AN OBSERVATIONAL STUDY OF GLYCEMIC STATUS IN NEW ONSET ACUTE STROKE AND THEIR CLINICAL OUTCOME IN A TERTIARY CARE TEACHING HOSPITAL

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Abstract

Objective: The study was aimed to test the blood glucose level in acute stroke patients to find out any correlation with types and prognosis of different glycaemic groups.

Method: It was a prospective observational study of patients admitted to hospital in Nizamabad due to an acute ischemic or hemorrhagic stroke (<24Hrs after the onset). Clinical parameters including history and clinical examination findings were recorded. CT scan of brain, blood glucose level, HbA1c, and other laboratory tests were taken in all the patients. 2D echocardiography (2D-ECHO) and X- Ray chest picture were also performed. According to glycaemia, the patients were classified into four groups such as Nondiabetic/euglycemic, known Diabetics on glycemic control therapy with or without glycemic control, Newly detected diabetics, and Stress hyperglycemia patients. On the day 1 and 15 National Institutes of Health Stroke Scale (NIHSS) was calculated to evaluate the severity of stroke and its outcome. Good prognosis was considered when NIHSS 5, moderate prognosis when NIHSS was 6-15, and poor prognosis when NIHSS was 16-20. Patients with NIHSS 20 died within 3 days of admission.

Results: Finally, 158 patients with acute stroke were included. Hemorrhagic stroke was seen in 43 (27.2%) and ischaemic stroke in 115 (72.8%) patients. Maximum cases were found in 51-60 years age group (37.9%) followed by 41-50 (20.3%) and 61-70 years age group (20.3%). Majority of study subjects were males, 65.8 % (n=104). Maximum cases were Euglycemics (44.3%), followed by stress hyperglycemic (27.8%), known diabetes (15.9%), and newly diagnosed diabetes (12%) presenting with acute stroke. Higher NIHSS score was found in stress hyperglycemic patients (19.4%) followed by known diabetics (17.3%), newly detected diabetics (16.3%), and euglycemics (9.5%). Maximum proportion (81.8%) of ischaemic stroke cases were found with stress hyperglycemia compared to other glycemic conditions but in hemorrhagic stroke maximum proportion (47.3%) were newly diagnosed diabetics. Maximum proportion of large size of lesion (47.4%) was found in newly diagnosed diabetes followed by stress hyperglycemia (45.55). Medium size of the lesions was found more in newly diagnosed diabetes (52.6%) followed by known diabetes cases (52%). Good outcome was found in 51 cases (32.2%), moderate outcome in 34 (21.5%), and poor outcome was in 30 (18.9%). 43 patients with NIHSS score >20 died within 3 days of admission (27.2%). Maximum proportion of death cases in ischemic group those belongs to newly diagnosed diabetes cases (8/9=88.8%). Higher deaths were found in blood sugar <110 mg/dl and blood sugar >199 mg/dl with an incidence rates of 41.2% and 53.4%.

Conclusion: Hyperglycaemia in non-diabetic patients after acute stroke is a stress response reflecting more severe neurological damage. Elevated HbA1c presenting stroke glycaemia status has a significant trend in increasing the risk of cause mortality. The management of hyperglycaemia in patients with diabetes and non-diabetes is an important aspect of the emergency management of stroke.

Keywords: Ischemic stroke, Hyperglycemia, NIHSS score, Hemorrhage.

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INTRODUCTION

A stroke or cerebrovascular accident is defined as the abrupt onset of a neurologic deficit that is attributable to a focal vascular cause (1). Stroke is one of the major causes of disability and mortality all over the world (2,3). Given its major socioeconomic burden, there is always a need to improve our understanding of its high risk population, complications, and prognosis.

Diabetes is a major risk factor for stroke occurrence. A high incidence of patients who developed stroke may have hyperglycemia, even without a previous history of diabetes (4). As reported by Frederic, 11.3% of cases of stroke gave history of diabetes when compared with 2% in the general population (5). The incidence of diabetes was found to be twice as high in patients admitted to hospital with any type of stroke than in patients with other neurologic diseases. The increased risk of stroke in diabetes and the increased prevalence rate of stroke in diabetes as compared to the general population was confirmed by a study done by Wolf et al(6). Diabetics as well as patients with stress hyperglycaemia have severe stroke and these patients are associated with poor prognosis (7). The mortality rate from stroke in diabetics was twice that of the general population (8). Glucose tolerance also deteriorates with age (9). Multivariant studies also show that blood glucose is a significant predictor of death (10). Diabetic macrovascular diseases including coronary heart diseases, stroke, and peripheral vascular diseases were common causes of morbidity and mortality among people with diabetes mellitus (11). As reported by several studies, it was found that hyperglycaemia in non-diabetic patients after acute stroke is a stress response reflecting more severe neurological damage. However, it is also suggested that hyperglycaemia influences the outcome of stroke severity.

Increased blood glucose concentration at or around the time of a cerebral ischaemic event may worsen outcome; even mild hyperglycaemia (6.6 mmol/L) may result in an increased brain damage and delayed recovery. Studies in rats showed that insulin improved the functional recovery from brain ischemia, probably through its effects on glucose and lactate levels (12).

Many investigators predict that this is not a benign condition and that stress-induced hyperglycemia is associated with a high mortality after stroke (13). Despite these observations, the relationship between admission glucose level and stroke outcome is still a field for ongoing research. This study aimed to assess the glycemic status after acute stroke and its role on stroke outcome.

MATERIALS AND METHODS

The present study was conducted in the critical care unit of the Department of General medicine, Government medical college and hospital, Nizamabad.

Study setting: The present study was conducted in the Department of General medicine, Government medical college and hospital, Nizamabad.

Study population: Patients admitted in Government medical college and hospital, Nizamabad in the Department of General medicine with stroke after taking their consent.

Study design: A hospital based prospective, observational study.

Sample size with justification: Calculated sample size was 158

$N=4PQ/L^2$

P = 3%; Q=47%; L= Allowable error (15% of p)

N = 4×53×47/7.95×7.95= 157.6

N = 158.

Duration of the study: From November 2017 to November 2018. Inclusion criteria: Patients above the age of 40yrs. Patients admitted within twenty-four hours of onset of stroke. Patients

with new onset cerebrovascular accident (stroke). Blood sugar recorded on admission with in twenty-four hours of the onset of stroke. Stroke that can be medically managed i.e. anti-coagulation therapy, antiplatelet therapy, neuroprotective drugs, and supportive treatment.

Exclusion criteria: Patients admitted after twenty-four hours of stroke. Those patients who received intravenous glucose before or during study period with stroke. Stroke with complications i.e. stroke requiring thrombolysis, surgical management [decompression] size of lesion >10mm, embolectomy, massive infarct/haemorrhage with altered behaviour, tumours, obstructive hydrocephalus, syndromes, other systemic complications requiring intensive care.

Methodology

Sample selection: 158 patients were selected by using randomized table method. Written informed and valid consents were taken from the patients after providing adequate information and answering their question and queries in detail.

Method: All patients were studied for clinical history, blood pressure, blood sugar, urea, creatinine, electrolytes, haemoglobin, total cell count, differential count, urine sugar, albumin, electrocardiogram, chest X-ray, CT scan brain (if require), and 2D-ECHO. The severity of stroke for each patient was calculated based on NIH stroke scale, NIHSS which takes the following clinical findings into account and each criteria awarded specific points (14,15).

The points were added, with a maximum of thirty points.

Once clinical diagnosis of acute stroke was made venous blood sample was taken, with in twenty-four hours of onset of symptoms, and sent to laboratory for glucose estimation.

In patients with blood sugar more than 6.1 mmol/L (110 mg/dl), Haemoglobin A1c (HbA1c) was performed, and diabetic status noted.

(HbA1c is structurally similar to haemoglobin A except for the addition of glucose Group to the terminal amino acid of the beta chain of the haemoglobin Molecule glycosylation).

Therefore, HbA1c is a function of the exposure of the red blood cells to glucose. Since the glucose linkage to haemoglobin is relatively stable, Hemoglobin A1c accumulates through out of the life span of erythrocyte and its concentration reflects the integrated blood glucose concentration over a period approximating to the half-life of erythrocytes, i.e. six to eight weeks. Measurement of HbA1c helps to monitor the overall degree of diabetic control achieved. The normal range of Hemoglobin A1c is 3.8% to 6.4%.

The patients can be classified into four groups (16):

1. Blood sugar < 6.1 mmol/l [110mg/dl]: Nondiabetic/euglycemic.
2. With history of diabetes: Known diabetics on glycemic control therapy with or without glycemic control.
3. Blood sugar > 6.1mmol/l[110mg/dl], no history of diabetes, and HbA1c > 6.4: Newly detected diabetics.
4. Blood sugar more than 6.1 mmol/l [110mg/dl], no history of diabetes, and HbA1c< 6.4: Stress hyperglycemias.

Then computerized tomography (CT) of the brain was performed in all patients:

- CT scan immediately done to rule out haemorrhagic stroke.
- Repeat CT scan after 48hours to confirm ischemic stroke.
- Detecting the type of stroke and location the site of lesion.
- Detecting the size of lesion (small <5mm; Medium 5-10 mm; Large >10 mm or involving more than one vascular territory).
- Identifying the presence of cerebral oedema or midline shift.

Patient was given corticosteroid according to protocol with vasogenic edema hemodynamically stable patients. Injection dexamethasone 8mg was given thrice daily and tappered accordingly after improvement on repeat CT scan.

The patients were assessed on the day of admission NIHSS score and the day 15 NIHSS Score outcome observed in the form of death, poor, moderate, and good prognosis.

Patients who were unable to return to any form of work, persistent disability, need for residential placement, dependent in activities of daily living, and stable deficit with no recovery were classified as those with poor outcome.

Patient whose symptoms improved, who were independent in attending day to day activities, improvement in motor function and aphasia, and no persistent disability were grouped as patients with good outcome.

Patients who fared in between these two groups were grouped as those with moderate outcome.

Statistical Analysis: The collected data entered into the Excel spread sheet and transferred to the SPSS version 23 for statistical analyses (IBM, Chicago, Illinois). Chi-square test was used as test of significance for categorical data. Unpaired t test was used for continuous data. P value less than 0.05 was considered as statistically significant.

RESULTS

Maximum cases were found in 51-60 years age group (37.9%) followed by 41-50 (20.3%) and 61–70 years age group (20.3%). Majority of study subjects were males, i.e. 65.8 % (n=104).

Table 1 Distribution of study subjects according to risk factors incidence in relation to gender

	Male	%	Female	%	Total	Total %
RISK FACTORS						
Hypertension	66	63.6	38	36.36	104	65.8
Smoking	63	100	0	0	63	39.8
Diabetes	27	60.7	17	39.3	44	27.8
Alcohol	39	96.1	2	3.85	41	25.9
Hyper Cholesterolemia	16	71.4	6	28.56	22	13.9
Atrial Fibrillation	0	0	2	100	2	1.26
Coronary Artery Disease	6	66.6	3	33.33	9	5.69
CLINICAL PRESENTATION						
Right hemiplegia	60	69.1	27	30.9	87	55
Left hemiplegia	39	64.1	22	35.9	61	38.6
Faciobrachial Monoplegia	3	37.5	5	62.5	8	5
Cerebellar symptoms	2	100	0	0	2	1.26
Loss of consciousness	49	60.8	31	39.2	80	50.6
Hemianopia	3	60	2	30	5	3.16
Aphasia	35	58.3	25	41.6	60	37.9
Bladder and Bowel involvement	25	59.6	17	40.4	42	26.5

Risk factors: Major risk factor was hypertension, i.e. 65.8% (104 cases), followed by smoking 39.8 % (63 cases), Diabetes in 27.8 % (44 cases) and Alcohol 25.9% (41 cases). Among major risk factor in males, smoking was found in 100%, alcohol was found in 96.1%, hypercholesterolemia was found in 71.4%, and hypertension was 63.6%. Whereas in females Diabetes was found in 39.3% and hypertension was found in 36.4% (Table 1).

Among neurological symptoms, maximum cases were presented with right hemiplegia in 55% (n=87), followed by loss of consciousness in 50.6% (n=80), left hemiplegia in 38.6% (n=61), aphasia in 37.9 %(n=60), and bladder & bowel involvement in 26.5%(n=42). Male patients were commonly presented with cerebellar symptoms, right hemiplegia, left hemiplegia, and loss of consciousness. Whereas faciobrachial monoplegia was predominantly seen in female patients (Table 1).

Glycemic status: 44.3% cases were euglycemic, 27.8% cases were stress hyperglycemic, 15.9% cases were known diabetic, and 12% cases were newly diagnosed diabetics.

Maximum NIHSS score was found in stress hyperglycemic patients (19.4%), followed by known diabetics (17.3%), newly detected diabetics (16.3%), and euglycemics (9.5%). This association was statistically significant (P<0.05) (Table 2).

Table 2 Stroke severity according to NIHSS score on admission day

Glycemic status	N	NIHSS score Mean ± SD	One-way ANOVA F test*
Euglycemia	70	9.5 ± 6.760	
Stress hyperglycemia	44	19.4±5.248	
Known diabetes	25	17.3±6.561	F=401.1,
Newly diagnosed diabetes	19	16.3±7.040	P<0.001

*The mean NIHSS score was tested in 4 glycemic groups using One-way F test analysis of variance (ANOVA) test. F-test in ANOVA is used to assess whether the expected values of a quantitative variable within four pre-defined groups with various glycemic condition differ from each other.

Table 3 Association between Glycemic status and type of stroke

Glycemic Status	Ischaemic Stroke		Hemorrhagic Stroke		TOTAL	
	No.	%	No.	%	No.	%
Euglycemia	54	77.1%	16	22.9%	70	44.3%
Stress hyperglycemia	36	81.8%	8	18.2%	44	27.8%
Known Diabetes	15	60.0%	10	40.0%	25	15.8%
Newly diagnosed Diabetes	10	52.7%	9	47.3%	19	12.1%
TOTAL	115	72.7%	43	27.3%	158	100%

$\chi^2 = 8.44$, df=3, $p<0.05$.

Maximum proportion (81.8%) of ischaemic stroke cases were found with stress hyperglycemia compared to other glycemic conditions but in hemorrhagic stroke maximum proportion (47.3%) were newly diagnosed diabetics. This association was statistically significant (P<0.05) (Table 3).

Table 4 Association between Glycemic status and size of the lesion

Glycemic status	Small		Medium		Large		Total
	Freq	%	Freq	%	Freq	%	
Euglycemia	46	65.7	13	18.6	11	15.7	70
Stress hyperglycemia	2	4.5	22	50	20	45.5	44
Known diabetes	3	12	13	52	9	36	25
Newly diagnosed diabetes	0	0	10	52.6	9	47.4	19
Total	51	32.2	58	36.8	49	31	158

Chi-square = 65.42, df=6, p<0.001.

Maximum proportion of large size of lesion (47.4%) was found in newly diagnosed diabetes followed by stress hyperglycemia (45.55). Medium size of the lesions were found more in newly diagnosed diabetes (52.6%) followed by known diabetes cases (52%). This association was statistically significant (P<0.05) (Table 4).
Among the 158 study subjects, hemorrhagic stroke was seen in 43 (27.2%) patients and ischaemic stroke was seen in 115 (72.8%) patients (Table 5).

Table 5 Distribution of NIHSS score on Day 15 among prognosis groups

Prognosis groups	N	NIHSS score (Mean ± SD)	ANOVA
Good	51	2.51±1.94	F=897.4, P=0.042*
Moderate	34	10.41±2.24	
Poor	30	18.23±1.45	
Death	43	0.000	
Total	158	6.513	

***significant**

Association between glycemic status and outcome: As NIHSS score increases, the severity of the disease was also increased. Maximum percentage (50%) of deaths were seen in newly diagnosed diabetes cases compared to other groups. Maximum cases of good outcome belonged to euglycemic group (65.9%).This association was statistically significant (P<0.05); (Figure 1).

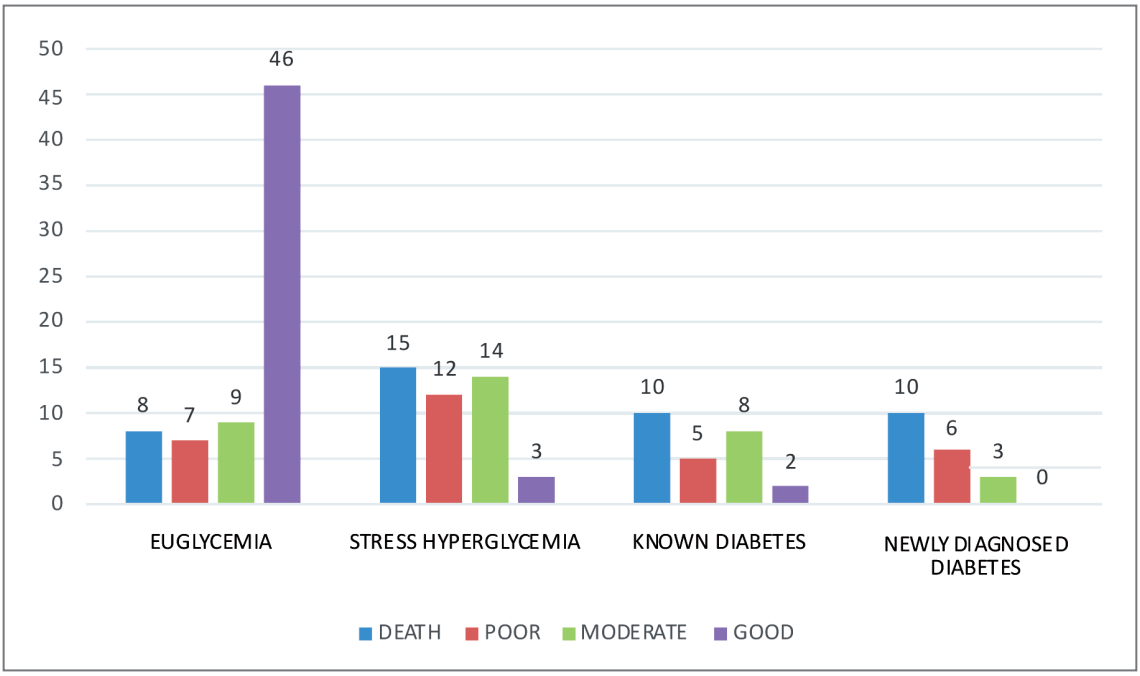


Fig. 1 Association between glycemic status and outcome. Chi-square=69.3, df= 9, P<0.001.

Table 6 Association between glycemic status and outcome in stroke groups

	Glycemic Status	Outcome				Total
		Good	Moderate	Poor	Death	
Hemorrhage group	Euglycemia	4	5	0	6	15
	Stress hyperglycemia	0	2	1	5	8
	Known diabetes	0	5	3	2	10
	Newly detected diabetes	0	3	5	2	10
	Total	4	15	9	15	43
Ischaemic group	Euglycemia	40	5	3	5	53
	Stress hyperglycemia	2	13	11	11	37
	Known diabetes	2	3	2	9	16
	Newly detected diabetes	0	0	1	8	9
	Total	44	21	17	33	115

All the good outcome cases in hemorrhagic stroke belonged to euglycemia group and in ischemia group also maximum cases of good outcome belonged to euglycemia. Maximum proportion of death cases belong to stress hyperglycemia in hemorrhagic stroke group (5/8=62.5%) (Table 6).

Maximum proportion of death cases in ischemic group belongs to newly diagnosed diabetes cases (8/9=88.8%).

Table 7 Correlation of Sugar Levels and Outcome in stroke Groups

Group			Outcome				
			Good	Moderate	Poor	Death	Total
HEMORRHAGE	SUGAR	A	5	5	0	7	17
		B	0	2	2	0	4
		C	0	7	0	0	7
		D	0	0	7	8	15
	Total		5	14	9	15	43
ISCHAEMIC	SUGAR	A	40	5	3	5	53
		B	2	12	11	0	25
		C	2	3	0	5	10
		D	0	0	3	24	27
	Total		44	20	17	34	115

A <110 mg/dl; **B =** 110-125 mg/dl; **C =** 126-199 mg/dl ; **D >**199 mg/dl

Association between outcome and sugar levels: More proportion of deaths were found in blood sugar (<110 mg/dl) and blood sugar (>199 mg/dl) such as 41.2% and 53.4%. Mortality was high in hyperglycemic cases in hemorrhagic stroke cases. In ishchaemic stroke maximum mortality was found with hyperglycemic patients (88.9%) (Table 7).

DISCUSSION

Clinical outcome after stroke is highly variable and depends on many factors (17). Accurate assessment of the expected outcome is important for clinical decision- making, to guide patient management (18).

Majority of the patients 60(37.9%) in our study were within the age group of 51 to 60 yrs, which is in agreement with the studies of Topie E et al (19) and Kyadav K et al (20). Study by Singh K Get al[21] shows that stroke majorly in age group of 51-60 i.e. 23(46%). Other studies found the prevalence of 41 – 50 years age group (10). Our study shows male preponderance, which is also seen in Prasad BNR et al (22). In our study of 158 patients showing male preponderance (65.8%) which is similar to Prasad BNR et al., also showed same male preponderance.

Risk factors incidence:

Among the 158 patients, 104(65.8%) cases were hypertensive with Male preponderance of in 66(63.6%) than females in 8(36.36%). More than half of diabetic patients were males in 27(60.7%) when compared to females in 17(39.3%). The risk of diabetes mellitus was 27.8%. More than two third of hypercholesterolemia patients were males in 16(71.4%) than in females 6(28.56%).

O' Donnell MJ et al[2] showed concordance with our study. This study showed patients with risk factors of hypertension (99%), diabetes mellitus (5%), alcohol intake (3.8%), cardiac causes (6.7%). Therefore, showing hypertension, smoking, diabetes, alcohol intake were significant risk factors for hemorrhagic stroke.

Glycemic status in study population:

Among the 158 patients in our study group 70 patients had normal blood glucose values. Raised blood glucose levels on admission were noticed in 19(12%) newly diagnosed diabetes, 25(15.9%) known diabetes, and 44(27.8%) stress hyperglycemia patients. Other study Singh KG et al showed preponderance of known diabetes 14(28%) in hyperglycemic group.

In ischemic stroke group stress hyperglycemia amounted to one third of the patients and one fifth in hemorrhagic group. The present study shows 15.9% (25/158) prevalence of known diabetics presenting with acute stroke; whereas the prevalence of stroke in known diabetics was 8.5%. But in a study, Kyadav K et al (20) known diabetics were high compared to the present study (24%).

The study also shows a high prevalence of newly diagnosed diabetics (12%) in patients presenting with acute stroke. In another study, the incident of stroke was 16% and 12% in known diabetics and newly diagnosed diabetics (10), which is similar to the present study. These are in agreement with the observations in other series (23). Previous study found a range of prevalence of undiagnosed diabetes in acute stroke population from 6% to 42% (24).

Severity of Stroke:

Severity of stroke was assessed with NIH Stroke scaling system (NIHSS) score. On the admission day hyperglycemic patients had a higher score when compared to euglycemic patients (17.27 vs. 9.5) which was statistically significant with $p = 0.001$. Among the admission day hyperglycemic patient's stress hyperglycemics had higher NIHSS score (19.4%). As score increases severity also increases.

Similar concordance was seen in Al- Weshshy A et al (25) showing NIHSS score high in hyperglycemia patients (14.9±5.9 vs 7.8±3.5, p=0.000). 38.1% of patients with stress hyperglycemia had high NIHSS score versus 10% diabetics and 5% control. 30 days mortality higher in stress hyperglycemia compared to diabetics.

Size of stroke lesion:

The size of the lesion was analyzed with the help of CT scan brain. Most of the euglycemic 46(65.7%) patients had small sized infarcts and hemorrhage whereas majority of the admission day hyperglycemic patients had large sized lesion with edema and midline shift. Among the hyperglycemic patients large sized lesion observed in newly diagnosed diabetes in 9(47.7%) and stress hyperglycaemia group in 20(45.5%). Similar result found in Singh KG et al (21) showing large sized lesions in stress hyperglycemia 5(100%) and also in newly diagnosed diabetes 11(100%).

Type of stroke:

Among the euglycemic group three fourth of the patients had ischemic stroke and one fourth had hemorrhagic stroke. Among patients with admission day hyperglycemia one third of the patients had hemorrhagic stroke. In newly detected diabetic patients, half of them had hemorrhagic stroke. Our study shows an increasing incidence of hemorrhagic stroke among diabetes patients.

Outcome of stroke:

In present study euglycemic patients had a better outcome when compared to the admission day hyperglycemic patients. Euglycemic patients had a better recovery after acute stroke. Sixty five percent of euglycemic patients had a good functional recovery. On the contrary, only three percent of admission day hyperglycemic patients had good functional recovery at the end of thirty day follow up. Early inpatient mortality was high in the admission day hyperglycemic patients. Fifty percent of the admission day hyperglycemic patients died within the first thirty days. In the euglycemic patients the early case fatality rate was only fifteen percent. Hence, there was a threefold increased risk of early mortality in the admission day hyperglycemic patients when compared to euglycemics. Poor outcome was noticed in 33.3% of the admission day hyperglycemic patients and in four percent of euglycemic patients.

The present study shows that the admission day elevated blood glucose level was associated with a high early mortality rate and an increased risk of poor functional recovery.

Several studies have confirmed that stress hyperglycemia is associated with a poor outcome (26,27,28). Jorgensen H et al (28), in their large prospective Danish study found that plasma glucose level >11 mmol/L (>198 mg/dL) was associated with a hospital mortality of 17% for non-diabetic patients, 24% for those with known diabetes, and 32% for patients with hyperglycemia with no history of previous diabetes.

Glycemic status and clinical outcome of hyperglycemia:

In the ischemic stroke group early mortality rate was 9.43 % in euglycemic patients and 56.25% in hyperglycemic patients. Poor outcome was noticed in 5.66 % in euglycemics and 12.5% in hyperglycemics. Hence, hyperglycemia was associated with an increased early mortality rate and poor functional outcome in ischemic stroke group.

In the hemorrhagic patients the early mortality in hyperglycemic patients was 20% and 40 % in euglycemic patients.

In the non-diabetes ischemic stroke patients stress hyperglycemia had worst outcome when compared to euglycemic group. The early mortality rate was 29.7 % in stress hyperglycemics and 9.43% in euglycemics. Hence, this study shows a three-and-a-half-fold increased risk of mortality in non-diabetes stress hyperglycemic patients when compared to non-diabetic euglycemic patients.

The study by Singh KG et al revealed a higher mortality with stress hyperglycaemics and diabetic groups, which was also consistent with other series as reported by some authors (29,30). However, some other studies did not show any significant increase in diabetic stroke deaths in diabetics compared to non- diabetics (31).

Outcome of stroke according to NIHSS score on day 15:

In our study group of 158, patients with NIHSS score <5 had good prognosis n=51 (2.51±1.94), patients with score between 5- 15 had moderate prognosis n=34(10.41± 2.24), patients with score between 15 to 20 had had poor prognosis n=30(18.23±1.45), patients score more than 20 died within 3 days of admission n=43(0.000). Therefore, as score increases severity of outcome increased.

Similar result found in Gajurel BP et al (32), showing better outcome with mean NIHSS score of 4.6±2.2, and poor outcome with mean NIHSS score of 14.16±7.96.

According to Lindsberg PJ and Roine RO (33), hyperglycemia found in two thirds (66%) of all ischemic stroke patients. In our study, hyperglycemia was noticed in 56% of patients in general and in 53% of patients with ischemic stroke. In Lindsberg PJ and Roine RO study, known diabetes and newly diagnosed diabetes contributed to one third of cases (33%). In our study the same group contributed to 28%.

A study by Christensen H and Boysen G (34) demonstrated that an elevated glucose level after acute stroke was associated with higher stroke severity than those with normal level. The mean NIHSS was 9.5 in euglycemics and 17.3 in hyperglycemic patients.

A study by Umpierrez GE et al (35) confirmed that patients with newly detected hyperglycemia had a significant higher early mortality and a lower functional outcome than patients with a history of diabetes or normoglycemia.

Capes SE et al in their metaanalysis concluded that hyperglycemic patients had threefold increased early mortality than euglycemic patients. After ischemic stroke admission hyperglycemia was associated with threefold increased 30 day mortality than euglcemics. After hemorrhagic stroke, admission hyperglycemia was not associated with higher mortality in either diabetic or non-diabetic patients. In our study, in ischemic patients who had elevated admission day glucose level experienced a three and a half fold increased early mortality than euglycemics.

The study clearly shows an increased early mortality rate and poor functional recovery in patients with diabetes and stress hyperglycemia when compared to euglycemics. Hence, there is an urgent need to confirm the improvement in these patients by normalizing blood sugar. Several trails are now under way to improve the outcome of Stroke by normalizing the blood glucose with human recombinant insulin.

Vinychuk SM et al (36) showed that administration of insulin to patients with hyperglycemia improves the functional recovery and vital activity of mild to moderate ischemic stroke patients. However, other clinical benefits of the insulin therapy remain to be determined.

Recommendations of our study includes:

Studies on larger number of patients and investigating the effect of thrombolytic therapy and lowering hyperglycemia on stroke outcome were recommended.

To improve the outcome, intensive glucose lowering therapies should be tried for a minimum of 72 hrs after acute ischemic stroke.

CONCLUSION

Maximum NIHSS score found in stress hyperglycemic patients compared to all other patients. Commonly large size of lesion was significantly found in stress hyperglycemic patients. Commonly higher death cases were found in patients with known diabetes. Severity of stroke correlates with the glycemic status of the patients in diabetics and non-diabetics. Hyperglycaemia in non-diabetic patients after acute stroke is a stress response reflecting more severe neurological damage. Management of hyperglycaemia in patients with diabetes and non-diabetes is an important aspect of the emergency management of stroke.

Ethical Approval

This protocol was approved by the institutional ethics committee, Government Medical College, Khaleelwadi, Nizamabad, Telangana State.

Conflict of Interests

All authors declared no potential conflicts of interest related to the research, authorship, and publication of this article.

Authors' Contributions

Both authors contributed to design, contributed to acquisition, analyses, and drafted the manuscript. Both authors contributed to conception and design, contributed to analysis and interpretation. Both authors were revised the manuscript critically and approved the content of this manuscript.

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REFERENCES

1. Smith WS, Joey D English, JhonstonSC. Cerebrovascular diseases. In: Kasper DL, Fauci AS, Longo DL, Hauser SL, James JL, Loscalzo J, editors. Harrison's Principles of Internal Medicine 18th ed. McGraw Hill, New York; 2010.pp. 3270-94.
2. O'Donnell MJ, Xavier D, Liu L, Zhang H, Chin SL, Rao-Melacini P, Rangarajan S, Islam S, Pais P, McQueen MJ, Mondo C. Risk factors for ischaemic and intracerebral haemorrhagic stroke in 22 countries (the INTERSTROKE study): a case-control study. The Lancet. 2010;376(9735):112-23.
3. Krishnamurthi RV, Feigin VL, Forouzanfar MH, Mensah GA, Connor M, Bennett DA, Moran AE, Sacco RL, Anderson LM, Truelsen T, O'Donnell M. Global and regional burden of first-ever ischaemic and haemorrhagic stroke during 1990–2010: findings from the Global Burden of Disease Study 2010. The Lancet Global Health. 2013;1(5):e259-81.
4. King H, Aubert RE, Herman WH. Global burden of diabetes, 1995–2025: prevalence, numerical estimates, and projections. Diabetes care. 1998 Sep 1;21(9):1414-31.
5. Melamed E. Reactive hyperglycaemia in patients with acute stroke. Journal of the neurological sciences. 1976;29(2):267-75.
6. Frederic MW. Cerebrovascular disease. In: Cardiac and Vascular Disease Conn HLJR and Horwitzo (EDs.), Lea and Febiger, Philladelphia. 1971; 1473-99.
7. Zhu B, Pan Y, Jing J, Meng X, Zhao X, Liu L, Wang Y, Wang Y, Wang Z. Stress hyperglycemia and outcome of non-diabetic patients after acute ischemic stroke. Frontiers in Neurology. 2019;10: 1003.
8. Wolf PA, Cobb JL, D' Agostine. Epidemiology of stroke. In: Barnett HJM and Mohr JP, editors. Stroke 2nd Edition. Churchill Livingstone, Edinburgh;1992.p 3-27.
9. Houseley E. Definition of risk factors in stroke. In: Gillingam FJ, Mawdsley C, Williams AE, editors. Stroke. New York, NY: Churchill Livingstone, Inc; 1976.p 251-60.
10. Davidson MB. The effect of aging on carbohydrate metabolism: a review of the English literature and a practical approach to the diagnosis of diabetes mellitus in the elderly. Metabolism. 1979;28(6):688-705.
11. Sharma AK, Mehrotra TN, Goel VK, Mitra A, Sood K, Nath M. Clinical profile of stroke in relation to glycaemic status of patients. The Journal of the Association of Physicians of India. 1996;44(1):19-21.
12. Joshi SR, Shah SN. Rising global burden of diabetes. The Asian Journal of Diabetology. 1996; 1 (3): 13-5.
13. Weir CJ, Murray GD, Dyker AG, Lees KR. Is hyperglycaemia an independent predictor of poor outcome after acute stroke? Results of a long term follow up study. Bmj. 1997;314(7090):1303.
14. Lyden P. Using the National Institutes of Health Stroke Scale: a cautionary tale. Stroke. 2017 Feb 1;48(2):513-9.
15. Lyden P, Brott T, Tilley B, Welch KM, Mascha EJ, Levine S, Haley EC, Grotta J, Marler J. Improved reliability of the NIH Stroke Scale using video training. NINDS TPA Stroke Study Group. Stroke. 1994;25(11):2220-6.
16. Capes SE, Hunt D, Malmberg K, Pathak P, Gerstein HC. Stress hyperglycemia and prognosis of stroke in nondiabetic and diabetic patients: a systematic overview. Stroke. 2001 Oct 1;32(10): 2426-32.
17. Flint AC, Smith WS. Predicting long-term outcomes for ischemic stroke based on admission variables (www.strokerounds.org). Stroke Rounds 2004;2:1–6.
18. Olai L, Omne-Ponte M, Borgquist K, et al. Prognosis assessment in stroke patients at discharge from hospital. Age Ageing 2007;36:184–9.
19. Topie E, Pavlieek I, Bainer V. Glycosylated haemoglobin in classification of origin of hyperglycaemia in acute cerebrovascular accident. Diabetic Med 1989; 6: 12-15.
20. Kyadav K, Chaudhary HR, Gupta RC, Jain R, Yadav SR, Sharma S, Meena R. Clinical profile and outcome of stroke in relation to glycaemic status of patients. Journal of the Indian Medical Association. 2004 Mar;102(3):138-9.

21. Singh KG, Singh SD, Bijoychandra K, Kamei P, Chingkhei BM. A study on the clinical profile of stroke in relation to glycaemic status of patients. J Indian Academy Clin Med. 2014;15(3):177-81.
22. Prasad BNR, Reddy AS, Prabhakar K, Thejdeep R, Teja NS, Reddy K, Maveesh. Stress Hyperglycemia as a Prognostic Marker in Acute Ischaemic Stroke. Ejpmr. 2016;3(3): 247-256.
23. Kiers L, Davis SM, Larkins R et al. Stroke topography and outcome in relation to hyperlycaemia and diabetes. Journal Neurology,Neurosurgery, Psychiatry 1992; 55 (4): 263-70.
24. Riddle MC, Hart J. Hyperglycaemia, recognised and unrecognized as a risk factor for stroke and transient ischaemic attacks. Stroke 1982; 13: 356-9.
25. Al-Weshahy A, El-Sherif R, Selim KA, Heikal A. Short term outcome of patients with hyperglycemia and acute stroke. The Egyptian Journal of Critical Care Medicine. 2017;5(3):93-8.
26. Baird TA, Parsons MW, Phan T, Butcher KS, Desmond PM, Tress BM, Colman PG, Chambers BR, Davis SM. Persistent poststroke hyperglycemia is independently associated with infarct expansion and worse clinical outcome. stroke. 2003;34(9):2208-14.
27. Khairollah A, Nicholas B, Geoffrey G. Hyperglycaemia and mortality. J R Soc Med 2007;100: 503–7.
28. Jorgensen H, Nakayama H, Raaschou HO, et al. Stroke in patients with diabetes.The Copenhagen Stroke Study. Stroke 1994;25:1977–84.
29. Woo E, Chan YW, Yu YL et al. Admission glucose level in relation to mortality and morbidity outcome in 252 stroke patients. Stroke 1988; 19: 185-91.
30. Toni D, Succhett MI, Argentin C. Does hyperglycaemia play a role as the outcome of acute ischaemic stroke patients. J Neurol 1992; 239: 283-6.
31. George LP. Mortality among persons with diabetes. In: Diabetes: Clinical Science in Practice. LislicRDG and Robbins DC (Eds.) Cambridge University Press, Melbourne 1995; 279-87.
32. Gajurel BP, Dhungana K, Parajuli P, Karn R, Rajbhandari R, Kafle D, Oli KK. The National Institute of Health Stroke Scale Score and Outcome in Acute Ischemic Stroke. Journal of Institute of Medicine. 2014;36(3).
33. Lindsberg PJ, Roine RO. Hyperglycemia in acute stroke. Stroke. 2004;35(2):363-4.
34. Christensen H, Boysen G. Blood glucose increases early after stroke onset: a study on serial measurements of blood glucose in acute stroke. European Journal of neurology. 2002 May;9(3):297-301.
35. Umpierrez GE, Isaacs SD, Bazargan N, You X, Thaler LM, Kitabchi AE. Hyperglycemia: an independent marker of in-hospital mortality in patients with undiagnosed diabetes. The Journal of Clinical Endocrinology & Metabolism. 2002;87(3):978-82.
36. Vinychuk SM, Melnyk VS, Margitich VM. Hyperglycemia after acute ischemic stroke: prediction, significance and immediate control with insulin-potassium- saline-magnesium infusions. Heart Drug. 2005;5(4):197-204.

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