Comparison of hospital complications and mortality for stroke patients treated by male vs female physicians: a propensity-score matched study

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Abstract

Background: The association between physician gender and the outcomes of stroke patients is not yet fully understood. The aim of this study was to evaluate outcomes after stroke hospitalization between patients who received female physicians' care (FPC) vs male physicians' care (MPC). **Methods:** We used Taiwan's National Health Insurance Research Database 2000-2009 claims data to conduct a stroke cohort study that included 493,223 hospitalized stroke patients. Using a matching procedure by propensity score, we selected 25,160 stroke patients with FPC and 25,160 stroke patients with MPC for comparison. Logistic regression was used to calculate the adjusted odds ratios (ORs) and 95% confidence intervals (CIs) of poststroke complications and in-hospital mortality between patients with FPC and MPC. **Results:** Compared with patients with MPC, stroke patients with FPC had significantly lower risks of poststroke pneumonia (OR 0.87, 95% CI 0.81-0.94), septicemia (0.79, 95% CI 0.70-0.88), acute renal failure (OR 0.78, 95% CI 0.65-0.95), admission to the intensive care unit (OR 0.73, 95% CI 0.69-0.77), and 30-day in-hospital mortality (OR 0.64, 95% CI 0.55-0.75). However, the risk of urinary tract infection (OR 1.16, 95% CI 1.09-1.23) was higher in patients with FPC than in those with MPC. Lower rates of poststroke adverse events in patients with FPC were noted in further analysis, including different morbidities and various types of stroke. **Conclusions:** Stroke patients with FPC showed reduced complications and mortality compared with MPC patients. Our findings warrant randomized control trials in the future to validate the influence of physician gender on stroke outcomes.

Background

With an estimation of 16.9 million incident strokes annually and 33 million stroke survivors worldwide, stroke remains the second-leading cause of death and the third-leading cause of disability-adjusted life-years in 2010 [1,2]. Stroke outcomes varied, and the sequelae of stroke were different among patients. Various factors are associated with stroke prognosis, the most important of which include age, sex, mean arterial pressure, comorbid conditions (including history of diabetes, baseline glucose levels, current smoking, atrial fibrillation, and statin intake before stroke), stroke severity, stroke mechanism and location, clinical findings, and related complications [3,4]. Advanced interventions such as thrombolysis, endovascular thrombectomy, hemostatic therapy, minimally invasive surgery, stroke unit care, and rehabilitation contribute to substantial improvement in the recovery of stroke patients [5,6]. In addition, hospital volume and physicians' experience also influence stroke outcomes [7,8].

Several studies have suggested differences in outcomes between patients receiving female physician's care (FPC) and those receiving male physician's care (MPC) [9-12]. In hospitalized elderly patients, care provided by female internists resulted in lower mortality and readmission rates than care provided by their male colleagues [9]. In the management of type 2 diabetes patients, female physicians provide better quality of care and risk management [10]. However, this difference might not be uniform across different patients. Physician gender did not influence the delivery outcomes of nulliparous women or the outcomes of elderly surgical patients [11,12]. Such differences in stroke patients have not yet been investigated. Previous studies focusing on the outcomes between patients with FPC and MPC were limited by relatively

small sample sizes [11], inadequate control of confounding bias [11], lack of matching by propensity score and limited generalizability [9-12].

In Western countries, women comprise nearly half of medical personnel, and they devote their efforts toward fields encompassing all aspects of care [13]. The number of women who decide to dedicate themselves to specialist training programs has recently been increasing [14]. Although the number of female physicians is rising, a gender difference remains among neurologists, given that only 26.9% of neurologists with medical practices in the United States are women [15]. In Taiwan, only 23.7% of neurologists with medical practices are women in 2018.

The association between physician gender and the outcomes of stroke patients is not yet fully understood. Using the claims data of the National Health Insurance in Taiwan, we conducted a population-based matched cohort study to compare the complications, mortality, and medical consumption between hospitalized stroke patients with FPC and MPC.

Methods

Source of data

The National Health Insurance was implemented in Taiwan since 1995, covering almost 23 million residents. Details of this insurance database and related available information have been described in our previous studies [16-18]. In brief, the claims data of Taiwan's National Health Insurance included records of all beneficiaries' medical services, including inpatient and outpatient demographics, primary and secondary diagnoses, procedures, prescriptions and medical expenditures. The validity of this database has been favorably evaluated, and research articles based on these data have been accepted in prominent scientific journals worldwide [16-18]. The guidelines of the Helsinki Declaration were obeyed during the execution of this study. This study was evaluated and approved by the joint institutional review boards of Taipei Medical University (TMU-JIRB-201701050) and E-DA Hospital (EDA-JIRB-2017144).

Study design

From the database of Taiwan's National Health Insurance, we identified 493,223 patients with stroke hospitalizations in 2000-2009, 10.2% (n=50,522) of whom received FPC. To obtain the appropriate number of study subjects, we used a propensity-score matching technique (case-control ratio=1:1) to select 25,160 hospitalized stroke patients with FPC and 25,160 patients with MPC. We compared the complications, mortality, intensive care, length of hospital stay, and medical expenditures during stroke hospitalization between patients with FPC and MPC.

Measures and definition

The status of low income was defined by the criteria from the Bureau of National Health Insurance in Taiwan. Previous medical use and medical conditions before stroke hospitalization were considered to be potential covariates in this study, as well as the number of emergency visits and hospitalizations. Based

on the administration and the *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)*, coexisting medical conditions were determined from medical claims for the 24-month preadmission period, including hypertension (*ICD-9-CM* 401-405), diabetes (*ICD-9-CM* 250), hyperlipidemia, mental disorders (*ICD-9-CM* 290-319), ischemic heart disease, heart failure, chronic obstructive pulmonary disease (*ICD-9-CM* 491, 492, 496), liver cirrhosis (*ICD-9-CM* 571.2, 571.5, 571.6), end-stage renal disease (D8 and D9), and cancer (*ICD-9-CM* 140-208). Types of stroke were also identified by the *ICD-9-CM* codes, including subarachnoid hemorrhage (*ICD-9-CM* 430), intracerebral hemorrhage (*ICD-9-CM* 431), other and unspecified intracranial hemorrhage (*ICD-9-CM* 432), occlusion and stenosis of precerebral arteries (*ICD-9-CM* 433), occlusion of cerebral arteries (*ICD-9-CM* 434), transient cerebral ischemia (*ICD-9-CM* 435), acute but ill-defined cerebrovascular disease (*ICD-9-CM* 436), other and ill-defined cerebrovascular disease (*ICD-9-CM* 437), and late effects of cerebrovascular disease (*ICD-9-CM* 438). Complications (such as pneumonia [*ICD-9-CM* 480-486], septicemia [*ICD-9-CM* 038 and 998.5], and urinary tract infection [*ICD-9-CM* 599.0]), mortality, length of hospital stay, and medical expenditures during stroke hospitalization were considered to be study outcomes.

Statistical analysis

We used propensity score-matched pair analysis to examine the associations between physician gender and outcomes of stroke hospitalization. A non-parsimonious multivariable logistic regression model was used to estimate a propensity score for patients with FPC or MPC. Covariates in this model included age, sex, low income, types of stroke, hypertension, diabetes, mental disorders, ischemic heart disease, chronic obstructive pulmonary disease, cancer, hyperlipidemia, heart failure, liver cirrhosis, renal dialysis, Charlson comorbidity index, hospital volume, emergency visits, hospitalizations, physician age, and physician division. We matched the patients with FPC to patients with MPC using a greedy matching algorithm (without replacement) with a caliper width of 0.2 SDs of the log odds of the estimated propensity score. Categorical variables between stroke patients with FPC and MPC were analyzed using frequencies (percentages) and chi-square tests. Continuous variables between stroke patients with FPC and MPC are presented as the means $\pm$ standard deviations and were analyzed using t-tests. We used logistic regression to calculate the adjusted odds ratios (ORs) and 95% confidence intervals (CIs) of the outcomes of stroke hospitalization associated with physician gender. In addition, subgroup analysis was used to stratify the subjects according to age, sex, number of medical conditions, and type of stroke to examine the outcomes of stroke hospitalization between patients with and without FPC in these strata.

Results

The baseline characteristics of hospitalized stroke patients are shown in Table 1. Under the propensity score matching procedure (Table 2), there were no significant differences in age, sex, low-income status, hospital volume, stroke type, number of hospitalizations, emergency visits, hypertension, diabetes, mental disorders, ischemic heart disease, chronic obstructive pulmonary disease, cancer, hyperlipidemia, heart failure, liver cirrhosis, renal dialysis, Charlson comorbidity index, physician age and physician division between stroke patients with MPC and FPC.

Compared with patients with MPC (Table 3), patients with FPC had lower risks of poststroke pneumonia (OR 0.87, 95% CI 0.81-0.94), septicemia (0.79, 95% CI 0.70-0.88), acute renal failure (OR 0.78, 95% CI 0.65-0.95), admission to the intensive care unit (OR 0.73, 95% CI 0.69-0.77), and 30-day in-hospital mortality (OR 0.64, 95% CI 0.55-0.75). However, the length of hospital stay was also higher in patients with FPC than in those with MPC (mean $\pm$ SD, 12.0 $\pm$ 11.2 days vs 10.4 $\pm$ 11.1 days; $p < .0001$). Even without the use of the matching procedure by propensity score (Supplementary Table 1), the complications and mortality after stroke were also associated with physician gender.

In Table 4, the stratification analysis shows that FPC was associated with reduced poststroke adverse events (including pneumonia, septicemia, acute renal failure, intensive care, and 30-day mortality) among the following demographic groups: men (OR 0.73, 95% CI 0.69-0.78), women (OR 0.79, 95% CI 0.73-0.85), patients aged 20-49 years (OR, 95% CI), patients aged 50-59 years (OR 0.77, 95% CI 0.68-0.86), patients aged 60-69 years (OR 0.69, 95% CI 0.62-0.76), patients aged 70-79 years (OR 0.77, 95% CI 0.70-0.84), and patients aged ≥ 80 years (OR 0.83, 95% CI 0.74-0.92). The association between FPC and reduced poststroke adverse events was significant in stroke patients with 0 medical conditions (OR 0.78, 95% CI 0.73-0.84), 1 medical condition (OR 0.74, 95% CI 0.69-0.80), 2 medical conditions (OR 0.84, 95% CI 0.74-0.96), 0 hospitalizations (OR 0.75, 95% CI 0.71-0.79), ≥ 1 medical condition (OR 0.77, 95% CI 0.67-0.88), 0 emergency visits (OR 0.77, 95% CI 0.72-0.81), 1 emergency visit (OR 0.73, 95% CI 0.66-0.80), and ≥ 2 emergency visits (OR 0.73, 95% CI 0.63-0.84). This relationship was also found in patients with ischemic stroke (OR 0.79, 95% CI 0.75-0.84), hemorrhagic stroke (OR 0.62, 95% CI 0.56-0.69) and other stroke (OR 0.73, 95% CI 0.56-0.96) and among patients in low- (OR 0.80, 95% CI 0.68-0.93), medium- (OR 0.77, 95% CI 0.71-0.84), and high-volume (OR 0.74, 95% CI 0.69-0.79) hospitals.

Discussion

In this nationwide retrospective cohort study matched by propensity score, stroke patients with FPC had the following characteristics compared to stroke patients with MPC: lower 30-day mortality; lower risk of pneumonia, septicemia, and acute renal failure; and shorter length of intensive care. We also found that FPC was associated with a reduced number of adverse events after stroke admission across a variety of conditions (e.g., patient age, medical utilization condition, physician age, and hospital volume) and patients' severity of illness (e.g., CCI score and medical condition).

According to previously published studies, several factors influence the outcomes of stroke patients. The type of stroke is an important factor associated with stroke outcomes [19]. Patients' baseline characteristics, including age, gender, age, sociodemographic data (level of urbanization and low-income status), and medical conditions (such as hypertension, diabetes, mental disorder, ischemic heart disease, COPD, cancer, heart failure, hyperlipidemia, liver cirrhosis, renal dialysis, and Charlson comorbidity index), were considered traditional factors that impacted stroke outcomes [20,21]. Hospital characteristics (hospital volume) and medical resource utilization (number of hospitalizations and emergency visits) might also influence the outcomes of stroke patients [7,22]. The characteristics of medical institutes might also play a role in the impact on the outcomes of stroke patients [8,23]. Physician age and division

were also analyzed in our study. All the factors listed above could potentially influence the results; thus, we used the propensity score-matched pair model to reduce such confounding effects in this study. We further performed multiple logistic regressions to adjust for residual confounding bias.

In addition to the factors listed above, physician gender may play an important role in the influence of stroke patients' outcomes. Here, we propose a possible hypothesis to explain the findings of this study. First, in traditional Chinese culture, women are considered to be the main family caregiver, while men are expected to work hard and earn money to support their families. Therefore, male physicians had better success in advancing in their careers than did female physicians [24]. In work settings, male physicians spend much more time playing several roles, including those focused on teaching, research, administration management, and social activities. It is possible that male physicians might have less time than female physicians to dedicate to patient care. In the work setting of Chinese hospitals, female physicians are minorities, and their male colleagues sometimes help to do patient care. It is reasonable to hypothesize that female physicians might have fewer patients with relatively uncomplicated cases. Second, physician gender might affect his or her workload, and thus, the workload burden might play a role in stroke patients' outcomes. In the United States, female physicians might have a lighter workload so that they can have more time with individual patients [25]. In Taiwan or Asian countries, limited information is available regarding this indicator. Given the previous description of traditional Chinese culture, it is reasonable to assume that Taiwanese female physicians might have a lighter workload and more time to care for individual patients. Third, physician gender might influence their provision of medical care to their patients. Female physicians were shown to have better communication than male physicians. Female physicians' communication could be considered more patient-centered, focused on building an active partnership, having positive and emotionally intelligent conversation, providing psychosocial counseling and opportunities to ask questions, and allowing for a longer length of time for visits and consultations [26,27]. Female physicians also showed more empathy to their patients [28]. Fourth, female physicians were more proactive in screening and prevention [29-31]. Patients of female physicians were significantly more likely to receive care that was consistent with guidelines and were more likely to seek help from other specialists [32,33]. Finally, female and male physicians might have distinct methods of evaluating risk and making decisions [34]. In earlier reports, breast cancer patients might have different suggestions and medical advice for surgical and adjuvant radiation therapy [35]. All the previously mentioned factors might contribute to differences in the outcomes of stroke patients based on physician gender. Our research showed that stroke patients with FPC had better outcomes during the index hospitalization. Inconsistent results were observed in other fields of medical specialties in previous studies [9,11,12]. In obstetric nulliparous women who underwent a trial of labor, the outcome was similar among physicians of both genders [11]. In patients who received nonelective surgeries, including a wide range of surgeries (such as orthopedic, urologic, and general surgery), postoperative mortality was not associated with the surgeon's gender [12]. In contrast to surgical patients, elderly inpatients receiving medical care from female internists had better outcomes (including mortality and readmission rates) than those who received care from male internists [9]. Patients with chronic conditions, such as diabetes, had a comprehensive preferred quality of care when they received their care

from female physicians. Patients of female physicians had significantly superior progress in approaching the optimal levels of HbA1c, LDL cholesterol, and blood pressure [10]. Further studies are necessary to determine why such gender disparities emerged.

Some study limitations should be noted when the results of this study are interpreted. First, our insurance-based study lacks information on laboratory examinations, image findings, patient lifestyle (such as alcohol consumption, smoking habits, body mass index and physical activity levels) and stroke severity (such as measurements from the National Institutes of Health Stroke Scale or the Barthel Index). Second, the residual confounding bias could not be excluded from this study, although we used matching methods by propensity score to balance the baseline characteristics between stroke patients receiving care from male and female physicians. Third, our results were limited to 30-day in-hospital mortality and associated adverse events. Whether such a difference could extend to a longer period was not determined and requires further investigation. Additionally, patients' neurological and functional recovery was not evaluated in this study.

Conclusions

In conclusion, we found that hospitalized stroke patients who received care from female physicians had fewer complications, less intensive care, and lower 30-day mortality than did patients who received care from male physicians. We suggested that randomized clinical trials could provide direct evidence for the association between physician gender and stroke outcomes.

List Of Abbreviations

CI, confidence interval; ICD-9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification; OR, odds ratio.

Declarations

Ethics approval and consent to participate: This study was evaluated and approved by the joint institutional review boards of Taipei Medical University (TMU-JIRB-201701050) and E-DA Hospital (EDA-JIRB-2017144).

Consent for publication: Not applicable.

Availability of data and materials: The datasets used and/or analyzed during the current study are available from the Ministry of Health and Welfare, Taiwan on research application.

Competing interests: The authors declare that they have no competing interests.

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