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Research Article

Role of Stroke Unit in Reducing Post Stroke Complications

Amal M. Al-Hashmi*, Ahmed Al-Saadi, Hotchand Maheshwari, Raya Almamai, Cheska Salunga, Ria T. Marfil and Sathiya Murthi

Stroke Unit/Royal Hospital, Muscat, Oman

***Corresponding Author**: Amal M. Al Hashmi, Stroke Unit/Royal Hospital, Muscat, Oman.

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Abstract

Background: Stroke is a sudden loss of brain function. Medical and neurological complications post-stroke may adversely affect outcome and in some cases may be preventable.

Objectives: This study aimed to identify how treatment in an acute Stroke unit (ASU) compares with treatment in a general medical ward (GMW) can affect morbidity and mortality post stroke.

Methods: We conducted a retrospective study of patients admitted at Royal hospital with acute stroke from 2009-2015. Patient data were retrieved through an electronic medical records system. The medical and neurological complications were assessed and compared for patients treated in the general medical ward (GMW) vs those treated in a recently established acute stroke unit (ASU). All cases were confirmed by detailed history, examination and brain imaging (CT or MRI). The total sample was 1544 patients.

Results: There was no significant difference in the baseline characteristics of both groups with mean age of 60 years. 66.4% were men and 33.6% were women. 80.6% of overall patients had ischemic stroke (IS) while 19.4% had hemorrhagic stroke (HS). 35.9% of the patients had at least one complication. There was no significant difference in overall medical and neurological complications between the two groups. Sub-analysis of the complications showed reduction in aspiration pneumonia in the ASU group (5.7%) vs in the general medical ward (GMW) group (10.5%) ($p < 0.05$). However, there was an increase in cardiac arrest in the ASU group (5.1%) vs in the GMW group (1.3%) ($p < 0.001$). In addition, death increased from 1 case in the GMW group to 7 cases in the ASU group ($p = 0.075$).

Conclusions: Post-stroke complications are still frequent despite treatment in the acute stroke unit. Stroke patients who received organized inpatient care in a stroke unit are less likely to develop medical complications post-stroke. However, more studies are needed.

Keywords: *Stroke; Ischemic stroke (IS) Hemorrhagic stroke (H); Complications; Aspiration Pneumonia; Cardiac arrest; Acute Stroke Unit (ASU)*

Introduction

Stroke is a clinical syndrome of presumed vascular origin, typified by rapidly developing signs of focal or global disturbance of cerebral functions. With more than 15 million strokes per year worldwide, stroke remains a leading cause of death and disabilities [1]. Most of the data come from the developed countries and very few reports from low- and middle-income countries. Medical and neurological compli-

cations are common post-stroke. The effectiveness of stroke units have been extensively investigated in prospective randomized European countries. Findings suggest that stroke units reduce both short and long term complications [2-7]. However, there is great variability in the outcome between individual studies [5]. Although this variability has been attributed to differences in patient selection, definitions of organized care, or experimental design between trials, the meta-analysis had strict criteria for experimental design and stroke care that were uniform across studies [8]. Patient selection criteria were less well-defined in most studies, leaving the possibility that differences in the types of patients or their stroke characteristics may have contributed considerably to the variability in outcome between studies. The influence of age and stroke severity on the effectiveness of stroke unit care has been demonstrated previously [6-9]. In this study, we sought to assess and compare the rate and types of post-stroke complications between patients admitted at an ASU and GMW in Oman. In addition to identify if post stroke complications are influence by stroke type and anatomical location.

Subjects and Methods

This is retrospective observational hospital-based study on patients admitted at Royal hospital Muscat Oman with acute stroke from 2009-2015. Royal hospital is the reference territory hospital in Muscat with catchment area of one million inhabitants. Patient data were retrieved through an electronic medical records system. Data were collected in data sheets; each sheet includes a code belonging to each patient. No personal data were exposed in the data collections sheet except the age and sex. In addition, all data were treated with confidentiality. From 2009-2012 all patients were admitted to the GMW whereas form 2013-2015 all patients were treated in the ASU. The original sample size was 1544 patients. 411 patients were excluded due to other diagnosis or absence of neuroimaging or due to lack of confirming test of the complications studied. This left us with a total of 1133 patients (Figure). Stroke was defined as an acute neurologic insult due to a vascular etiology and could be either ischemic or hemorrhagic. All cases were confirmed by detailed history, examination and brain imaging (CT or MRI). The medical and neurological complications were assessed and compared before and after establishing the ASU (Table 1).

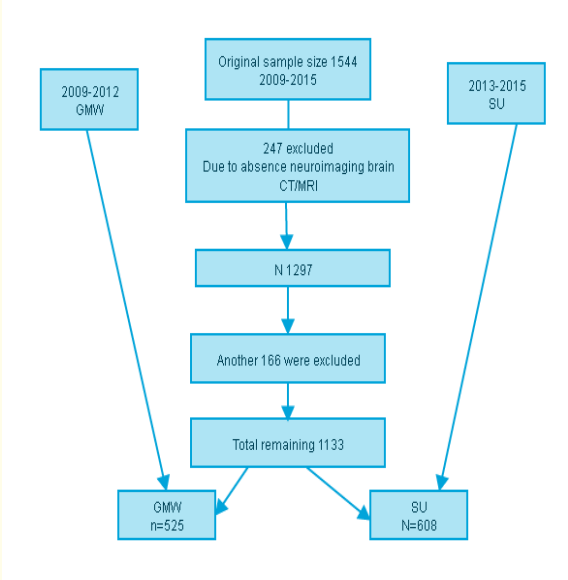

Figure: *Study Design (its optional to include or exclude this figure).*

Complication	Definition
Aspiration Pneumonia	Auscultator respiratory Crackles combined at least with 1 of the following: Tempreture 38°c, new sputum or positive chest radiography
UTI	Clinical symptoms and sings of UTI with positive dipstick for Nitrate or positive urine C/S
Pulmonary embolism	Clinical diagnosis supported by HR computed tomography scan or ventilation /perfusion scan
Acute Abdomen	Clinical diagnosis supported by Abdomen US/ CT
Cardiac Arrest	Clinical diagnosis with clear documentation of the event (ECG tracing)
Herniation	Clinical diagnosis supported by neuroimaging
Increased ICP	Clinical diagnosis (headache, vomiting papilledema) supported by neuro imaging

Figure: *Study Design (its optional to include or exclude this figure).*

Patients

The inclusion criteria were patients aged 18->80 years living in the catchment area and admitted through the emergency room of the hospital or transferred from other secondary hospitals. 0-7 day's history of acute focal neurological symptoms and signs confirmed to be acute stroke by neuroimaging (CT or MRI). Both ischemic and hemorrhagic stroke subtypes were included. All complications were confirmed by appropriate investigations. Exclusion criteria were symptoms and signs due to other diagnosis or absence of neuroimaging to confirm stroke. Symptoms onset greater than 7 days before admission or evidence of sub-acute stroke on neuro imaging (Head CT or MRI brain). Absence of confirming investigation of the complications. Table 2 summarizes the inclusions/exclusion criteria.

Inclusion Criteria	Exclusion Criteria
Age: 18->80	Age < 18
Both sex	Symptoms and sings due to other diagnosis and Absence of neuro imaging
0-7 days stroke history of focal neurological confirmed by neuro imaging	Absence of neuroimaging
Both stroke subtypes Ischemic/Hemorrhagic	Symptoms and sings > 7 days
Complications studied supported and confirmed by appropriate investigations	Absence supported investigation
	IVH

Table 2: *Inclusion /exclusion criteria, definition of stroke.*

Stroke unit

The ASU in the Royal hospital Oman was established on 2nd February 2013 and is the first unit in the country to provide multidisciplinary stroke care. The unit has a capacity of 11 monitored beds, 6 reserved for men and 5 reserved for women. The medical treatment team in ASU followed current practice guidelines for the management of acute stroke.

A standard examination was performed including neurological assessment, blood tests, urgent computed tomography (CT) of the brain. If an ischemic stroke was suspected after clinical and CT evaluation, and patient was outside the window for tPA therapy. Acetylic acid 75 mg was immediately administered orally. Alternatively, clopidogrel 75 mg od in case of acetylic acid failure. All patients will be monitored for 72 hours and then as required. As early as possible, the patient was mobilized, often within the first hours after admission to the hospital. The routine of mobilization of patients with hemorrhages was the same as for those with ischemic strokes. Patients with paralysis and patients who were impossible to mobilize because of inability to cooperate were given subcutaneous low-molecular-weight heparin. Parenteral iso-osmolar fluid was administered routinely the first 24 hours. Hyperglycemia was treated with insulin when serum glucose was 12 mmol/L. Fever was treated with antipyretics (paracetamol, 1000 mg tablet) when temperature was 38°C. In addition, all patients will be on anti-constipation prophylaxis Antihypertensive treatment is initiated as soon as needed. All patients are kept nill per oral NPO until further assessment by a speech therapist. If cardio-embolic stroke was suspected, a cardiologist was consulted and eventually anticoagulation was initiated. All patients with acute ischemic stroke will have echo cardiogram/TEE and carotid Doppler done before discharge form the unit. Additional investigations include CTA, vascultic, thrombophilia, homocystine work etc., depending on the cases. The staff was multidisciplinary with neurologists, trained nurses, physiotherapists, occupational therapists, and speech-therapists. A stroke team met weekly for evaluation of the progress and to plan further treatment for each patient. All patients will be evaluated by physiotherapists during day one of admission. A multidisciplinary team met with the relatives intermittently to plan treatment and support after discharge.

General Medical Ward

The hospital has one department of medicine with five wards. Stroke patients were admitted to all these wards, dependent on capacity. Patients treated within the general medical wards were given traditional medical treatment without special or standardized efforts geared toward this patient group. As in the ASU, a CT scan was requested but not routinely as an emergency examination. Patients were immobilized until hemorrhage was excluded by CT scan. Patients with ischemic strokes were then mobilized, whereas patients with hemorrhages were often immobilized for 1 week. Aspirin was given if the CT scan did not reveal a bleeding. Inconsistently prophylactic administration of low-molecular-weight heparin was given to prevent venous thrombosis for immobilized patients. There was no routine of giving antipyretics or parenteral iso-osmolar fluids, as in the ASU. Anticoagulation was started when a possible cardiogenic embolic source was detected. Patients were offered physiotherapy, but none received speech or occupational therapy assessment, and evaluation of a neurologist when it was requested by the staff.

Statistical analysis

Means, SD and statistical tests for significance were calculated and performed using the statistical program IBM SPSS 22 for Microsoft Windows. Independent t test was used to compare group means for continuous variable (age, sex) Fisher's exact test and Chi-square were used to test group differences for nominal variables (e.g. stroke subtypes, stroke anatomical locations etc.). Chi-squire test was also used to compare characteristics. No correction was made for multiple testing. A value of $p < 0.05$ (2-sided) was considered significant.

Results

1133 patients met the inclusion criteria; 66.4% were men and 33.6% were women. Of the 1133 patients, 80.6% had IS whereas 19.4% had HS. The majority of the patients had anterior circulation stroke (73.3%). 35.9% of the patients had at least one complication. There was no major difference in baseline characteristics of the patients who were admitted in the ASU or in the GMW (Table 3). 525 patients were admitted to GMW in comparison to 608 admitted to the ASU. There was no significant difference in the mean age between the patients admitted to the GMW [60.02 (14.29)] and ASU [59.63 (13.43)]. There was no significant difference in overall neurological or medical complications between the two groups (Figure e-1).

Characteristics	GMW	ASU	P-value
Number of patients	525 (46.3%)	608 (53.7%)	1133
Mean Age	60.02 (14.29)	59.63(13.43)	0.632
Men	347 (66.1%)	405 (66.6%)	0.900
Women	178 (33.9%)	203 (33.4%)	0.900
Ischemic	405 (77.1%)	508 (83.6%)	0.007
Hemorrhagic	120 (22.9%)	100 (16.4%)	0.007
Anterior Circulation	392 (74.7%)	439 (72.2%)	0.381
Posterior Circulation	133 (25.3%)	169 (27.8%)	0.381

Table 3: *Basic characteristics of both groups.*

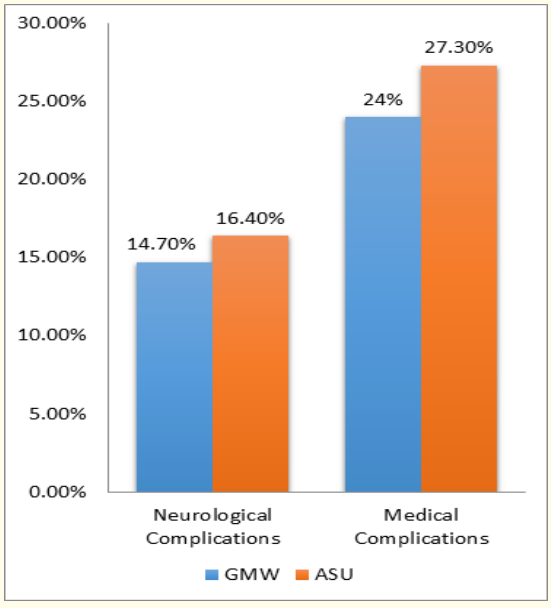

Figure e-1: *Overall medical and neurological complications both groups.*

Sub-analysis of the complications showed reduction in aspiration pneumonia from 10.1% in GMW to 6.1% in ASU group (p-value = 0.015). However, there was an increase in cardiac arrest from 1.3% in GMW to 5.1% in ASU group (p-value < 0.001). There was no significant difference in urinary tract infections (UTIs), pulmonary embolism or acute abdomen between the two groups (Figure e-2). In terms of neurological complications, there was no difference in hemorrhagic transformation, increased intracranial pressure or herniation. In addition there was no significant difference in the mortality between the two groups. Further sub-analysis between ischemic and hemorrhagic stroke revealed an increase in overall neurological complications (14% in IS vs 22.3% in HS) and medical complications (24.1% in IS [p = 0.004]) vs 32.7% in HS [p = 0.01]). There was also an increase in the increased intracranial pressure (p < 0.001) and herniation in HS (p < 0.038). Moreover, cardiac arrest was seen more in HS (7.3%) vs in IS (2.6%) (p = 0.002). There is no significant difference in the other complications and mortality between IS and HS (Table 4).

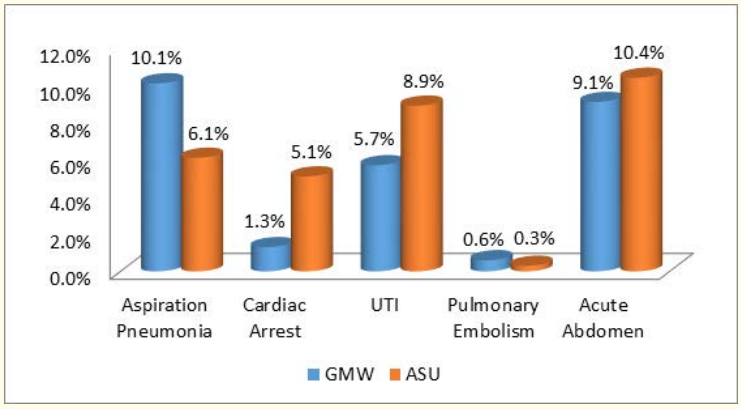

Figure e-2: *Medical complications between both groups.*

	Ischemic Stroke(IS)	Hemorrhagic stroke(HS)	P-value
Number of patients (N)	913 (80.6%)	220 (19.4%)	
Age	60.11(13.67)	58.57(14.42)	0.177
Men	603 (66%)	149 (67.7%)	0.691
Women	310 (34%)	71 (32.3%)	0.691
Anterior Circulation	654 (71.6%)	177 (80.5%)	0.008
Posterior Circulation	259 (28.4%)	43 (19.5%)	0.008
Overall Neurological complications	128 (14%)	49 (22.3%)	0.004
Overall Medical Complications	220(24.1%)	72(32.7%)	0.01
Increased ICP	94 (10.3%)	43 (19.5%)	< 0.001
Herniation	0 (0%)	2 (0.9%)	0.038
Aspiration Pneumonia	67 (7.3%)	23 (10.5%)	0.128
Cardiac arrest	24 (2.6%)	16 (7.3%)	0.002
UTI	68 (7.4%)	16 (7.3%)	1
Pulmonary Embolism	5 (0.5%)	0 (0.0%)	0.590
Acute Abdomen	83 (9.1%)	28 (12.7%)	0.128
Discharge with Full Recovery	200 (21.9%)	52 (23.6%)	0.588
Discharge with Residual Weakness	599 (65.6%)	130 (59.1%)	0.072
Others (LAMA & Travels)	107 (11.7%)	37 (16.8%)	0.055
Death	7 (0.8%)	1 (0.5%)	1

Table 4: *Complication occurrence and outcome in IS and HS.*

We examined how anatomical location of the stroke anterior circulation involvement vs posterior circulation involvement could influence the development of both medical and neurological complications. The study showed an increase in the aspiration pneumonia in the anterior circulation stroke group (9.3%) vs the posterior circulation stroke group (4.3%) (p = 0.006). However, there was no significant difference in the other complications or mortality between the two groups (Table e-1). Looking at the outcome and mortality, this study did not show any significant difference in the outcome between both groups not the general analysis nor of the sub analysis group (Table e-2).

	Anterior Circulation	Posterior Circulation	P-value
Number of patients (N)	831 (73.3%)	302 (26.7%)	
Age	59.86 (14.30)	59.68 (12.47)	0.004
Men	543 (65.3%)	209 (69.2%)	0.228
Women	288 (34.7%)	93 (30.8%)	0.228
Overall Neurological complications	140 (16.8%)	37 (12.3%)	0.064
Overall Medical Complications	221(26.6%)	71 (23.5%)	0.318
Increased ICP	106 (12.8%)	31 (10.3%)	0.303
Herniation	2 (0.2%)	0 (0.2%)	1
Aspiration Pneumonia	77 (9.3%)	13 (4.3%)	0.006
Cardiac arrest	28 (3.4%)	12 (4%)	0.590
UTI	66 (7.9%)	18 (6%)	0.305
Pulmonary Embolism	4 (0.5%)	1 (0.3%)	1
Acute Abdomen	75 (9%)	36 (11.9%)	0.174
Discharge with Full Recovery	178 (21.4%)	74 (24.5%)	0.294
Discharge with Residual Weakness	537 (64.6%)	192(63.6%)	0.779
Others (LAMA & Travels)	109 (13.1%)	35 (11.6%)	0.546
Death	7 (0.8%)	1 (0.3%)	0.689

Table e-1: *Influence of stroke location in both groups.*

	General Medical Ward	Acute Stroke Unit	P-value
Number of patients (N)	525 (46.3%)	608 (53.7%)	
Age	60.02 (14.29)	59.63(13.43)	0.135
Men	347 (66.1%)	405 (66.6%)	0.900
women	178 (33.9%)	203 (33.4%)	0.900
Ischemic	405 (77.1%)	508 (83.6%)	0.007
Hemorrhagic	120 (22.9%)	100 (16.4%)	0.007
Anterior Circulation	392 (74.7%)	439 (72.2%)	0.381
Overall Neurological complications	77 (14.7%)	100 (16.4%)	0.460
Overall Medical Complications	126(24%)	166(27.3%)	0.220
Hemorrhagic transformation	22 (5.4%)	26 (5.1%)	0.882
Increased ICP	60 (11.4%)	77 (12.7%)	0.584

Herniation	1 (0.2%)	1 (0.2%)	1
Aspiration Pneumonia	53 (10.1%)	37 (6.1%)	0.015
Cardiac arrest	7 (1.3%)	33 (5.1%)	< 0.001
UTI	30 (5.7%)	54 (8.9%)	0.053
Pulmonary Embolism	3 (0.6%)	2 (0.3%)	0.668
Acute Abdomen	48 (9.1%)	63 (10.4%)	0.548
Discharge with Full Recovery	125 (23.8%)	127 (20.9%)	0.252
Discharge with Residual Weakness	341 (65%)	388 (63.8%)	0.709
Others (LAMA & Travels)	58 (11%)	86 (14.1%)	0.129
Death	1 (0.2%)	7 (1.2%)	0.075

Table e-2: *Summary of Study Results.*

Discussion

The present retrospective observational study assesses the role of ASU treatment in Oman. The observed results suggest that treatment in the ASU is beneficial for decreasing the risk of post-stroke complications. A number of observational studies have recently been conducted in several countries, and they have reported the efficacy of stroke units and primary stroke centers in a real-world setting [10-14]. These studies showed the absolute reduction in mortality for patients admitted to a stroke unit or stroke center regardless of the stroke type. Most recently Inoue et al from Japan reported an absolute reduction in mortality for patients with both intracerebral hemorrhage and cerebral infarction.11 In addition Italy and Canada reported a reduction in mortality of ≈5% [14-16]. The meta-analyses reported a beneficial effect of care in a stroke unit that was independent of patient characteristics and variation in stroke unit organization [16-17]. However most of the studies have looked at the role of stroke unit or organized stroke care in reducing mortality and improving outcome post stroke. In the present study our focus was to assess how treatment in ASU vs in GMW has a role in reducing post-stroke complications and what complications in particular can be reduced the most due to treatment in ASU. Therefore, we assessed and compared the development of each medical and neurological complications (Table 1) before and after the establishments of the ASU. Our results demonstrated a reduction in aspiration pneumonia from 10.1% within the GMW group to 6.1% in ASU group (p-value = 0.015). Although there was no difference in pulmonary embolism development between both groups (p-value = 0.668), there was a decline from 0.6% in the GMW group to 0.4% in ASU group. A possible reason for the beneficial effect of ASU treatment observed in our study was due to the following reasons. In our ASU, a neurologist with experience treating stroke patients is present most if not at all times, nurses who have received special training for stroke care are allocated to patient care, which is more than the number of untrained nurses available in GMWs. Additionally, in our ASU appropriate allocation of experienced and trained physical, occupational and speech therapy staff at all times. In addition, there is a clear clinical pathway and protocol that defines the steps to follow from admission to discharge.

This study showed that there was a significant increase in overall neurological complications (14% in IS vs 22.3% in HS). Medical complications were seen in 24.1% in IS (p = 0.004) vs 32.7% in HS (p = 0.01). There was also an increase in intracranial pressure and herniation in HS (p < 0.001) vs IS with (p < 0.038). Moreover, cardiac arrest was seen more in HS 7.3% in comparison with 2.6% in IS (p = 0.002). There was no significant difference in the other complications and mortality between ischemic and hemorrhagic stroke. We also studied how anatomical location of the stroke anterior circulation involvement versus posterior circulation involvement can influence the development of both medical and neurological complications. The study showed there was significant increase in the aspiration pneumonia in the anterior circulation stroke group 9.3% vs 4.3% in posterior circulation stroke group (p = 0.006). However, there was no significant difference in the other complications or mortality between the two groups.

Despite treatment in a chain of care of probable high quality, acute complications were still common post-stroke. In our study, 1/3 of stroke patients experienced 1 or more complications. The list of complications that can develop post- stroke is long and it was challenging to include and compare all the complications pre- and post-stroke unit establishment. This was due to poor documentation and absence of definite diagnosis before the existence of the ASU despite the availability of all tests at the same hospital. Although the original two arms were almost equal, the majority of exclusions were from the arm of GMW admissions due to the above-mentioned reasons. There are several limitations to the present study. There was no clear management plan and documentation for most patients admitted prior the establishment of ASU. Missing confirmatory tests of complications studied in the GMW led to the exclusion of patients despite a definite diagnosis of acute stroke.

We could not objectively assess disability and outcome between both groups using mRS or other scales. The GMW group disabilities and outcomes were only measured subjectively without using any scale. This might contribute to the fact that this study could not demonstrate a clear significant difference in the outcomes between both groups. In addition, premature discharge or leaving against medical advice might have influenced the result and the ultimate outcome. This study showed an increase in cardiac arrest in the ASU group compared to the GMW group, possibly related to the fact that stroke unit received the more complicated cases. Moreover, patients in the ASU group were monitored continuously so cardiac arrest was easily detected; none of the patients admitted to the GMW were monitored, so some might have developed cardiac arrest that went undetected.

Conclusion

Complications are still frequent post-stroke despite treatment in the ASU. Aspiration pneumonia, UTI and ICP are the most commonly encountered complications. Post-stroke complications are more commonly encountered in HS than IS. The anatomical location of the stroke can influence post-stroke complications development. More studies are needed to better understand and characterize these complications to help us create standardized protocols and guidelines to improve the stroke outcome and prevent complications.

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