

# Sex Differences in Acute Stroke Care in a Statewide Stroke Registry

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**Background and Purpose**—Many studies have reported poorer stroke outcomes in women, and some studies have reported sex differences in care. We analyzed data from a hospital-based stroke registry to determine whether acute stroke care and discharge status differed by sex.

**Methods**—Detailed chart-level information was collected on 2566 subjects admitted for acute stroke or transient ischemic attack to 15 Michigan hospitals in 2002. Sex differences in stroke care and patient status at discharge (in-hospital mortality and modified Rankin Scale score) were assessed after adjusting for differences in demographics, clinical characteristics, and comorbidities by multivariable models. Modified Rankin Scale score data were analyzed by proportional-odds models.

**Results**—Women were older than men (70 vs 67 years) and were more likely to have congestive heart failure and hypertension. Men were more likely to smoke and have a history of heart disease and dyslipidemia. After multivariable adjustment, women were less likely to receive thrombolytic therapy (odds ratio [OR]=0.56; 95% CI, 0.37 to 0.86) or lipid testing (OR=0.76; 95% CI, 0.61 to 0.94) and were more likely to suffer urinary tract infections (OR=2.57; 95% CI, 1.87 to 3.54). In-hospital mortality was similar in women and men (9% vs 8%); however, women had poorer discharge modified Rankin Scale scores (OR=1.17; 95% CI, 1.01 to 1.35).

**Conclusions**—Although considerable parity exists in many aspects of acute stroke care, women were less likely than men to receive thrombolytic treatment and lipid testing, even after adjustment. However, given the largely similar care observed, it is unlikely that differences in care explain the poorer functional outcomes in female stroke survivors. (*Stroke*. 2008;39:24-29.)

**Key Words:** diagnosis ■ quality of health care ■ sex ■ stroke registries ■ thrombolytic therapy

Stroke is a leading cause of death in the United States, ranking third for females and fourth for males. Although age-adjusted stroke mortality rates are similar for men and women, women have a higher overall crude stroke mortality rate (68.2 vs 44.2 per 100 000 in 2002).<sup>1</sup> One large population-based study found a higher case fatality 1 year after stroke in men 65 years and older,<sup>2</sup> whereas a large European study found that men were more likely to survive to 28 and 90 days after stroke.<sup>3</sup> However, other registry-based studies have found no significant differences in stroke survival by sex.<sup>4,5</sup>

Several studies have found that women who survive stroke have less favorable outcomes than men. Women are less likely to be discharged home<sup>2,4,5</sup> and are more likely to have impairments and activity limitations on follow-up.<sup>3,5-7</sup> Women may experience more mental impairment,<sup>4</sup> depression,<sup>8</sup> and fatigue<sup>9</sup> and have a lower overall quality of life<sup>10</sup> than men after stroke. In cohort-based studies, various investigators have found sex differences in stroke symptoms and past medical history.<sup>4,5,11,12</sup> For example, women with stroke have been found to have more atrial fibrillation (AF)<sup>3,5,13</sup> and hypertension,<sup>3,5</sup> whereas men have been found to have more

heart disease<sup>5</sup> and diabetes.<sup>2</sup> Although stroke occurs at a later age in women, adjustment for age and these other sex differences in medical history and presentation generally have not eliminated the differences in the outcomes noted.

Many publications that have focused on sex differences in care for acute myocardial infarction and coronary artery disease (reviewed in Sheifer et al<sup>14</sup>) have found that women are less likely to receive referrals for revascularization procedures or to receive medications indicated on evidence-based guidelines. If women receive systematically inferior stroke care, such a disparity could contribute to their poorer outcomes. Several stroke-related studies, including some in the United States, have found sex differences in the use of echocardiography, carotid imaging, and endarterectomy.<sup>3,15-18</sup> In a Canadian registry, women were less likely to be seen by a stroke team or have their lipids assessed.<sup>5</sup> Data from Scottish primary-care practices showed that the use of antiplatelet drugs and statins was lower in women stroke survivors, as was warfarin among those with AF.<sup>19</sup> These findings prompted us to examine data from a statewide hospital-based stroke registry for evidence of systematically different care for female stroke patients.

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## Subjects and Methods

### Registry Design

The Michigan Acute Stroke Care Overview and Treatment Surveillance System (MASCOTS) was a statewide, hospital-based, acute stroke registry prototype for the Paul Coverdell National Acute Stroke Registry.<sup>20</sup> Details of the design of the MASCOTS registry have been published previously.<sup>20,21</sup> A single-stage cluster design that used a modified stratified sampling regimen was implemented to obtain a representative statewide sample of 16 Michigan hospitals. Human subject approval was obtained from each hospital's institutional review board.

### Data Collection

Acute stroke admissions were prospectively identified at each hospital during a 6-month period in 2002 by trained stroke clinical coordinators. A standardized data collection instrument was developed to obtain information on demographics, prehospital care, prestroke ambulatory status, in-hospital procedures, past medical history, evidence of poor prognosis (ie, terminal/comfort care, life expectancy <6 months, or extensive/metastatic cancer), discharge status, and secondary prevention interventions. Modified Rankin Scale (mRS) score at discharge was determined on the basis of a comprehensive chart review. In a separate reliability study, we found that these mRS determinations had excellent interrater reliability (intraclass correlation coefficient=0.8). Site coordinators were instructed to collect specific information on the decision to treat with intravenous recombinant tissue plasminogen activator (rt-PA) at the time of the initial Emergency Department evaluation. This included the documentation of up to 21 potential contraindications, including aspects of patient history, stroke characteristics, physiologic status, computed tomography findings, patient refusal, and inability to obtain consent. All other data, including in-hospital procedures, treatments, contraindications to anticoagulant and antithrombotic treatment, and discharge instructions, were abstracted retrospectively. To ensure the accuracy and uniformity of data collection across the sites, the data coordinators attended an initial training session and had access to technical support throughout the study. All data submitted to the main study center underwent an extensive series of quality and logic checks.

### Statistical Analysis

All statistical analyses were conducted with SAS version 9.1.3 (Statistical Analysis Software). Comparisons between men and women with respect to categorical variables were made by  $\chi^2$  analysis. Comparisons of treatments were restricted to relevant subsets of eligible patients.

Confounding was controlled through unadjusted, age-adjusted, and multivariable logistic modeling. Generalized estimating equations models were developed to account for the potential for care and outcomes to be correlated within hospitals. For the multivariable logistic models, all demographic and clinical characteristics that were found to differ by sex were included, ie, age, history of heart disease, hypertension, dyslipidemia, congestive heart failure, smoking status, and prestroke ambulatory status. Because the relation of age with some outcomes may not be linear, higher-order age terms (ie, age<sup>2</sup>) were considered in all multivariable models and retained if statistically significant. To test whether the expectation of short-term survival influenced rt-PA treatment decisions, these analyses were repeated after excluding subjects with documented evidence of a poor prognosis. Age and sex interaction effects on rt-PA were also explored.

For the mRS, comparison between men and women across the full range of scores was assessed with the Cochran-Mantel-Haenszel test with modified Ridit scores to account for ordered categories.<sup>22</sup> To assess whether patient status at discharge differed by sex across the entire spectrum of the mRS, proportional-odds models were developed, which excluded subjects who died in hospital (ie, mRS scores of 0 to 5). Because the assumption of proportional odds, ie, the assumption that a common odds ratio [OR] exists across all possible cutpoints of the mRS, was met for sex but was violated for some

potential covariates, a partial proportional-odds model was developed with the use of PROC GENMOD.<sup>22</sup> In a partial proportional-odds model, a common OR based on cumulative logits across all possible cutpoints of an ordinal scale is generated for the primary variable of interest while the effects of other covariates are allowed to differ across the levels of outcome.<sup>22</sup> Because of the complexities of fitting the partial proportional-odds model, a parsimonious approach to adjustment was taken, wherein covariates were only retained if they meaningfully confounded the association between sex and mRS (this was defined a priori as an alteration in the OR for sex by at least 5%).

## Results

Fifty-three percent (n=1381) of the 2566 registry subjects were female. Many demographic and clinical characteristics measured at baseline differed by sex (Table 1). As expected, women were older than men, with a notably higher proportion in the  $\geq 80$  age group (31.5% vs 20.1%). Women were less likely to smoke and to have heart disease or dyslipidemia but were more likely to have congestive heart failure and hypertension and be nonambulatory before their strokes. No statistically significant sex differences were apparent for race, stroke subtype, or prior medical histories of stroke, AF, or diabetes. Female stroke survivors were more likely than men to have documented evidence of a poor prognosis (22% vs 18%,  $\chi^2=8.61$ ,  $df=1$ ,  $P<0.01$ ), indicating clinical circumstances consistent with a life expectancy of <6 months.

Among 834 and 750 female and male subjects with ischemic stroke, women were less likely than men to receive rt-PA (2.4% vs 4.4%, Table 2). Likewise, among 81 women and 99 men with ischemic stroke who arrived <2 hours after symptom onset and had no contraindications to rt-PA, a lower percentage of women received treatment (18.5% vs 28.3%, Table 2). The predominant reason listed for nontreatment was time >3 hours from symptom onset (82% of men and 85% for women). Documented reasons for nontreatment did not differ significantly by sex ( $\chi^2=3.3$ ,  $df=4$ ,  $P=0.25$ ). On the basis of unadjusted analyses, women were less likely to receive cardiac monitoring, lipids investigation, and echocardiography during their hospital stay (Table 2). When all possible procedures used to investigate the cerebrovasculature were considered, women were marginally significantly less likely than men to have an examination. Although no sex difference was observed for duplex ultrasound, a lower proportion of women received angiography compared with men. During hospitalization, women were equally likely as men to receive warfarin for AF, antithrombotic treatments, prophylaxis against deep vein thrombosis, and dysphagia screening. No sex difference was evident for having a neurologist involved in care (79.1% for women and 81.5% for men,  $P=0.12$ ).

Rates of complications due to deep vein thrombosis or pulmonary embolism were similar by sex, but a larger proportion of women than men experienced a urinary tract infection (UTI; 11.1% vs 4.3%, Table 3). Few differences in discharge procedures were evident. Among patients who survived to discharge, a lower proportion of women than men were discharged home (53% vs 59%). However, neither in-hospital mortality rates (9% of women vs 8% of men) nor length of stay differed significantly by sex.

**Table 1. Comparison of Demographic and Clinical Characteristics of MASCOTS Registry Subjects by Sex**

|                             | Male |        | Female |        | <i>P</i> Value* |
|-----------------------------|------|--------|--------|--------|-----------------|
|                             | No.  | %      | No.    | %      |                 |
| Total                       | 1185 | 46.2   | 1381   | 53.8   |                 |
| Age, y                      |      |        |        |        |                 |
| Mean (SD)                   | 66.6 | (14.9) | 70.0   | (15.6) |                 |
| 18–49                       | 173  | 14.6   | 165    | 12.0   | <0.0001         |
| 50–59                       | 198  | 16.7   | 182    | 13.2   |                 |
| 60–69                       | 235  | 19.8   | 232    | 16.8   |                 |
| 70–79                       | 341  | 28.8   | 367    | 26.6   |                 |
| 80+                         | 238  | 20.1   | 435    | 31.5   |                 |
| Race                        |      |        |        |        |                 |
| Black                       | 184  | 15.5   | 218    | 15.8   | 0.91            |
| Other                       | 43   | 3.6    | 43     | 3.1    |                 |
| White                       | 895  | 75.5   | 1046   | 75.7   |                 |
| No data                     | 63   | 5.3    | 74     | 5.4    |                 |
| Stroke subtype†             |      |        |        |        |                 |
| Ischemic stroke             | 751  | 63.4   | 834    | 60.4   | 0.30            |
| Hemorrhagic stroke          | 209  | 17.6   | 265    | 19.2   |                 |
| Transient ischemic attack   | 225  | 19.0   | 282    | 20.4   |                 |
| Past medical history        |      |        |        |        |                 |
| Stroke                      | 404  | 34.1   | 487    | 35.3   | 0.53            |
| Heart disease               | 455  | 38.4   | 381    | 27.6   | <0.0001         |
| AF                          | 153  | 12.9   | 202    | 14.6   | 0.21            |
| Congestive heart failure    | 122  | 10.3   | 198    | 14.3   | <0.01           |
| Diabetes mellitus           | 313  | 26.4   | 363    | 26.3   | 0.94            |
| Hypertension                | 784  | 66.2   | 975    | 70.6   | 0.02            |
| Dyslipidemia                | 371  | 31.3   | 371    | 26.9   | 0.01            |
| Current smoker              | 325  | 27.4   | 290    | 21.0   | <0.001          |
| Prestroke ambulatory status |      |        |        |        |                 |
| Ambulatory                  | 1074 | 90.6   | 1200   | 86.9   | <0.01           |
| Nonambulatory               | 54   | 4.6    | 96     | 7.0    |                 |
| Not documented              | 57   | 4.8    | 85     | 6.2    |                 |

\*Unadjusted *P* value from  $\chi^2$  test.

†Ischemic stroke includes ischemic stroke of uncertain duration. Hemorrhagic stroke includes intracerebral hemorrhage, subarachnoid hemorrhage, and hemorrhagic stroke of uncertain type.

Results of the multivariable analyses are presented in Table 4. After adjustment, most of the associations with sex were attenuated and became nonsignificant (the majority of these changes were noted after age adjustment alone; data not shown). The odds of having lipids tested remained lower for women than for men (OR=0.76), and women had greater odds of experiencing a UTI (OR=2.57). Women had lower odds of receiving rt-PA, even after adjustment and restriction to subjects who arrived within 2 hours after symptom onset with no documented contraindications. Exclusion of patients with a poor prognosis increased the magnitude of this difference (OR=0.37; 95% CI, 0.25 to 0.55). Among subjects presenting within 2 hours of

**Table 2. Thrombolytic Treatment, In-Hospital Treatments, and In-Hospital Procedures by Sex Among MASCOTS Registry Subjects**

|                                   | Male |      | Female |      | <i>P</i> Value* |
|-----------------------------------|------|------|--------|------|-----------------|
|                                   | No.  | %    | No.    | %    |                 |
| Thrombolytic treatment            |      |      |        |      |                 |
| rt-PA†                            | 33   | 4.4  | 20     | 2.4  | 0.03            |
| rt-PA, <2 h‡                      | 28   | 28.3 | 15     | 18.5 | 0.13            |
| In-hospital treatments            |      |      |        |      |                 |
| Warfarin§                         | 75   | 57.3 | 101    | 60.8 | 0.53            |
| Antithrombotic treatment          | 930  | 95.5 | 1048   | 94.0 | 0.13            |
| Deep vein thrombosis prophylaxis¶ | 421  | 35.7 | 529    | 38.4 | 0.15            |
| In-hospital procedures            |      |      |        |      |                 |
| Cardiac monitor                   | 723  | 61.2 | 787    | 57.1 | 0.04            |
| Lipids investigated               | 499  | 51.2 | 464    | 41.6 | <0.0001         |
| Cerebrovasculature investigated#  | 935  | 79.2 | 1048   | 76.1 | 0.06            |
| Duplex ultrasound                 | 613  | 51.9 | 722    | 52.4 | 0.80            |
| Angiography**                     | 517  | 43.8 | 541    | 39.3 | 0.02            |
| Screening for dysphagia††         | 405  | 42.4 | 500    | 45.6 | 0.14            |
| Echocardiography                  | 783  | 66.3 | 859    | 62.3 | 0.04            |

\**P* value from  $\chi^2$  test.

†Restricted to subjects with ischemic stroke.

‡Restricted to subjects with ischemic stroke who arrived &lt;2 h after symptom onset and had no documented contraindications.

§Restricted to subjects who had AF present in the hospital and had no documented contraindications.

||Restricted to subjects who had ischemic stroke or transient ischemic attack.

¶Clinical interventions within 48 h in nonambulatory patients.

#Underwent at least 1 of the following: duplex ultrasound, magnetic resonance angiography, computed tomography angiography, cerebral angiography, or transcranial Doppler.

\*\*Underwent magnetic resonance angiography, computed tomography angiography, or cerebral angiography.

††Restricted to subjects who did not have transient ischemic attack.

symptom onset with no contraindications, an interaction between sex and age was statistically significant ( $P<0.01$ ). In subjects <75 years, women were significantly less likely to receive rt-PA (OR=0.15; 95% CI, 0.04 to 0.60) compared with men, whereas in older subjects there was no statistically significant sex difference in treatment (OR=1.63; 95% CI, 0.46 to 5.82 for women vs men).

The mRS scores at discharge in women were shifted in the direction of poorer outcomes ( $P<0.001$  by Cochran-Mantel-Haenszel test; the Figure). In the unadjusted proportional-odds model, this corresponded to a proportional OR of 1.29 (95% CI, 1.12 to 1.49), indicating that women had 29% greater odds of an unfavorable outcome at all possible dichotomizations. Of all potential confounders tested, only age, age<sup>2</sup>, and prestroke ambulatory status had any meaningful effect on the magnitude of this association. After adjustment for these variables, female stroke survivors still had poorer functional status (proportional OR=1.17; 95% CI,

**Table 3. Complications, Discharge Procedures, and Outcomes by Sex Among MASCOTS Registry Subjects**

|   | Male |      | Female |      | P Value* |
|---|------|------|--------|------|----------|
|   | No.  | %    | No.    | %    |          |
| Complications                               |      |      |        |      |          |
| Deep vein thrombosis/<br>pulmonary embolism | 15   | 1.3  | 20     | 1.5  | 0.69     |
| Pneumonia†                                  | 67   | 5.7  | 79     | 5.7  | 0.95     |
| UTI†  | 51   | 4.3  | 153    | 11.1 | <0.0001  |
| Discharge treatments                        |      |      |        |      |          |
| Anticoagulant medication‡                   | 54   | 83.1 | 74     | 86.1 | 0.62     |
| Antithrombotic medication§                  | 859  | 94.7 | 959    | 95.0 | 0.74     |
| Smoking counseling                          | 76   | 25.1 | 72     | 26.4 | 0.72     |
| Lipid-lowering therapy¶                     | 336  | 35.9 | 339    | 31.7 | 0.05     |
| Antihypertensive medication**               | 612  | 85.5 | 747    | 83.8 | 0.37     |
| Antidiabetic medication**                   | 235  | 81.3 | 272    | 79.8 | 0.62     |
| Outcomes                                    |      |      |        |      |          |
| Discharged home††                           | 507  | 59.4 | 510    | 52.8 | <.01     |
| Died in hospital                            | 98   | 8.3  | 124    | 9.0  | 0.52     |
| Length of stay >4 d                         | 553  | 46.8 | 659    | 47.8 | 0.61     |

\*P value from  $\chi^2$  test.

†Defined as new-onset events requiring treatment with antibiotics.

‡Restricted to subjects who had AF present in the hospital and had no documented contraindications to anticoagulant use.

§Restricted to subjects who had ischemic stroke or transient ischemic attack and no contraindications to antithrombotics.

||Restricted to current smokers.

¶Restricted to subjects who had ischemic stroke or transient ischemic attack.

\*\*Restricted to subjects with a past medical history of the relevant condition.

††Among subjects discharged alive.

1.01 to 1.35), although the effect was clearly attenuated after adjustment.

## Discussion

In this analysis of data from a statewide acute stroke registry, we found that women hospitalized for stroke had significantly lower odds of receiving rt-PA treatment and lipid investigation and had substantially higher odds of experiencing a UTI. We also found that female stroke survivors had poorer functional status at hospital discharge than male survivors as measured by the mRS, whereas in-hospital mortality was equivalent for both sexes.

After adjusting for age and comorbidities, we found that women had about half the odds of receiving thrombolysis<sup>23</sup> compared with men, and this finding remained after we restricted the analysis to subjects arriving within a narrow (<2-hour) time window. This disparity was greatest among subjects <75 years and was actually strengthened after excluding subjects with documented evidence of poor short-term survival prognosis. Clearly, the discrepancy in rt-PA use observed in the MASCOTS registry was not driven by the greater proportion of aged or terminally ill subjects among women, so other factors must be at play. A large study of community hospitals found a trend toward lower rt-PA use in women,<sup>24</sup> but rates of thrombolysis have been found to be

**Table 4. Unadjusted and Adjusted ORs\* for Selected Hospital Procedures, Complications, Secondary Prevention Measures, and Outcomes by Sex**

|  | Unadjusted<br>Female vs Male |             | Adjusted†<br>Female vs Male |             |
|--|------------------------------|-------------|-----------------------------|-------------|
|  | OR*                          | 95% CI      | OR*                         | 95% CI      |
| <b>Thrombolytic treatment</b>            |                              |             |                             |             |
| rt-PA‡                                   | 0.52                         | (0.35–0.77) | 0.56                        | (0.37–0.86) |
| rt-PA, <2 h§                             | 0.53                         | (0.36–0.78) | 0.54                        | (0.34–0.86) |
| Warfarin if AF present in hospital       | 1.16                         | (0.69–1.94) | 1.41                        | (0.87–2.28) |
| <b>Antithrombotic treatment</b>          |                              |             |                             |             |
| Antithrombotic treatment                 | 0.74                         | (0.53–1.02) | 0.93                        | (0.70–1.24) |
| Deep vein thrombosis prophylaxis         | 1.10                         | (0.90–1.34) | 1.09                        | (0.90–1.32) |
| Cardiac monitor (AF investigated)        | 0.85                         | (0.72–0.99) | 0.89                        | (0.75–1.05) |
| Lipids investigated                      | 0.68                         | (0.57–0.83) | 0.76                        | (0.61–0.94) |
| Angiography                              | 0.83                         | (0.72–0.96) | 0.94                        | (0.82–1.07) |
| Dysphagia screening                      | 1.15                         | (0.99–1.33) | 1.07                        | (0.91–1.24) |
| Echocardiography                         | 0.83                         | (0.72–0.96) | 0.90                        | (0.75–1.08) |
| Pneumonia                                | 1.01                         | (0.79–1.29) | 0.93                        | (0.67–1.29) |
| UTI                                      | 2.78                         | (2.05–3.76) | 2.57                        | (1.87–3.54) |
| Anticoagulants at discharge              | 1.15                         | (0.61–2.18) | 1.24                        | (0.60–2.55) |
| Antithrombotics at discharge             | 1.08                         | (0.77–1.53) | 1.26                        | (0.87–1.81) |
| Smoking counseling                       | 1.12                         | (0.83–1.51) | 1.23                        | (0.89–1.69) |
| Lipid-lowering therapy at discharge      | 0.84                         | (0.69–1.02) | 0.96                        | (0.75–1.23) |
| Antihypertensive medication at discharge | 0.89                         | (0.69–1.12) | 0.95                        | (0.76–1.18) |
| Antidiabetes medication at discharge     | 0.90                         | (0.68–1.21) | 0.97                        | (0.71–1.32) |
| Discharged home                          | 0.76                         | (0.61–0.95) | 0.86                        | (0.69–1.08) |
| In-hospital mortality                    | 1.10                         | (0.85–1.43) | 1.00                        | (0.74–1.33) |

Note: All models are subset to the same relevant subgroups detailed in the footnotes to Tables 2 and 3.

\*ORs and 95% CIs from generalized estimating equations models adjusting for correlated care within hospitals.

†Adjusted for age, history of heart disease, hypertension, dyslipidemia, congestive heart failure, smoking status at time of stroke, and prestroke ambulatory status.

‡Includes all subjects with ischemic stroke.

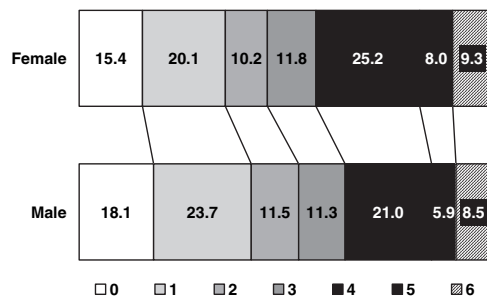
§Restricted to subjects with ischemic stroke who arrived <2 h after symptom onset and had no documented contraindications.

||Restricted to subjects with ischemic stroke or transient ischemic attack.

similar for men and women in other studies.<sup>5,25</sup> It has been suggested that sex differences in symptoms at presentation may create treatment delays for women,<sup>12</sup> and future analyses from the MASCOTS registry will address this possibility. We would also suggest that efforts to understand these differences should be undertaken in the context of improving the low rates of rt-PA utilization among all eligible patients, regardless of sex.

In adjusted models, we found that women were less likely than men to receive lipids testing in the hospital, although there was no difference in lipid treatment rates at discharge. As with rt-PA, we repeated this analysis after excluding patients with a





**Figure.** Distribution of mRS scores at discharge by sex.  $P < 0.001$  for mean score difference between men and women, Cochran-Mantel-Haenszel statistic with modified Riddit scores.

poor prognosis, but the adjusted OR did not change appreciably. A Canadian registry also found that women were less likely to have lipids investigated in hospital.<sup>5</sup>

In unadjusted analyses, we found that a number of other diagnostic procedures were performed less often on women, including cardiac monitoring, angiography, and echocardiography; however, these differences disappeared after further adjustment. In many cases, the apparent unadjusted sex differences in acute stroke management were strongly confounded by age, suggesting that the sex differences in management may reflect age-related differences in decision making. Age probably incorporates a range of influences, including extenuating circumstances related to comorbid conditions and patient preferences. At least 2 other studies in the United States have found that women with stroke receive fewer diagnostic procedures: a Corpus Christi, Tex, study found that women were less likely to receive echocardiography and carotid imaging,<sup>18</sup> and analysis of administrative data in Connecticut found lower angiography rates in women.<sup>15</sup> A European stroke registry found that women received less brain imaging, carotid ultrasound, and echocardiography.<sup>3</sup>

Various studies have found that women have poorer functional stroke outcomes. A large European study found that women were more likely to have a poor outcome (mRS score of 2 to 5) 3 months after stroke but found no differences in mortality.<sup>3</sup> In the Canadian registry, no sex difference in in-hospital mortality was found, but women who survived to discharge were slightly more likely than men to have a poor mRS at discharge (score of 4 to 5, 30% vs 26%).<sup>5</sup> Because we assessed the full range of mRS scores, we were able to extend these findings to conclude that mRS scores for female survivors are shifted in the direction of poorer scores (proportional OR=1.17). Although our results are comparable with other studies that have assessed mRS at hospital discharge, the sex differences are small compared with those of studies that have assessed longer-term outcome.<sup>3,4,6</sup> As we have previously reported on a subset of registry subjects who were followed up at 90 days after discharge, women were less than half as likely to experience recovery in activities of daily living as defined by a Barthel Index score of at least 95.<sup>26</sup> It appears that the sex difference in stroke outcome may widen in the months after hospital discharge. The relatively small magnitude of the sex difference found in discharge mRS in the MASCOTS registry

could possibly be explained by stroke severity or other physiologic derangement not collected in this registry.

We found that women had 2.5 times greater odds of experiencing a UTI compared with men. Our overall prevalence of UTI (8%) was similar to that found in a study of stroke complications.<sup>27</sup> Other studies have found that women in intensive care settings are more prone to UTIs than men,<sup>28</sup> and among intensive care patients who develop sepsis, women are more likely than men to have bacteria from a genitourinary source.<sup>29</sup> In a tertiary analysis of data from the GAIN trial, UTI acquired within 7 days of stroke onset was shown to increase the odds of a poor outcome at 3 months as measured by a Barthel Index  $< 60$  (OR=1.9) and Rankin Scale score  $\geq 2$  (OR=3.1) after adjusting for baseline prognostic variables.<sup>30</sup> Thus, our observed sex difference in UTIs occurring in hospital has the potential to explain some of the sex differences in stroke recovery, and efforts at UTI prevention may present an opportunity to improve stroke outcomes for women.

Several of the sex differences in demographic and clinical characteristics identified in this analysis are similar to those found in other studies. It is well known that women are, on average, older than men at stroke onset. The mean age difference in our data (66.6 vs 70.0 years) was comparable to that in many other studies. We also found that women were more likely to have a history of hypertension,<sup>2,3,5,19</sup> or congestive heart failure,<sup>2</sup> corroborating findings from other studies. Not surprisingly, we also found that men were more likely to have a history of heart disease,<sup>3,5,19</sup> were more likely to smoke,<sup>3</sup> and were more likely to have a documented history of dyslipidemia.<sup>5</sup> We did not find statistically significant differences in race or in past medical history of stroke, AF, or diabetes mellitus, although other studies have found that men were more likely to have prior stroke<sup>5</sup> and diabetes<sup>5,19</sup> and that women were more likely to have AF.<sup>2,3,5,13</sup> We found no evidence of a sex difference in stroke subtype, measured by the broad categories of ischemic stroke, hemorrhagic stroke, and transient ischemic attack. However, other studies that have used other categorization systems have found sex differences in stroke type. In general, men have been found to have more ischemic strokes,<sup>3,5,19</sup> whereas women were found to have more infarctions involving the anterior circulation and subarachnoid hemorrhages.<sup>5,13</sup>

This registry study has some limitations. The National Institutes of Health Stroke Scale was poorly documented; therefore, we were unable to adjust for stroke severity in these analyses. Some studies have found that women have more severe strokes, more coma, or a lower level of consciousness on admission,<sup>3,13,31</sup> whereas others have found no sex differences in stroke severity<sup>3-6</sup>; thus, it is unclear as to whether stroke severity would confound the findings observed in this study. Similarly, information on physiologic parameters were not collected by the registry; information on blood pressure, temperature, and blood glucose could shed light on possible biologic bases for sex differences in stroke outcomes and recovery and perhaps enhance our understanding of the disparity in rt-PA use. In addition, our information on prestroke functional status was limited to ambulatory status and would not adequately capture subtler aspects of prestroke status, such as frailty. The strengths of this study stem from

the fact that the MASCOTS registry was designed to track the quality of acute stroke care in a representative statewide sample of hospitals. Acute stroke admissions were prospectively identified, and careful attention was paid to the quality of data collected. The study was therefore well equipped to consider detailed information on many aspects of acute stroke care and management. We believe that these results have high internal validity and are generalizable to Michigan and elsewhere in the United States.

In conclusion, we found that women who survive stroke have poorer mRS scores at discharge, are more likely to experience UTIs in hospital, and are less likely to receive thrombolytic therapy and lipids investigation. All of the other sex differences observed in the unadjusted analyses were found to be primarily explained by women's greater age. Overall, we did not find evidence of major differences in the quality of care based on patient sex. Thus, as evidence that women experience poorer recovery after stroke accumulates,<sup>3,6,26</sup> it seems unlikely that discrepant use of procedures, treatments, and secondary prevention measures is a major cause.

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### Disclosures

None.

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