International Journal of Physical Medicine & Rehabilitation

Research Article Open Access

Impact of Acute Stroke Unit on Patient Outcomes in Saudi Arabia

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Abstract

Background: Evidence from developed countries indicates that acute stroke units (ASUs) improve stroke outcomes. Data from developing countries on efficacy of ASUs are limited.

Aims: To determine whether establishing an ASU impacts stroke outcomes in the Saudi health care system.

Methods: This improvement project was conducted at King Abdulaziz Medical City in Riyadh, Saudi Arabia from January 2012 to December 2013. An ASU was established to provide improved care for stroke patients. We compared death, unfavourable outcomes, independence at discharge, and NIHSS at discharge between patients treated by traditional practice versus those treated in an ASU using multiple regression analysis.

Results: Of 861 patients admitted with initial diagnoses of acute stroke, 525 were treated in an ASU. Patients admitted to the ASU were younger and had less medical comorbidity compared to those treated in traditional practices. After adjustment for age, sex, comorbidities, stroke severity, and stroke classification, ASU admission was associated with milder neurological deficit at discharge as measured by National Institutes of Health Stroke Scale (NIHSS). Furthermore, non-adherence to best practices was lower in patients treated in an ASU compared to general floors. Patients admitted to an ASU had shorter lengths of stay. There were no significant differences between the two groups in rate of death, unfavourable outcomes, or independence at discharge.

Conclusion: Establishment of an ASU in the Saudi health care system improved adherence to best practices, reduced LOS, and was associated with lower stroke severity at discharge.

Keywords: Stroke; Saudi Arabia; Stroke unit; Death; Complications

Introduction

Acute stroke units (ASUs) are geographically distinct hospital units where organized stroke care is delivered by specialized multidisciplinary teams according to written clinical care pathways [1]. Meta-analyses of randomized clinical trials have shown that implementation of stroke units increases chances of survival after stroke, reduces dependency, and increases the likelihood of returning home [1]. Further, ASUs reduce lengths of stay, improve care processes, and increase adherence to best practices [2-4]. Many international scientific organization guidelines recommend that all hospitalized stroke patients receive care in organized stroke units [5-8].

Evidence of stroke unit efficacy comes mainly from western developed countries. These types of units have not been rigorously evaluated in other parts of the world. Further, adoption of such practices can be challenging for many reasons such as cost, rarity of stroke expertise, limited resources, and lack of availability of medical supervision, inadequate equipment, and local culture [9]. For example, Saudi Arabia has more than 350 hospitals, but only two have stroke units [10].

In this study we examined whether establishing and admitting patients into a stroke unit had an impact on patient outcomes in an academic medical centre in the Saudi health care system.

Methods

Study design, area and settings

This prospective study was conducted at King Abdulaziz Medical City in Riyadh (KAMC-R), Saudi Arabia from January 2012 to December 2013. This study was part of organization-wide improvement initiatives in collaboration with the Institute for Healthcare Improvement (NIH). We used a model of improvement developed by associates in process improvement as a framework to guide improvement work. The model focused on testing changes on a small scale using Plan-Do-Study-Act (PDSA) cycles [11]. The project aimed for improvement of acute stroke inpatient care and establishment of an acute stroke unit. The project was divided into three phases: preparatory phase, implementation phase, and sustainability phase. During the three month preparatory phase, we formed a multidisciplinary team, established evidence-based clinical care pathways, trained staff, and prospectively collected baseline data. During the implementation phase, we identified a geographical location for an ASU, implemented clinical care pathways, and progressively began to admit stroke patients to the ASU under the care of stroke neurologists. In the third phase, we continued to collect data, presented data to the appropriate authorities, received approval for permanent adoption of the implemented changes, and mobilized the resources necessary for long-term sustainability.

Stroke care before intervention

KAMC-R is a more than one thousand bed, joint commission accredited academic and tertiary centre. It provides free of charge comprehensive care for National Guard employees and their dependents. In addition, any patient with a life threatening illness such as acute stroke has immediate free access to care through the

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Received July 29, 2019; **Accepted** August 07, 2019; **Published** August 14, 2019

Citation: Khathaami AMA, Aldhokair S, Tarawneh M, Khatri I, Alotaibi N (2019) Impact of Acute Stroke Unit on Patient Outcomes in Saudi Arabia. Int J Phys Med Rehabil 7: 523.

emergency department. The hospital receives an average of 500 stroke patients per year. Prior to this project, stroke patients were seen in the emergency unit by an internal medicine team unless the patient was younger than 45 years of age, or eligible for thrombolysis. As such, the majority of stroke patients were admitted under the care of an internal medicine team with regular neurological consultation. A small portion of stroke patients were admitted under the care of neurologists who may or may not have had cerebrovascular fellowship training. Stroke patients could be allocated anywhere in the medical wards. There were no dedicated beds or a special unit for stroke patients, and no existing written care pathways.

Intervention

We followed the Guide to the Implementation of Stroke Unit Care, written by Canadian Stroke Network [12]. Among the three models of stroke unit described in the literature (integrated stroke units, acute care stroke units, and rehabilitation stroke units), we adopted the acute care stroke unit model. This model provides immediate initial rehabilitation care to stroke patients during the acute phase following a stroke. Patients requiring longer term rehabilitation are transferred to separate dedicated neuro-rehabilitation units supervised by physiatrists and rehabilitation specialists within the same facility. The components of a stroke unit are:

- Specialized, geographically defined unit dedicated to management of stroke patients.
- Dedicated multidisciplinary team which includes members from stroke neurology, nursing, occupational therapy, physiotherapy, speech-language pathology, social work, physiatrist, and clinical nutrition. Team members are trained according to the latest best practices in stroke.
- Patients are assessed within 24-48 h using standardized and valid assessment tools such as Barthel Index (BI), modified Rankin Scale (mRS), National Institutes of Health Stroke Scale (NIHSS), Functional Independence Measure (FIM), and dysphagia screening tool.
- Care is delivered according to comprehensive, evidence-based, written protocols, order sets, and care pathways/algorithms.
- Patient and caregiver education provided by education nurses and stroke support groups.
- Weekly team meetings to discuss individual patients and project progress.

Data collection

Data were collected prospectively by an independent quality specialist. The variables collected were demographic data, stroke vascular risk factors, stroke subtypes (ischemic, haemorrhagic, transient ischemic attacks (TIAs), cerebral venous thrombosis, and stoke mimics), admission and discharge NIHSS scores, which ranges from 0 (normal function) to 42 (death), with higher scores indicating a greater deficit, modified Rankin Scale (mRS) at discharge, length of stay, in-hospital post-stroke complications (death, aspiration pneumonia, urinary tract infection, venous thromboembolism (VTE), fall, bed sores, recurrent stroke or TIA, and neurological deterioration). Neurological deterioration is defined as worsening of NIHSS by four points at any time during hospitalization. Stroke diagnosis, stroke classification, and inpatient complications were assessed by the treating stroke neurologists.

Admission criteria to the ASU

Patients with confirmed or probable stroke or TIA at initial presentation who were hemodynamically stable (not on inotropic agents or ventilation support) were admitted directly to the ASU. Diagnosis of probable stroke or TIA was determined during admission after completion of investigations. Those who required inotropes, ventilation support, or received thrombolysis were admitted to neuro-intensive care then transferred to the ASU when they were deemed stable for transfer. During the study period and due to administrative decision, patients were not eligible to be admitted to the ASU if they were >80 years old, had a mRS>2 before stroke, were bedridden prior to stroke, had a history of dementia, or had a terminal illness. These subsets of stroke patients were admitted under the care of internal medicine and received traditional care.

Data analysis

We compared the cohort of patients who received care in the ASU to those who were treated in general medical wards. We included ischemic stroke, haemorrhagic stroke (except subarachnoid haemorrhage) and transient ischemic attacks. The study outcomes were in-hospital death, unfavourable outcome at discharge, length of stay (LOS), independence at discharge (mRS $\leq$ 2), and non-adherence to best practices. Unfavourable outcome was defined as composite outcome of death and/or any post-stroke in-hospital complications (death, aspiration pneumonia, urinary tract infection, venous thromboembolism, fall, bed sores, recurrent stroke or transient ischemic attack and neurological deterioration). Non-adherence to best practices was defined as any of the following: failure to screen for dysphagia before PO feeding, failure to give antiplatelet within 48 hours of admission when indicated, failure to give deep vein thrombosis (DVT) prophylaxis when needed, failure to provide anticoagulants for atrial fibrillation, statin therapy on discharge, antiplatelet on discharge, or education on discharge. Data were presented as mean ± standard deviation (SD) for continuous variables and frequency with percentages for categorical variables. Student's t-test and $\chi 2$ test were used to compare means and proportions, respectively. We compared outcomes across the 2 groups using multivariable logistic regression analyses adjusted for age, sex, comorbidities, stroke severity (NIHSS at admission <7 versus $\geq$ 7), and stroke classification (ischemic, haemorrhagic, and TIA). To compare median LOS and median NIHSS across the 2 groups, we used multivariate quantile regression, controlling for age, sex, comorbidities, stroke severity, and stroke classification. All statistical tests were considered significant at $p<0.05$. Data were analysed using the statistical program Stata (version 15).

Results

Patient characteristics

Eight hundred sixty-one patients were admitted between January 2012 and December 2013 with initial diagnoses of acute stroke or TIA. Of these patients, 525 were treated in an ASU. The baseline characteristics of the two cohorts are shown in Table 1. Patients admitted to the ASU were younger (mean 56 vs. 66 years; P <0.001) and had fewer medical comorbidities. The ASU group had a lower rate of ischemic heart diseases (15.6 vs. 26.7%; P<0.001), less hypertension (66.2 vs. 77.1%; P=0.001), less diabetes (54.4 vs. 62.9%; P=0.01), and less dyslipidaemia (32.5 vs. 53.2%; P<0.001). The proportion of ischemic stroke in the ASU cohort was lower than that of the general floor cohort (65.1 vs. 73.8%; P<0.02), while admission for TIA increased after establishment of the ASU (18.6 vs. 12.1%; P<0.02). There were no

statistically significant differences in the proportions of haemorrhagic stroke or stroke mimics between the two cohorts. Patients treated in the ASU had milder neurological deficits at presentation (NIHSS<7), (88.8 vs. 77.4%; P=0.001).

Patient outcomes

Patient outcomes including death, unfavourable outcome, non-adherence rate, independence at discharge, median LOS, stroke severity at discharge (NIHSS ≥ 7), and median NIHSS at discharge are summarized in Tables 2-4. Using bivariate analysis, the data showed that death occurred at lower rate in ASU patients compared to patients treated on the general floor but did not reach statistical significance (2.3 vs. 4.7%; odd ratio, 0.46; 95% confidence interval [CI], 0.21-1.03; P=0.06). In addition, unfavourable outcome (death and/or any complication) occurred in a lower percentage in the ASU group (12.3 vs. 20.7%; odd ratio, 0.5; 95% CI, 0.36-0.8; P=0.002). Also, patients treated in the ASU were more likely to be independent at discharge (77.6 vs. 57.1%; odd ratio, 2.2; 95% CI, 1.6-3.2; P<0.001). The proportion of patients with moderate to severe stroke at discharge (NIHSS ≥ 7) was lower in the ASU group than in the general floor group (9.7 vs. 18.8%; odd ratio, 0.4; 95% CI, 0.27-0.63; P<0.001). After adjustment for age, sex, comorbidities, stroke severity, and stroke

Characteristics	ASU	General floor	p
	(N=525)	(N=336)	Value
Mean age ± SD (years)	56 ± 13	66 ± 11	<0.001
Female sex-no. (%)	204 (38.8)	112 (33.3)	0.09
Medical history-no. (%)			
Ischemic heart disease	82 (15.6)	90 (26.7)	<0.001
Arterial hypertension	348 (66.2)	260 (77.1)	0.001
Diabetes mellitus	286 (54.4)	212 (62.9)	0.01
Atrial Fibrillation	30 (5.70)	31 (9.19)	0.06
Dyslipidaemia	76 (32.5)	334 (53.2)	<0.001
Stroke subtypes-no. (%)			
Ischemic stroke	342 (65.1)	249 (73.8)	0.02
Transient ischemic attack	98 (18.6)	41 (12.1)	
Haemorrhagic stroke	47 (8.9)	30 (8.9)	
Others*	38 (7.72)	17 (5.0)	
NIHSS score †			
≥ 7	59 (11.2)	76 (22.6)	<0.001

* Cerebral sinus thrombosis and stroke mimics.
† National Institutes of Health Stroke Scale (NIHSS)

Table 1: Demographic and clinical characteristics of patients treated in the acute stroke unit (ASU) versus those treated on the general floor.

Outcome	ASU (N=487)*	General floor (N=319)*	U-OR	95%CI	p value	A-OR	p value	95% CI
Death	11 (2.3)	15(4.7)	O.46	0.21-1.03	0.06	1.35	0.5	0.52-3.51
Non-adherence to best practices**	156 (32.0)	210(65.8)	0.24	0.18-0.33	<0.001		<0.001	0.15-0.3
Unfavourable outcome no. (%) †	60 (12.3)	66 (20.7)	0.5	0.36-0.8	0.002	0.8	0.5	0.53-1.3
Independence at discharge‡	378 (77.6)	182 (57.1)	2.2	1.6-3.2	<0.001	1.1	0.6	0.68-1.91
NIHSS score ≥ 7	47 (9.7)	60 (18.8)	0.4	0.27-0.63	<0.001	0.5	0.006	0.31-0.82

*Excluding stroke mimics

**Non-adherence to best practices is defined as any of the following: failure to screen for dysphagia before PO feeding, failure to give antiplatelet within 48 hours of admission when indicated, failure to give DVT prophylaxis, anticoagulation for atrial fibrillation when indicated, statin therapy on discharge, antiplatelet on discharge, and education on discharge.

†Unfavourable outcome was defined as a composite outcome of death, pneumonia, urinary tract infection, fall, venous thromboembolism, bed sores, neurological deterioration, recurrent stroke or TIA during hospitalization.

‡Defined as modified Rankin Scale ≤ 2

Table 2: Adjusted and unadjusted ORs for outcomes according to type of care.

	Unadjusted median NIHSS						Quantile Regression (50th Percentile)		
	ASU (N=466)	95% CI	General floor (N=278)	95% CI	p value	Coef.	Std. Err	95% CI	p value
Median NIHSS	1	1-2	3	2-3	<0.001	-1	0.23	-1.99	<0.001

*Excluding mimics, death

Table 3: Median NIHSS at discharge according to type of care*.

	Unadjusted median LOS						Quantile Regression (50th Percentile)		
	Stroke unit (N=513)	95% CI	General floor (N=321)	95% CI	p value	Coef.	Std. Err	95% CI	p value
Median LOS (days) §	6	5-7	8	7-9	<0.001	-1.93	0.68	-3.85	0.005

*Including mimics

§LOS denotes length of stay during hospitalization.

Table 4: Median LOS according to type of care*.

classification in multiple regression analysis, there were no significant differences between the two groups in death rate, unfavourable outcome, or independence at discharge. However, ASU admission was associated with a lower percentage of patients with NIHSS ≥ 7 at discharge compared to those on the general floor (adjusted odd ratio, 0.5; 95% CI, 0.31-0.82; P=0.006). Non-adherence to best practices was lower in the ASU compared to the general floor (32.0 vs. 65.8%; odd ratio, 0.24; 95% CI, 0.18-0.33; P<0.001). Patients admitted to the ASU had a shorter length of stay (6 days vs. 8 days; Median difference, 2 days; P=0.001). Multivariate quantile regression, controlling for age, sex, comorbidities, stroke severity, and stroke classification, resulted in statistically significant differences in LOS in favour of the ASU.

Discussion

Patients who are managed in a stroke unit setting are more likely to survive, return home, and regain independence than those managed in conventional care settings [13]. This might be explained largely by reduction in post-stroke complications due to immobility, stroke recurrence, and stroke progression. This reduction is achieved through comprehensive implementation of many processes and measures to prevent venous thromboembolism, aspiration, infections, and falls [14]. ASUs also provide rapid access to investigations. Prompt and timely recognition of underlying pathophysiology promotes implementation of early secondary prevention measures. Furthermore, other factors such as multidisciplinary approaches, availability of trained staff and care driven by best practices may contribute to better outcomes.

The results of our study showed that the stroke unit improved access of care for patients with TIA and minor strokes. Admission of these patients has increased since establishment of the stroke unit. The stroke unit allows for expedited evaluation and management, resulting in implementation of early prevention measures. Furthermore, the stroke unit care improved adherence to best practices, reduced length of stay, and was associated with better outcomes as measured by NIHSS at discharge. The overall death rate was low in both groups. This was partially related to the study population, which included mild strokes, transient ischemic attacks, and mimics. In such groups, the mortality rate is low. Bivariate analysis showed that the stroke unit was associated with a lower death rate, which was likely due to the imbalanced baseline characteristics between the two groups. There was a trend toward lower rate of death and post stroke complications in favour of the ASU. However, this difference was not statistically significant after adjustment for imbalanced baseline characteristics. It is possible that a larger sample size may have resulted in a statistically significant difference.

Our data are consistent with well-established evidence from multiple randomized clinical trials conducted in developed countries. Observational data published from developing countries showed similar results. Studies from China, India, South Africa, Thailand, Croatia, Mauritania, Turkey, and Croatia indicated that ASU improve patient outcomes across different health systems and cultures [15-22]. However, a study published from Brazil showed no significant benefit in patients treated in an ASU compared to those treated in a general ward [23]. Further, data from Qatar showed that patients treated in stroke unit had fewer complications and better outcome [24].

One limitation of this study was the imbalance between the two groups in term of age, comorbidity, and stroke severity. This was partially related to the admission criterion set by the team, as patients who were >80 years of age, bed-ridden, suffering from dementia, or had a terminal illness prior to stroke onset were considered ineligible for admission to the specialized stroke unit, and admitted under the care of general medicine. Further, the stroke unit increased access of care for TIA and minor strokes, which created an imbalance in stroke severity favouring the stroke unit. To overcome these differences between the two cohorts, we adjusted for age, comorbidities, stroke subtypes, and severity in multivariate analyses. However, the possibility remains that the impact of ASU implementation was overestimated. The second limitation was that the dependency rate measured by mRS as an outcome was measured at discharge, which is opposite to traditional measurement of stroke outcome at three months. Third, this study was an observational, non-randomized study which was potentially subject to bias. Finally, this was a single-centre study. There could be significant variability between hospitals and healthcare systems in the country. The extent to which these results generalize to other hospitals or geographic regions in Saudi Arabia is unknown.

Conclusion

In conclusion, this study demonstrated the benefits of a stroke unit in the context of the Saudi healthcare system and culture. These data should help to encourage all hospitals across the country to adopt this practice. To date, only two stroke units exist in Saudi Arabia. Increasing the number of stroke units and the numbers of patients that receive care in ASU is a viable strategy for improvement of stroke treatment.

Sources of Funding

No funding was provided for this study. The stroke unit manpower and resources were provided by the hospital.

Disclosures

Authors were involved in establishment of a stroke unit in Saudi Arabia, but their role in that operation did not affect their scientific judgment.

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