

The role of serum ferritin, pro-brain natriuretic peptide and homocysteine levels in determining ischaemic stroke subtype, severity and mortality

血清鐵蛋白，前腦排鈉利尿肽及高半胱氨酸水平在確定缺血性中風種類，嚴重性及死亡率之角色

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Background: In ischaemic stroke, there are many biochemical and immunological reactions secondary to a reduced cerebral blood flow. The purpose of this study is to investigate the correlation between stroke subtype, stroke severity, mortality, and serum ferritin, pro-brain natriuretic peptide (pro-BNP), homocysteine values before a specific treatment is given to stroke patients in the emergency department. **Methods:** Consecutive acute ischaemic stroke patients admitted between December 2007 and April 2008 were enrolled into the study. Serum ferritin, pro-BNP and homocysteine levels were studied before specific treatment was carried out. Stroke subtypes were determined according to the Trial of Org 10172 in Acute Stroke Treatment (TOAST) and Oxfordshire Community Stroke Project (OCSP) criteria. The severity of stroke was determined by the National Institutes of Health Stroke Scale (NIHSS). Fifteen healthy individuals who matched the study group in terms of sex and age were chosen as control. **Results:** Ninety-two patients were included in the study. There was a significant difference in the serum ferritin, pro-BNP and homocysteine levels between patients who died and those who survived ($p=0.013$, $p<0.001$ and $p=0.003$ respectively). Serum ferritin, pro-BNP and homocysteine levels were higher in all stroke subtypes than in the control group. Comparing among stroke subtypes, only serum pro-BNP levels were higher in the cardioembolic stroke group than in the atherothrombotic stroke and lacunar stroke groups ($p=0.003$ and $p<0.001$ respectively); and only serum pro-BNP levels were higher in the total anterior circulation infarct group than in the posterior circulation infarct and lacunar infarct groups ($p=0.010$ and $p=0.017$ respectively). Pro-BNP levels were significantly higher in patients with NIHSS score >15 than NIHSS=8-15 and NIHSS=1-7 ($p=0.016$ and $p<0.001$ respectively). **Conclusion:** Ferritin, pro-BNP and homocysteine levels were raised in acute ischaemic stroke patients. However, only serum pro-BNP level is clinically useful in predicting stroke subtype, severity and mortality that could provide an insight to the choice of treatment. (*Hong Kong j.emerg.med.* 2010;17:13-21)

背景：在缺血性中風時，大腦血流量的減少可引致很多生化及免疫的反應。本研究的目的是調查在急症室給與中風病人特定治療之前，血清鐵蛋白、前腦排鈉利尿肽及高半胱氨酸的數值與中風種類、中風嚴重性及死亡率之關係。**方法：**2007年12月至2008年4月期間，徵募因急性缺血性中風入院的一連串病人進行研究。在施行特定治療前，研究血清鐵蛋白，前腦排鈉利尿肽及高半胱氨酸的水平。根據多士（TOAST）及牛津郡社區中風計劃（OCSP）的準則決定中風的種類。使用美國國立衛生研究院

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腦中風量表 (NIHSS) 決定中風的嚴重程度。挑撰了 15 名與研究組在性別及年齡方面相配的健康人士作對照組。**結果：**研究包括 92 名病人。死亡及存活病人之間的血清鐵蛋白、前腦排鈉利尿肽及高半胱氨酸的水平有顯著的差別 (分別為 $p=0.013$, $p<0.001$ 及 $p=0.003$)。所有中風種類的血清鐵蛋白、前腦排鈉利尿肽及高半胱氨酸水平都較對照組為高。在中風種類間比較, 只有心栓子性中風組的血清前腦排鈉利尿肽較粥樣化血栓形成性中風及腔隙性中風組為高 (分別為 $p=0.003$ 及 $p<0.001$) , 及只有全前循環梗塞組的血清前腦排鈉利尿肽水平較後循環梗塞及腔隙性梗塞組為高 (分別為 $p=0.010$ 及 $p=0.017$)。NIHSS 分數大於 15 的病人的前腦排鈉利尿肽較 NIHSS=8-15 及 NIHSS=1-7 者顯著較高 (分別為 $p=0.016$ 及 $p<0.001$)。**結論：**急性缺血性中風病人的鐵蛋白、前腦排鈉利尿肽及高半胱氨酸皆上昇。然而, 只有血清前腦排鈉利尿肽水平在臨床上預測中風種類、嚴重性及死亡率是有用的, 可以對治療的選擇提供深入的了解。

Keywords: Brain natriuretic peptide, ferritins, homocysteine, mortality, stroke

關鍵詞：腦排鈉利尿肽、鐵蛋白、高半胱氨酸、死亡率、中風

Introduction

In ischaemic stroke events, many biochemical and immunological reactions occur secondarily in response to the reduced cerebral blood flow. There have been many advances in the molecular, genetic, clinical and biochemical aspects of ischaemic stroke research. Measurement of proteins and substances that are released by neurons, glia, endothelial cells, platelets and leucocytes have been used in addition to neurocognitive tests to detect brain damage after cerebral hypoxia and ischaemia.¹ Detecting those substances also helps in fast diagnosis and early treatment. Measuring the markers that indicate neurological damage in the early phase can help in minimising unnecessary monitoring and time costs in neurological and neuropsychological tests. Although those chemical markers can reveal the severity of the cerebral damage, their clinical importance in localisation should be studied.²

Ferritin, pro-brain natriuretic peptide (pro-BNP) and homocysteine are neurobiological markers which are being studied intensively and have been shown to increase in ischaemic stroke patients.³⁻⁷ However, we could not find any research to show whether the three markers would work in the same patient group, or which marker is a better determinant than the others. Therefore, we decided to investigate the correlation between stroke subtype, stroke severity, mortality and serum ferritin, pro-BNP, homocysteine values before

a specific treatment was given to stroke patients in the emergency department.

Materials and methods

Study population and ferritin, pro-BNP, homocysteine measurement

This study was carried out on 92 patients who were admitted to our emergency department because of acute ischaemic stroke between December 2007 and April 2008, following an approval from the Ethical Committee Presidency of Dicle University Faculty of Medicine. Fifteen healthy people of similar sex and age were recruited to the study as controls. Inclusion and exclusion criteria of the study are shown in Table 1.

Blood samples were taken from the patients before specific treatments were given. All patients were investigated by CT or MRI to determine the stroke subtype and to exclude haemorrhagic strokes and other intracerebral lesions.^{8,9} Sub-extremity Doppler was applied to all patients to detect deep venous thrombosis and venous thromboembolism, along with echocardiography, abdominal and carotid ultrasonography. The demographic, clinical, laboratory and radiological records of each patient were examined. Radiological findings of cerebral ischaemia were recorded according to the cerebral maps by Tatu et al.¹⁰ Stroke subtypes were determined according to the Trial of Org 10172 in Acute Stroke Treatment (TOAST) criteria and

Table 1. Inclusion and exclusion criteria of the study**Inclusion criteria of the study**

1. Acute ischaemic stroke
2. Consent to be included in the study

Exclusion criteria of the study

1. Haemorrhagic stroke
2. Acute or chronic blood loss
3. Iron deficiency
4. Collagen vascular or connective tissue disease
5. Malignancy
6. Liver disease
7. Age younger than 15 years
8. Patients whose classification cannot be done according to OCSF
9. Patients whose classification cannot be done according to TOAST
10. Patients whose NIHSS score cannot be calculated at the time of admission

NIHSS=National Institutes of Health Stroke Scale; OCSF=Oxfordshire Community Stroke Project; TOAST=Trials of Org 10172 in Acute Stroke Treatment

Oxfordshire Community Stroke Project (OCSF), and National Institutes of Health Stroke Scale (NIHSS) scores were determined in all patients by a single neurologist.^{9,11} Patients were divided into four groups according to their NIHSS stroke severity (NIHSS 0: normal; NIHSS 1-7: mild stroke; NIHSS 8-15: medium stroke; NIHSS >15: severe stroke).¹²

The researchers who studied ferritin, pro-BNP and homocysteine levels in the blood samples were blind to the diagnosis of the patients and control group. Ferritin concentrations were determined using an electro-chemiluminescent immunoassay method (Modular Analytics E170; Roche, USA) with a reference level of 13-150 ng/ml. The pro-BNP and homocysteine concentrations were determined using a chemiluminescent immunoassay method (Immulite 2500; Siemens, USA) with a reference level of 20-110 pg/L and 5-12 pg/ml respectively.

Statistical analysis

Results are given as mean±standard deviation (SD). The chi-square test for categorical variables and student's t-test for continuous variables were used for univariate statistical analyses. The Mann-Whitney U test was used for multi-comparison, and Kruskal Wallis one-way variance analysis was used when sample sizes were not equal, and groups did not show homogenous

distribution in in-group comparisons. Statistical significance was taken as $p < 0.01$ for comparisons between groups, and $p < 0.05$ for other comparisons. Stepwise logistic regression analysis was used to analyse variables which were seen as significant in univariate analyses to determine the independent factors affecting mortality.

Results***Patient characteristics***

During the study period, a total of 92 acute ischaemic stroke patients (44.6% male) who passed our inclusion and exclusion criteria were recruited. The average age was 65.59 ± 11.00 years and average referral time from symptom onset to hospital was 7.15 ± 5.40 hours. The average length of stay in the hospital was 10.00 ± 7.69 days. Table 2 shows the clinical and demographic characteristics of the patients.

Stroke category and serum ferritin, pro-BNP, homocysteine levels

The serum ferritin, pro-BNP and homocysteine levels differed according to the stroke types. According to the TOAST classification, cardioembolic stroke and atherothrombotic stroke groups differed from the control group in serum ferritin, pro-BNP and

Table 2. Baseline clinical characteristics of patients

| Characteristics of patients (n=92) | |
|--|-------------|
| Age (years; mean±SD) | 65.59±11.00 |
| Male/Female | 41/51 |
| Referral time to hospital (hours; mean±SD) | 7.15±5.40 |
| Length of stay in hospital (day; mean±SD) | 10.00±7.69 |
| Co-morbid disease | |
| Previous hypertension | 62 (67.4%) |
| Known diabetes | 26 (28.3%) |
| Chronic renal failure | 3 (3.3%) |
| Ischaemic heart disease | 7 (7.6%) |
| Absence of co-morbidity | 23 (25.0%) |
| Echocardiography | |
| Left ventricular hypertrophy | 12 (13.0%) |
| Left atrial thrombus | 14 (15.2%) |
| Diastolic dysfunction | 4 (4.3%) |
| Valvular heart disease | 18 (19.6%) |
| Normal echocardiography | 49 (53.3%) |

homocysteine levels. There was no significant difference between the control group and transient ischaemic attack (TIA). There was a difference found on the serum ferritin and pro-BNP levels between the control group and lacunar infarct patients, but not on homocysteine levels (Tables 3-5). There was no difference between the stroke subtypes according to the TOAST classification on serum ferritin ($p=0.953$) and homocysteine ($p=0.170$) levels, but there was a difference on pro-BNP ($p=0.001$) levels. Serum pro-BNP levels were higher in the cardioembolic stroke group than in the atherothrombotic stroke and lacunar stroke groups ($p=0.003$ and $p<0.001$ respectively) (Table 4).

There were significant differences in serum ferritin, pro-BNP and homocysteine levels between stroke subtypes according to the OCSP classification (total anterior circulation infarct [TACI], partial anterior circulation infarct [PACI], lacunar infarct [LACI] and posterior circulation infarct [POCI]) and the control group (Tables 3-5). Comparison of stroke subtypes showed that serum ferritin ($p=0.321$) and homocysteine ($p=0.621$) levels did not vary between subtypes but serum pro-BNP did ($p=0.03$). Serum pro-

BNP levels were higher in the TACI group than in the POCI and LACI groups ($p=0.010$ and $p=0.017$ respectively) (Table 4).

Stroke severity and serum ferritin, pro-BNP, homocysteine levels

When patients were grouped by NIHSS grouping to determine stroke severity on admission, those with mild (NIHSS=1-7), medium (NIHSS=8-15) and severe (NIHSS>15) strokes had higher serum ferritin, pro-BNP and homocysteine levels than the control group (Tables 3-5). When patients were compared according to stroke severity, no difference was found in serum ferritin ($p=0.228$) levels, but serum pro-BNP ($p<0.001$) and homocysteine ($p=0.025$) levels were different. Serum pro-BNP levels were significantly higher in severe stroke patients than in mild and medium stroke patients ($p<0.001$ and $p=0.016$ respectively). Serum homocysteine levels were significantly higher in severe stroke patients than in mild stroke patients ($p=0.013$).

Mortality and serum ferritin, pro-BNP, homocysteine levels

Twenty-eight of the 92 patients (30.4%) in this study died. There was no statistically significant difference

Table 3. Serum ferritin level difference between patient group and control group

| Stroke category and severity | n | Ferritin concentration (ng/ml; mean±SD) | p |
|------------------------------|----|---|--------|
| TOAST classification | | | |
| Atherothrombotic | 50 | 155.3±106.3 | <0.001 |
| Cardioembolic | 28 | 147.5±61.9 | <0.001 |
| Lacunar | 10 | 169.7±95.5 | 0.001 |
| Transient ischaemic attack | 4 | 98.1±86.3 | 0.221 |
| Control | 15 | 57.1±114.8 | |
| OCSP classification | | | |
| TACI | 9 | 86.9±110.6 | <0.001 |
| PACI | 41 | 135.9±82.9 | <0.001 |
| LACI | 32 | 161.5±110.7 | <0.001 |
| POCI | 10 | 156.8±71.8 | <0.001 |
| Control | 15 | 157.1±114.8 | |
| Stroke severity | | | |
| NIHSS score 0 | 4 | 132.0±101.5 | 0.037 |
| NIHSS score 1-7 | 37 | 150.9±86.1 | <0.001 |
| NIHSS score 8-15 | 27 | 126.2±87.6 | 0.001 |
| NIHSS score >15 | 24 | 186.1±100.6 | <0.001 |
| Control | 15 | 57.1±114.8 | |

LACI=lacunar infarct; NIHSS=National Institutes of Health Stroke Scale; OCSP=Oxfordshire Community Stroke Project; PACI=partial anterior circulation infarct; POCI=posterior circulation infarct; TACI=total anterior circulation infarct; TOAST=Trials of Org 10172 in Acute Stroke Treatment

Table 4. Serum pro-BNP level difference between patient group and control group

| Stroke category and severity | n | Pro-BNP concentration (pg/L; mean±SD) | p |
|------------------------------|----|---------------------------------------|--------|
| TOAST classification | | | |
| Atherothrombotic | 50 | 938.5±992.0 | <0.001 |
| Cardioembolic | 28 | 1555.3±1017.3 | <0.001 |
| Lacunar | 10 | 384.6±524.7 | 0.002 |
| Transient ischaemic attack | 4 | 851.8±1055.7 | 0.037 |
| Control | 15 | 55.1±36.8 | |
| OCSP classification | | | |
| TACI | 9 | 1832.5±1076.4 | <0.001 |
| PACI | 41 | 1077.2±998.1 | <0.001 |
| LACI | 32 | 968.1±1001.7 | <0.001 |
| POCI | 10 | 609.1±844.5 | 0.002 |
| Control | 15 | 55.1±36.8 | |
| Stroke severity | | | |
| NIHSS score 0 | 4 | 292.0±370.3 | 0.100 |
| NIHSS score 1-7 | 37 | 530.5±740.8 | <0.001 |
| NIHSS score 8-15 | 27 | 1177.4±1013.5 | <0.001 |
| NIHSS score >15 | 24 | 1880.9±889.0 | <0.001 |
| Control | 15 | 55.1±36.8 | |

LACI=lacunar infarct; NIHSS=National Institutes of Health Stroke Scale; OCSP=Oxfordshire Community Stroke Project; PACI=partial anterior circulation infarct; POCI=posterior circulation infarct; pro-BNP=pro-brain natriuretic peptide; TACI=total anterior circulation infarct; TOAST=Trials of Org 10172 in Acute Stroke Treatment

Table 5. Serum homocysteine level difference between patient group and control group

| Stroke category and severity | n | Homocysteine concentration (pg/ml; mean±SD) | p |
|------------------------------|----|---|--------|
| TOAST classification | | | |
| Atherothrombotic | 50 | 16.54±10.11 | <0.001 |
| Cardioembolic | 28 | 14.05±5.40 | <0.001 |
| Lacunar | 10 | 11.13±4.71 | 0.016 |
| Transient ischaemic attack | 4 | 12.93±5.76 | 0.124 |
| Control | 15 | 7.45±2.54 | |
| OCSP classification | | | |
| TACI | 9 | 15.71±5.02 | <0.001 |
| PACI | 41 | 14.98±8.57 | <0.001 |
| LACI | 32 | 15.64±9.90 | <0.001 |
| POCI | 10 | 12.77±4.20 | 0.001 |
| Control | 15 | 7.45±2.54 | |
| Stroke severity | | | |
| NIHSS score 0 | 4 | 9.43±5.24 | 0.736 |
| NIHSS score 1-7 | 37 | 12.49±4.66 | <0.001 |
| NIHSS score 8-15 | 27 | 15.43±7.37 | <0.001 |
| NIHSS score >15 | 24 | 19.46±11.96 | <0.001 |
| Control | 15 | 7.45±2.54 | |

LACI=lacunar infarct; NIHSS=National Institutes of Health Stroke Scale; OCSP=Oxfordshire Community Stroke Project; PACI=partial anterior circulation infarct; POCI=posterior circulation infarct; TACI=total anterior circulation infarct; TOAST=Trials of Org 10172 in Acute Stroke Treatment

on gender between survival and death ($p=0.362$); but for age, it was significant ($p=0.01$). Table 6 shows the clinical and demographic differences between patients who survived and those who died.

Mortality was higher in patients with left atrial thrombus in transthoracic echocardiograph than in patients without them ($p=0.009$). Patients with cardioembolic infarct according to the TOAST classification had higher mortality than others (atherothrombotic, lacunar and TIA) ($p=0.014$). Patients with total anterior circulation infarct according to the OCSP classification had higher mortality ($p<0.001$) than those with partial anterior circulation infarct, lacunar infarct and posterior circulation infarct. When the serum levels of ferritin, pro-BNP and homocysteine were compared, it was found that these levels were significantly higher in patients who died than those who survived ($p=0.013$, $p<0.001$ and $p=0.003$ respectively). When comparing variables that were shown to be important on mortality in univariate analyses by the regression method, we

found that serum pro-BNP level (OR=1.002, 95%CI=1.001, 1.002 and $p<0.001$), absence of any co-morbid disease (OR=0.066, 95%CI=0.009, 0.470 and $p=0.007$) and serum ferritin level (OR=1.011, 95%CI=1.003, 1.019 and $p=0.009$) were independent predictors of mortality (Table 7) .

Discussion

We confirmed that ferritin, pro-BNP and homocysteine levels were higher in ischaemic stroke patients than in healthy people.

Published data on predicting stroke type, stroke severity and mortality with serum homocysteine were contradictory. The mechanism of how atherothrombosis could have depended on homocysteine or its metabolites is not fully known, though much epidemiological evidence indicates that hyperhomocysteinemia could be an independent risk factor for atherosclerosis in coronary, cerebral and

Table 6. Demographic and clinical difference between patients who survived and patients who died

| Variable | Patient survived n=64 | Patient died n=28 | p |
|---|-----------------------|-------------------|--------|
| Age (years; mean±SD) | 63.95±11.96 | 69.32±7.30 | 0.010 |
| Gender | | | |
| Male | 31 | 10 | 0.367 |
| Female | 33 | 18 | |
| TOAST classification | | | |
| Atherothrombotic | 36 | 14 | 0.744 |
| Cardioembolic | 14 | 14 | 0.014 |
| Lacunar | 10 | – | 0.029 |
| Transient ischaemic attack | 4 | – | 0.310 |
| OCSF classification | | | |
| LACI | 24 | 8 | 0.556 |
| TACI | 1 | 8 | <0.001 |
| PACI | 32 | 9 | 0.175 |
| POCI | 7 | 3 | 1.000 |
| Co-morbid disease | | | |
| Previous hypertension | 41 | 21 | 0.379 |
| Known diabetes | 16 | 10 | 0.423 |
| Chronic renal failure | 3 | – | 0.551 |
| Ischaemic heart disease | 3 | 4 | 0.194 |
| Presence of any co-morbid disease | 44 | 25 | 0.038 |
| Echocardiography | | | |
| Left ventricular hypertrophy | 11 | 1 | 0.098 |
| Left atrial thrombus | 5 | 9 | 0.009 |
| Diastolic dysfunction | 4 | – | 0.310 |
| Valvular heart disease | 14 | 4 | 0.576 |
| Normal echocardiography | 36 | 13 | 0.521 |
| Referral time to hospital (hours; mean±SD) | 6.79±5.28 | 7.31±5.49 | 0.665 |
| Length of stay in hospital (days; mean±SD) | 9.00±10.68 | 10.44±6.00 | 0.509 |
| Ferritin (ng/ml; mean±SD) | 134.2±80.4 | 192.8±106.0 | 0.013 |
| Pro-BNP (pg/L; mean±SD) | 724±850 | 1835±957 | <0.001 |
| Homocysteine (pg/ml; mean±SD) | 12.9±6.3 | 19.7±10.5 | 0.003 |

LACI=lacunar infarct; OCSF=Oxfordshire Community Stroke Project; PACI=partial anterior circulation infarct; POCI=posterior circulation infarct; pro-BNP = pro-brain natriuretic peptide; TACI=total anterior circulation infarct; TOAST=Trial of Org 10172 in Acute Stroke Treatment

Table 7. Stepwise logistic regression model for predictors on mortality

| Predictors* | B (standard error) | 95% confidence interval | Odds ratio | p |
|------------------------------|--------------------|-------------------------|------------|--------|
| Constant | 5.489 (1.232) | – | – | – |
| Absence of co-morbid disease | 2.719 (1.002) | 0.009-0.470 | 0.066 | 0.007 |
| Ferritin | 0.011 (0.004) | 1.003-1.019 | 1.011 | 0.009 |
| Pro-BNP | 0.002 (0.000) | 1.001-1.002 | 1.002 | <0.001 |

*All variables with p<0.05 in univariate analysis were included in this model.

Pro-BNP=pro-brain natriuretic peptide

peripheral vessels.¹³⁻¹⁵ Kelly et al reported in a meta-analysis involving 1487 patients that medium and high homocysteine levels and ischaemic stroke were related.¹⁶ Serum homocysteine levels were found to be lower in healthy subjects than in ischaemic stroke patients in our study.

The relationship between homocysteine and stroke subtype is not obvious. A series of studies conducted by McIlroy et al showed that hyperhomocysteinemia might play a role in the pathogenesis of atherothrombotic vascular diseases.¹⁷ Tan et al reported that hyperhomocysteinemia could be an independent risk factor of ischaemic stroke in Asian adults.¹⁸ Similarly, our study showed that serum homocysteine levels were significantly higher in cardioembolic and atherothrombotic stroke subtypes in which large arteries were affected. However, among lacunar infarct and TIA groups in which small arteries were affected and small infarcts occurred, the elevated level of homocysteine was not statistically significant.

A study by Youssef et al indicated that the association between the NIHSS scale reflecting stroke severity and the serum homocysteine levels was not significant,¹⁹ whereas in our study serum homocysteine levels were significantly higher in patients with greater neurological deficits.

There are many studies in the literature which showed that rise of homocysteine in the serum of acute ischaemic stroke patients could have contributed to mortality. In patients with severe hyperhomocysteinemia, early deaths as a result of ischaemic stroke were frequently seen.^{13,16,17} In our study there was an association between serum homocysteine level and mortality, however it was not an independent predictor affecting mortality on regression analysis. We think that homocysteine level can be a risk factor in cerebral ischaemic vascular diseases and controlling homocysteine levels should be included in treatment.

There have been many studies investigating the relationship between stroke subtypes, post stroke mortality and serum ferritin level. Some studies found a meaningful relationship between serum ferritin and stroke severity and mortality²⁰⁻²² and some did not.^{23,24}

We found that the serum ferritin levels of acute ischaemic stroke patients were higher than those of healthy people. In our study, patients of all subtypes except TIA had higher serum ferritin levels than the control group. However when comparing stroke subgroups, we found no correlation between stroke subtype, severity and serum ferritin levels. Both univariate analyses and logistic regression analysis showed a statistically significant relationship between serum ferritin level and mortality. Although the OR was estimated to be 1.011 that was close to one, it would still represent a clinically useful predictor because of the marked variations of serum ferritin levels among different stroke patients. It is hard to determine whether rise in ferritin levels could be secondary to stress in the first hours of ischaemic stroke. So there is a need for a multi-centre case cohort study investigating the relationship between ferritin and ischaemic stroke.

As parenchymal damage is seen in acute ischaemic stroke, pro-BNP in serum rises to a measurable level.^{3,4} In a study by Yip et al, it was reported that serum pro-BNP levels were higher in ischaemic stroke patients than in healthy control group, and correlated with stroke severity.²⁵ Conversely, Di Angelantonio et al found no correlation between ischaemic lesion size and pro-BNP levels.²⁶ Our findings showed that serum pro-BNP levels would rise in acute ischaemic stroke and this rise could correlate with stroke subtypes and stroke severity. Serum pro-BNP rose especially high in cardioembolic stroke and the TACI group. Also, the NIHSS score of the patients correlated with the rise in serum pro-BNP level. Univariate analyses and logistic regression analysis showed a statistically significant correlation between serum pro-BNP level and mortality. Again, although the OR (=1.002) was close to one, it would still represent a useful clinical marker because of the high variations of pro-BNP levels among different stroke patients.

Conclusion

Serum ferritin, pro-BNP and homocysteine levels all rise in acute ischaemic stroke patients. However, among them, serum pro-BNP level is the most

important and clinically useful neurobiological marker in predicting stroke subtype, severity and mortality.

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