One of the most important advances in the treatment of stroke is the routine management of patients on stroke care units (SCUs). Randomized controlled trials and meta-analyses have consistently shown that stroke units are the only intervention that decreases both death and dependency. Importantly, this intervention improves stroke patient outcomes irrespective of characteristics, such as age and subtype of ischemic stroke, and it does not have an impact on length of stay (LOS) in hospital. Hence, American, Canadian, and European guidelines declare that all hospitalized stroke patients be treated in SCUs. The critical components of an inpatient SCU that are required to see these benefits have been debated, but it is generally accepted that a SCU must, at minimum, be a geographically defined hospital unit where patient care is provided by a multidisciplinary team that exclusively manages stroke patients.

Despite the strong evidence supporting the benefits of organized SCU, a significant proportion of Canadian stroke patients still do not receive it. Recently, the Canadian Stroke Network published a national audit of patients admitted with stroke to acute care hospitals between 2008 and 2009. This audit showed that only 23% of Canadian patients (n=34,735) were admitted to a SCU at any time during their hospitalization, and even at centers having SCUs, only 47% of strokes were treated on a SCU. Increasing access to SCUs is even more of a challenge in lower- and middle-income countries. It has been suggested that in an optimal model of a SCU, 80% of hospitalized patients would receive at least part of their care in a SCU. To achieve this target both nationally and globally, SCUs will need to be expanded to smaller hospitals and sites with limited access to resources such as advanced neuroimaging. The extent to which SCUs will have an impact on outcomes in these smaller Canadian hospitals is not as well characterized.

The primary objective of this study was to examine the change in patient outcomes >6 years in a smaller (<350 beds) community hospital in Edmonton, Canada, before and after the implementation of a SCU. Unlike many previous

### Background and Purpose
Geographically distinct multidisciplinary stroke care units (SCUs) have been shown by systematic reviews to have superior patient outcomes compared with conventional care in general medical wards. However, the effectiveness of SCUs in smaller North American community hospitals is less well defined. The objective of this study was to determine the impact of establishing a specialized SCU at a community hospital on patient outcomes.

### Methods
This is a retrospective cohort study of 805 patients with stroke admitted to 2 community hospitals in Edmonton, Canada, from 2003 to 2009 using an administrative database. Stroke was identified by International Classification of Disease, 10th Edition, codes. One of the community hospitals established a SCU on January 1, 2007. This date was used to subdivide the patient population into 2 cohorts: phase 1 from 2003 to 2006 and phase 2 from 2007 to 2009. Outcomes measured were mortality, discharge disposition, length of stay, and complications and were adjusted for age, sex, and medical comorbidities.

### Results
Patient mortality decreased significantly from 17.1% to 8.3% (adjusted odds ratio [OR], 0.54; 95% confidence interval [CI], 0.31–0.95) after SCU implementation, whereas it remained ≈19% at the control hospital. SCU also increased the odds that patients would be discharged home independently (adjusted OR, 2.17; 95% CI, 1.49–3.15; P<0.001) without increasing length of stay.

### Conclusions
Establishing a SCU in a community hospital not only increases the survival of stroke patients, but also the proportion of patients discharged home to live independently. The benefits of SCU reported in larger tertiary centers extend to smaller community hospitals with more limited resources. (Stroke. 2014;45:00-00.)

**Key Words:** hospital units ■ outcome assessment (health care) ■ stroke (acute)
observational studies, the intervention is compared with a closely matched control hospital in the same healthcare organization that continued to manage stroke patients on a general medical unit throughout the same study period. This allowed for determination of the impact of stroke unit care while adjusting for secular trends in stroke care.

Methods

Study Design

This is a retrospective cohort study of stroke patients treated at 2 urban community hospitals, the Grey Nuns (GNH) and Misericordia (MCH), from 2003 to 2009. The Human Research Ethics Board at the University of Alberta approved the study design. The study hospitals are located in Edmonton, Alberta (≈20 km apart), which is a metropolitan area with a population of 1.1 million. The hospitals are part of the same healthcare organization (Covenant Health) and with similar numbers of beds (347 beds for GNH and 306 beds at MCH). Laboratory, medical imaging, and other infrastructure are equivalent between sites. Neither hospital has on-site neurosurgical or neuroradiological services.

In phase 1 (2003–2006), stroke patients were cared for in general medical wards by internists at both sites. In 2007 at the start of phase 2, a SCU was established at the GNH. Phase 2 stroke patients admitted to the GNH received acute care and rehabilitation on a geographically defined 10-bed comprehensive SCU by a multidisciplinary team that included stroke neurologists (Figure). The resources available at each hospital before and after SCU implementation are summarized according to European Stroke Organization (ESO) criteria in Table 1. There was no change in the model of stroke care at the MCH during phase 2. There was a lag in the development of an acute stroke pathway, which was established at the end of phase 2 at the GNH. During the study period, hyperacute stroke patients were diverted at the prehospital level to a tertiary hospital with intravenous tissue plasminogen activator (tPA) capability. tPA was administered at the prehospital level to a tertiary hospital with intravenous tissue plasminogen activator (tPA) capability. tPA was administered to <1% of cases at both sites during the study.

Stroke patients were identified from a discharge abstract database using standard validated stroke International Classification of Disease, 10th Edition, definitions (H34.1, I63.x, I64.x, I61.x, I60.x, G45.x). Patient characteristics (age, sex, and medical comorbidities) were also collected. Comorbid conditions were classified according to European Stroke Organization (ESO) criteria in Table 1. There was no change in the model of stroke care at the MCH during phase 2. There was a lag in the development of an acute stroke pathway, which was established at the end of phase 2 at the GNH. During the study period, hyperacute stroke patients were diverted at the prehospital level to a tertiary hospital with intravenous tissue plasminogen activator (tPA) capability. tPA was administered to <1% of cases at both sites during the study.

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Patient outcomes at 2 community hospitals during a study period were subdivided into 2 phases (number of patients indicated in parentheses). Phase 2 (black arrow) started in January 2007 with the establishment of a stroke care unit (SCU) at the GNH. GNH indicates Grey Nuns; and MCH, Misericordia.

Results

Patient Characteristics

Nine hundred eighty-three patients were admitted to the 2 hospitals between 2003 and 2009 with diagnoses of hemorrhagic (10.2%), ischemic stroke (71.6%), and TIA (10.2%). An a priori decision was made to exclude 178 patients with TIA from the analysis. The baseline characteristics of the remaining 805 patients with stroke admitted to the 2 hospitals during the 2 phases of the study are shown in Table 2. Women accounted for 51.3% of patients. Across both phases, the overall patient volumes were higher at the GNH compared with the MCH (510 versus 295). With the implementation of the SCU, there was a decrease in the mean age of admitted stroke patients (from 74.1 to 70.1 years; P=0.001). Patients admitted at the GNH also had less medical comorbidities in phase 2 as indicated by the drop in the numbers of patients with a modified Deyo–Charlson score ≥2 from 29.8% to 19.9% (P=0.004). The proportion admitted with hemorrhagic strokes in each phase ranged between 11.8% and 13.4% and did not significantly change over study phases. Other comorbidities listed were similar between hospitals, with the exception being the proportion of patients with dementia and congestive heart failure, which dropped at the GNH during phase 2.

Patient Outcomes

Patient outcomes including mortality, discharge disposition, complications, and LOS are summarized in Table 3. With implementation of the stroke unit at GNH, the median LOS decreased from 12 to 8 days (P=0.027). The median LOS at MCH also dropped in phase 2 from 14 to 8 days; however, this did not reach significance (P=0.136). Complication rates at the MCH did not change during the study period. In contrast, the rate of developing pneumonia during hospitalization decreased by ≥50% with SCU implementation (from 10.2% to 5.3%; P=0.037; Table 3). In-hospital stroke mortality at the MCH remained constant (18.8% to 19.4%), whereas SCU at the GNH was associated with an 8.8% absolute decrease in mortality (from 17.1% to 8.3%; P<0.05).

Multivariate logistic regression was used to calculate the OR adjusted for age, sex, and medical comorbidities. SCU significantly reduced in-hospital mortality (adjusted OR, 0.54; 95% confidence interval [CI], 0.31–0.95; P=0.035) and also resulted in a >2-fold increase in the odds of discharging home or home with support (adjusted OR, 2.17; 95% CI, 1.49–3.15; P=0.001). At the study hospital without SCU, there were no significant changes in outcomes in the multivariate analysis.

Statistics

Statistical analyses were performed using Stata 12.1 (StataCorp, TX) software. Univariate comparisons of continuous variables were performed using t tests. χ² test was used for categorical variables. We compared outcomes across the 2 phases of the study for each hospital using multivariable logistic regression analyses adjusted for age, sex, and comorbidities (dichotomized Charlson index). The primary study outcome was in-hospital case mortality. Other outcomes examined included favorable discharge disposition (defined as home or home with support) and LOS (dichotomized using median of 8 days). In multivariate regression models, we also fitted the interaction term of hospital by phase to determine if these differences in patient outcomes between study phases were modified by site of hospitalization. The significance level for all tests was set at P<0.05.
Table 3 shows the proportion of stroke patients that were discharged home (with and without support) by hospital across the 2 phases of the study. In phase 1, 39.2% and 41.6% of patients were discharged home from the MCH and GNH, respectively. In phase 2, this increased to 61.5% at the site with SCU, whereas at the site without SCU, discharges increased by 4.6%. This difference between hospitals between the 2 study phases is reflected in the interaction term (hospital
by phase). Adjusting for comorbidities, the hospital by phase interaction was significant for discharges home, including home with support ($P=0.04$), and approached but did not achieve significance for in-hospital mortality ($P=0.06$).

**Discussion**

The results of this study show that establishing a comprehensive SCU in a smaller Canadian community hospital reduced in-hospital case fatality from 17% to 8%. This is comparable with previous observational studies and exceeds that reported from larger (>1000 beds) tertiary Canadian hospitals. Furthermore, SCU resulted in a 2.2-fold increase in the odds that hospitalized stroke patients would be discharged home without increasing LOS.

One advantage of this study compared with similarly designed single-site studies of SCU outcomes is that we

### Table 2. Patient Characteristics and Comorbidities

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>GNH Phase I (no SCU)</th>
<th>P Value</th>
<th>GNH Phase II (SCU)</th>
<th>P Value</th>
<th>MCH Phase I (no SCU)</th>
<th>P Value</th>
<th>MCH Phase II (no SCU)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients</td>
<td>245</td>
<td>265</td>
<td></td>
<td></td>
<td>202</td>
<td>93</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, y (SD)</td>
<td>74.5 (13.2)</td>
<td>&lt;0.001</td>
<td>70.1 (14.7)</td>
<td></td>
<td>75.9 (13.0)</td>
<td></td>
<td>75.1 (13.7)</td>
<td>0.655</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women, %</td>
<td>51.4</td>
<td>0.715</td>
<td>49.8</td>
<td></td>
<td>55.9</td>
<td>0.227</td>
<td>48.4</td>
<td></td>
</tr>
<tr>
<td>Stroke types</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIS, %</td>
<td>88.2</td>
<td>0.832</td>
<td>87.5</td>
<td></td>
<td>86.6</td>
<td>0.913</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICH, %</td>
<td>11.8</td>
<td>0.256</td>
<td>12.5</td>
<td></td>
<td>13.4</td>
<td>0.488</td>
<td>12.9</td>
<td></td>
</tr>
<tr>
<td>Comorbidities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>27.8</td>
<td>0.609</td>
<td>29.8</td>
<td></td>
<td>26.7</td>
<td>0.430</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>20.0</td>
<td>0.752</td>
<td>21.1</td>
<td></td>
<td>21.3</td>
<td>0.867</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>66.1</td>
<td>0.538</td>
<td>68.7</td>
<td></td>
<td>61.9</td>
<td>0.331</td>
<td></td>
<td></td>
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<tr>
<td>Dyslipidemia</td>
<td>22.4</td>
<td>0.858</td>
<td>26.8</td>
<td></td>
<td>5.4</td>
<td>0.678</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peripheral vascular disease</td>
<td>4.1</td>
<td>0.109</td>
<td>3.8</td>
<td></td>
<td>4.3</td>
<td>0.161</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Renal disease</td>
<td>9.4</td>
<td>0.109</td>
<td>5.7</td>
<td></td>
<td>7.4</td>
<td>0.952</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>9.8</td>
<td>0.218</td>
<td>6.8</td>
<td></td>
<td>9.9</td>
<td>0.081</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>11.4</td>
<td>0.007</td>
<td>4.9</td>
<td></td>
<td>11.9</td>
<td>0.913</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dementia</td>
<td>15.9</td>
<td>0.003</td>
<td>7.5</td>
<td></td>
<td>17.3</td>
<td>0.335</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modified Charlson score $\geq 2$, %</td>
<td>29.8</td>
<td>0.004</td>
<td>18.9</td>
<td></td>
<td>28.2</td>
<td>0.885</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

AIS, acute ischemic stroke; GNH, Grey Nuns; ICH, intracerebral hemorrhage; MCH, Misericordia; and SCU, stroke care unit.

### Table 3. Patient Outcomes, Length of Stay, and Complications

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>GNH Phase I (no SCU)</th>
<th>P Value</th>
<th>GNH Phase II (SCU)</th>
<th>P Value</th>
<th>MCH Phase I (no SCU)</th>
<th>P Value</th>
<th>MCH Phase II (no SCU)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median length of stay, days (IQR)</td>
<td>12 (5–26) 8 (3–19)</td>
<td>0.027</td>
<td>14 (5–36)</td>
<td>0.136</td>
<td></td>
<td></td>
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<tr>
<td>Complications, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>DVT or PE</td>
<td>0.8</td>
<td>0.299</td>
<td>1.5</td>
<td>0.681</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Falls</td>
<td>1.2</td>
<td>0.591</td>
<td>5.4</td>
<td>0.730</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Pneumonia</td>
<td>10.2</td>
<td>0.037</td>
<td>13.4</td>
<td>0.714</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>UTI</td>
<td>14.3</td>
<td>0.073</td>
<td>14.4</td>
<td>0.715</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Discharge disposition, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home</td>
<td>25.7</td>
<td>&lt;0.001†</td>
<td>28.2</td>
<td>0.688†</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home with support</td>
<td>13.5</td>
<td>13.4</td>
<td>11.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rehabilitation</td>
<td>23.7</td>
<td>18.8</td>
<td>12.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To LTC</td>
<td>20.0</td>
<td>20.8</td>
<td>21.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mortality</td>
<td>17.1</td>
<td>18.8</td>
<td>19.4</td>
<td></td>
<td></td>
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</tbody>
</table>

DVT indicates deep vein thrombosis; GNH, Grey Nuns; LTC, long-term care; MCH, Misericordia; PE, pulmonary embolism; and UTI, urinary tract infection.

*P<0.05 for pairwise comparisons of proportions using Z-test between phases for each hospital.

†P value for $\chi^2$ test comparing proportions of discharge disposition by study phase.
included a closely matched control hospital. This allowed us to adjust for secular improvements in stroke care during the 6-year study period that may have resulted from public health initiatives such as the Canadian Stroke Strategy and the Alberta Provincial Stroke Strategy (APSS)⁴⁰ as well as other medical advances in stroke care. For example, the APSS was a CAD $20 million program designed to improve stroke outcomes at all levels throughout the province of Alberta and included interventions ranging from primary prevention to rehabilitation.⁴¹ The present study showed that improvements in patient outcomes with respect to mortality and discharge disposition with SCU were additive to improvements in care that resulted from APSS initiatives.

These results also confirm that the benefit of SCU extends beyond tertiary hospitals to community hospitals with more limited resources. Our findings are in keeping with an Australian multicenter analysis of SCU implementation in nonprincipal referral hospitals that also found similar decreases in mortality and improvements in discharge dispositions.⁴² The primary limitation identified in the Australian study was its inability to correct for secular trends, which we have addressed in the present analysis. Interestingly, the same study did not see this benefit in patients treated in large principal centers after opening SCUs.

Although the specific mechanism by which SCUs improve outcomes remains unclear, early mobilization, improved blood pressure management, and adherence to guidelines have been identified as some of the key components.⁴³,⁴⁴ SCUs standardize the early management of stroke, which is where gaps in care often exist between rural and small urban hospitals without SCUs and larger metropolitan hospitals.⁴⁵ For example, with SCU implementation in this study, a standardized dysphagia screening tool⁴⁶ was introduced as part of the admission orders for all patients with stroke. Improved dysphagia management likely, in part, accounted for the substantial reduction in rates of in-hospital pneumonia. Pneumonia is a preventable complication associated with poor outcome and has been attributed as the cause of almost a third of in-hospital deaths in stroke patients.²⁷

One limitation of this study is that patient volumes at the site with SCU were higher across both study phases even without any change in prehospital pathways. It is possible that more patients with minor strokes were admitted, although we are not able to confirm this hypothesis, because standardized measures of stroke severity were not tracked. The site without SCU also tended to admit patients with more medical comorbidities. To overcome these differences between sites, we adjusted for comorbidities in multivariate analyses; however, there remains a possibility that the impact of SCU implementation is overestimated. A second limitation is that stroke patients within the time window (<4.5 hours) for tPA were excluded as they were diverted at the prehospital level to a tertiary site. This potentially biases the sample at both sites, but offers the advantage of separating the impact of SCU implementation from changes in outcomes due to establishing tPA pathways. Finally, this is a single-site study. There could be significant variability between hospitals and healthcare systems. The extent to which these results generalize to other hospitals or geographic regions is unknown.

In conclusion, this study demonstrates that the benefits of SCUs seen in larger Canadian tertiary hospitals also extend to smaller community hospitals with more limited resources. A core component of optimizing stroke care and reducing stroke costs in Canada and other regions globally is to increase the numbers of patients that receive care on SCUs. This study proposes that constrained community hospitals and hospitals with relatively constrained resources could effectively establish SCUs and dramatically improve patient outcomes. Developing SCUs in smaller, nontertiary hospitals may be a viable strategy to increase the numbers of stroke patients that can benefit from SCUs.

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Disclosures
None.

References


Impact of Stroke Care Unit on Patient Outcomes in a Community Hospital
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