**Annals of Clinical and Analytical Medicine**
*Review*

# Management and evolutionary profile of ischemic stroke in Morocco: a narrative review



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## Abstract

Advances in ischemic stroke diagnosis and treatment are pivotal in reducing its impact worldwide. This study examines ischemic stroke patient management and outcomes in Morocco. A narrative review analyzed ischemic stroke management and outcomes in Moroccan hospitals. From 28 studies, patients typically arrived at imaging departments 26 to 61 hours after symptom onset. Treatment focused on cardiovascular risk factors: Antihypertensives (43% to 67.8%), platelet aggregation inhibitors (16% to 57%), statins (10% to 12%), antidiabetics (13.2% to 47.9%), and thrombolysis (1.94% to 14.7%). Carotid stenosis and hemicraniectomy were less common. National Institutes of Health Stroke Scale scores (NIHSS) improved post-thrombolysis from 10.4-14.8 initially to 9.56 within 24 hours. Modified Rankin scores varied widely, from full recovery (29.65%) to recurrence (14.75%). Acute phase mortality ranged from 1.1% to 16.4%, with 3-month mortality from 4.3% to 32.5%. Improving stroke care in Morocco entails reducing pre-hospital thrombolysis delays and expanding neurovascular units nationwide.

**Keywords**

ischemic stroke, management, evolutionary profile, morocco

**DOI: 10.4328/ACAM.22340** Ann Clin Anal Med 2026;17(8):874-879
Received: 25/07/2024 Accepted: 03/10/2024 Published Online: 20/12/2024 Printed: 01/08/2026
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## Introduction

Stroke is the leading cause of disability, the second leading cause of death, and the third leading cause of dementia worldwide.[1-2] It represents a major public health issue, with a socio-economic cost accounting for 2 to 4% of total healthcare expenditure in industrialized countries and globally. Importantly, stroke is the primary cause of disability, leading to significant physical and intellectual functional impairments.[3]

From 2030, epidemiological projections predict that stroke will be the leading cause of death (14.4% of all deaths) and the third leading cause of disability (6%) in middle-income countries, and the third leading cause of death (8.2% of all deaths) and the eighth leading cause (2.8%) of disability in low-income countries.[4]

Despite limited access to timely, evidence-based acute stroke treatments, the creation of neurovascular emergency centers in the United States (Stroke Centers), and later in France and other Western countries, has had a positive impact on the management of these patients.[5] Early detection and treatment of risk factors have contributed to the steady global decline in ischemic stroke incidence.

In Morocco, the prevalence of cerebrovascular accidents is estimated at 284/100,000 inhabitants and the incidence at 106/100,000 inhabitants. The number of strokes will reach 50,000 new cases per year in 2030, with a predilection for the elderly, i.e., 12 to 20 per 1,000 per year in subjects aged 75 to 84, and more than half of strokes occur in adults aged 75 or over.[6]

This narrative review aimed to evaluate and synthesize the available evidence on the management and clinical outcomes of ischemic stroke in Morocco.

### *Characteristics of the Included Studies*

This narrative review included twenty-eight (n = 28) studies: twenty (n = 20) original articles and eight (n = 08) medical theses. The studies were conducted in Rabat (n = 04), Casablanca (n = 08), a mix of Casablanca and Rabat (n = 01), Marrakech (n = 06), Fez (n = 08), and Meknes (n = 01).

### *Ethical Approval*

Ethical approval was not required.

### *Statistical Analysis*

As this was a narrative review, no original statistical analysis was performed.

### *Reporting Guidelines*

This narrative review was prepared to summarize the available evidence; no formal systematic review protocol was registered.

### *Sex Ratio and Mean Age of Ischemic Stroke Patients in Morocco by Study*

The studies (n = 25) show a male predominance in the sex ratio (1.23 to 3.45), with only three studies reporting a ratio of 1.[7] A slight female predominance, with a ratio of 0.7-0.9, was reported in eight studies.[8-9-10-11-12-13] Two studies did not specify the mean age of patients. Chraa et al. found the age to be under 45 in 36% of cases and over 45 in 64%,[14] while Bourazza et al. reported a mean age of 64 (Supplementary Table 1).[15]

### *Stroke Management in Morocco: Admission Timing and Diagnostic Imaging*

The time taken to admit patients, from symptom onset to arrival at the various hospital structures studied, was reported in 5 studies (n = 5).[10,16-17-18] The average delay ranged from 26 hours (Azdad et al.[10]) to a maximum of 61.95 hours (Younmadji et al.).[17] Furthermore, the study by Allaoui showed that the average delay between symptom onset and the first cerebral imaging was 12 hours across all cases.[11] In young subjects, the consultation time has been quantified in two studies.[7,19] Mbagui and Ibouajbane et al. reported consultation times of 134.4 hours and 342 hours, respectively.[12,19]

### *Therapeutic management*

### *Prophylactic Treatment of Stroke*

According to Hadi et al. (2018),[18] therapeutic management of ischemic stroke has been based on symptomatic treatment with antiplatelet agents, statins, control of cardiovascular risk factors, and motor and speech rehabilitation; and finally, interventional or surgical etiological treatment, depending on the cause, may be indicated.

Antiplatelet agents were reported in five studies. Their use was 35.7% in the study by Abjaw et al.,9 53.3% in the study by Azdad et al.,[10] 16% in the study by Bendriss et al., 28.4% in the study by Chraa et al.,[7] and 57% in the study by Younmadji et al.[17] Similarly, statin therapy was reported in three studies: 61.4% in the study by Azdad et al.,[10] 7.8% in the study by Chraa et al.,[7] and 55% in the study by Younmadji et al.[17] Statin use ranged from 7.8% to 61.4% across these studies.

Anticoagulant therapy was reported in 14.9% of cases in the study by Azdad et al.,[10] 60% in the study by Allaoui et al., and 18% in the study by Younmadji et al.[17] The use of anti-inflammatory drugs was not consistently reported across the included studies. They were reported in the studies by Allaoui et al. (76%), Rachdi et al. (63%), and Chraa et al. (61%), whereas their use was not specified in the study by Chatou et al.[20]

### *Etiological Treatment of Stroke*

### *Thrombolysis*

All the studies (n = 4) that mentioned this therapeutic procedure were conducted in the neurology department of the Hassan II University Hospital in Fez. The proportion of patients treated with thrombolysis ranged from 1.8% in Azdad et al.[10] to 2.9% in Rachdi et al.[10] In addition, two studies by Younmadji et al. and Daouda et al. revealed two mean proportions of thrombolysed patients of 1.94% and 2.8%, respectively.[17,21] All of these studies mention that thrombolysis treatment is still limited due to the lack of neurovascular units and the length of time it takes for patients to be treated in the hospital (more than four and a half hours).

### *Surgical Management*

Surgical treatment of the causes by hemicraniectomy was mentioned in only one study, Azdad et al.,[10] a study carried out at the Hassan II University Hospital in Fez on 12 patients eligible for interventional surgery on the carotid arteries and 3 others for hemicraniectomy (Table 2).

### *Evolutionary profile of patients with ischemic stroke according to the studies included (Post-stroke phase)*

The outcome profile of ischemic stroke patients was analyzed in twenty studies (n = 20). Findings reveal that 54.5% of patients remained stationary, as reported by Azdad et al.[10] and Younmadji et al.[17] Chraa et al. reported complete recovery without complications in 38.2% of patients, while 50% had partial recovery with persistent sequelae, including 29.6% with residual motor deficits, 5% with epilepsy, and 2% with vascular dementia.

Neurological outcomes showed that 22.5% of patients improved, as reported by Rachdi et al.[23] Independence rates at 3 months were 3% overall, 6% among those over 50, 35% among women, and 48.6% among men.[16] Recurrent neurological complications affected 9% of patients, and 3% experienced epileptic seizures.[14] Ibouajbane et al. reported that 10% of patients had recurrences and 2.5% had seizures during the acute phase.[12] Psychologically, 47% of patients experienced depression, and 31% had anxiety, according to Chouhani et al.[24] noting depression in 16% and anxiety in 14%.[25] Additionally, infectious complications were reported in 38.09% of cases, including urinary tract infections (24%) and pulmonary infections.[8-9-10]

Among totally dependent stroke cases, 4.5% had irreversible complications,[7] while 40% experienced incomplete recovery with sequelae in the study by Allaoui et al.[11] After thrombolysis, 48% showed significant improvement within 24 hours, and 40.3% had favorable results at 3 months.[26]

Mortality rates post-stroke ranged from 3% to 16%, especially among the elderly, with 10.8% and 3% dying during the disease course (Azdad et al., 2012).[10] and Younmadji et al.[17]

In Morocco, the modified Rankin Score (mRS*) studies showed that 38.2% to 52.1% of patients had no symptoms, 9% to 77% had no disability apart from symptoms, 6% to 50% had mild disability, 29.6% to 61% had moderate disability, and 4.3% to 10.8% resulted in death. Moderately severe and major disabilities were not clearly addressed.

*Evolutionary profile according to NIHSS score of stroke patients after thrombolysis:*

Four studies (n = 4) in this review reported the outcome profile of patients with ischemic stroke after intravenous thrombolysis.[7,13,17] According to the NIHSS score at admission and discharge, a clear improvement was observed in all these studies, with a 6.5-point reduction ($P$ = .5) after 24 hours.[7] and a 77% reduction, or more than 4 points.[13] According to Rhissassi et al.,[27] the NIHSS score at discharge was higher than at admission in 34.2% of cases and unchanged in 60.6% of cases (Table 3).

*Post-stroke Mortality (Acute and Chronic)*

Mortality rates in the acute phase were reported by six studies, ranging from 3% in Younmadji et al. (27) to 13% in Chraa. Four studies by Rhissassi et al., Azdad et al., Sarya et al., and Chtaou et al. reported values of 5.8%, 9.9%, 10%, and 10.8%, respectively.[10,26-27-28] Post-ischemic stroke mortality in the young population was reported in (n = 3) studies. It is 0% according to Ibouajbane.[12] 1.1% according to Mbagui.[19] and 16.4% according to Chraa et al.[7]

Chronic phase mortality (mortality after three months of ischemic stroke):

Mortality after 3 months of the onset of ischemic stroke disease has been reported by four studies. Daouda et al (2018), Younmadji et al., Chatou et al., and Rachdi et al. reported mortality rates of 4.3%, 21.7%, 29%, and 32.5%, respectively, in ischemic stroke treated with thrombolysis.[17,20-21,29] Similarly, three studies by Bendriss et al., Rachdi et al and Hadi et al. reported mortality rates after 3 months of 5.4%, 10%, and 8%, respectively.[16,18,22] Beyond 3 months, no study has reported on this parameter.

*Stroke Management and Health Education*

Four studies (n = 04) highlighted the importance of health education in the management of ischemic stroke. Daouda et al. 2018 mentioned that education has a positive impact on the organization of pre-hospital medical management of patients who have had an ischemic stroke.[21] As for the study by Chraa et al.,[7] stroke management should be improved through population education. In fact, the study by Bendriss et al.[22] emphasizes that effective management of ischemic stroke should be based on strengthening and on educating healthcare professionals and the general public about stroke symptoms. According to Rachdi et al,.[16] public education must be integrated into the care pathway to reduce admission times and increase the number of patients likely to benefit from thrombolysis.

In Morocco, the management of ischemic strokes primarily focuses on etiological treatment and associated risk factors. Ischemic strokes account for 80% to 83% of cases, consistent with global data.[7,29-30] The average patient age is 62 ± 5 years, and over 80% of strokes occur in individuals aged 65 and older.[31] Studies by Mbagui et al.,[9] Chraa et al.,[14] and Chraa et al.[7] show that ischemic strokes are less frequent in patients under 45 but significant in those over 60. Regarding gender, there is a male predominance, consistent with literature reviews from the Arab world and the Eastern Mediterranean, where men account for 55.9% to 75% of cases, with a sex ratio of 3.55.[7,32]

*Time to Admission and Diagnostic Management Using Medical Imaging*

*Pre-hospital Management and Time to Admission*

Pre-hospital management of stroke in the acute phase is crucial for identifying and referring patients to appropriate centers with the necessary medical and technical resources.[33] In Morocco, although there have been significant advancements in diagnostic imaging, access to these resources remains inequitable, especially for thrombolysis. The use of diagnostic imaging for stroke, which is crucial for confirming cerebral ischemia, especially in the initial hours, relies on the availability and accessibility of these tools.[26,28]

*Variability in Imaging Access Times*

Studies indicate variability in the time required to utilize different diagnostic imaging methods, influenced by the study and context. On average, the time to imaging admission is 44 hours, according to multiple studies.[9-10,12-13,18,21-22,25,28] This aligns with findings from a recent study showing pre-hospital periods ranging from 26 to 61.9 hours.[34]

*Therapeutic Management*

The public health impact of accidents has prompted numerous studies on therapeutic management.[35] These studies often focus on medical or surgical aspects, with a common emphasis on the etiological and symptomatic treatment of ischemic stroke.[33] Effective secondary prevention strategies are also crucial in reducing stroke recurrence.[36]

Study sites vary in levels and skills, with most studies (n = 21) focusing on university hospital centers (UHC). Early management in a neurovascular unit significantly reduces mortality and functional impairment in patients with ischemic stroke.[37] In Morocco, neurovascular units are mainly found in UHCs and some private clinics in major cities (Rabat, Casablanca, Marrakech, Fez). The shortage of specialized resources complicates the management of ischemic stroke and its complications.[10,18,34,38]

Data on the availability and benefits of neurovascular units in Africa are scarce, with few studies examining their role in stroke management.[39] A recent study highlighted the lack of stroke management units and the high economic cost of access to brain imaging and thrombolysis as significant barriers to improving stroke care in Africa.[40]

*Intravenous Thrombolysis*

Intravenous thrombolysis is recommended in global guidelines for the management of ischemic stroke and has significantly reduced disability related to these events.[41-42] Administered within a narrow therapeutic window, tissue plasminogen activator (alteplase) has proven effective for acute ischemic cerebrovascular accidents.[43]

In Morocco, the first studies on thrombolysis were conducted at the Fez University Hospital, with treatment rates ranging from 1.8% to 2.9%. However, the percentage of treated patients remains insufficient, primarily due to long pre-hospital delays and other contraindications.[10,16,21,26,44] According to Daouda et al., 11% of cerebral infarctions did not benefit from thrombolysis because they were admitted beyond 4.5 hours.[21] Other studies indicate that only 1% to 8% of admitted patients receive reperfusion treatment, with just 3% undergoing thrombolysis according to a recent meta-analysis.[45-46] Reducing in-hospital delays could increase the proportion of treated patients and improve stroke prognosis in Morocco. In Africa, intravenous thrombolysis remains rare, mainly due to cost.[39,47,40,48-49]

### *Surgical Management*

In Morocco, surgical management of ischemic stroke, including carotid stenosis treatment and correction of vascular risk factors, ranks second due to technical requirements. A single study by Azdad in 2012 addressed carotid stenosis treatment and the use of hemicraniectomy.[10] The literature suggests a reduction in mortality following decompressive hemicraniectomy, with several randomized studies, such as the DECIMAL study in France, evaluating its value in malignant Sylvian infarcts.[50] However, the French EVA3S study (endarterectomy versus angioplasty in patients with symptomatic tight carotid stenosis) was prematurely halted due to increased complications, including stroke or death, following angioplasty (9.6% vs. 3.9% in the surgery group). The overall complication rates (stroke, death) were 6.84% for angioplasty compared to 6.34% for surgery, failing to demonstrate the "non-inferiority" of carotid angioplasty.[51-52]

### *Etiological Treatment of Risk Factors Associated With Ischemic Stroke*

The control of blood pressure and diabetes is a major requirement in therapeutic protocols for managing ischemic stroke, as confirmed by 11 studies.[9-10,13,17,20,22-23,26,28,31,53] This aligns with studies from the Middle East (1980-2015), highlighting hypertension and diabetes as primary stroke risk factors.[54] Chraa et al. emphasize that managing arterial hypertension is central to ischemic stroke management.[7] Bendriss et al. stress the importance of cardiovascular assessment for improving prognosis in ischemic stroke patients.[22]

Major trials have shown that statins reduce the risk of cerebrovascular accidents in both primary and secondary prevention.[55] Azdad et al.[10] found that atorvastatin significantly reduced overall stroke risk by 16% and by 22% in stroke patients, consistent with the Stroke Prevention by Aggressive Reduction in Cholesterol (SPARCL) study, indicating in the Middle East and North Africa (MENA) that intensive cholesterol-lowering strategies reduce cerebrovascular and cardiovascular risks in secondary prevention.[55]

Other studies conclude that antiplatelet agents reduce the risk of thrombotic events following a stroke or transient ischemic attack by 25%. Anticoagulants and vitamin K antagonists also reduce the risk of ischemic stroke.[9,11,17] Further studies confirm the efficacy of anticoagulants and antiplatelet agents in preventing stroke in patients with atrial fibrillation.[55-56]

### *Evolutionary Profile of Patients with Ischemic Stroke After Thrombolysis*

Thrombolysis is recommended in global guidelines for ischemic stroke management.[42] Reperfusion therapies like intravenous thrombolysis and endovascular thrombectomy have significantly reduced disability and revolutionized stroke management.[41] Thrombolysis with alteplase is effective in the acute phase of stroke, with benefits across all ages and severities.[43,57] The 1995 American NINDS study demonstrated the efficacy of early fibrinolytic treatment with recombinant tissue plasminogen activator (rt-PA) (within 3 hours of symptom onset).[6,30]

At 3 months, 50% of patients who received fibrinolytic treatment were independent on the Barthel score, compared with 38% in the placebo group. Additionally, 31% of rt-PA-treated patients had no sequellar deficits (NIHSS) versus 20% in the placebo group, with no excess mortality observed (17% in the rt-PA group vs. 21% in the placebo group).[10,30]

A meta-analysis of the European ECASS I and II studies and the NINDS study shows rt-PA reduces the risk of death or dependence at 3 months by approximately 30%, without increasing mortality.[30] Results from the first year of rt-PA clinical use in the USA suggested similar or lower rates of hemorrhage compared to the NINDS findings.[42,58]

### *Post-Ischemic Stroke Outcomes and Mortality Without Thrombolysis*

Stroke patients are at high risk of recurrent stroke, with higher mortality after recurrence compared to the initial stroke.[59] Stroke recurrence rates and the prognosis for physical and intellectual disability, as well as mortality, are higher than the initial prognosis.[6]

Three-month mortality among thrombolysed patients exceeded 20% in most studies, higher than the 13.4% reported in a meta-analysis, while acute mortality ranged from 3% to 13% in this review, lower than rates reported in other Arab and African countries.[60]

These rates are also lower than one-month case fatality rates in Middle Eastern countries, which ranged from 12% to 32% according to a systematic review from 1980 to 2015.[54] The lower mortality rates in Morocco could be due to a lack of studies assessing ischemic stroke mortality.[45]

### *Management of Ischemic Stroke and Health Education*

This review highlights the importance of public education in stroke management. Daouda et al., Chraa et al., and Bendriss et al. advocated for improved stroke management at all levels, particularly through public education.[21,22] Rachdi et al.[29] stress that raising awareness and integrating education into care can reduce admission times and increase thrombolysis rates. The European Ad Hoc Consensus Group.[61] confirms that media campaigns effectively boost stroke awareness. In Morocco, improved stroke management could benefit from establishing a national "Stroke Unit" and a vascular network.

## Limitations

This review is limited by the restricted geographic scope of available studies, which are concentrated in major cities of central Morocco, with virtually no data from the northern and southern regions, thereby compromising the generalizability of the findings. Moreover, most studies originate from university hospitals and exclude non-hospitalized patients, who account for nearly half of all stroke cases, introducing a significant selection bias toward more severe forms of stroke. Finally, the predominance of observational study designs (case series and cross-sectional studies), often lacking multivariate statistical analyses, limits the epidemiological robustness of the evidence and hinders the identification of reliable causal associations.

## Conclusion

Improving the management of ischemic stroke in Morocco requires reducing prehospital delays to enable timely thrombolysis and ensuring the nationwide deployment of specialized neurovascular care units. These two closely interdependent strategies are essential to optimize clinical outcomes, reduce disability and mortality, and alleviate the overall burden of stroke in the country.

## Declarations

***Animal and Human Rights Statement***

*Ethical approval and informed consent were not required because this narrative review was based on previously published data and did not involve new human or animal participants.*

***Informed Consent***

*Not applicable.*

***Data Availability***

*Data sharing is not applicable to this article, as no new datasets were generated or analyzed. All data were obtained from previously published studies.*

***Conflict of Interest***

*The authors declare no conflict of interest.*

***Funding***

*None.*

***Author Contributions (CRediT Taxonomy)***

*Conceptualization: H.A., M.C., N.A.*
*Methodology: H.A., M.C., L.C.*
*Investigation: H.A., M.C., L.C.*
*Data Curation: H.A., M.C.*
*Formal Analysis: H.A., M.C., N.A.*
*Writing – Original Draft: H.A.*
*Writing – Review & Editing: M.C., L.C., N.A.*
*Supervision: N.A.*

***AI Usage Disclosure***

*The authors declare that no AI-assisted technologies were used.*

***Abbreviations***

*MENA: Middle East and North Africa*
*mRS: modified Rankin Scale*
*NIHSS: National Institutes of Health Stroke Scale*
*rt-PA: Recombinant tissue plasminogen activator*
*UHC: University Hospital Center*

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***Additional Information***

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***How to cite this article:***

*Hafid Arzoug, Mohammed Chiyami, Loubna Chouaf, Nawal Adali. Management and evolutionary profile of ischemic stroke in Morocco: a narrative review. Ann Clin Anal Med 2026;17(8):874-879. doi:10.4328/ACAM.22340*