Open Access Library Journal
2025, Volume 12, e13287
ISSN Online: 2333-9721
ISSN Print: 2333-9705

Retrospective Study and Analysis of Improvement Strategies for Progressive Ischemic Stroke

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How to cite this paper: Qi, L. and Zhang, H. (2025) Retrospective Study and Analysis of Improvement Strategies for Progressive Ischemic Stroke. *Open Access Library Journal*, **12**: e13287.
https://doi.org/10.4236/oalib.1113287

Received: March 17, 2025
Accepted: April 5, 2025
Published: April 8, 2025

Abstract

Progressive ischemic stroke (PIS) is a severe neurological condition with high disability and mortality rates, significantly increasing the economic burden on patients and healthcare systems. It also exacerbates doctor-patient tensions, potentially leading to medical disputes. This retrospective study analyzed 210 cases from the Advanced Stroke Center of the Second Affiliated Hospital of Qiqihar Medical University, comparing PIS patients with general ischemic stroke patients. The results showed that PIS patients exhibited significantly lower improvements in NIHSS (-4.20 ± 0.01 vs. 3.20 ± 0.01, $p < 0.001$) and MRS (-1.25 ± 0.02 vs. 1.24 ± 0.05, $p < 0.001$), alongside markedly higher hospitalization costs (9235.0 ± 200.3 vs. 4205.2 ± 120.5, $p < 0.001$). Moreover, the study highlighted the substantial psychological and financial toll of PIS, with affected patients reporting significantly lower General Self-Efficacy Scale (GSES) scores (3.5 ± 0.4 vs. 9.5 ± 0.7, $p < 0.001$) and higher Personal Financial Wellness Scale (PFWS) scores (35.2 ± 0.4 vs. 70.0 ± 0.8, $p < 0.001$), indicating diminished confidence among medical professionals and severe economic stress for patients and families. These findings underscore the necessity of a multidimensional intervention strategy integrating ethical, economic, and clinical approaches to mitigate the adverse effects of PIS.

Subject Areas

Clinical Medicine, Social Medicine

Keywords

Progressive Ischemic Stroke, Retrospective Study, Improvement Strategies

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1. Introduction

Progressive Ischemic Stroke (PIS) is a distinct subtype of stroke characterized by the continuous progression of pathological changes in brain tissue over a period of time following onset, leading to a gradual or stepwise worsening of neurological deficits. Currently, there is controversy surrounding the definition of progressive stroke for two primary reasons. First, both the hyperacute and acute phases of typical stroke exhibit an inherent "fluctuating progression" pattern, where the condition reaches a peak before gradually improving. Second, the progressive nature of ischemic stroke is complex, with complications and comorbidities often contributing to disease deterioration. Therefore, this study adopts the definition proposed by Jianzhang Li [1] in 2006, which describes PIS as a type of stroke where, despite standardized and active clinical interventions, the primary pathological process continues, leading to sustained neurological deterioration over a certain period.

In recent years, with advancements in medical treatment, therapeutic options for PIS have expanded, resulting in an increasing rate of symptom relief. Mechanical thrombectomy is considered the optimal intervention for large-vessel PIS [2]; however, cases of PIS secondary to microvascular occlusion are also common, accounting for 20% - 30% of all PIS cases [3]. Unfortunately, mechanical thrombectomy is not effective in treating this subset of PIS. Medical treatment options include traditional antiplatelet therapy, anticoagulation, thrombolysis, and lipid-lowering therapy. In recent years, the use of tirofiban has shown promising results in improving neurological function and reducing disability rates [4] [5]. However, despite systematic and standardized treatment, PIS continues to be associated with high disability and mortality rates.

In real-world clinical practice, PIS poses a significant challenge for both healthcare providers and patients, as well as for healthcare insurance systems. For physicians, the continued deterioration of patients despite costly and sustained treatment regimens not only reduces medical confidence and enthusiasm but also exposes them to unwarranted criticism and potential medical disputes. For patients, worsening neurological function significantly increases medical expenses, caregiving burdens, and even "financial toxicity," imposing severe economic and psychological stress on both patients and their families. Furthermore, the high costs associated with PIS treatment contribute to substantial financial risks for healthcare insurance systems and impose a heavy societal burden.

Currently, research on PIS both domestically and internationally primarily focuses on exploring treatment strategies. However, No studies have quantified PIS's systemic burden across ethics, economics, and clinical outcomes. This study conducts a retrospective analysis of 210 medical records from the Advanced Stroke Center of the Second Affiliated Hospital of Qiqihar Medical University to assess the burden of PIS on patients. Furthermore, the study integrates perspectives from medical ethics, economics, and practical clinical diagnosis and treatment approaches to propose a more systematic clinical strategy for managing PIS.

2. Methods

2.1. Data Extraction

This study is a retrospective cohort study aimed at evaluating the differences in clinical characteristics and treatment outcomes between patients with Progressive Ischemic Stroke (PIS) and general ischemic stroke patients. The study population includes stroke patients admitted to the Advanced Stroke Center of the Second Affiliated Hospital of Qiqihar Medical University between December 2022 and December 2024. The study group and control group were selected at a 1:1 ratio, with the study group consisting of 105 PIS patients and the control group comprising 105 randomly selected ischemic stroke patients (excluding PIS cases). All patient records and related data were extracted from the hospital's electronic medical record system and processed using Python and Stata for data extraction, cleaning, and verification. Gender was analyzed as a binary variable, age as a continuous variable, and scale data as ordinal variables.

2.2. Research Methods

This study follows a retrospective design, covering the period from December 1, 2022, to December 31, 2024. The study protocol involves extracting and processing data from the hospital's medical records database. To ensure patient privacy and confidentiality, all data underwent de-identification and anonymization before analysis.

Inclusion Criteria:

1) Primary diagnosis of ischemic stroke.

2) At least one completed hospitalization.

3) Patients in the study group were diagnosed with PIS, defined according to the criteria proposed by JianZhang Li [1] and Shuijiang Song [6]: patients who experienced an increase in NIHSS score by ≥2 points or an increase in motor NIHSS score by ≥1 point within 72 hours of onset, despite active treatment.

Exclusion Criteria:

1) Patients with hemorrhagic stroke, epilepsy, encephalitis, or other neurological disorders.

2) Patients who were transferred to another department during hospitalization.

2.3. Study Content

Baseline characteristics, including gender, age, history of hypertension, history of coronary heart disease, and history of diabetes, will be compared between the study and control groups to ensure no significant differences in these variables ($p > 0.05$).

Comparison of the changes in National Institute of Health Stroke Scale (NIHSS) scores, Modified Rankin Scale (MRS) ratings, hospitalization costs, and Personal Financial Wellness Scale (PFWS) scores between the two groups before and after treatment. The study aims to assess the clinical and economic burden of

PIS. Additionally, treating physicians will evaluate patients using the General Self-Efficacy Scale (GSES) with a score range of 1 - 10. A p-value < 0.05 will be considered statistically significant.

2.4. Statistical Methods

During the data processing and analysis phase, Python was used for statistical calculations on extracted risk factor data. SPSS 26.0 and Stata software were used to present patient demographic and clinical characteristics through descriptive statistics. Categorical variables were analyzed using the chi-square test or Fisher's exact test, while continuous variables were compared using t-tests or Mann-Whitney U tests. Python was used for raw data analysis, while SPSS 26.0 and Stata software were employed for statistical analysis and visualization.

3. Outcome

3.1. Comparison of Baseline Characteristics

There was no statistically significant difference in baseline characteristics, including gender, age, and history of comorbidities, between the control group and the study group (P > 0.05) (Table 1).

Table 1. Baseline characteristics comparison.

Characteristic	Study Group (n = 105)	Control Group (n = 105)	t(F)	P
Male	52	53	0.019	0.890
Age(year)	64.5 ± 0.51	65.2 ± 0.34	1.3042	0.255
Hypertension	82	85	0.263	0.608
CHD	41	41	0.000	1.000
Diabetes	62	60	0.078	0.780

CHD: Coronary Heart Disease.

3.2. Comparison of Clinical Outcomes

The NIHSS and MRS score differences in the study group were lower than those in the control group, while hospitalization costs, PFWS scores, and GSES scores were higher. All study indicators showed statistical significance (P < 0.05) (Table 2).

Table 2. Comparison of clinical outcomes.

	Study Group (n = 105)	Control Group (n = 105)	t(F)	P
NIHSS Change	-4.20 ± 0.01	3.20 ± 0.01	273,800.00	0.000
MRS Change	-1.25 ± 0.02	1.24 ± 0.05	7750.13	0.000
Hosipitalization Costs	9235.0 ± 200.3	4205.2 ± 120.5	460.30	0.000
PFWS Score	35.2 ± 0.4	70.0 ± 0.8	158949.00	0.000
GSES Score	3.5 ± 0.4	9.5 ± 0.7	5815.39	0.000

4. Discussion

4.1. Medical Dilemmas of PIS

In this study, the General Self-Efficacy Scale (GSES) scores of physicians significantly decreased, while the Personal Financial Wellness Scale (PFWS) scores of patients or their families also showed a marked decline. This suggests that the presence of progressive ischemic stroke (PIS) significantly reduces medical confidence among physicians and has a strong negative impact on both the economic and health conditions of patients, thereby severely affecting the shared core interests of both doctors and patients—mutual well-being and freedom. Undoubtedly, facing irreversible diseases is a universal human challenge. While many attribute such conditions to the inevitability of "birth, aging, illness, and death," the ethical dilemmas underlying these diseases remain worth exploring.

The early warning mechanism for PIS involves a combination of clinical and imaging markers. Studies suggest that a high ABCD2 score (>4), initial NIHSS > 7, and early infarct expansion on DWI imaging may serve as key predictors of progressive deterioration. Identifying patients at high risk within the first 48 hours is crucial for timely intervention. Differentiation between PIS and other progressive conditions requires careful exclusion of arterial dissection, cardioembolic sources, and systemic hypercoagulable states. Advanced imaging techniques, including ASPECTS scoring and perfusion-weighted imaging, may aid in distinguishing high-risk patients from those with benign fluctuations.

It is often intuitively believed that the progression of a disease represents a dual failure of physicians in both moral responsibility and technical competence. This creates an ethical challenge for medical professionals—a conflict between the "principle of non-maleficence" and the boundaries of medical responsibility. If physicians are held indefinitely accountable for irreversible diseases, it may drive progress in medical philosophy and technology, but prolonged failures can also lead physicians into a state of nihilism, reducing their confidence in medicine. More critically, when the boundaries of responsibility are unclear, misunderstandings between doctors and patients increase, sometimes escalating into legal disputes. A study by Peng Xianwei [7] analyzed 71 medical disputes related to cerebral infarction and found that in most cases, patients experienced disability or death due to stroke progression. However, only eight cases were attributed to primary medical negligence, suggesting that the majority of physicians fulfilled their medical responsibilities but still faced significant misunderstandings from patients and their families. At its core, this reflects an ethical debate on the very "meaning of treatment."

From a Kantian metaphysical perspective, respect for individual autonomy dictates that life should be preserved and respected even when quality of life is low. In contrast, modern philosophers such as Singer [8] argue that the continuation of life should be predicated on its quality, supporting an "anti-speciesist" perspective. Differences in ethical viewpoints and ambiguous boundaries of responsibility contribute to the adverse consequences of PIS.

For patients and their families, PIS also signifies a failure to manage their own health conditions, often leading to severe psychological distress, including anxiety, depression, and despair. A retrospective study indicated that despite advances in medical technology, the incidence of post-stroke depression remains as high as 20% - 60% [9]. Additionally, family members often experience significant psychological distress, exacerbating the "secondary blow" of stroke. Furthermore, the ethical challenge of patient autonomy arises, as 36.2% of patients in this study were unable to express their will due to impaired consciousness or cognitive decline. When the opinions of family members conflict with the patient's presumed wishes, ethical dilemmas inevitably emerge.

Another major issue is the financial burden associated with PIS. Compared to general ischemic stroke patients, PIS patients in this study had significantly higher hospitalization costs. The subsequent PFWS scores further indicated that both direct and indirect economic burdens increased significantly for patients and their families. This not only created substantial obstacles to further treatment and rehabilitation but also contributed to a phenomenon known as "financial toxicity." This economic strain could, in turn, negatively impact the patient's condition, leading to poor adherence to treatment, increased out-of-pocket medical expenses, heightened anxiety and depression, and ultimately worse prognoses, thereby creating a vicious cycle [10]. Notably, PIS patients often incur unexpected medical expenses during hospitalization, with significantly higher rates of complications and comorbidities than general stroke patients. These issues also present challenges for healthcare insurance management and cost-control strategies. Under the Diagnosis-Intervention Packet (DIP) payment model, which is based on the primary diagnosis, the unpredictability and complexity of PIS often lead to high DIP multiplier rates and excessive medical insurance expenditures.

4.2. Strategies for Improving PIS Medical Dilemmas

Prevention remains the most crucial strategy for mitigating the consequences of progressive and irreversible diseases.

In the context of doctor-patient relationships, more effective and accessible education and communication strategies should be developed to prevent conflicts. Medical explanations should be structured logically and layered appropriately, providing detailed descriptions of different stroke stages and associated risks to patients and their families. To minimize information overload, analogies and metaphors can be employed—such as comparing progressive stroke to "a rusting water pipe over the years" or "a clogged pipe leading to brain function impairment." Non-offensive, visual aids such as anatomical models, diagrams, or 3D digital representations should be incorporated in clinical settings to enhance patient and family comprehension. A formal and structured conclusion should always follow, emphasizing that while the disease carries inherent risks, physicians are fully committed to providing the most effective treatment possible.

When patients have intact cognitive and decision-making abilities, their

autonomy should be fully respected. This approach aligns with the principle of "patient-centered care" and helps mitigate decision-making conflicts among family members should the disease progress. During treatment, physicians should guide families toward an understanding of "quality of life" rather than a rigid pursuit of life extension. Once the disease progresses, efforts should focus on preserving the patient's fundamental values and intentions, striving to prevent further deterioration while optimizing neurological function. Failure is an inescapable part of life, and only through the rigor of medicine and the rationality of philosophy can we properly address the challenges posed by failed medical interventions.

From a macroeconomic perspective, the rational allocation of medical resources is essential. A 2021 global systematic study on stroke expenditures indicated that better financial planning for prevention, hospitalization, outpatient rehabilitation, and social services could effectively reduce treatment costs and economic burdens [11]. While the implementation of DRGs and DIP payment policies has reduced inpatient costs, investments in primary and secondary stroke prevention, outpatient rehabilitation, and home-based recovery remain insufficient. A new DIP model focused on health outcomes is urgently needed [12]. Flexible reimbursement policies should be introduced specifically for progressive strokes.

On a microeconomic level, prioritizing prevention is key for chronic diseases. A 2021 study on atrial fibrillation-related ischemic stroke found that a family-based approach—including dietary, lifestyle, and health habit interventions—effectively reduced treatment costs. Healthcare organizations should enhance education for high-risk stroke populations to mitigate the financial risks associated with PIS.

In clinical practice, a systematic "early warning" and "differentiation" mechanism should be established for PIS patients. The development of stroke centers has significantly improved the systematic, integrative, and fault-tolerant capacity of stroke treatment. Multidisciplinary collaboration between neurology, neurosurgery, interventional radiology, rehabilitation, and nutrition departments can effectively identify and manage potential PIS patients. Comprehensive use of ABCD2 scores, NIHSS scores, and MRS scores can aid in early stroke risk assessment and stratification [13] [14].

Further refinement of stroke classification is necessary, distinguishing between anterior and posterior circulation strokes, large- and small-vessel strokes, and atherosclerotic versus embolic strokes. Such stratification should begin at the initial consultation to facilitate appropriate treatment strategies. Previous studies have shown that integrating physician-nurse with SBAR(Situation-Background-Assessment-Recommendation) handover protocols significantly reduces diagnostic delays [15]. These approaches can effectively detect stroke progression in real-time while minimizing errors caused by communication gaps during physician shift changes.

High-risk patients should receive enhanced bedside monitoring and family education. In cases of deterioration, medical staff should be able to respond

promptly to prevent "wake-up stroke" risks. Moreover, secondary prevention strategies for underlying conditions—such as diabetes, hypertension, coronary artery disease, and hyperlipidemia—are crucial. Recent efforts in China to establish specialized outpatient clinics for chronic disease screening, including blood pressure and glucose monitoring, require ongoing support from both the medical community and society.

Establishing a systematic early warning protocol is essential for timely intervention. A standardized screening framework should include ABCD2 scores, NIHSS progression monitoring, and DWI-based infarct evolution assessment. High-risk patients must undergo enhanced bedside monitoring and multidisciplinary evaluation by neurology, radiology, and rehabilitation specialists. To ensure effective implementation, hospitals should invest in real-time electronic medical records (EMR) integration and automated alert systems. The success of this strategy can be measured by the proportion of PIS cases identified within the first 24 - 48 hours (target > 80%) and the reduction in neurological deterioration during hospitalization (target > 30%).

5. Conclusion

This study highlights the overlooked challenges of PIS, which significantly hinder stroke treatment and impose a heavy medical and financial burden on both patients and physicians. The "trident" strategy—integrating ethics, economics, and clinical medicine—can effectively reduce the impact of PIS, but its success requires collective societal efforts. The sample size in this study remains relatively small, and biases inherent in retrospective studies are unavoidable. Future research should aim to expand to multicenter, large-scale, and prospective studies to further clarify the causes and outcomes of PIS.

Acknowledgements

I am deeply thankful to my family and friends for their unwavering emotional support, encouragement, and understanding throughout my journey. Their belief in me has been a constant source of motivation.

Conflicts of Interest

The authors declare no conflicts of interest.

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