is effective, public knowledge of stroke warning signs is limited, contributing to delayed care.[8]

Stroke diagnosis and management are further hindered by limited access to imaging, especially in rural areas. Sultana et al. (2020) found that urban hospitals have better access to advanced imaging like CT and MRI, while rural hospitals face significant barriers.[9] Jahan et al. (2019) highlighted the lack of specialized stroke care in resource-limited settings, which further exacerbates treatment delays.[10]

Technological advances, including AI-assisted stroke diagnosis, have shown promise. Patel et al. (2021) demonstrated that AI could help in interpreting imaging results more rapidly, which could be transformative in low-resource settings.[11] However, access to such technologies remains limited in Bangladesh.

Stroke prevention through public education has also been identified as crucial. Shaheen et al. (2022) conducted an educational intervention in rural Bangladesh, finding that improving stroke awareness can lead to faster hospital visits and better treatment outcomes.[12]

In summary, while stroke remains a significant public health issue in Bangladesh, barriers such as limited healthcare access, diagnostic delays, and low public awareness continue to impact outcomes. Advances in imaging and technology, along with increased stroke education, are essential to addressing these challenges.

Discussion:

Stroke is a leading cause of death and disability in Bangladesh, with a significant impact on public health. According to the World Health Organization, stroke is responsible for approximately 6% of all deaths annually in Bangladesh, contributing to an increasing burden on the healthcare system.[3] Recent studies highlight the rise in stroke-related hospital admissions, with a growing proportion of patients being diagnosed with ischemic stroke.[1] As the burden of stroke continues to escalate, it is crucial to explore strategies to improve early recognition, treatment, and public awareness.

Epidemiology and Risk Factors:

Several studies emphasize the high prevalence of stroke in Bangladesh. A study by Rahman et al. (2020) reported a stroke prevalence of 1.6% in the Bangladeshi population, with ischemic strokes comprising around 80% of these cases.[1] Hypertension, diabetes, smoking, and physical inactivity are identified as the primary risk factors for stroke in Bangladesh, similar to other parts of South Asia.[2] Alam et al. (2019) observed that 65% of stroke patients had hypertension and 30% had diabetes, highlighting the need for early prevention and better management of these risk factors.[2] These findings suggest that addressing modifiable risk factors could significantly reduce stroke incidence and improve long-term outcomes.

Stroke Assessment and Public Awareness:

The **FAST** approach (Face, Arms, Speech, Time) is a key tool for the early recognition of stroke and can

help reduce pre-hospital delays, which are critical in improving stroke outcomes. Early identification of stroke symptoms is essential, as delayed treatment can lead to irreversible brain damage. Research by Siddique et al. (2021) showed that rural areas in Bangladesh experience up to a 25% delay in accessing diagnostic imaging, which compounds the difficulties in stroke management and treatment.[5] The **FAST** acronym helps non-medical personnel quickly identify stroke symptoms and seek timely medical attention, which is crucial in the context of Bangladesh's healthcare challenges.

1. **Early Recognition and Faster Treatment:**

   The FAST approach enables individuals, caregivers, and even bystanders to promptly recognize stroke symptoms, leading to faster hospital arrivals. As stroke treatment is highly time-sensitive, every minute of delay can result in the loss of nearly 1.9 million neurons.[5] Early recognition, as emphasized by the **FAST** approach, improves the chances of receiving appropriate treatment, particularly thrombolytic therapy or mechanical thrombectomy, both of which have strict time-based treatment windows.[6]

2. **Reducing Treatment Delays and Improving Key Performance Indicators (KPIs):**

   The **FAST** approach plays an essential role in aligning stroke management with key performance indicators (KPIs) in healthcare. KPIs such as Door-to-Needle Time (DTN) and Door-to-Groin Puncture Time (DTP) are critical in improving outcomes for acute ischemic stroke patients. The goal for DTN is ≤60 minutes, with best practices aiming for ≤45 minutes, and for DTP ≤90 minutes, with optimal practice being ≤75 minutes.[7] As stroke awareness increases through public campaigns utilizing **FAST**, more patients will likely arrive at hospitals in time for appropriate treatments within these critical time frames.

3. **Enhancing Public Awareness and Addressing Rural-Urban Disparities:**

   A significant challenge in Bangladesh is the disparity in stroke care between urban and rural areas. Rural populations often face delays due to limited healthcare access, lower awareness levels, and fewer specialized medical services. Khan et al. (2020) reported that public awareness about stroke symptoms and the FAST approach remains low, particularly in rural areas.[8] Integrating the FAST approach into public health campaigns could significantly improve early recognition and reduce treatment delays in rural communities, potentially improving survival rates and recovery outcomes.

4. **Recent Advancements and Technological Integration:**

   Recent advancements in stroke care, such as artificial intelligence (AI) in stroke imaging and diagnosis, have shown promise in reducing treatment delays and improving accuracy. Patel et al. (2021) demonstrated that AI algorithms can assist healthcare professionals in interpreting CT and MRI images more efficiently, helping streamline stroke diagnosis in low-resource settings like Bangladesh.[11] However, access to such technologies remains almost unavailable in Bangladesh.

5. **Streamlining Pre-Hospital and Emergency Response:**

   The pre-hospital phase of stroke management is crucial in ensuring timely interventions. Emergency responders trained in the FAST approach can prioritize stroke cases, expediting transport to appropriate hospitals and allowing stroke teams to prepare for rapid imaging and interventions. In a resource-limited setting like Bangladesh, training first responders and increasing public knowledge about stroke symptoms can significantly reduce the time to treatment, improving patient outcomes.

Stroke Prevention and Public Education

Prevention plays a crucial role in reducing the stroke burden in Bangladesh. Public education campaigns that focus on controlling risk factors such as hypertension, diabetes, and smoking, alongside promoting physical activity, could lead to a substantial reduction in stroke incidence. Studies have shown that comprehensive public awareness interventions, like those implemented by Shaheen et al. (2022), can increase community knowledge and lead to more timely medical attention, reducing delays in care.[12]

Continued efforts to raise awareness about stroke risk factors and symptoms, particularly in rural areas, are essential to addressing the growing stroke burden in Bangladesh.

Stroke Imaging in Bangladesh:

Stroke is a medical emergency that requires timely diagnosis and appropriate intervention. Imaging plays a vital role in guiding stroke management, as it helps determine the type of stroke, assess brain damage, and guide treatment strategies such as thrombolysis and mechanical thrombectomy. In Bangladesh, stroke imaging practices, while advanced in urban hospitals, face several barriers in rural and secondary healthcare centers. These barriers impede the timely diagnosis and treatment of stroke patients, especially in the early and acute phases.

Challenges in Stroke Imaging in Bangladesh

Despite the critical role of imaging in stroke diagnosis and treatment, Bangladesh faces multiple challenges in accessing and utilizing advanced stroke imaging techniques, particularly in rural areas:

- **Limited Access to Advanced Imaging**: MRI and advanced imaging techniques such as CT Perfusion (CTP) are not available in many regions, leading to delays in accurate stroke diagnosis. According to Siddique et al. (2021), rural areas face significant barriers in accessing MRI facilities, which are often concentrated in urban centers.[5] This results in prolonged diagnostic delays, affecting patient outcomes.
- **Cost Constraints**: Advanced imaging procedures like MRI and CTP are expensive, and many patients in Bangladesh are unable to afford these services. A study by Khan et al. (2020) emphasized that out-of-pocket expenses for imaging are a significant barrier, especially for patients in low-income rural communities.[8] Although the cost of imaging in Bangladesh is relatively low compare to the others Asian countries.
- **Shortage of Trained Personnel**: Bangladesh suffers from a shortage of trained radiologists and stroke specialists. These professionals are primarily located in urban areas, which leads to delays in the interpretation of images and subsequent treatment decisions, as noted by Jahan et al. (2019).[10]
- **Lack of Public Awareness**: Many stroke patients arrive at hospitals too late, reducing the efficacy of thrombolytic and reperfusion therapies. A study by Shaheen et al. (2022) found that public awareness of stroke symptoms and the importance of early treatment is low in rural areas, leading to delays in seeking medical care.[12]

Imaging Protocol Based on Stroke Time Window

The management of stroke is highly time-sensitive, and imaging is essential for confirming the diagnosis and determining the most appropriate treatment options. Stroke imaging protocols are often divided into phases: the hyperacute, acute, subacute, and chronic phases, each of which requires different imaging techniques.

Hyperacute Phase (0-24 hours)

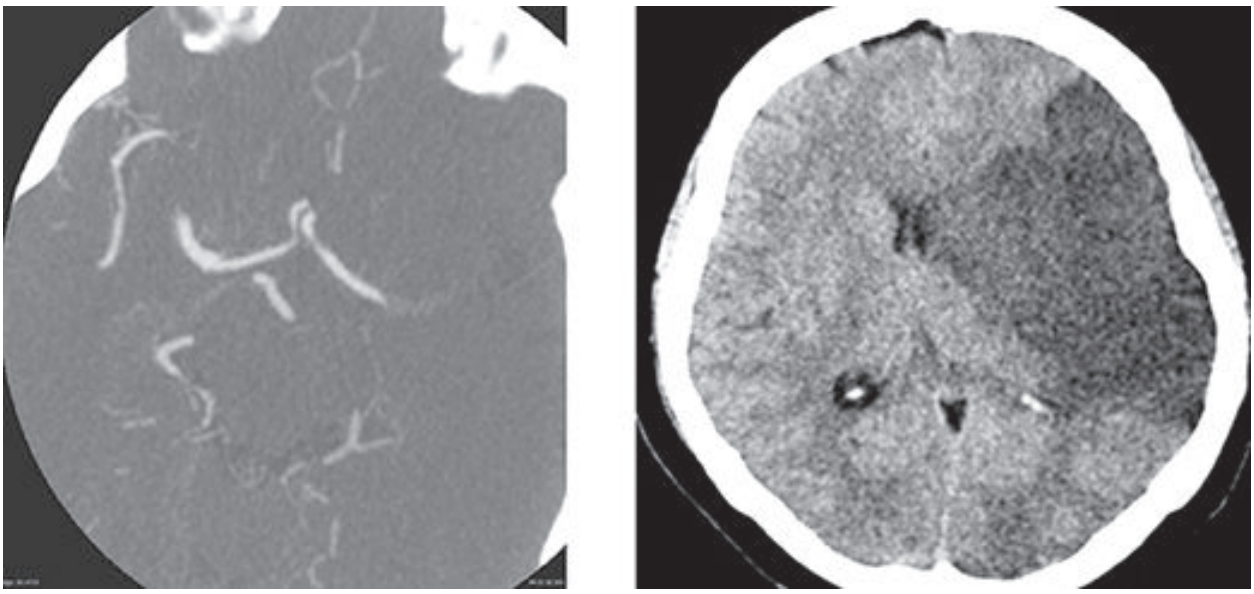
In the first 24 hours after symptom onset, timely imaging is essential for early diagnosis, identifying large vessel occlusions (LVOs), and determining tissue viability for reperfusion therapies such as thrombolysis and thrombectomy. Key imaging techniques used in this phase include:

- **Non-contrast CT**: This is the rapid initial imaging technique for detecting hemorrhagic strokes and early ischemic changes.
- **CT Angiography (CTA)**: This helps visualize large vessel occlusions, especially in major arteries like circle of Willis arteries (COW) and Carotid arteries.
- **CT Perfusion (CTP)**: This technique assesses blood flow to the brain and helps identify ischemic penumbra (the area of brain tissue at risk but still viable for reperfusion).
- **MRI (DWI)**: Diffusion-weighted imaging is the most sensitive technique for detecting acute ischemia within minutes of symptom onset.

In Bangladesh, access to MRI and advanced imaging such as CTP is limited outside major cities, resulting in delayed diagnoses and treatment decisions.[5]

Acute Phase (24 hours to 1 week)

In the acute phase, imaging helps evaluate the extent of tissue damage, monitor reperfusion, and guide decisions on whether to proceed with thrombolysis or thrombectomy. Key imaging techniques during this phase include:



A B

Figure 1: *CT angiogram (A) showing occlusion of the left middle cerebral artery (MCA) and subsequently, there is left MCA territory acute infarction (B) with development of cytotoxic edema causing rightwards midline shift.*

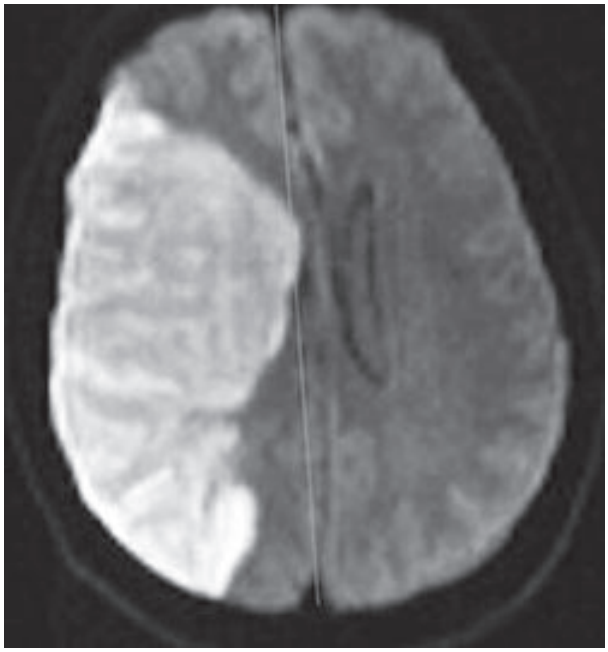


Figure 2: *A diffusion-weighted MR I scan showing an area of restricted diffusion in the right MCA territory, indicative of acute ischemia. DWI is the most sensitive technique for detecting acute infarct within minutes of symptom onset. However, DWI can't differentiate the tissue viability effectively.*

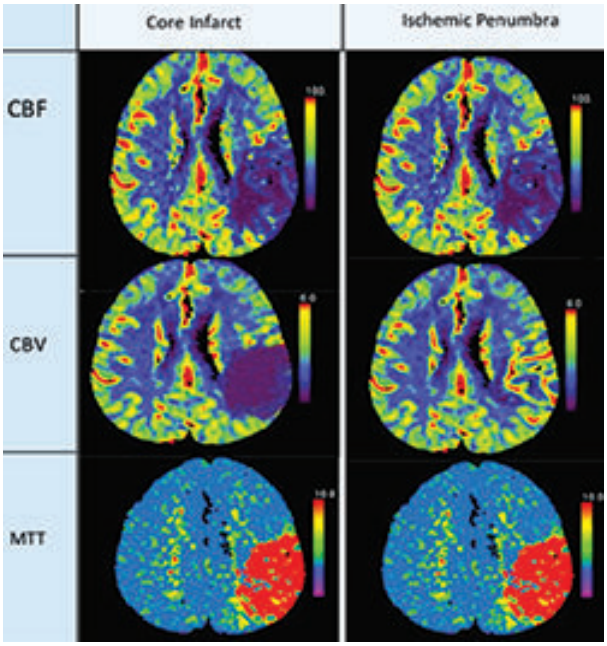


Figure 3: *A CT perfusion scan showing areas of Core infarct in the left column (there is neuronal death of the affected tissue) which suggesting that thrombectomy will not be benefited for the treatment, and on the other side, area of mismatched perfusion defect in the right column indicates ischemic penumbra (the area of brain tissue at risk but still viable for reperfusion) which confirms the indication of Interventions such as thrombectomy.*

- **Non-contrast CT**: Useful for detecting hemorrhages and ischemic lesions.
- **CT Angiography (CTA)**: Employed for follow-up after the initial treatment to assess the restoration of blood flow.
- **CT Perfusion (CTP)**: Continues to assess ischemic penumbra and infarct core, particularly for patients outside the 3-hour thrombolysis window but within the 6–24 hours thrombectomy window.
- **MRI (T1, T2, FLAIR, SWI, DWI, PWI, MRA)**: MRI techniques help identify restricted diffusion areas and areas of ischemic penumbra, guiding treatment decisions.

Due to resource constraints in peripheral hospitals, many patients in Bangladesh are unable to undergo timely follow-up imaging, impacting treatment decisions and outcomes.[13-14]

Subacute Phase (1 week to 3 weeks)

In the subacute phase, imaging is crucial for tracking tissue recovery, monitoring edema, and detecting complications such as hemorrhagic transformation. Imaging techniques during this phase include:

- **MRI (T1, T2, FLAIR, DWI, SWI)**: Tracks edema, tissue evolution, and infarction progression or hemorrhagic transformation.
- Non-contrast CT, **CT Angiography (CTA)**: Follow-up imaging to detect hemorrhagic transformation, recurrent occlusions or complications from arterial dissection.
- **CT Perfusion (CTP)**: Assesses the success of reperfusion and monitors for any secondary damage.

Due to the mobility challenges of patients and financial constraints, follow-up imaging in the subacute phase is often delayed, leading to suboptimal monitoring of stroke recovery in rural regions.[4]

Chronic Phase (3 weeks and beyond)

In the chronic phase, imaging helps evaluate long-term recovery, brain atrophy, and the development of neuroplasticity. The key imaging techniques include:

- **MRI (T1, T2, FLAIR, DWI)**: These are used to monitor brain atrophy and scarring in infarcted regions.
- Non-contrast CT**, CT Perfusion (CTP)**: Although rarely used in the chronic phase, it may still help assess residual ischemic areas or collateral circulation.

In Bangladesh, the economic burden of healthcare is a major challenge, and many patients in the chronic phase cannot afford imaging, limiting long-term monitoring of stroke recovery and rehabilitation.

Summary Table: Stroke Imaging

Phase of Stroke	Key Imaging Techniques	Purpose/Benefits	Challenges in Bangladesh
Hyperacute (0-24 hours)	Non-contrast CT, CT Angiography (CTA), CT Perfusion (CTP), MRI (DWI)	- Rapid diagnosis of stroke type (ischemic vs hemorrhagic) and large vessel occlusions. - Assessment of tissue viability for reperfusion therapies.	- Limited access to MRI, especially in rural areas. - Delays in receiving imaging.
Acute (24 hours to 1 week)	Non-contrast CT, CTA, CTP, MRI (**T1, T2, FLAIR, SWI, DWI, PWI, MRA**)	- Monitor ischemic damage. - Guide decisions on thrombolysis and thrombectomy. - Follow-up on vessel occlusions and reperfusion.	- Limited advanced imaging facilities in peripheral hospitals.
Subacute (1 week to 3 weeks)	Non-contrast CT, CTA, CTP, MRI **(T1, T2, FLAIR, DWI, SWI)**	- Monitor for secondary complications (hemorrhagic transformation, edema). - Track tissue recovery and assess reperfusion.	- Difficulty in timely follow-up imaging due to patient mobility and financial constraints.
Chronic (3 weeks and beyond)	Non-contrast CT, CT Perfusion, MRI (T1, T2, FLAIR, DWI)	- Assess long-term brain changes (atrophy, scar tissue). - Evaluate recovery and neuroplasticity.	- Limited accessibility to chronic-phase imaging due to economic constraints.

Conclusion:

Stroke remains a critical healthcare issue in Bangladesh. Despite the utility of the FAST approach for early detection, delayed medical intervention continues to result in significant mortality and disability. Rapid imaging is crucial for effective treatment, as each minute of delay can lead to irreversible neuronal death. To overcome the stroke burden, we recommend the following:

1. Public Education: Launch nationwide campaigns to raise awareness of stroke symptoms and the FAST approach, particularly in rural areas.
2. Improved Healthcare Infrastructure: Increase access to imaging services in rural and underserved areas through government and private initiatives.
3. Training and Capacity Building: Invest in training programs for radiologists and stroke specialists to improve early diagnosis and treatment.
4. Timely Intervention: Ensure adherence to KPIs, such as door-to-needle and door-to-groin puncture times, for timely thrombolysis and thrombectomy.

By improving public awareness, healthcare infrastructure, and adherence to stroke KPIs, Bangladesh can reduce the stroke burden and significantly enhance patient outcomes.

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