# Risk Factors for Pressure Sores in Hospitalized Acute Ischemic Stroke Patients

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*Background:* Acute ischemic stroke patients are a group at high risk for pressure sores. It is important to identify risk factors for pressure sores in acute ischemic stroke patients in order to facilitate early adoption of appropriate preventive and treatment measures. *Methods:* Data were derived from the China National Stroke Registry. Acute ischemic stroke patients aged >18 years who presented at the hospital within 14 days after the onset of symptoms were eligible for this study. Comprehensive baseline data were collected. The definition of pressure sores was based on assessment at discharge of whether the patient had pressure sores at any time during hospitalization. *Results:* 12,415 patients with a mean age of 67 years and a mean length of hospitalization of 14 days were included in the study. Among these patients, 97 (0.8%) had pressure sores during hospitalization. In the multivariate analysis of risk factors for pressure sores, age (each increment of 5 years), being unmarried, NIHSS at admission (each increment of 3 points), mRS at admission (3-5 points), diabetes mellitus, hemoglobin at admission (each incremental reduction of 10 units), and history of peripheral vascular disease all were significantly correlated with the occurrence of pressure sores among acute ischemic stroke patients during hospitalization. *Conclusions:* Old age, severe neurological disability, being unmarried, low hemoglobin, and history of diabetes mellitus and peripheral vascular disease were risk factors for pressure sores in acute ischemic stroke patients.

**Key Words:** Risk factors—pressure sores—acute ischemic stroke—occurrence



## Introduction

Pressure sores, also termed pressure ulcers and bedsores, refer to localized injury to the skin and/or soft tissue caused by long-term or strong pressure (including shear force and/or abrasion with pressure).[1,2] Pressure sores commonly affect the areas around bone protuberances. Stroke patients are a group at high risk for pressure sores. Pressure sores are not only painful, they restrict patients' movement, and may lead to infection and poor nutrition.[3-5] As well as affecting stroke prognosis, pressure sores may also increase intensive nursing time, length of hospitalization, and medical expenditures.[6-8] It is important to identify risk factors for pressure sores in stroke patients in order to facilitate early adoption of appropriate preventive and treatment measures. This study used data from the China National Stroke Registry (CNSR) to determine the risk factors for the development of pressure sores in hospitalized acute ischemic stroke patients.

## Methods

### *Study Population*

Data were derived from CNSR, a nationwide prospective registry of 21,902 consecutive patients with a diagnosis of ischemic stroke, intracerebral hemorrhage, or transient ischemic attack (TIA) from 132 hospitals in China between September 2007 and August 2008. Details

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of the rationale, design, and baseline studies using the CNSR have been published.[9] The validity of CNSR database had been favorably evaluated, and research articles based on it had been accepted in prominent scientific journals worldwide.[10-14] Data on demographics, clinical characteristics, complications during hospitalization, and outcomes at 3, 6, and 12 month follow-up visits were collected. The collection of data for the CNSR study was approved by the ethics committees of all participating hospitals. Written informed consent was obtained from all patients or their legal representatives.

Acute ischemic stroke patients aged >18 years who presented at the hospital within 14 days after the onset of symptoms were eligible for this study. Acute ischemic stroke was diagnosed according to the World Health Organization criteria[15] and confirmed by brain computerized tomography or magnetic resonance imaging. Acute ischemic stroke was diagnosed when the following conditions were met: acute occurrence within 14 days of neurologic deficit, with focal or overall involvement of the nervous system, lasting for >24 hours and after excluding nonvascular causes (primary and metastatic neoplasms, postseizure paralysis, head trauma, etc.) that led to brain function deficit, and excluding intracerebral hemorrhage by computed tomography or magnetic resonance imaging.

The definition of pressure sores in the CNSR database adopted that issued by the US National Pressure Ulcer Advisory Panel (NPUAP) in 2007.[1] The definition of pressure sores in our study was based on assessment at discharge of whether the patient had pressure sores at any time during hospitalization. Baseline data used in analysis included sex, age, marital status, hypertension, diabetes mellitus, dyslipidemia, coronary heart disease, peripheral vascular disease, atrial fibrillation/atrial flutter, history of TIA or stroke, history of smoking, history of drinking, family history of stroke, NIH Stroke Scale/Score (NIHSS), a weighted score of stroke severity, modified Rankin Scale (mRS), a score of poststroke dependency, glucose index, hemoglobin index, and body mass index (BMI) when first seeking medical attention.

### *Statistical Analysis*

Categorical variables were analyzed using the chi-squared test, with normally distributed continuous variables analyzed using the t-test when having a normal distribution, and non-normally distributed data analyzed using the Kruskal-Wallis test. This study compared the baseline and demographic characteristics, stroke risk factors, NIHSS at admission, glucose at admission, hemoglobin index, and BMI of stroke patients with and without pressure sores during hospitalization. Univariate analysis was first performed to find factors correlated with pressure sores during hospitalization, and binary logistic regression was then used to perform multivariate analysis to identify independent risk factors for pressure sores. All variables found to have a $P$ value of less than 0.05 in univariate analysis were entered into this model, and the variables selected on the basis of maximum-likelihood value and statistical significance were subjected to forward stepwise regression. The primary endpoint was the occurrence of pressure sores in acute ischemic stroke patients during hospitalization.

## Results

### 1. Baseline data of acute ischemic stroke patients

Among the 21,902 patients in the CNSR database, 12,415 were diagnosed with acute ischemic stroke, had complete baseline data, and had completed pressure sore assessment during hospitalization. These patients had a mean age of 67 (57-75) years, and a mean length of hospitalization of 14 days (11-20 days). Among these patients, 97 (0.8%) had pressure sores during hospitalization. Table 1 displays baseline data of the 12,415 patients in the groups with and without pressure sores. Statistically significant differences were found between groups in age, sex, marital status, NIHSS and mRS at admission, diabetes mellitus, peripheral vascular disease, coronary heart disease, atrial fibrillation/atrial flutter, history of TIA or stroke, history of smoking and drinking, and blood glucose and hemoglobin values at admission.

### 2. Assessment of risk factors for pressure sores during hospitalization (results of univariate analysis)

Table 2 shows the results of univariate analysis of factors correlated with patients' pressure sores during hospitalization. These results indicate statistically significant differences between groups in age, sex, marital status, NIHSS and mRS at admission, diabetes mellitus, peripheral vascular disease, coronary heart disease, atrial fibrillation/atrial flutter, history of TIA or stroke, current smoking status, blood glucose at admission, and hemoglobin level.

### 3. Assessment of risk factors for pressure sores during hospitalization (results of multivariate analysis)

In the multivariate analysis of risk factors for pressure sores, according to the results of univariate analysis, correction factors included age, sex, marital status, hypertension, diabetes mellitus, dyslipidemia, peripheral vascular disease, coronary heart disease, atrial fibrillation/atrial flutter, stroke history, NIHSS at admission, mRS at admission, blood glucose at admission, hemoglobin index, and BMI. The results in Table 3 indicated that age (each increment of 5 years), being unmarried, NIHSS at admission (each increment of

**Table 1.** *Baseline data of acute ischemic stroke patients with and without pressure sores during hospitalization*

| | Cases (n = 12,415, %) | No pressure sore group (n = 12,318, %) | Pressure sore group (n = 97, %) | *P* value |
|---|---|---|---|---|
| Mean NIHSS at admission (interquartile range) | 4 (2-9) | 4 (2-9) | 18 (9-25) | .0001 |
| Mean mRS at admission (3-5 points) | 635 (5.1) | 609 (4.9) | 26 (26.8) | .0001 |
| Mean length of hospitalization (interquartile range) | 14 (11-20) | 14 (11-20) | 20 (9-34) | <.0001 |
| Mean age (interquartile range) | 67 (57-75) | 67 (57-75) | 75 (68-80) | .001 |
| Sex (male) | 7658 (61.6%) | 7613 (61.8) | 45 (46.4) | .001 |
| Marital status (married) | 11089 (89.8) | 11016 (89.9) | 73 (75.3) | .0001 |
| Hypertension | 7909 (63.7) | 7843 (63.7) | 66 (68.0) | .372 |
| Diabetes mellitus | 2677 (21.6) | 2640 (21.4) | 37 (38.1) | .0001 |
| Dyslipidemia | 1390 (11.2) | 1382 (11.2) | 8 (8.2) | .355 |
| Peripheral vascular disease | 77 (0.6) | 72 (0.6) | 5 (5.2) | .0001 |
| Coronary heart disease | 1792 (14.4) | 1769 (14.4) | 23 (23.7) | .009 |
| Atrial fibrillation/atrial flutter | 918 (7.4) | 901 (7.3) | 17 (17.5) | .0001 |
| History of TIA or stroke | 4234 (34.1) | 4177 (33.9) | 57 (58.8) | .001 |
| Current smoker | 4934 (39.8) | 4910 (39.9) | 24 (24.7) | .0024 |
| Heavy drinker | 1171 (9.4) | 1169 (9.5) | 2 (2.1) | .013 |
| BMI (≤24) | 6815 (60.9) | 6763 (60.8) | 52 (69.3) | .321 |
| (25-30) | 3788 (33.8) | 3768 (33.9) | 20 (26.7) | |
| (≥30) | 592 (5.3) | 589 (5.3) | 3 (4.0) | |
| Blood glucose at admission (mmol/L) | 6.77 ± 2.36 | 6.76 ± 2.35 | 7.69 ± 3.27 | .0001 |
| Hemoglobin after admission (g/L) | 137.05 ± 19.28 | 137.14 ± 19.21 | 126.49 ± 23.65 | .0001 |

Abbreviations: BMI, body mass index; mRS, modified Rankin Scale; NIHSS, NIH Stroke Scale/Score; TIA, transient ischemic attack.

**Table 2.** *Results of univariate analysis of the occurrence of pressure sores among hospitalized acute ischemic stroke patients (n = 12,415)*

| | OR | 95% CI | *P* value |
|---|---|---|---|
| Age (each increment of 5 years) | 1.38 | (1.25-1.52) | <.0001 |
| Sex-female | 1.87 | (1.25-2.79) | .002 |
| Unmarried | 2.93 | (1.84-4.66) | <.0001 |
| NIHSS at admission (each increment of 3 points) | 1.34 | (1.32-1.46) | <.0001 |
| mRS at admission (3-5 points) | 7.041 | (4.46-11.12) | <.0001 |
| Hypertension | 1.22 | (0.79-1.86) | .37 |
| Diabetes mellitus | 2.26 | (1.50-3.41) | .0001 |
| Dyslipidemia | 0.71 | (0.34-1.45) | .36 |
| BMI (≥30) | 0.66 | (0.21-2.22) | .490 |
| Peripheral vascular disease | 9.24 | (3.65-23.41) | <.0001 |
| Coronary heart disease | 1.85 | (1.16-2.97) | .01 |
| Atrial fibrillation/atrial flutter | 2.69 | (1.59-4.57) | .0002 |
| History of TIA or stroke | 2.78 | (1.85-4.17) | <.0001 |
| Current smoker | 0.50 | (0.31-0.79) | .003 |
| Heavy drinker* | 0.20 | (0.049-0.82) | .912 |
| Hemoglobin (each incremental reduction of 10 units) | 1.26 | (1.15-1.34) | <.0001 |
| Elevated glucose at admission | 0.891 | (0.851-0.932) | <.0001 |

Abbreviations: BMI, body mass index; CI, confidence interval; mRS, modified Rankin Scale; NIHSS, NIH Stroke Scale/Score; OR, adds ratio; TIA, transient ischemic attack.

*Heavy Drinker: >=5 standard alcohol intake per day and more than 5 drinks per week.

3 points), mRS at admission (3-5 points), diabetes, hemoglobin at admission (each incremental reduction of 10 units), and history of peripheral vascular disease all were significantly correlated with the occurrence of pressure sores among acute ischemic stroke patients during hospitalization.

**Table 3.** *Results of multivariate logistic regression analysis of the risk factors for the occurrence of pressure sores in acute ischemic stroke patients during hospitalization*

| | OR value | 95% CI | *P* value |
|---|---|---|---|
| Age (each increment of 5 years) | 1.156 | (1.03-1.98) | .0136 |
| Unmarried status | 1.953 | (1.103-3.458) | .02 |
| NIHSS at admission (each increment of 3 points) | 1.34 | (1.26-1.43) | <.0001 |
| mRS at admission (3-5 points) | 2.101 | (1.19-3.72) | .01 |
| Diabetes mellitus | 2.445 | (1.45-4.11) | .0008 |
| Hemoglobin at admission (each incremental reduction of 10 units) | 1.18 | (1.06-1.31) | .003 |
| Peripheral vascular disease | 7.49 | (2.63-21.40) | .0002 |

Abbreviations: BMI, body mass index; CI, confidence interval; mRS, modified Rankin Scale; NIHSS, NIH Stroke Scale/Score; OR, adds ratio; TIA, transient ischemic attack.

## Discussion

The results of this study indicated that age (each increment of 5 years), being unmarried, NIHSS at admission (each increment of 3 points), mRS at admission (3-5 points), diabetes mellitus, hemoglobin at admission (each incremental reduction of 10 units), and history of peripheral vascular disease are risk factors for pressure sores during hospitalization for acute ischemic stroke. This result suggests that an overall evaluation of these factors should be performed during the clinical nursing assessment process; if intensive nursing care can be directed toward patients with these risk factors, the development of pressure sores may be reduced or eliminated.

Bed sores, also known as pressure ulcers, were renamed pressure sores by the US NPUAP in 2016,[2] and are currently listed as an important indicator of quality nursing care in patients hospitalized for cerebrovascular disease. However, few large-sample studies have analyzed the risk factors for pressure sores among stroke patients. The CNSR database is currently China's largest database of patients hospitalized for acute stroke, and the current study is the largest-sample investigation of the occurrence of pressure sores and risk factors among patients hospitalized for acute ischemic stroke in China. While the occurrence of pressure sores among hospitalized acute ischemic stroke patients in China was lower than expected, this result may be due to the fact that this study assessed only sores during the period of hospitalization (a relatively short period) and the NIHSS scores of the population as a whole were relatively low (mean NIHSS score at admission of persons with no pressure sores was 4). Another reason may be that the medical staff of Chinese hospitals paid more attention to the early care of stroke patients than before.

The development of pressure sores in stroke patients is a process involving numerous factors. As a consequence, clarifying the various risk factors and their roles in the occurrence of pressure sores will help in preventing pressure sores in stroke patients. In this study, a history of peripheral vascular disease was a risk factor, which suggests that nurses should pay particular attention to stroke patients with peripheral vascular disease. The results of this study also indicated that, while diabetes mellitus is also a risk factor for pressure sores among patients with acute ischemic stroke, elevated glucose at admission was not correlated with pressure sores, which suggests that the damage caused by long-term blood glucose abnormalities are closely connected with pressure sores. The effect of diabetes mellitus on pressure sores may be associated with diabetic neuropathy and vascular pathologies; neuropathy reduces patients' sensitivity to pain, and vascular pathologies may result in poor microcirculation in tissue, which promotes the formation of pressure sores.[16,17] While the effect of body weight and obesity on the formation of pressure sores has received considerable attention, the findings of previous studies have been inconsistent; although some studies have concluded that both obesity and an excessively low body weight are risk factors for pressure sores, others have concluded that the increased fat layer of obese patients tends to protect the skin and prevent the formation of pressure sores.[18,19] Rather than body weight, BMI should be a more precise risk factor for pressure sores.[5] This study performed various levels of analysis on the effect of BMI but found that, in all cases, baseline BMI was not correlated with pressure sores. For its part, each increase of 3 in NIHSS score increased the likelihood of pressure sores. This result suggests that, in stroke patients, impaired neurological function has a greater effect on patients' movements and pressure sores than BMI. This study also found that low hemoglobin at admission (each incremental reduction of 10 units) is also a risk factor for pressure sores, a finding not reported in previous studies.

The limitations of this study include the following: (1) Since this study constituted a retrospective investigation, the collection of data concerning factors affecting the occurrence of pressure sores may be inadequate; such factors may also have included state of nutrition (such as albumin level) and use of specific drugs (such as sedatives). (2) We looked only at the presence of pressure sores at any time during the hospitalization, without regard for when sores developed. A more detailed assessment could determine the days of hospitalization on which pressure sores are mostly likely to develop. Such information would help nurses increase their vigilance on days when patients are most at risk.

## Supplementary Materials

Supplementary data to this article can be found online at doi:10.1016/j.jstrokecerebrovasdis.2019.02.033.

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