Impact of Monitoring and Management of Physiological Parameters on Acute Ischaemic Stroke

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ABSTRACT

Background and purpose of study: Considerable effort has been directed towards acute stroke research with numerous drug therapies being tried and tested. Monitoring and attempting to stabilize physiological parameters within normal limits were standard practice for acute stroke units. So the purpose of this study was designed to evaluate the effect of changes in these physiological parameters on acute ischemic stroke. Patients and Methods: The present study included 90 patients with acute ischemic stroke. They were randomly allocated to stroke care monitoring unit (SCMU) (50 patients) as group A, and conventional care unit (CU) (40 patients) as group B. The 2 groups were matched as regard; age, time window and initial clinical assessment using Scandinavian Stroke Scale (SSS) & Barthel Index (BI). The strategies to correct alteration on different physiological parameters were identical for both groups. Results: Patients who had hyperthermia, hypertension, hypotension, hyperglycemic and hypoxia at onset of ischemic stroke had significant low SSS & BI compared to patients with normal physiological parameters. SCMU patients had higher BI score and lower mortality rate than those in CU. The length of hospital stay was significantly shorter in patients admitted in SCMU compared with those of CU. Abnormal physiological parameters were frequently discovered and easily corrected in SCMU and was less likely to develop medical complications than those in CU. Conclusion: These findings confirm that monitoring and early correction of physiological parameters was feasible in acute ischaemic stroke patients. (Egypt J. Neurol. Psychiat. Neurosurg., 2006, 43(1): 451-459)

INTRODUCTION

Considerable effort has been directed towards acute stroke research with numerous drug therapies being tried and tested. As yet there is still no routine treatment that is unequivocally effective in acute stroke. There has been considerable interest in various strategies to reduce neuronal injury and subsequent disability after stroke, such as thrombolysis and neuroprotection. However, one of the major successful developments in stroke management over the last decade has been the birth of dedicated stroke units.

Thrombolytic therapy given within 6 hours of stroke reduced death or dependency at 3 to 6 months. However, the optimum criteria to identify the patients most likely to benefit and least likely to be harmed, the latest time window, the effect of prior aspirin use, increasing patients age, stroke severity, agent, dose, and route of administration are not clear.

Heparins should not be indiscriminately given to all acute brain ischemic patients. The efficacy of heparins has been inadequately tested in patients with stroke subtypes and occlusive vascular lesions.

The development of stroke units has been a major breakthrough in reducing disability. Monitoring and attempting to stabilize acute physiological parameters within normal limits such as blood pressure, temperature, heart rate, hydration status, glucose levels and oxygen saturations, has become standard practice for acute stroke units. Thus strategies to monitor and correct changes in acute physiological parameters may potentially reduce neuronal damage in the acute phase of stroke and improve survival. Treatment in stroke units (without intensive monitoring) is the only treatment option proven to reduce death in acute stroke patient and had a beneficial long-term effects on survival and...
disability. So the purpose of this study is to evaluate the changes in some physiological parameters such as temperature, blood pressure, cardiac rhythm, blood glucose and oxygen saturation, and the impact of monitoring & management of these parameters on the course of acute ischemic stroke.

**PATIENTS AND METHODS**

**Patients**

The present study included 90 patients with first-ever acute ischemic stroke. They were consecutively selected according to inclusion criteria to stroke care monitoring unit (SCMU) (50 patients) as group A, and conventional care unit (CU) (40 patients) as group B according to availability of beds, during a period from June 2004 to May 2005 in the neurology department, Assiut University Hospital.

Patients included in this study were clinically diagnosed as first-ever acute ischemic stroke in the carotid artery territory with their symptoms started less than 48 hours before admission. Patients had moderate to severe acute ischemic stroke according to the severity of the motor deficit affecting the arm and/or leg described by the Medical Research council (MRC) as, mild (grad 4), moderate (grade 3) and severe (0-2).

Patients with old poliomyelitis, deformity, and deep venous thrombosis, or limb ischemia, life-threatening concurrent illness such as serious metabolic, hepatic, or renal failure were excluded.

The mean age of the studied sample was 57.1±14.9, forty-seven (52.2%) patients were males and 43 (47.8%) were females. Forty-three patients had right-sided hemiplegia and 47 patients had left sided hemiplegia. The 2 groups (A & B) were matched for mean age, sex distribution, affected side and initial clinical assessment (Scandinavian Stroke Scale (SSS), and Barthel Index (BI) measurements).

**Methods**

1. Each patient underwent a complete clinical examination, SSS and BI measurements.
2. Brain computerized topography (CT) scan.
3. Measurements of; heart rate, blood pressure, body temperature, oxygen saturation, blood glucose level, and electrocardiogram (ECG).
4. Blood urea & creatinine, complete blood picture, liver function test and prothrombine time & concentration.

Patients in group A were continuously monitored with Dataspoke® Passport™ EL model monitors for at least 48 hours (and longer if needed) for cardiac rhythm (5 lead ECG), body temperature, blood pressure (noninvasive automatic measurement), O₂ saturation (Pulse oximeter), and blood glucose concentration. After the first 48 hour, monitoring was stopped when the condition of the patient was stable and the physiological variables showed no abnormality over the last 24 hours.

Patients in-group B, observation consisted of manual measurement of body temperature, blood pressure, heart rate, 4 times a day, oxygen saturation levels were determined when seemed necessary by the attending physician. Any medical complication or changes in physiological parameters occurring during hospitalization were recorded.

For ethical reasons patients in the two groups were treated in a similar way according to a standardized protocol adapted from Sulter & De Keyser. Thus, strategies to correct, hypotension or hypertension, hypoxia, hyperglycemia, elevated body temperature and cardiac arrhythmia, once detected were identical for both groups.

The patients or their legal representative gave written informed consent to participate in the study. Local ethical committee approval of Assiut University Hospitals was obtained.

**Statistical analysis:**

Data collected and analyzed by computer program SPSS “Ver.12”. Data expressed as mean±standard deviation, number and percentage. ANOVA used for repeated measures. Chi square test to detect significance difference in non-
parametric data. Using student t-test to determine significant difference in numeric data.

**RESULTS**

Patients with hyperthermia (> 37.5 °C) had significantly lower SSS and BI at admission and discharge when compared to normothermic patients (p= 0.0001). There was significantly lower BI in patients with abnormal blood pressure (hypertensive and hypotensive) (p=0.05) compared to normotensive patients at discharge. Hyperglycemic patients had significantly lower BI at admission and discharge compared to normoglycemic patients. Patients with hypoxia showed significantly lower SSS at admission (p= 0.0001) and BI at admission & discharge (p= 0.05 & 0.001 respectively) compared to those with normal O₂ saturation. There was no significant difference in SSS & BI in patients with abnormal cardiac rhythm compared to those with normal rhythm at admission or at discharge (Table 1).

At discharge, group A patients showed significantly better functional outcome than those in group B (P= 0.01) according to BI. Also, there was a significant higher mortality rate in-group B compared to group A (30% versus 10%) (Table 2).

The length of hospital stay was significantly shorter in-group A than group B (p= 0.001). As 28 (56%) of patients of group A discharge before one week compared to 10 (25%) in group B. hospital stay one to two weeks were 11 (22%) in group A and 10 (25%) in group B while hospital stay for more than two weeks were 6 (12%) in group A and 8 (20%) in group B.

During period of follow up, abnormal physiological parameters were frequently discovered and easily corrected in group A compared to patients in group B. Hyperthermia, arrhythmia, hypotension, hypertension, hyperglycemia and hypoxia were recorded 117, 35, 16, 18, 35 and 33 time respectively in group A versus 40, 23, 8, 11, 23 and 17 time respectively in group B. Patients in group B were more likely to develop medical complications as chest and urinary tract infection, gastrointestinal bleeding & diarrhea, pulmonary edema and haematuria than those in group A with significant difference in all parameters (Table 3).

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**Table 1.** Severity of acute ischemic stroke in relation to physiological parameters at admission and discharge according to SSS and BI.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>No (%)</th>
<th>SSS Admission</th>
<th>SSS Discharge</th>
<th>BI Admission</th>
<th>BI Discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Body temperature</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>56 (62.2)</td>
<td>21.8±10.9</td>
<td>38.6±9.0</td>
<td>15.7±13.4</td>
<td>47.1±22.1</td>
</tr>
<tr>
<td>Hyperthermia</td>
<td>34 (48.8)</td>
<td>5.2±7.1***</td>
<td>25.6±35.5*</td>
<td>2.8±4.7***</td>
<td>12.6±10.9***</td>
</tr>
<tr>
<td><strong>Blood pressure</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>54 (60)</td>
<td>16.4±12.2</td>
<td>35.2±11.7</td>
<td>12.0±12.1</td>
<td>42.4±23.6</td>
</tr>
<tr>
<td>Abnormal blood pressure</td>
<td>36 (40.)</td>
<td>11.1±11.7</td>
<td>32.5±21.2</td>
<td>7.8±9.5</td>
<td>26.3±24.6*</td>
</tr>
<tr>
<td><strong>Serum glucose</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>60 (66.7)</td>
<td>16.5±12.3</td>
<td>34.1±13.3</td>
<td>12.4±13.5</td>
<td>40.8±26.5</td>
</tr>
<tr>
<td>Hyperglycemia</td>
<td>30 (33.3)</td>
<td>10.7±10.9</td>
<td>34.9±34.8</td>
<td>5.5±7.5*</td>
<td>25.2±17.8*</td>
</tr>
<tr>
<td><strong>O2 saturation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>75 (83.3)</td>
<td>16.7±12.3</td>
<td>35.6±22.97</td>
<td>12.0±13.0</td>
<td>38.4±25.2</td>
</tr>
<tr>
<td>Hypoxia</td>
<td>15 (16.7)</td>
<td>7.4±10.6***</td>
<td>24.9±13.5</td>
<td>4.0±6.9*</td>
<td>17.5±15.9**</td>
</tr>
<tr>
<td><strong>Cardiac rhythm</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>63 (70)</td>
<td>14.2±12.6</td>
<td>32.1±12.3</td>
<td>10.0±11.9</td>
<td>36.2±23.7</td>
</tr>
<tr>
<td>Abnormal</td>
<td>27 (30)</td>
<td>14.9±12.5</td>
<td>38.6±33.6</td>
<td>10.4±13.1</td>
<td>35.3±27.8</td>
</tr>
</tbody>
</table>

* Abnormal blood pressure means hypertensive (28 patients) and hypotensive (8 patients).
Hyperthermia = Body temperature > 37.5 °C,  Hyperglycemia = Serum blood glucose > 7.8 mmol/L, Hypertension = Mean arterial blood pressure > 130 mmHg or systolic BP > 220.
Hypotension = Mean arterial blood pressure < 80 mmHg. Hypoxia = O₂ saturation < 95%,
Abnormal cardiac rhythm = New onset/worsening of arrhythmias, worsening of preexisting cardiac disease, new changes in ECG or heart failure.

Table 2. Distribution of cases according to BI scale at discharge.

<table>
<thead>
<tr>
<th>Group</th>
<th>Excellent</th>
<th>Good</th>
<th>Moderate disability</th>
<th>Severe disability</th>
<th>Deaths</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (50)</td>
<td>3(6%)</td>
<td>1(2%)</td>
<td>15(30%)</td>
<td>26(54%)</td>
<td>5(10%)</td>
<td>0.01*</td>
</tr>
<tr>
<td>B (40)</td>
<td>-</td>
<td>-</td>
<td>4(10%)</td>
<td>24(60%)</td>
<td>12(30%)</td>
<td></td>
</tr>
</tbody>
</table>

Excellent BI= 95-100 Good BI= 75-90 Moderate disability BI= 55-70 Sever disability BI < 50 (7)

Table 3. Number of detected abnormal physiological parameters and medical complications in the two groups during follow up.

<table>
<thead>
<tr>
<th>Item</th>
<th>Group A</th>
<th>Group B</th>
<th>P. Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abnormal physiological parameters:</td>
<td></td>
<td></td>
<td>0.001***</td>
</tr>
<tr>
<td>Hyperthermia</td>
<td>117</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Arrhythmia</td>
<td>35</td>
<td>23</td>
<td>0.03*</td>
</tr>
<tr>
<td>Hypotension</td>
<td>16</td>
<td>8</td>
<td>0.02*</td>
</tr>
<tr>
<td>Hypertension</td>
<td>18</td>
<td>11</td>
<td>0.02*</td>
</tr>
<tr>
<td>Hyperglycemia</td>
<td>35</td>
<td>23</td>
<td>0.03*</td>
</tr>
<tr>
<td>Hypoxia</td>
<td>33</td>
<td>17</td>
<td>0.02*</td>
</tr>
<tr>
<td>Complications:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chest infection</td>
<td>12(24%)</td>
<td>15(37.5%)</td>
<td></td>
</tr>
<tr>
<td>Urinary tract infection</td>
<td>2(4%)</td>
<td>4(10%)</td>
<td></td>
</tr>
<tr>
<td>GIT Bleeding&amp;diarrhea</td>
<td>5(10%)</td>
<td>7(17.5%)</td>
<td>0.01*</td>
</tr>
<tr>
<td>Pulmonary edema</td>
<td>1(2%)</td>
<td>1(2.5%)</td>
<td></td>
</tr>
<tr>
<td>Heamaturia</td>
<td>0</td>
<td>1(2.5%)</td>
<td></td>
</tr>
</tbody>
</table>

DISCUSSION

For almost all patients with stroke, even those with a mild one, the event represents a major change in life. Although much attention has been given to management issues in the acute phase, even with more advanced therapies, the proportion of all patients who are actually cured is very small. Equally important to the development of particular emergency treatment is the recognition that the organization of stroke service per se plays a key role in the provision of effective therapy and improving the over all outcome after stroke.

The present study clarified that; there was direct relationship between body temperature and the severity of stroke at admission and at discharge. Hyperthermic patients had significantly lower SSS and BI score compared to normothermic patients. Our results were in agreement with Meden et al., who demonstrated that early body temperature measurements (within the first 6 hours) seem to be more strongly related to outcome than later measurement. Reith et al. recognized an association between body temperature, initial stroke severity, and clinical outcome. Wang et al. suggested that hyperthermia post stroke was detrimental in stroke recovery. Kammersgaard et al. suggest that admission body temperature seems to be a major determinant for long-term mortality after stroke and hypothermic therapy in the early stage in which body temperature was kept low for longer period could be a long-lasting neuroprotective measure.

Castillo et al. explained elevated body temperature after stroke as: an acute phase response disturbance of central mechanisms of temperature control or the presence of infection. Azzimondi et al. explained poor neurological outcome in patients with elevated body temperature in acute ischemic stroke by increased metabolic demands, enhanced release of neurotransmitters, and increased free radical production. While Noor et al. showed that hyperthermia reduce the neuroprotective effect of tPA in ischemic brain injury. So immediate reduction of
elevated body temperature rapidly was important to improve acute ischemic stroke outcome.

In the present study, the significant association between the abnormality of blood pressure and the poor SSS and BI scale encouraging the physician to control the blood pressure early in acute ischemic stroke patients. This was in agreement with Leonardi-Bee et al.16, who reported that both high and low blood pressure was associated with poor outcome after acute ischemic stroke. Britton et al.17 suggested that, acutely hypertensive patients experience more end-organ morbidity and poor ischaemic stroke prognosis.

More important, Christensen et al.18 study showed that the initial stroke severity influences the course of BP, not vice versa. BP fall within the first 4 hours was associated with mild stroke and a good outcome, where as a sustained high BP associated with severe stroke and poor outcome. These observational data cohere nicely with the study by Mattle et al.19, they demonstrating that recanalization of initially occluded vessel are associated with BP reduction. Birns et al.20 suggested that lowering blood pressure in predisposed patients who may already be in the normotensive range further reduces the risk of vascular events, particularly stroke. This has led to a move away from using thresholds of blood pressure to determine treatment and towards a policy favoring antihypertensive treatment in all those considered to be at high vascular risk.

Adams et al.21 stated that persistent arterial hypotension is rare in patients with acute ischemic stroke, but if present, the cause should be sought. Cause includes aortic dissection, volume depletion and decreased cardiac output secondary to myocardial ischemia or cardiac arrhythmias. Correction of hypovolemia and optimization of cardiac output are important priorities during the first hours after stroke.

At admission the association between the hyperglycemia and severity of stroke recorded in the present study may suggest the deleterious effect of hyperglycemia on infracted area. Toni et al.22 and Burno et al.23 reported that hyperglycemia had a deleterious effect in the form of exacerbating ischemic brain injury, accelerating the molecular processes leading to cell death, and resulting finally in larger infarct volumes and poorer outcomes. Capes et al.24 studied the effect of stress hyperglycemia and showed that in patients with no history of diabetes who have an ischemic stroke, even moderately elevated glucose levels were associated with both a 3-fold higher risk of short term mortality and an increased risk of poor functional recovery compared with lower glucose levels. Ribo et al.25 concluded that the acute but not chronic hyperglycemia might hamper the fibrinolytic process, delaying reperfusion of the ischemic penumbra. Thus early measures to reduce hyperglycemia had favorable results.

There was a significant low SSS & BI in hypoxic patients than those with normal O₂ saturation at admission and discharge. Walshaw and Pearson26 founded that hypoxia following stroke results in anaerobic metabolism and depletion of energy stores, thereby worsening brain injury. Hacke et al.27 and Krieger et al.28 recommend that maintaining adequate tissue oxygenation is of great importance during periods of acute cerebral ischemia in order to prevent hypoxia and potential worsening of the neurological injury. Singhal et al.29, and Yin et al.30 suggested that tissue hypoxia is a key factor contributing to cell death after stroke and oxygen easily diffuses across the blood-brain barrier. Moreover, oxygen had multiple beneficial biochemical, molecular, and hemodynamic effects.

Williams31 suggested that supplemental oxygen should be administered if oxygen saturation were below 95%. Treib et al.32 found that patients with acute ischemic stroke should be monitored with pulse oximetry with a target oxygen saturation level of >95%. Dixon et al.33 suggested that hyperoxia might be a useful physiological therapy that slows down the process of infarction. Singhal et al.34 reported that high-flow oxygen therapy started 12 hours after onset of ischemic stroke transiently improved clinical function and MRI parameters of ischemia.

Routine 100% oxygen supplementation for 24 hours after stroke onset had no benefit in survival in a subgroup of minor to moderate stroke patients. However, this intervention worsened survival at 7 months. This worsening was explained by increased free radical oxygen formation during reperfusion causing further tissue injury35. In the present study, patients who had moderate to severe ischaemic stroke were given oxygen only if oxygen saturation <95%.

The present study has shown that patients with abnormal cardiac rhythm at admission had no significant effect on stroke severity. Rapid correction of these abnormalities resulted in improvement in patient’s outcome. Bonita et al.36 founded that there was an association between ischemic stroke and coronary heart diseases. Howard et al.37 stated that ischemic heart disease was the concomitant condition that carries a high risk of
premature mortality or morbidity of cerebrovascular stroke. Also, Marini et al.\textsuperscript{39} found a high prevalence of atrial fibrillation in patients with a first-ever ischemic stroke, especially among elderly women. The over all contribution of atrial fibrillation to stroke mortality was relevant, suggesting that together with new strategies to prevent the development of arrhythmia more appropriate treatment were needed.

**Continuous Monitoring and its Impact:**

The present study demonstrated that allocation to care in a monitoring stroke unit (SCMU) rather than a conventional unit (CU) increases the probability of good outcome at discharge in first-ever ischemic stroke patients. Patients admitted to SCMU showed better functional outcome and less severe functional disability than those admitted to CU. The length of hospital stay significantly shorter in patients admitted to SCMU and there was significant increase in mortality rate in patients admitted to CU. Changes in physiological parameters were more frequently recorded and easily detected in patients admitted to SCMU especially during the first 48 hours but the duration of these complications was shorter. Patients admitted to CU were more likely to develop other complications such as chest infection, urinary tract infection, and gastrointestinal manifestations. These findings confirm that intensive, non invasive physiological monitoring was feasible in acute stroke patients and capable of improving the rate of detection of, and subsequent intervention for, adverse changes in physiological variables before they became symptomatic.

Kalra and Eade\textsuperscript{39} suggested that SCMU care can reduce the frequency of complications associated with stroke and that it is associated with better outcome. Wardlaw et al.\textsuperscript{40} reported that mortality in the acute phase has been associated with complication arising during the first week of management and related to the quality of care provided during this period. The monitoring of physiological parameters in the acute phase of ischemic stroke can be considered an important management tool that can improve significantly the quality of care provided. Also Cavallini et al.\textsuperscript{10} demonstrated that allocation to care in a monitoring SCMU rather than CU increases 2.5-fold probability of a good outcome at discharge. Sulter et al.\textsuperscript{41} founded that the number of patients with poor outcome was less in the SCMV group than in conventional stroke unit group [7 (25.9%) vs 13 (48.1%)]. Mortality was lower in the SCMV group than in CU group [1(3.7%) VS 7(25.9%)]. Rudd et al.\textsuperscript{42} in England founded that patients managed in hospital admitting a large proportion of their patients to stroke units have better process of care and survival than those admitted to hospitals with low stroke unit provisions.

Today, the recommendation of intensive continuous monitoring as a routine is far from evidence based. In the present study monitoring didn't interfere with early mobilization. Monitoring is mostly used in the very early course of the disease when in most patients, extensive mobilization is not prescribed. Even so, the devices were not that bulky and can be removed during physiotherapy when the therapist is present.

**REFERENCES**

7. Bendszus M.; Urbach M.; Ries F.; Solymosi L. (1998); Outcome after intra-arterial fibrinolysis compared with natural course of patients with a dense middle cerebral artery on early CT. Neuro radiology, 40: 54-58.


التهابات الصدر، التهابات قناة مجسر البول، نزيف الجهاز البصري والإسهال، والارتفاع الرئوي، والنزيف البولي فقد كانت أكثر في المرضى الذين تم حجزهم في وحدة الرعاية التقليدية.