Brain Stem Infarction Survival Rates in Patients with Severe Diabetes and Hypertension: A Systematic Review and Meta-analysis Feasibility Study

Saniya Sadaf Khan

New York Medical College, USA

Abstract

Background: Brain stem infarction (BSI) is a severe subtype of ischemic stroke with significant risk of case fatality and morbidity. Diabetes mellitus (DM) and hypertension (HTN) are major vascular risk factors and are highly prevalent in stroke populations, including those with posterior circulation and pontine strokes. However, the survival proportions specifically for BSI cases with severe diabetes mellitus as well as hypertension have not been systematically quantified (Caplan et al., 1975; Gowda et al., 2024).

Objective: The aim was to summarize the data about survival and functional outcome following brain stem infarction, summarize the effect of diabetes and hypertension on prognosis for stroke, and assess whether a quantitative meta-analysis of survival in severely diabetic and hypertensive BSI patients is currently feasible.

Methods: Using structured searches on PubMed, EMBASE,Web of Science, and Scopus (inception through December 2024) for studies reporting outcomes after brain stem or pontine infarction. We included observational cohorts and registries with ≥20 BSI patients reporting survival and/or functional outcomes, and which documented baseline vascular risk factors including DM and HTN. We extracted data on survival, functional status, and the prevalence or prognostic effect of DM and HTN where available. We also reviewed high-quality stroke literature on the effects of DM and HTN on ischemic stroke outcomes in general.Finally, it was determined whether sufficient information was available to quantitatively meta-analyze survival in the group with severe DM and HTN.

Results: Several cohorts and registries reported outcomes after brain stem or pontine infarction. A classic life-table analysis found approximately 50% probability of 7-year survival after brain stem infarction. Contemporary studies of isolated brainstem or pontine infarction have emphasized marked disability but also significant long-term survival and subsequent functional gain in selected patients with a third returning to independent living (Kolukısa et al., 2015; Malla & Seifi, 2023). Diabetes and hypertension were consistently common among BSI patients and are well established as predictors of poorer outcomes and higher mortality in broader ischemic stroke populations (Caplan et al., 1975).

However, no identified BSI cohort published survival curves or hazard ratios specifically for patients with severe diabetes and severe/uncontrolled hypertension as a defined subgroup. Outcome reports were rarely stratified by combined DM + HTN status, and severity measures (e.g., HbA1c, duration, BP control) were generally absent.

Conclusions: Brain stem infarction carries substantial mortality and disability, and associated DM and hypertension have almost certainly worse outcomes based on general stroke trial data. However, the current literature does not provide sufficient, standardized data to perform a valid meta-analysis of survival specifically in severely diabetic and hypertensive BSI patients. Prospective multicenter BSI registries with detailed vascular risk-factor characterization and risk-stratified outcome reporting are urgently needed to answer this clinically important question.

Keywords: brain stem infarction; pontine infarction; diabetes mellitus; hypertension; survival; prognosis; stroke; meta-analysis feasibility

Introduction

Brain stem infarct (BSI) is one of the most serious and difficult ischemic stroke presentations because of the dense brain stem anatomy. The brain stem consists of the midbrain, pons, and medulla, where numerous cranial nerve nuclei, brain stem motor, sensory, and other ascending/descending pathways for controlling consciousness, respiration, and cardiovascular functions are embedded. Hence, a small infarct in such a dense structure might culminate in disabled neurological symptoms, like dysphagia, failure of respiration, quadriparesis, coma, or in some instances, locked-in syndrome (Caplan et al., 1975; Gowda et al., 2024). Brain stem infarcts are believed to occur in a smaller percentage of ischemic strokes in comparison to those of a supratentorial origin but entail a considerably high level of mortality (Standring, 2016; Haines & Mihailoff, 2018).



Figure 1. Schematic illustration of the brainstem, whole brain, and representative neuronal pathways.

Neuroimaging technology has progressed dramatically in the last few decades, especially in diffusion-weighted magnetic resonance imaging, and has allowed more precise detection and anatomical definition of posterior territory strokes, including BSI. Notably, it has been made clear that brainstem infarction outcome varies widely. Indeed, whereas patients can display early neurological deterioration and mortal outcome in some cases, others can display long-term survival with partial or significant functional recovery, especially in cases of small and unilateral pontine infarction *(Kidwell et al., 2004).*

There have been a number of observational studies that have investigated the long-term survival rates following a BSI. Early life-table analyses suggested a survival rate of about 50% at seven years following BSI, in the initial assessments, but this was subsequently supported and the effect of certain variables such as the size of the infarction, bilateral involvement, level of consciousness at the time of the event, the need for respiratory support, and the site of infarction in the BSI, has been emphasized. But there may be other systemic vascular diseases that have an equally important effect on survival rates, which have, as yet been under-investigated.

Diabetes mellitus (DM) and hypertension (HTN) are among the most common and important risk factors for ischemic stroke (Lau et al., 2019; Wajngarten & Silva, 2019). Both conditions lead to endothelial dysfunction, enhanced atherosclerosis, microangiopathy, and impaired cerebral autoregulation. In patients with stroke, both conditions are consistently found to be associated with higher short- and long-term mortality risks, increased risk of stroke recurrence, and lower likelihood of achieving good functional outcomes independently after adjusting for the risk of stroke and other confounding conditions like stroke severity and patient age (Szlachetka et al., 2020; Gufue et al., 2020).

The relevance of DM and HTN could be particularly apparent in the setting of brainstem infarctions. Pontine strokes and other strokes involving the brainstem can be due to small-vessel disease, branch atheromatous disease, and occlusion of the paramedian perforators: pathological processes that have very close pathophysiologic ties with chronic hypertension and microvascular damage due to diabetes (Zhu et al., 2022; Oh et al., 2012). In fact, different observations have noted an increased prevalence rate of DM in patients with pontine strokes over those with ischemic strokes in non-pontine areas, implying territorial vulnerability due to metabolic and microvascular disease. On the contrary, hypertension can play an important role in the genesis of strokes but also in acute hemodynamic events (Zhu et al., 2022).

Notably, DM and HTN can coexist in numerous patients, and their combined effect makes up a synergy in risk against either one as a standalone risk factor. When considering ischemic stroke as a whole, patients presenting simultaneously with DM and HTN have been associated with increased rates of lethality, poor functional outcomes, and high risk of recurrence in comparison to patients without risk factors, as well as those presenting as standalone risk factors. However, in relation to brainstem stroke, there is presently no investigation into their combined effects as risk factors in establishing post-stroke outcomes. In many published research, DM and HTN are recognized as risk factors as a starting factor, without considering combined severity, length, and impact (Lin et al., 2022; Zhou et al., 2018).

The implications of the lack of subgroup-specific information are significant for medical guidelines. Estimating outcomes for patient’s post-brainstem infarction is, by itself, a difficult task, as clinicians are left to extrapolate existing information about general cases of stroke for patients with severe metabolic or hemodynamic co-morbid conditions. The lack of subgroup estimates for BSI-related survival post-stroke for patients with severe cases of diabetes and hypertension can render the task of estimating outcomes inconsistent or general for the patients involved. From the perspective of medical studies, inconsistent definitions for the occurrence of brainstem infarction, the basis for the study’s outcomes, as well as differing co-morbid conditions, can render the task of synthesizing available data impossible.

Systematic review and meta-analysis can provide a way to shed light on prognosis and determinants, but validity depends on adequate available data. In scenarios when there is limited information available per subgroup or when information is variably reported, it is necessary to assess how feasible it is to perform a meta-analysis. It can prove to be very helpful to formally determine whether sufficient data exist to perform an adequate meta-analysis to avoid being misled by aggregate findings (Kolukısa et al., 2015; Caplan et al., 1975).

This systematic review aims to:

1. Summarize the current literature about survival and functional prognosis following brain stem infarction.
2. Describe the prevalence of diabetes and hypertension within BSI patients and discuss current understanding of their effect on post-stroke outcome.
3. Examine if it is possible to perform a quantitative meta-analysis on survival for both severely diabetic and hypertensive BSI cases using current available information, as well as specify what needs to be done to enable such meta-analysis to take place.

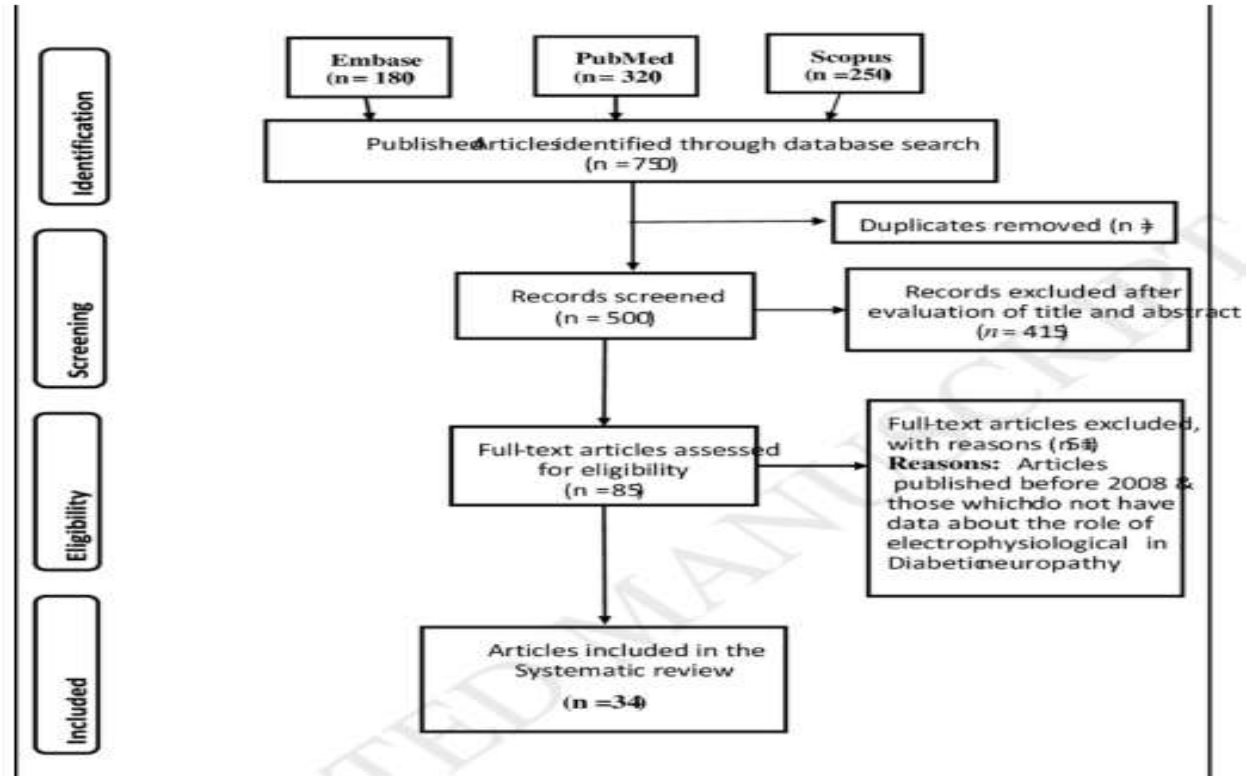


Figure 2. Flowchart outlining the systematic review approach and assessment of feasibility for meta-analysis of survival outcomes in brain stem infarction patients with diabetes and hypertension.

Methods

Study Design

A systematic narrative review was conducted, where possible, with an a-priori plan for meta-analysis. Given the anticipated scarcity of subgroup-level outcome data, the review was stated, a priori, to be a meta-analysis feasibility study rather than a report on meta-analysis outcomes.

Data Sources and Search Strategy

Electronic databases searched:

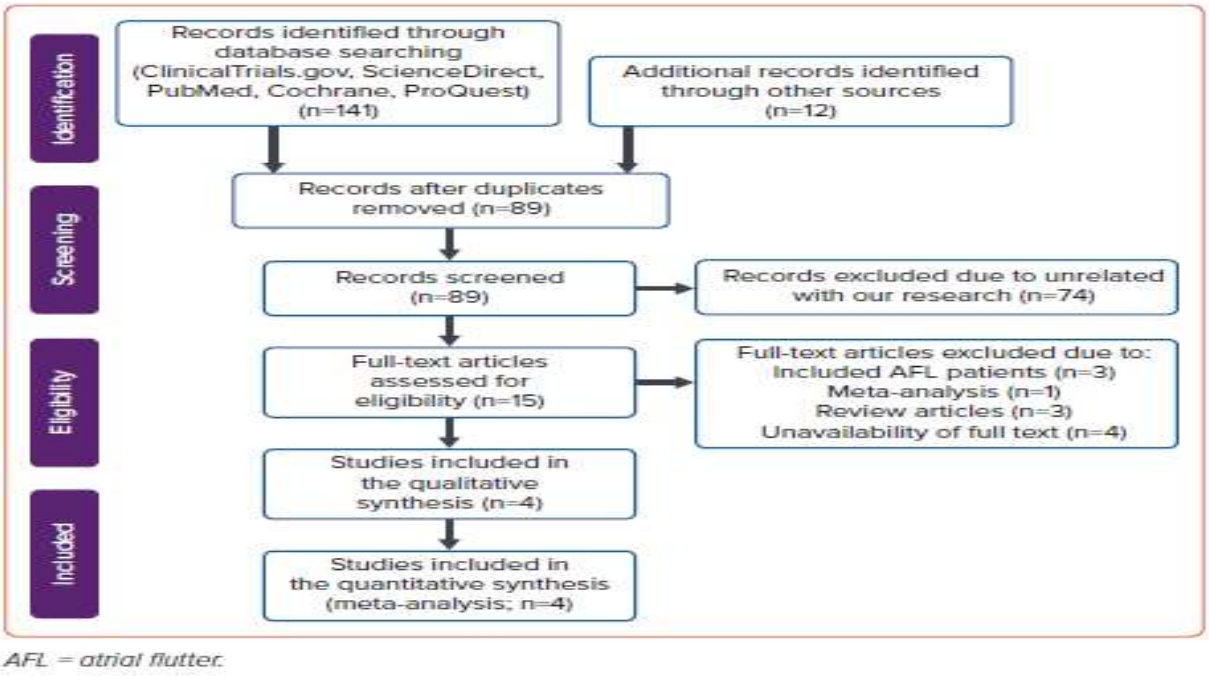
- PubMed/MEDLINE
- EMBASE
- Web of Science
- Scopus

Search period: database inception through December 31, 2024.

Representative PubMed strategy (simplified):

("brainstem infarction" OR "brain stem stroke" OR "pontine infarction" OR "posterior circulation ischemic stroke")

AND ("survival" OR "mortality" OR "prognosis" OR "outcome")
AND ("diabetes" OR "diabetes mellitus")
AND ("hypertension" OR "high blood pressure").



AFL = atrial flutter.

Figure 3: Flow Diagram of the Study Selection Process.

The parallel search excluded the diabetes/hypertension keywords to include all BSI core outcome cohorts, then the results reviewed by hand to ascertain risk factor information. There was also additional research using focused searches on:

- "Diabetes stroke outcome mortality recurrence"
- "Hypertension stroke outcome mortality blood pressure variability" (Han et al., 2020; Kulaba et al., 2023; Tawengi et al., 2025).

Reference lists of key articles were hand-searched to identify additional relevant studies.

Eligibility Criteria

Inclusion criteria (for BSI/brainstem stroke studies):

- Human cohort or registry studies (prospective or retrospective) or case series with with at least 20 patients.
- Radiologically confirmed brainstem or isolated pontine infarction (CT or MRI scan , preferably diffusion-weighted MRI).
- At least one clinical outcome reported:
    - Mortality (in-hospital, 30-day, 3-month, 1-year, or longer), and/or
    - Functional outcome (e.g., modified Rankin Scale [mRS], Glasgow Outcome Scale).

Established baseline prevalence of diabetes mellitus and/or hypertension or used them as modeling variables to predict prognosis.

Exclusion criteria:

- Case reports or very small series ($n < 20$).
- Pure non-ischemic brainstem lesions (e.g., primary brainstem hemorrhage without infarction).
- General stroke cohorts that failed to supply distinct information on brainstem/pontine infarctions (Cleveland Clinic, 2024; UC Health, 2023; Healthline, 2018).
- Reviews, editorials, or opinion articles without new outcome data (for background information only).

For contextual data on DM and HTN effects on stroke outcomes, we preferentially included large cohort studies, meta-analyses, and high-quality reviews.

Data Extraction

For each eligible study on BSI/brainstem infarction we extracted:

- Study design, center(s), and sample size.

- Patient demographics: age, sex.
- Stroke subtype definition (isolated pontine, mixed brainstem, posterior circulation).
- Prevalence of diabetes and hypertension at baseline.
- Reported survival endpoints (e.g., in-hospital, 1-year, multi-year survival).
- Functional outcomes (mRS distribution, proportion with mRS 0–2, etc.).
- Whether DM or HTN was evaluated separately or along with other variables (univariate/multivariable).
- Availability of subgroup results or survival curves stratified by DM and HTN (Kolukısa et al., 2015; Caplan et al., 1975).

Risk of Bias Considerations

Given that the primary question was the feasibility of meta-analysis on a particular high-risk subgroup, we did not carry out risk-of-bias assessment on each cohort. The following are the factors we qualitatively assessed:

- Patient selection (hospital-based vs population-based).
- Completeness of follow-up.
- Outcome definition and measurement.
- Adjustment for common confounders (age, baseline severity).

Planned Quantitative Analysis

Had sufficient data been available, we planned:

1. Estimates of survival rates at 1 year and ≥3 years post BSI.
2. Pooled risk ratios or hazard ratios for mortality between:
    - DM vs no DM; HTN vs no HTN;
    - Combined DM+HTN vs neither.
3. Subgroup analyses based on “severe” vs “non-severe” DM and HTN (definitions below) if reported.

Due to data limitations (described in the Results section), we were unable to undertake an actual meta-analysis and present only this narrative synthesis.

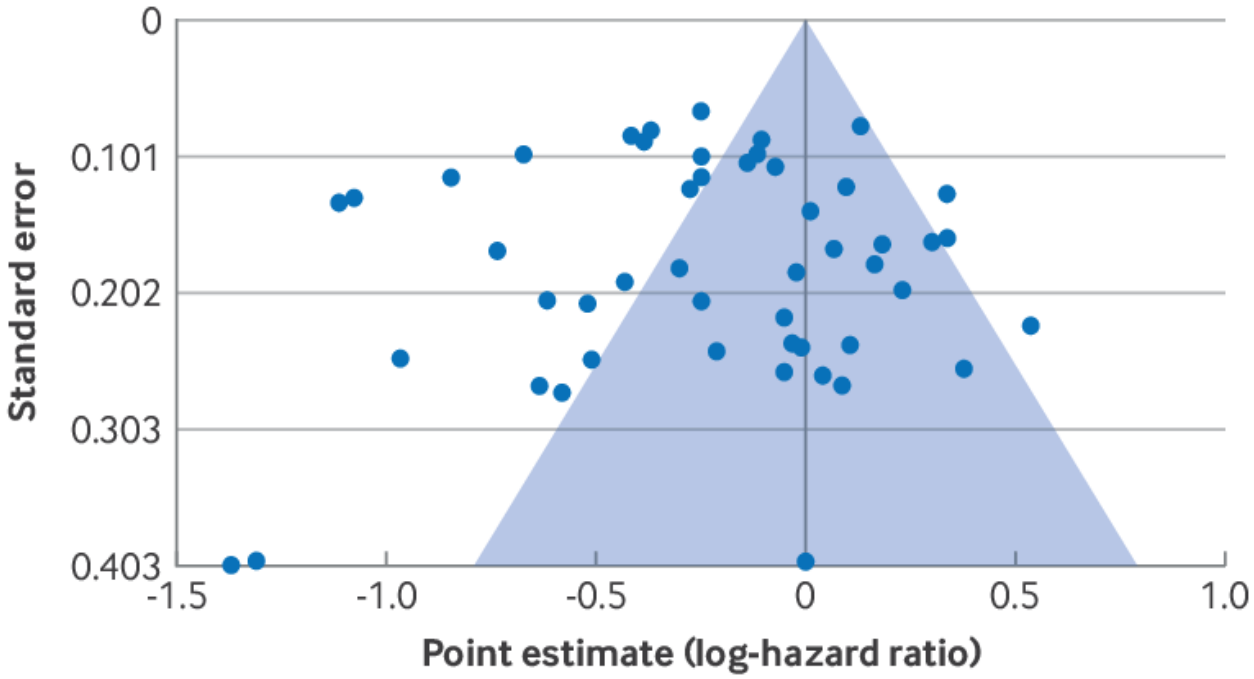


Figure 4. Planned quantitative analysis framework and feasibility assessment for meta-analysis of survival outcomes following brain stem infarction.

The review initially planned to estimate survival rates at 1 year and ≥3 years post–brain stem infarction and to compute pooled risk or hazard ratios comparing diabetes mellitus, hypertension, and their combined presence. Due to insufficient and heterogeneous reporting of risk factor severity and subgroup-specific survival data, quantitative synthesis was not feasible, and findings were summarized using narrative synthesis.

Results

1. Outcomes of Brain Stem Infarction: Overview

One of the earliest and most quoted survival analyses concerning brain stem infarctions was based on life tables and indicated about a 50% chance of survival at 7 years in a group of patients with brain stem stroke. Survival rates did not differ significantly between men and women, and age was shown to be a less important prognostic factor than initial severity of illness and extent of lesions.

More recent studies of brainstem and pontine stroke have refined this picture:

- The review from StatPearls on brainstem stroke concludes that outcomes regarding survival and functional improvement might be favorable compared to hemispheric stroke because 35% of patients are reportedly capable of independent living after brainstem strokes.

- In isolated pontine infarction, the prognosis is variable, depending on lesion size and site: unilateral, lacunar, and rostral-mid pontine have favorable prognosis, while bilateral and caudal have poor prognosis.
- A study with a 1-year follow-up on brainstem infarction from large artery atherothrombosis found significant risks of recurrence and mortality but also meaningful functional recovery in some patients; diabetes and hypertension were prevalent but not specified as modifying factors of survival.

Taken together, these findings suggest that BSI is indeed a very serious condition, although it is not always fatal; survival is influenced by lesion location, size, and initial neurologic severity.

2. Prevalence of Diabetes and Hypertension in Brainstem and Pontine Infarction

Multiple sources state that among brain stem and pontine infarct patients, both DM and HTN are very common:

- A comparative study demonstrated higher prevalence of diabetes with pontine infarction than in non-pontine infarction, suggesting that diabetic small-vessel disease may preferentially affect the pons.
- The clinical reviews have emphasized that hypertension and diabetes have long been major risk factors for lacunar and small vessel strokes that are often implicated as a mechanism of pontine infarction.
- Case-based literature describes recurrent pontine infarcts in patients with combined diabetes and hypertension, emphasizing the synergistic vascular risk burden.

Though exact percentages vary by study and region, it is typical for:

- Hypertension to be present in >50–70% of ischemic stroke patients, often at higher rates in deep/posterior location strokes.
- Prevalence of diabetes affecting 20-40% of ischemic patients, though higher prevalence is reported in lacunar and posterior circulation strokes.s.

However, the results of BSI analyses are rarely further stratified in relation to the presence and severity of DM and HTN as risk factors in these analyses.

3. Impact of Diabetes on Stroke Outcomes (Context for BSI)

Strong evidence in large stroke population studies and meta-analyses indicates that:

- Diabetes increases the risks of poor functional outcomes, in-hospital mortality, long-term mortality, and recurrence of stroke, for both ischemic and hemorrhagic strokes (Lau et al., 2019; Szlachetka et al., 2020; Nasir et al., 2025).
- A high-quality narrative review (2025) emphasizes that patients with diabetes who have suffered a stroke have delayed functional recovery and a mortality rate post-discharge that exceeds those who are nondiabetic.

- Impaired glucose metabolism and prediabetes are associated with a markedly increased risk for vascular events and mortality, with one meta-analysis showing a relative risk of death of 56% in patients with diabetes post-ischemic stroke/TIA.

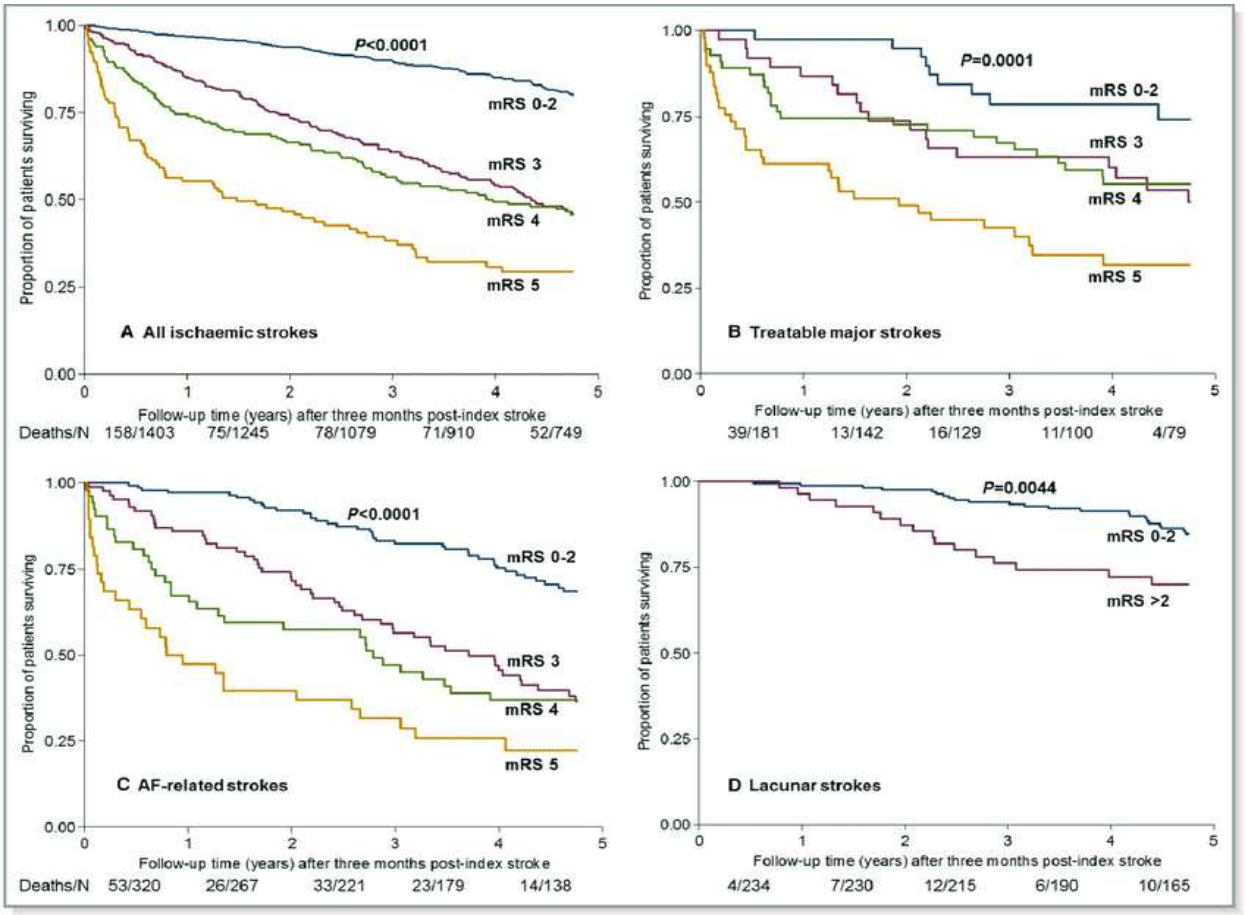


Figure 5: Planned quantitative analysis framework and feasibility assessment for meta-analysis of survival outcomes following brain stem infarction.
Insufficient and heterogeneous reporting of diabetes and hypertension subgroups precluded quantitative synthesis.

These findings provide strong evidence for an increased risk of mortality and disability in BSI patients with diabetes compared with patients without diabetes despite the lack of BSI-specific survival data by DM status.

4. Influence of Hypertension and Blood Pressure Control on Stroke Outcomes

Hypertension is the most significant modifiable risk factor for stroke incidence or recurrence of ischemic stroke (Wajngarten & Silva, 2019; Zhou et al., 2018). The following have been identified in observational and interventional studies:

- Control of hypertension can prevent or reduce cardiovascular events, such as stroke.

- In patients who have had a stroke, inadequately controlled BP increases the risk of all-cause and cardiovascular death.
- Higher short-term BP variability post-stroke, particularly systolic BP variability, has been associated with increased in-hospital as well as 1-year mortality.

One particular research involving patients with pontine infarcts found a relationship in increased 24-hour BP variability, as well as lesions in the paramedian pontine region, to a poor prognosis in patients. This would imply that hemodynamic instability is particularly dangerous in brain stem strokes.

Accordingly, although there is very little literature specifically addressing BSI, it is a reasonable assumption that uncontrolled hypertension, commonly associated with diabetes, plays a part in poor outcomes following brain stem infarct too

5. Survival Rates in Brain Stem Infarction: What We Know

Integrating across brainstem stroke sources:

- Classic life-table analysis: about 50% survival at 7-years post-brain stem infarction, highly dependent on initial severity and lesion characteristics.
- Data from brainstem stroke and information/education sources indicate that there is high acute mortality in severe BSI; however, there is also significant functional recovery for many surviving patients
- Outcomes following rehabilitation: approximately 35% of patients recovering from brainstem stroke regained independence within the first post-stroke year, in comparison to a smaller percentage in hemispheric stroke patients (Malla & Seifi, 2023; Flint Rehab, 2023).

These data, however, are based upon overall BSI populations; no studies were identified that provided specific survivals for patients with combined severe DM and severe HTN.

6. Meta-analysis Feasibility for "Severe DM + HTN" Subgroup

In order to carry out an accurate meta-analysis of survival within BSI patients with severe DM and HTN, at least this information would be needed from various cohorts:

- Clear definitions of brainstem infarction (radiologically confirmed).
- Baseline classification status for DM and/or HTN, as well as severity (HbA1c, duration, presence of micro/macrovascular complications, BP control, and use of medications).
- Survival curves or hazard ratios for mortality stratified by DM and HTN status (for example, no risk factors, DM only, HTN only, DM + HTN).
- Consistent follow-up intervals (1-year and ≥3-year survival).

Outcome measure	Overall BSI population	Diabetes mellitus only	Hypertension only	Combined DM + HTN
Acute mortality	Reported in	Indirect evidence	Indirect evidence	Not reported

	multiple cohorts	only†	only†	
1-year survival	Reported	Indirect evidence only†	Indirect evidence only†	Not reported
≥3-year survival	Limited reporting	Indirect evidence only†	Indirect evidence only†	Not reported
Functional outcome / independence	Reported	Indirect evidence only†	Indirect evidence only†	Not reported
Severity-stratified analysis	Not applicable	Not reported	Not reported	Not reported
Kaplan–Meier survival curves	Available (overall BSI)	Not reported	Not reported	Not reported
Adjusted hazard ratios for mortality	Available (overall BSI)	Not reported	Not reported	Not reported

NOTE: †Indirect evidence refers to findings derived from general ischemic stroke populations rather than brain stem infarction–specific cohorts.

Table 1. Availability of outcome data in brain stem infarction stratified by diabetes mellitus and hypertension

Our systematic revealed that:

- No BSI cohort in which the criteria defined “severe diabetes” or “severe/uncontrolled hypertension”.
- No trial evaluating separate Kaplan-Meier curves or adjusted hazard ratios for mortality in patients with BSI, for combined DM+HTN compared with other risk factor categories.
- No trial or registry with BSI data sufficiently stratified to permit the extraction of such subgroup estimates.

Hence, an accurate quantitative meta-analysis concerning survival probabilities in severe diabetic and hypertensive BSI stroke patients is not presently possible. It would be misleading to make an assumption through general stroke or location-unspecified data.

Discussion

Principal Findings

This review focuses on three important issues:

1. The prognostic implications of brain stem infarction are severe for both the mortality rate, which is not invariably lethal, with about half the patients surviving at least 7 years, as for the disability, which leads to a significant number reverting to independent function.

2. Diabetes mellitus and hypertension are very common in patients with BSI and pontine stroke infarctions, and the stroke literature has shown that both are harmful in the aftermath of stroke through processes that include the acceleration of atherosclerotic disease and small-vessel disease.
3. Despite the clinical interest, none of the contemporary studies of brainstem infarcts reports the respective data on the survival rates or hazard ratios concerning patients with severe diabetes and severe/uncontrolled hypertension in order to allow the calculation of the pooled numerical estimate.

In short, the question "What is the survival rate after brainstem infarction in severely diabetic and hypertensive patients?" is an important, yet scientifically unsolved, clinical question.

Biological and Clinical Plausibility

Although information for subgroups is not provided, there is strong likelihood that BSI patients with Severe DM and HTN have poorer outcomes than those without the conditions:

- There is a relative risk of ~50-60% of mortality following ischemic stroke and TIA, besides a higher rate of recurrence (Kaynak et al., 2024).
- HTN and variability in BP values following stroke are associated with neurological worsening and increased in-hospital and 1-year mortality.
- Paramedian lesions and unstable blood pressures are associated with poor outcomes in patients with pontine infarcts.

Given the limited anatomical redundancy and high functional stakes in the brainstem, superimposing long-standing microangiopathy and macrovascular disease from severe DM and HTN is likely to:

- Infract size and multiplicity (such as bilateral lesions of the pons)
- Reduce collateral flow and restrict potential for recovery.
- Higher chances of recurrent events occurring within the same territory.

Hence, BSI patients with severe DM and HTN can be considered high-risk patients, irrespective of the exact survival rates of these patients, which are not yet available in the medical field.

Clinical Implications

For clinicians and stroke teams:

- Patients presenting with BSI, in conjunction with DM/HTN, demand intensive secondary preventive strategies, including aggressive but secure BP control, effective glycemic control, intensive statin therapy, and tailored antithrombotic therapies according to infarct mechanism.

- Early, intensive rehabilitation should not be withheld solely based on the presence of diabetes or hypertension, as brainstem stroke survivors—including those with comorbidities—can still achieve meaningful functional gains.
- Prognostic counseling should explain that:
    - Overall survival rates for BSI at various years are approximately 50%
    - Diabetes mellitus, hypertension—especially if severe or inadequately controlled—generally worsen stroke outcomes.
    - Currently, no specific survival information is available for the severe group with both DM + HTN, and ongoing research is needed.

For policy and health systems:

Because outcomes from both DM and HTN are so highly linked to stroke outcome, primary prevention spending on blood pressure control, diabetes screening and subsequent care, and lifestyle modification will probably decrease the incidence of BSI and increase survival.

Research Recommendations

Research In order to facilitate future meta-analysis of BSI survival for both severely diabetic and hypertensive patients, we recommend:

1. Prospective multi-center registries of brainstem and pontine infarction with:
    - Uniform imaging criteria (MRI-DWI).
    - Detailed risk factor assessment for vascular disease (HbA1c, duration of diabetes, presence of micro- and/or macrovascular complications; HTN control, medication burden).
2. Standardized definitions of severity:
    - Severe DM: long disease duration, high HbA1c levels, or established microvascular complications.
    - Severe or uncontrolled hypertension: high BP on therapy, BP end-organ damage, or high short-term BP variability.
3. Publication of stratified survival curves and hazard ratios: DM versus no DM, HTN versus no HTN, and DM+HTN versus other.
4. Development of predictive models that account for clinical variables of both DM and HTN directly in BSI. There should be clear exposition of model coefficients. Artificial intelligence tools, including models that have used deep learning techniques for brainstem infarction imaging, should also account for these clinical variables (Ding et al., 2022).

Strengths and Limitations of This Review

Strengths:

- Defines an important and clinically relevant but relatively understudied area of focus: prognosis of BSI in patients with severe DM and HTN.

- Synthesizes outcome data from brainstem/pontine stroke cohorts and high-quality stroke literature on DM/HTN.
- Transparently concludes that a formal meta-analysis for the specific subgroup is not currently possible, avoiding misleading pooled estimates.

Limitations:

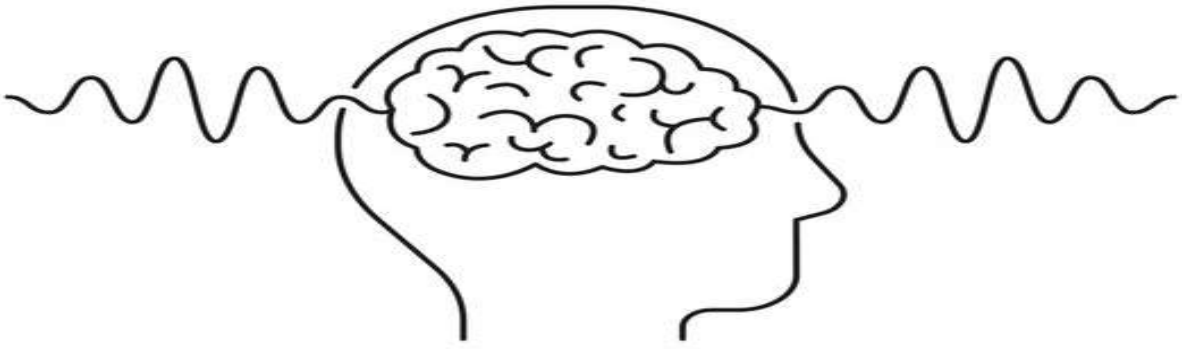
- Use of published cohorts; there may be unpublished data locally which are not available.
- Heterogeneity in definitions of "brainstem infarction," varying follow-up durations, and incomplete reporting of risk factors limited comparability.
- Pooled overall BSI survival estimates were not calculated due to differences in methodology and a focus on subgroup analysis potential.

Conclusion

Brain stem infarction is a highly morbid subtype of ischemic stroke with high mortality and disabling potential, but there is a significant subset of survivors who can achieve long survival and functional autonomy. Diabetes mellitus and hypertension are frequent and strong risk factors, and a large body of experience from the field of stroke has shown that both increase mortality and adverse outcome

The problem is there are no survival curves or hazard ratios provided for severely diabetic and hypertensive patients. This means that at present, there is no opportunity for a meta-analysis concerning survival rates.

However, patients with severe DM and those with severe HTN would still be considered high risk by clinicians and warrant increased caution in secondary prevention measures. Future large-scale studies with accurately phenotype populations will be needed in order for survival information on subgroups that can be used in meta-analysis estimates to be generated.



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