

## Abstract

**Objective:** Ischemic stroke is a significant public health issue in Thailand as it is a leading cause of death and long-term disability. Some patients having suboptimal access to care within the stroke unit due to high bed occupancy. The study aims to investigate factors associated with prolonged hospital stays among acute ischemic stroke patients admitted to the stroke unit of Maharat Nakhon Ratchasima Hospital.

**Method:** This retrospective study was conducted at a large tertiary-care hospital and involved 343 patients with acute ischemic stroke or transient ischemic attack (TIA). Data collection included both patient-related factors and complications. Prolonged hospital stays were defined as a length of stay exceeding 7 days.

**Result:** There was a total of 343 cases, with 172 patients (50.1%) being male. The mean age was 64.2 years old (SD  $\pm$  14.74). The median length of hospital stay (LOS) was 2 days (IQR 1-5). NIHSS scores at the time of admission had a median of 3 (IQR 1-7). Patient-related factors that related to prolonged hospitalization were included NIHSS scores  $>15$  ( $p < 0.001$ , OR 11.2), a Barthel Activities of Daily Living Index (BI) score  $<75$  ( $p < 0.001$ , OR 49.3), and the presence of atrial fibrillation ( $p < 0.001$ , OR 7.3). Furthermore, swallowing, and respiratory issues, particularly dysphagia ( $p < 0.001$ , OR 35.7), were associated with prolonged hospitalization. Medical complications that related to prolonged hospitalization were aspiration pneumonia ( $p < 0.001$ , OR 12), hospital/ventilator acquired pneumonia (HAP/VAP) ( $p < 0.001$ , OR 76.8), urinary tract infection (UTI) ( $p < 0.001$ , OR 18.8), pressure sores ( $p < 0.001$ , OR 62.4), sepsis ( $p < 0.001$ , OR 4.4),

# Factors Associated with Prolonged Hospital Stays in Acute Stroke Unit

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and congestive heart failure ( $p < 0.001$ , OR 10.8). Neurological complications associated with prolonged hospital stays included large or malignant infarction ( $p < 0.001$ , OR 20.8), hemorrhagic transformation ( $p < 0.001$ , OR 13), brain herniation ( $p = 0.01$ , OR 5.9), and patients who underwent neurological surgery ( $p = 0.01$ ).

**Summary:** The findings of this study underscore the importance of tailored care plans for patients with these risk factors, the implementation of preventive measures for associated complications, and the need to reduce the likelihood of unfavorable treatment outcomes and prolonged hospitalization in the stroke unit.

## Introduction

Stroke (or cerebrovascular accident) is a highly significant disease in the nervous system. It occurs when brain cells are deprived of blood supply. It is divided into two main types: ischemic stroke and hemorrhagic stroke. Ischemic strokes commonly occur in patients with risk factors related to cardiovascular risk factors, such as high blood pressure, as well as other risk factors like smoking, obesity, dyslipidemia, diabetes mellitus, chronic kidney disease, and atrial fibrillation. These risk factors tend to increase due to current lifestyles and environments. Additionally, strokes can also be caused by vascular diseases such as ruptured blood vessels or abnormal blood clotting. Patients may experience a sudden decrease in blood flow to the brain, leading to cell death, resulting in impaired brain function. Symptoms and manifestations of stroke include weakness or numbness on one side of the body, difficulty speaking, slurred speech, facial drooping, confusion, and dizziness. Stroke is a significant

public health issue in Thailand as it is a leading cause of death and long-term disability.<sup>1</sup>

According to death certificate data in the year 2021, major causes of death include all types of cancer, cerebrovascular diseases, pneumonia, ischemic heart disease, and road traffic accidents.<sup>1</sup> Stroke is the second leading cause of death and the third leading cause of disability worldwide, according to a global survey in 2019. There were over 101 million stroke patients globally, with 12.2 million new cases reported (or approximately one new case every 3 seconds), and 6.5 million deaths. In Thailand, based on the Ministry of Public Health's health statistics report for the year 2020, a total of 34,545 people died from strokes (with a mortality rate of 53 per 100,000 population).<sup>1</sup>

The treatment of acute ischemic stroke with clear-cut evidence includes administering intravenous thrombolysis within 4.5 hours, or the use of rtPA (recombinant tissue plasminogen activator). Treatment may also involve mechanical thrombectomy, the process of removing blood clots from obstructed major brain arteries, within 24 hours. Patients may be treated within a stroke unit, where they receive antiplatelet medication such as aspirin within 48 hours after symptom onset. Surgical intervention, such as decompressive craniectomy, may be performed in cases where there is large brain infarction with cerebral edema within 48 hours.<sup>2</sup>

Some acute ischemic stroke patients experience prolonged hospital stays, which can pose challenges in bed occupancy rate management. Stroke units are the primary facilities for treating acute ischemic stroke patients, where patients have a significantly higher chance of survival and reduced disability rates.<sup>3</sup> These units

are specialized in the care of stroke patients and have systematic care plans in place. They are staffed with specialized healthcare professionals, including neurologists and stroke nurses, who are experts in patient care. They are equipped with comprehensive medical tools and equipment for continuous monitoring of patients' neurological signs. Therefore, having a high bed occupancy rate in the stroke unit is a critical issue in the care of acute ischemic stroke patients.

Currently, the number of stroke patients is on the rise, leading to some patients having suboptimal access to care within the stroke unit due to high bed occupancy. This means that some acute ischemic stroke patients may need to be admitted to general medical wards initially, which may result in less comprehensive care, monitoring, and follow-up of neurological symptoms compared to what is provided in dedicated stroke units.

Previous studies have explored clinical factors related to the length of hospital stays in acute stroke unit. However, each study used different definitions for prolonged hospitalization and varied in terms of patient management and hospital transfer contexts. These past studies identified clinical factors associated with extended hospital stays, including clinical factors related to the patients themselves. These factors were associated with longer hospital stays and included the severity of stroke measured by the National Institutes of Health Stroke Scale (NIHSS), the patient's ability to perform activities of daily living assessed by the Barthel Activities of Daily Living (ADL) index, the degree of disability based on the Modified Rankin Scale (MRS), the location of brain lesions, the Glasgow Coma Scale (GCS) score, patients with swallowing difficulties, and those with speech problems.<sup>4-8</sup> Complications

during hospitalization were found to be significant factors contributing to extended hospital stays. These complications included complications related to the stroke itself (such as malignant infarction or brain herniation), pneumonia, urinary tract infections, and pressure sores.<sup>10, 12-18</sup> Additionally, administration of recombinant tissue plasminogen activator (rtPA) was associated with reduced hospital stays.<sup>16,18</sup> It's important to note that the definitions and contexts of prolonged hospitalization varied among these studies, and these findings should be considered in the context of each study's specific patient population and healthcare system.

This study will focus on patients admitted in acute stroke unit of the Department of Medicine at Maharat Nakhon Ratchasima Hospital, there is specialized care and treatment exclusively for patients with acute ischemic stroke and transient ischemic attack (TIA). The total number of beds available is 24. The study aims to investigate factors associated with prolonged hospital stays among acute ischemic stroke patients admitted to the stroke unit of Maharat Nakhon Ratchasima Hospital. This research is valuable for future care planning of acute ischemic stroke patients to ensure improved treatment outcomes. Identifying relevant factors will allow for increased vigilance in at-risk patient groups and aid in planning interventions to prevent various complications that may result in prolonged hospitalization.

## Material and Methods

### Study populations

This study is a retrospective study based on medical records of all patients diagnosed with acute ischemic stroke or transient ischemic attack (TIA) and treated in the stroke unit of Maharat Nakhon Ratchasima Hospital between April 1, 2023, and June 30, 2023.

### Data collection and terminology

Criteria for patient selection are as follows: inclusion criteria were (1) patients aged 15 years or older, (2) patients diagnosed with acute ischemic stroke or transient ischemic attack and (3) patients treated in the stroke unit of the Department of Internal Medicine. Exclusion criteria were (1) incomplete or missing medical records and (2) patients admitted to the hospital with other conditions and subsequently developing acute ischemic stroke during their hospital stay.

Definition and diagnosis of diseases are based on symptoms, signs, and additional standard investigation.<sup>9</sup> Stroke: A condition in which a patient experiences sudden, immediate neurological symptoms or signs, lasting more than 24 hours, caused by a vascular cause from blood vessels and not explained by other conditions. Transient Ischemic Attack (TIA): A condition in which a patient experiences neurological symptoms or signs for less than 24 hours, caused by insufficient blood supply to the brain or nerves and not explained by other causes.<sup>10</sup>

Data collection will include various variables such as age, gender, comorbidities (hypertension, diabetes mellitus, dyslipidemia, atrial fibrillation). Severity of the stroke is assessed using the National Institute of Health Stroke Scale (NIHSS)<sup>11</sup>, calculated based on the physical examination of the patient as follows: NIHSS 0-4 points: minor, NIHSS 5-15 points: moderate, NIHSS 16-20 points: moderate to severe, and NIHSS more than 24 points: severe. Length of stay (LOS) in the hospital is calculated based on the number of days a patient receives treatment in the hospital, from admission to discharge, including returning home or transfer to another hospital. It is specifically calculated for the duration of stay at Maharaj Nakhon Ratchasima Hospital. Prolonged hospital stays were defined as a length of stay

exceeding 7 days. Functional ability is assessed on admission using the Barthel Activities of Daily Living Index (BI)<sup>12</sup> with patients divided into two groups: those with BI scores less than 75 and those with scores greater than or equal to 75. Disability level is assessed using the Modified Rankin Scale (MRS)<sup>13</sup>, with patients divided into two groups: those with MRS scores of 0-3 and those with scores greater than 3. Complications are categorized into medical and neurological complications. Medical complications include aspiration pneumonia, hospital/ventilator acquired pneumonia (HAP/VAP), urinary tract infection (UTI), pressure sores, sepsis, delirium, and congestive heart failure (CHF). Neurological complications include large infarct or malignant infarct, hemorrhagic transformation, brain herniation, and patients requiring neurological surgery.

### Statistical analysis

The data analysis was performed using the SPSS software package. Continuous variables were summarized as either mean  $\pm$  standard deviation (SD) for data that followed a normal distribution or median (range) for data that did not exhibit a normal distribution. To assess differences between groups, the student's t-test was employed for normally distributed data, while the Wilcoxon rank-sum test was used for non-normally distributed data. Categorical variables were presented as proportions, and comparisons were made using the chi-square test. Odds ratios were calculated to ascertain the factors associated with an extended hospital stay. A p-value less than 0.05 was considered statistically significant, indicating a meaningful relationship or difference between variables.

## Result

Demographic and clinical characteristic data that was shown in Table 1, revealed a total of 343

participants. Among them, 172 individuals were male, accounting for 50.1% of the sample. The mean age was 64.24 years, with a standard deviation of 14.74 years. The majority of patients were aged 60 years or older, comprising 220 individuals (64.1%), while the group with an age less than 60 years included 123 patients (35.9%). The median length of hospital stay (LOS) was 2 days, with an interquartile range (IQR) of 1-5 days.

Patients were categorized into three groups based on their hospitalization duration: 1-3 days (239 patients, 69.7%), 4-7 days (74 patients, 21.6%), and more than 7 days (30 patients, 8.7%). Common comorbidities among the stroke patients included hypertension, affecting 187 patients (54.5%), diabetes mellitus in 112 patients (32.7%), dyslipidemia in 82 patients (23.0%), and atrial fibrillation in 34 patients (9.9%).

**Table 1** Baseline characteristic (343 patients)

| Clinical profile                             | Number (%*)       |
|--|-------------------|
| <b>Sex</b>                                   |                   |
| - Male                                       | 172 (50.1%)       |
| <b>Age, Mean <math>\pm</math> SD (years)</b> | 64.24 $\pm$ 14.74 |
| - <60 years                                  | 123 (35.9%)       |
| - $\geq$ 60 years                            | 220 (64.1%)       |
| <b>Length of stay (days), Median (IQR)</b>   | 2 (1-5)           |
| - LOS 1-3                                    | 239 (69.7%)       |
| - LOS 4-7                                    | 74 (21.6%)        |
| - LOS > 7                                    | 30 (8.7%)         |
| <b>Comorbidities</b>                         |                   |
| - Hypertension                               | 187 (54.5%)       |
| - Diabetes mellitus                          | 112 (32.7%)       |
| - Dyslipidemia                               | 82 (23.0%)        |
| - Atrial fibrillation                        | 34 (9.9%)         |

Abbreviations: SD, standard deviation, IQR, interquartile range, LOS, length of stay. \* Percent from all of 343 patients.

**Table 2** Severity of the stroke is assessed using the National Institute of Health Stroke Scale (NIHSS), the Barthel Activities of Daily Living Index (BI) and disability level is assessed using the Modified Rankin Scale (MRS). (343 patients)

| Stroke related score                         | Number (%*) |
|--|-------------|
| <b>NIHSS (stroke severity), median (IQR)</b> | 3 (1-7)     |
| - NIHSS 0-4 (minor)                          | 216 (63%)   |
| - NIHSS 5-15 (moderate)                      | 94 (27.4%)  |
| - NIHSS 16-20 (moderate to severe)           | 19 (5.5%)   |
| - NIHSS $>$ 24 (severe)                      | 14 (4.1%)   |
| <b>Barthel Index, median (IQR)</b>           | 80 (50-90)  |
| - BI <75                                     | 145 (42.3%) |
| - BI $\geq$ 75                               | 198 (57.7%) |
| <b>Modified Rankin Scale, median (IQR)</b>   | 2 (1-4)     |
| - MRS 0-3                                    | 224 (65.3%) |
| - MRS $>$ 3                                  | 119 (34.7%) |

Abbreviations: NIHSS, the National Institute of Health Stroke Scale, IQR, interquartile range, BI, Barthel index of Activities of Daily Living, MRS, Modified Rankin scale. \* Percent from all of 343 patients.

In this study, the patients had NIHSS scores at the time of admission, with a median of 3, and an interquartile range (IQR) of 1-7. Most patients had a low severity level of the disease, categorized as NIHSS 0-4 (minor), which included 216 individuals (63%). There were 94 patients (27.4%) with NIHSS scores of 5-15 (moderate), 19 patients (5.5%) with NIHSS scores of 16-20 (moderate to severe), and 14 patients (4.1%) with NIHSS scores exceeding 24 (severe). The patients' ability to perform daily activities, as assessed by the Barthel Activities of

Daily Living Index (BI), had a median score of 80, with an IQR of 50-90. Patients were divided into those with low risk (BI  $\geq$ 75 points), totaling 198 individuals (57.7%). Regarding the level of disability assessed using the Modified Rankin Scale (MRS score), the median was 2, and the IQR ranged from 1 to 4. Patients were categorized into a group with low disability (MRS 0-3 score), consisting of 224 individuals (65.3%), and a group with high disability (MRS  $>$ 3 score), which included 119 individuals (34.7%) (Table 2).

**Table 3** The number of patients with dysphagia or respiratory problems. (343 patients)

| Problems                 | Number (%*) |
|--------------------------|-------------|
| - Dysphagia              | 90 (26.2%)  |
| - Endotracheal tube      | 39 (11.4%)  |
| - Tracheostomy procedure | 4 (1.2%)    |

\* Percent from all of 343 patients.

Patients in the study had dysphagia that did not meet the standard swallowing assessment criteria, totaling 90 individuals (26.2%). Among the patients, 39 required the use of an endotracheal

tube for breathing assistance (11.4%), and 4 patients underwent a tracheostomy procedure (1.2%) (Table 3).

**Table 4** Medical complications and neurological complications (343 patients)

| Complications                                      | Number (%*) |
|--|-------------|
| <b>Medical complication</b>                        |             |
| - Aspiration pneumonia                             | 39 (11.4%)  |
| - Hospital/Ventilator acquired pneumonia (HAP/VAP) | 24 (7%)     |
| - Urinary tract infection (UTI)                    | 12 (3.5%)   |
| - Pressure sore                                    | 6 (1.7%)    |
| - Sepsis   | 23 (6.7%)   |
| - Venous thromboembolism (VTE)                     | 2 (0.6%)    |
| - Delirium   | 10 (2.9%)   |
| - Congestive heart failure (CHF)                   | 21 (6.1%)   |
| <b>Neurological complications</b>                  |             |
| - Large infarct or malignant infarct               | 43 (12.5%)  |
| - Hemorrhagic transformation                       | 19 (5.5%)   |
| - Brain herniation                                 | 12 (3.5%)   |
| - Required neurological surgery                    | 2 (0.6%)    |

\* Percent from all of 343 patients.

The complications were shown in Table 4. Patients who experienced complications during their hospital stay were categorized into two main groups: those with medical complications and those with neurological complications. Among patients with medical complications, there were 39 individuals (11.4%) diagnosed with aspiration pneumonia, 24 patients (7%) with hospital/ventilator-acquired pneumonia (HAP/VAP), 12 patients (3.5%) with urinary tract infections (UTI), 6 patients (1.7%) with pressure sores, 23 patients (6.7%) with sepsis, 2 patients (0.6%) with venous thromboembolism (VTE), 10 patients (2.9%) with delirium, and 21 patients (6.1%) with congestive heart failure (CHF). These medical complications represent a spectrum

of health challenges that patients faced during their hospitalization, potentially affecting their clinical course and outcomes.

On the other hand, patients who experienced neurological complications included 43 individuals (12.5%) with large infarcts or malignant infarcts in the brain, 19 patients (5.5%) with hemorrhagic transformation resulting in bleeding within the brain due to acute ischemic stroke, 12 patients (3.5%) with brain herniation, and 2 patients (0.6%) who required neurological surgery. These neurological complications further underscore the complexity of the patients' conditions and the diverse range of challenges that healthcare providers had to manage during their hospitalization.

**Table 5** Factors associated with prolonged hospitalization in Acute Stroke Unit. (343 patients)

| Factors  | LOS 1-7 days    | LOS >7 days          | p Value | Odds Ratio<br>(95% CI) |
|--|-----------------|----------------------|---------|------------------------|
|  | (N, %*)         | (N, % <sup>+</sup> ) |         |                        |
|  | N = 313 (91.3%) | N = 30 (8.7%)        |         |                        |
| Male   | 153 (48.9%)     | 19 (63.3%)           | 0.18    |                        |
| Age >60 years  | 201 (64.2%)     | 19 (63.3%)           | 0.54    |                        |
| NIHSS >15  | 20 (6.4%)       | 13 (43.3%)           | <0.001  | 11.2 (4.8-26.3)        |
| Barthel Index (BI) <75                                 | 116 (37.1%)     | 29 (96.7%)           | <0.001  | 49.3 (6.6-366.3)       |
| <b>Comorbidities</b>                                   |                 |                      |         |                        |
| - Hypertension   | 166 (53.0%)     | 21 (70.0%)           | 0.086   |                        |
| - Diabetes mellitus                                    | 104 (33.2%)     | 8 (26.7%)            | 0.545   |                        |
| - Dyslipidemia   | 74 (23.6%)      | 8 (26.7%)            | 0.661   |                        |
| - Atrial fibrillation                                  | 21 (6.70%)      | 11 (36.7%)           | <0.001  | 7.3 (3.1-17.2)         |
| <b>Patients with dysphagia or respiratory problems</b> |                 |                      |         |                        |
| - Dysphagia  | 63 (20.1%)      | 27 (90.0%)           | <0.001  | 35.7 (10.5-121.5)      |
| - Endotracheal tube                                    | 26 (8.3%)       | 13 (43.3%)           | <0.001  | 8.4 (3.7-19.3)         |
| - Tracheostomy procedure                               | 0               | 4 (13.3%)            | <0.001  | Incalculable           |

Abbreviations: LOS, length of stay, 95% CI, 95% confidence interval, NIHSS, the National Institute of Health Stroke Scale, BI, Barthel index of Activities of Daily Living. \* Percent from 313 patients (LOS 1-7 days), <sup>+</sup> Percent from 30 patients (LOS >7 days).

The factors associated with prolonged hospital stays in this study were shown in Table 5. When dividing the length of hospital stays (LOS) into two groups, namely those with hospital stays of 0-7 days and those with longer hospital stays exceeding 7 days,

the study included 313 individuals (91.3%) in the former group and 30 individuals (8.7%) in the latter group. The associated factors were then analyzed to identify significant factors related to prolonged hospital stays.



Patient-related factors that prolonged hospital stays (LOS > 7 days) in patients with acute ischemic stroke included patients with a higher severity level of the disease, as indicated by NIHSS scores greater than 15 ( $p < 0.001$ , OR 11.2), lower abilities in performing daily activities, as indicated by a Barthel Activities of Daily Living Index (BI) score of less than 75 ( $p < 0.001$ , OR 49.3). According to patients' comorbidities, patients with atrial fibrillation (AF) were significantly associated with longer hospital stays ( $p < 0.001$ , OR 7.3). Additionally,

factors related to swallowing and respiratory problems were linked to prolonged hospital stays, including patients with dysphagia ( $p < 0.001$ , OR 35.7), patients requiring an endotracheal tube ( $p < 0.001$ , OR 8.4), and patients who underwent a tracheostomy procedure ( $p < 0.001$ ).

These findings highlight the importance of assessing and managing these factors to improve the overall care and outcomes of patients during their hospital stays.

**Table 6** Complications associated with prolonged hospitalization in Acute Stroke Unit. (343 patients)

| Complications                                      | LOS 1-7         | LOS >7               | p      | Odds Ratio        |
|--|-----------------|----------------------|--------|-------------------|
|  | (N, %*)         | (N, % <sup>+</sup> ) | Value  | (95% CI)          |
|  | N = 313 (91.3%) | N = 30 (8.7%)        |        |                   |
| <b>Medical complications</b>                       |                 |                      |        |                   |
| - Aspiration pneumonia                             | 24 (7.7%)       | 15 (50.0%)           | <0.001 | 12 (5.3-27.6)     |
| - Hospital/Ventilator acquired pneumonia (HAP/VAP) | 6 (1.9%)        | 18 (60.0%)           | <0.001 | 76.8 (25.8-228.1) |
| - Urinary tract infection (UTI)                    | 5 (1.6%)        | 7 (23.3%)            | <0.001 | 18.8 (5.5-63.7)   |
| - Pressure sore                                    | 1 (0.3%)        | 5 (16.7%)            | <0.001 | 62.4 (7-554.9)    |
| - Sepsis   | 17 (5.4%)       | 6 (20.0%)            | <0.01  | 4.4 (1.6-12.1)    |
| - Venous thromboembolism (VTE)                     | 1 (0.3%)        | 1 (3.3%)             | 0.168  |                   |
| - Delirium   | 9 (2.9%)        | 1 (3.3%)             | 0.61   |                   |
| - Congestive heart failure (CHF)                   | 12 (3.8%)       | 7 (23.3%)            | <0.001 | 10.8 (4.1-28.4)   |
| <b>Neurological complications</b>                  |                 |                      |        |                   |
| - Large infarct or malignant infarct               | 24 (76.7%)      | 19 (63.3%)           | <0.001 | 20.8 (8.9-48.2)   |
| - Hemorrhagic transformation                       | 10 (31.9%)      | 9 (30.0%)            | <0.001 | 13 (4.8-35.4)     |
| - Brain herniation                                 | 8 (25.6%)       | 4 (13.3%)            | 0.01   | 5.9 (1.7-20.8)    |
| - Required neurological surgery                    | 0               | 2 (6.7%)             | <0.01  | Incalculable      |

Abbreviations: LOS, length of stay. 95% CI, 95% confidence interval. \* Percent from 313 patients (LOS 1-7 days), <sup>+</sup> Percent from 30 patients (LOS >7 days).

Medical complications that occurred during hospitalization and were associated with longer hospital stays (LOS > 7 days) included various conditions (Table 6). Among these were aspiration pneumonia, which had a significant association with LOS > 7 days, with a p-value of less than 0.001 and an odds ratio (OR) of 12. Hospital/ventilator acquired pneumonia (HAP/VAP) was another

complication linked to longer hospital stays, with a p-value of less than 0.001 and a substantial OR of 76.8. Urinary tract infection (UTI) was also a factor, with a p-value of less than 0.001 and an OR of 18.8. Pressure sores were found to be strongly related to extended hospitalization, with a p-value of less than 0.001 and an OR of 62.4. Sepsis showed an association with LOS > 7 days, with a p-value of



less than 0.01 and an OR of 4.4. Congestive heart failure (CHF) or pulmonary edema was significantly related to longer hospital stays, with a p-value of less than 0.001 and an OR of 10.8.

Complications involving the nervous system that were associated with prolonged hospital stays (LOS > 7 days) encompassed several conditions. Large or malignant infarct, which had a p-value of less than 0.001 and an OR of 20.8, was one such condition. Hemorrhagic transformation was also significantly related to extended hospitalization, with a p-value of less than 0.001 and an OR of 13. Brain herniation showed an association with LOS > 7 days, with a p-value of 0.01 and an OR of 5.9. Additionally, patients who underwent neurological surgery were significantly linked to longer hospital stays, with a p-value of less than 0.01. These findings emphasize the importance of managing and preventing these medical complications to potentially reduce the length of hospital stays for patients with.

## Discussion

In Nakhon Ratchasima province, there is a healthcare system that provides treatment and referrals for patients within the province. General or smaller-scale hospitals in the area are equipped to care for patients with acute ischemic stroke. These hospitals have the capability to perform brain computed tomography (CT) scans and provide treatment with intravenous thrombolysis. Some of these hospitals include Theparatana Hospital (Muang District), Pakchong Nana Hospital, Phimai Hospital, Buayai Hospital, and Pakthongchai Hospital. Additionally, there are several private hospitals in the province that offer similar services.

In cases where the hospitals mentioned earlier can provide care for patients from the emergency room admission to being treated as inpatients in the stroke unit until discharge, patients do not need to be transferred to Maharat Nakhon Ratchasima Hospital. However, if a patient's condition exceeds the capabilities of these hospitals, such as having a large ischemic stroke, critical location of the ischemic stroke with a high risk of worsening symptoms, or the need for brain surgery, they will be transferred. This includes patients with unstable conditions, ischemic stroke patients with underlying heart issues, and those referred by the originating hospital for specialized care. Due to these reasons, patients receiving treatment at the stroke unit of Maharat Nakhon Ratchasima Hospital may have more severe symptoms, greater complexity, or higher risk compared to other hospitals.

This study was conducted at Maharat Nakhon Ratchasima Hospital, which is the largest and most prominent tertiary care hospital in Nakhon Ratchasima province. The acute stroke unit has the capacity to care for up to 24 beds exclusively dedicated to the management of acute ischemic stroke patients. In cases where all beds are occupied, new patients will be initially treated in either the general medical wards or the intensive care unit, depending on bed availability. However, once a patient has received a comprehensive diagnosis and a clear treatment plan, they may be transferred back to their district hospitals for continued care.

The study, titled "Factors associated with prolonged hospital stay in the stroke unit" collected data from April 1, 2023, to June 30, 2023, involving a total of 343 patients who received treatment in the acute stroke unit. The average length of hospital stay was found to be 3.43 days (IQR 1-5 days),

which was shorter compared to other studies. Most patients had a hospital stay duration of 1-3 days (239 patients or 67.7%), primarily because these patients received a comprehensive diagnosis, had clear treatment plans, stable conditions, and were sent back to their district hospitals for further care. Therefore, the findings of this study can be applied specifically to the context of large hospitals that handle complex cases and can transfer patients to district hospitals. The study also defined prolonged hospital stay as more than 7 days (LOS>7), which is similar to the study by Dabilgou AA, et al.<sup>7</sup> However, when compared to most other studies, which often define prolonged hospital stays as even longer durations, it's important to note that the majority of patients in this study had relatively short hospital stays. Using a higher cutoff point may result in a very small number of patients with longer hospital stays and may not be clinically relevant in the context of Maharat Nakhon Ratchasima Hospital.

The factor of patient gender was not found to be associated with the length of hospital stay, which is consistent with the findings of most previous studies. Age factors, specifically being older than 60 years, were also not significantly related to prolonged hospital stay, aligning with the studies by Dabilgou AA, et al.<sup>7</sup>, and Amrish Saxena, et al.<sup>5</sup> However, it's worth noting that each study may have different age cutoff points for defining significance. In the researchers' perspective, if a higher age cutoff point were used, age could potentially become a significant factor. This is because older age is often associated with more comorbidities, slower recovery compared to younger patients, and a higher likelihood of age-related medical complications.

The severity of the disease, as indicated by NIHSS scores greater than 15 points, was found to

be significantly associated with a longer hospital stay, consistent with previous studies such as the one by Ku-Chou Chang, et al.<sup>4</sup>, and Kasemsap N, et al.<sup>16</sup> NIHSS scores reflect the severity of the disease as assessed through physical examinations. Higher NIHSS scores indicate more severe brain ischemia, whether it results from a large ischemic stroke. Patients in this group are at a higher risk of both medical and neurological complications compared to those with lower disease severity.

Factors related to the patients' underlying medical conditions, such as hypertension, diabetes mellitus, and dyslipidemia, were not significantly associated with prolonged hospital stays in acute stroke unit. However, in patients with atrial fibrillation (AF), there was a significant correlation with longer hospital stays (OR = 7.3). This finding aligns with previous studies conducted by Arboix, et al.<sup>14</sup>, Songthammawat T.<sup>8</sup>, and Kasemsap N.<sup>16</sup> In patients with AF, cardioembolic stroke, which typically results in larger ischemic strokes, can occur due to the dislodgment of blood clots from the heart. These larger strokes often lead to more severe symptoms and, consequently, longer hospitalizations.

Patients with swallowing problems, known as dysphagia, as assessed by a standard swallowing screening tool, were significantly associated with longer hospital stays. This is because these patients often require the insertion of a nasogastric tube (NG tube) for nutrition, and they are at a higher risk of developing aspiration pneumonia. Additionally, patients who need an endotracheal tube for assisted breathing also tend to have longer hospital stays due to the severity of their symptoms, altered mental status, or the inability to manage their own airway.

Patients who experience medical complications such as aspiration, hospital-acquired pneumonia, or ventilator-associated pneumonia, urinary tract infections, pressure sores, sepsis, and congestive heart failure are significantly associated with longer hospital stays. This aligns with previous studies conducted by Arboix et al.<sup>14</sup>, Ku-Chou Chang et al.<sup>4</sup>, Dabilgou AA et al.<sup>7</sup>, Amrish Saxena et al.<sup>5</sup>, Songthammawat T.<sup>8</sup>, and Kasemsap N.<sup>16</sup> Patients with pneumonia, urinary tract infections, or sepsis often require infection screenings due to the presence of fever in the hospital. They may also need antibiotics and close monitoring of their response to treatment, which can contribute to prolonged hospitalization. Patients with pressure sores may need wound care. Congestive heart failure or pulmonary edema is a significant complication that can occur, particularly in patients with acute ischemic stroke who routinely receive intravenous fluid. It may lead to pulmonary edema if not properly assessed, along with a timely evaluation of heart function.

Patients with neurological complications, such as large ischemic strokes, hemorrhagic transformation, brain herniation, and those who undergo brain surgery, are at higher risk of experiencing severe complications that are often unavoidable. Therefore, it may be necessary to implement vigilant monitoring measures for high-risk patients to promptly detect and address these complications, leading to appropriate and timely treatment.

### Summary

Factors associated with prolonged hospitalization in acute stroke can be categorized into general patient-related factors and complication-related factors. Among patient-related factors, individuals

with a National Institutes of Health Stroke Scale (NIHSS) score exceeding 15, the Barthel Index less than 15, the presence of atrial fibrillation (AF) and patients struggling with dysphagia, or difficulty swallowing, also contribute to prolonged hospitalization.

On the other hand, complication-related factors associated with longer hospital stays encompass a range of issues. Patients who develop aspiration pneumonia, hospital-acquired pneumonia/ventilator-acquired pneumonia, urinary tract infections, pressure sore, sepsis, or congestive heart failure during their hospital stay often experience prolonged hospitalization. Furthermore, patients with complications related to the nervous system, such as large ischemic strokes, hemorrhagic transformation, brain herniation or those undergoing brain surgery, may also necessitate longer hospital stays due to postoperative care, rehabilitation, and management of these complex conditions.

The findings of this study underscore the importance of tailored care plans for patients with these risk factors, the implementation of preventive measures for associated complications, and the need to reduce the likelihood of unfavorable treatment outcomes and prolonged hospitalization in the stroke unit.

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