Nutritional status of hospitalized acute stroke patients

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The nutritional status of 201 hospitalized stroke patients was assessed from anthropometric, haematological and biochemical data in an observational prospective study. On admission, sixty-two (31 %) stroke patients had BMI < 20, ninety-nine (49 %) had a triceps skinfolds thickness below the 25th centile, twenty-five (12 %) had a mid-arm circumference below the 25th centile and thirty-eight (19 %) had a serum albumin concentration below 35 g/l. Baseline nutritional status was worse among those who later died or remained in hospital compared with those discharged and most patients who remained in hospital showed marked and significant deterioration in all measures of nutritional status within 4 weeks of hospitalization. After adjusting for age, stroke severity and co-morbidity, low serum albumin concentrations of these patients in hospital were a strong and independent predictor of death following acute stroke (odds ratio 1·13 (95 % CI 1·01–1·27) for 1 g/l lower serum albumin concentration).

Stroke: Nutritional status: Hospital patients

Nutrition is often neglected by medical staff during an acute illness (Garrow, 1994). A recent report revealed that undernutrition in British hospitals is prevalent, largely unrecognized in hospital patients on admission, and tends to worsen during the hospital stay (McWhirter & Pennington, 1994). Acute illness may influence nutritional status, but the effect of ill-health on the nutritional status of hospital patients should be limited to the time of the acute illness because any nutritional disadvantage should be overcome once the patient recovers. Elderly patients, including those who have had a stroke, are more at risk of undernutrition than other groups because of reduced nutritional reserves, prolonged hospital stay and increased demands of repeated ill-health (Department of Health and Social Security, 1992). Stroke may compound these problems because of physical and mental incapacity, problems with perception and communication, and swallowing disorders (Axelsson *et al.* 1989; Unosson *et al.* 1994). The full extent of undernutrition and its independent contribution to stroke outcome is not presently known. It is also not known whether it can be corrected, and whether doing so would improve the outcome.

The aim of the present study was therefore to describe the nutritional status of acute stroke patients during hospitalization and to measure its impact on outcome.

Methods

Subjects

All stroke patients admitted to Leicester General Hospital from June 1994 to October 1995 and diagnosed according to the WHO criteria (1971) but excluding those with cerebral or subarachnoid haemorrhage were identified prospectively. Patients suffering from diagnosed malabsorption, previous gastrectomy, biochemical evidence of hepatic or renal impairment, uncontrolled heart failure, sepsis or diagnosed malignancy were excluded. The study was approved by Leicestershire Health Ethical Committee and all patients or their carers gave written informed consent. All patients had clinical data recorded prospectively. Outcome measures including disability, handicap and mortality were recorded during the hospital stay and at 3 months.

Measurement of nutritional status

Nutritional status was assessed within 48 h of admission and after 2 and 4 weeks. Each patient's nutritional status was determined from anthropometric, haematological and biochemical data. Armspan was measured by doubling halfspan which was taken from the centre of the sternal

Abbreviations: AMC, arm-muscle circumference; BSF, biceps skinfold; MAC, mid-arm circumference; TSF, triceps skinfold.
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notch in the midline to the fingertip in the recumbent position using a flexible tape (Kwok & Whitelaw, 1991). Weight was measured with a portable mechanical chair scale. Armspan and weight were used to determine body mass index (BMI; weight (kg) $\div$ (armspan (m))^2). Mid-arm circumference (MAC) was measured by a flexible tape measure at the level of the midpoint between acromion and olecranon, with the elbow flexed at 90°; the mean of three readings was taken. Triceps (TSF) and biceps (BSF) skinfolds were taken at the same level over the triceps and biceps muscles respectively with the arm hanging relaxed at the side. TSF and BSF were measured using skinfold callipers accurate to 0·2 mm (John Bull, British Indicators Ltd., Burgess Hill, West Sussex, UK) and the mean of three measures was recorded (CV 5·8 and 4·4 respectively). MAC, TSF and BSF were taken from the left arm, except when the left arm was paralysed. The arm-muscle circumference (AMC) was calculated as AMC = MAC − (TSF × 0·314). All anthropometric measurements were performed by a single observer (SEG). Values were compared with normal values standardized for sex and age (for age 65 to 85 + years) drawn from published data on the population of South Wales based on 1500 subjects (Burr & Philips, 1984).

Besides the routine blood tests, the following haematological and biochemical tests were performed as part of the nutritional assessment: haemoglobin (Hb), packed cell volume, albumin, transferrin and serum Fe, B_{12} and folic acid. Only serum albumin, transferrin and Fe concentrations were repeated during the study period. Tests were performed by Leicestershire Central Pathology Laboratory.

Statistical analysis

Comparison of nutritional indices between groups were carried out using the paired and unpaired *t* tests, repeated measures and one-way ANOVA. Mean values and standard deviations were quoted, and for data with skewed distributions, $\log_{10}$ (TSF, BSF) and square root (serum Fe) transformations were used and normality was checked using Normal probability plots (Shapiro Wilk test).

To examine the independent influence of admission nutritional status indices (body weight, BMI, MAC, AMC, TSF, serum albumin, transferrin and serum Fe), age, stroke severity (Modified Rankin, incontinence of urine), co-morbidity (drug intake, previous illnesses) and sex on mortality at 3 months, a logistic regression analysis model was undertaken (Altman, 1991). Each nutritional status variable was first analysed separately against the dependant variable outcome (which was dichotomized, i.e. alive *v.* dead). Those variables with significant association with the outcome variable ($P < 0·05$) were entered with other variables into the final model. Important interactions between variables were also investigated.

Sample size determination

In order for the study to have had a high chance of detecting a statistically significant and a worthwhile prevalence of undernutrition, if one existed, and to be reasonably sure that no such effect existed if it were not found in this study, the sample size calculation was based on pre-study considerations. From previous studies the prevalence of undernutrition in acute stroke patients admitted to hospital has been reported to be about 16 % (Axelsson *et al.* 1988). Assuming the same prevalence in our patients, we estimated that 207 patients would be needed for this study to obtain an estimate accurate to within 5 % (i.e. for the 95 % CI to have width 10 %).

Results

Characteristics of the stroke patients are shown in Table 1. Seven patients were excluded because of a cerebral or subarachnoid haemorrhage shown by computer-assisted tomography. Of the 225 stroke patients considered for the study, 201 (89 %) had their nutritional status assessed on admission; the number of patients with complete data for repeat measurements at 2 and 4 weeks were ninety-six (43 %) and fifty-one (23 %) respectively. Exclusions were due to early deaths or discharges.

Nutritional status on admission

There were significant differences in baseline nutritional status between those who remained in hospital, died or were discharged within 4 weeks of hospitalization, with nutritional status being worse among those who died or remained in hospital compared with those discharged (Table 2). Altogether, ninety-nine (49 %) of the 201 stroke patients had a TSF below the 25th centile and forty-six (23 %) had a TSF below the 5th centile. Twenty-five (12 %) had a MAC below the 25th centile and four (2 %) had a MAC below the 5th centile. Of the patients, 14 % had an AMC below the 25th centile and 3 % below the 5th centile. There were sixty-two patients (31 %) with a BMI of less than 20, and thirty-eight (19 %) had a serum albumin level below 35 g/l (range 35–55 g/l).

Table 3 shows significant sex differences in some of the nutritional indices assessed on admission. Undernutrition was evident in those who had lived in institutions or sheltered accommodation, but less so for those who lived in the community alone or with a spouse before admission, but after adjusting for age most differences were not statistically significant (Table 4).

Changes in nutritional status during hospitalization

All measures of nutritional status except serum Fe concentrations showed significant and marked deterioration during the study period (Table 5). The most dramatic deterioration in nutritional status was seen in the first 2 weeks of the study period. For example, within the first 2 weeks of hospitalization, sixty-one (64 %) of those patients who survived lost weight, twenty-nine (30 %) gained weight and in six (6 %) weight remained unchanged to within 0·4 kg, compared with twenty-three (45 %), twenty-four (47 %) and five (8 %) respectively during the second 2 weeks of the hospital stay. After adjusting for age and stroke severity, nutritional status deteriorated significantly

Table 1. Demographic data and other characteristics of 201 stroke patients on admission
(Actual numbers with percentages in parentheses unless otherwise stated)

Variable		Missing data
Mean (SD) age (years)	77·9 (9·1)	
Interquartile range (years)	72–84	
Males	81 (40)	
Smoking:		
current smokers*	34 (17)	5 (3)
ex-smokers	33 (16)	
Alcohol > 14 units/week	11 (5)	
Previous illnesses:		
cerebrovascular disease	64 (32)	
ischaemic heart disease	47 (23)	
hypertension	62 (31)	
diabetes mellitus	22 (11)	
atrial fibrillation on ECG in hospital	21 (10)	
Median delay between stroke and hospital admission (hours)	9	9 (4)
Interquartile range (hours)	5–24	
CT head:	121 (60)	2 (1)
normal CT	25 (21)	
infarction	96 (79)	
Speech affected	64 (32)	1 (0·5)
Difficulty in swallowing†	22 (11)	2 (1)
Incontinence of urine‡	87 (43)	4 (2)
Disability, modified Rankin score (median)	5	1 (0·4)
Interquartile range	4–6	
Median stay (days)	23	1 (0·5)
Interquartile range (days)	12–49	
Outcome at 3 months:		
alive	140 (70)	1 (0·4)
dead	61 (30)	

* Patients who had stopped smoking ≤3 months before admission were considered current smokers.
† Unable to swallow 50 ml water on two occasions during hospitalization.
‡ On one occasion, or catheterized.

during the hospital stay for those who had lived in institutions, sheltered accommodation, alone in the community or with a spouse, but the differences between the cumulative changes in groups were not statistically significant (Table 6). Men lost 2·4 (SD 2·9) % of their baseline mean body weight compared with women who lost 1·8 (SD 3·1) % during the course of hospitalization, but the difference between the changes in the two groups were not statistically significant. However serum albumin showed significant deterioration in men compared with that of women during 4 weeks of hospitalization (Table 7).

The baseline nutritional status of stroke patients with inability to swallow was worse compared with those able to swallow (Table 8). Interestingly however, plasma Na and urea were significantly higher in stroke patients with inability to swallow at admission compared with those able to swallow. Hb, serum creatinine and approximated plasma osmolality were not significantly different between the two groups (Table 9). All measures of nutritional status with exception of body weight showed a non-significant deterioration in those with a swallowing difficulty compared with those without (Table 8). Drug intake did not influence the nutritional status either on admission or during the hospital stay.

The multiple logistic regression analysis showed that among nutritional status indices only the serum albumin

Table 2. Comparison of baseline nutritional status between those stroke patients who remained as in-patients, were discharged, or who died within 4 weeks of hospitalization
(Mean values with standard deviations for 201 patients)

Group ...	Discharged (*n* 107)		Stayed in hospital (*n* 51)		Died (*n* 43)		
	Mean	SD	Mean	SD	Mean	SD	*P* value
Weight (kg)	65·6	14	62·7	13·6	56·1	8	0·048
TSF (mm)	7·6	1·7	9·3	1·7	6·1	1·9	0·010
BSF (mm)	5·0	1·5	5·7	1·6	4·6	1·6	0·336
MAC (mm)	261	33	258	34	240	31	0·002
AMC (mm)	232	29	226	28	216	27	0·012
Albumin (range 35–55 g/l)	38·9	3·3	38·0	3·8	36·4	4·1	0·002
Transferrin (range 2–4 g/l)	2·7	0·5	2·8	0·5	2·7	0·8	0·423
Iron (range 14–28 μmol/l)	10·9	0·8	9·6	0·7	6·8	0·5	0·001

TSF, triceps skinfold; BSF, biceps skinfold; MAC, mid-arm circumference; AMC, arm-muscle circumference.

Table 3. Nutritional status of 201 stroke patients on admission
(Mean values with standard deviations)

	Men (n 87)		Women (n 114)					
	Mean	SD	Mean	SD	Mean difference	95% CI		P value
BMI (kg/m^2)	22·2	3·9	22·9	5·0	− 0·7	− 2·2,	0·8	0·335
Weight (kg)	68	12·5	59·9	13·4	8·2	3·9,	12·5	0·0001
TSF (mm)	5·7	1·6	9·0	1·9	− 4·6	− 6·1,	− 3·1	0·0001
BSF (mm)	5·0	1·5	4·9	1·7	− 0·3	− 1·2,	0·6	0·505
MAC (mm)	262	26	252	38	11	10,	200	0·019
AMC (mm)	243	22	215	27	27	200,	350	0·0001
Albumin (range 35–55 g/l)	38·8	3·5	37·9	3·8	1·0	− 0·1,	2·0	0·056
Transferrin (range 2–4 g/l)	2·66	0·45	2·83	0·77	− 0·2	− 0·4,	0·02	0·084
Iron (range 14–28 µmol/l)	10·6	0·6	8·4	0·7	2·2	0·6,	3·8	0·016
Haemoglobin (g/dl)	14·4	1·7	13·3	1·7	1·1	0·6,	1·6	0·0001
Vitamin B_{12} (200–950 ng/l)	516	1·56	573	1·7	− 56	− 2·46,	588	0·395
Serum folate (2·5–13 µg/l)	6·12	1·4	6·11	1·5	− 0·2	− 1·4,	0·9	0·561

TSF, triceps skinfold; BSF, biceps skinfold; MAC, mid-arm circumference; AMC, arm-muscle circumference.

Table 4. Nutritional status of 201 stroke patients according to their residence in the community before admission
(Mean values with standard deviations)

	Living with a spouse (n 80)		Living alone (n 67)		Institution or sheltered accommodation (n 51)		
	Mean	SD	Mean	SD	Mean	SD	P value*
Age	74	9	80	8	81	10	0·0001
Sex, male (%)	56 (70)		24 (36)		25 (49)		0·0001†
BMI (kg/m^2)	22·6	4·6	22·4	5·5	21·3	5·7	0·692
Weight (kg)	66	14·8	62·8	12·4	60·4	11·9	0·486
MAC (mm)	264	34	255	34	246	31	0·399
AMC (mm)	236	30	221	26	218	27	0·051
TSF (mm)	7·1	1·8	8·1	1·9	7·2	1·9	0·189
BSF (mm)	5·1	1·5	4·8	1·6	4·9	1·7	0·448
Albumin (g/l)	38·6	3·8	38·1	3·7	37·8	3·6	0·831
Transferrin (g/l)	2·7	0·5	2·9	0·8	2·6	0·6	0·035
Iron (µmol/l)	9·8	0·95	9·5	0·64	8·3	0·55	0·667
Haemoglobin (g/dl)	13·9	1·9	13·8	1·9	13·4	1·6	0·523

MAC, mid-arm circumference; AMC, arm-muscle circumference; TSF, triceps skinfold; BSF, biceps skinfold.
* P value for the main effects of residence on nutritional status indices after adjusting for age using ANOVA.
† Kruskall-Wallis H test.
‡ Data are missing for three of the 201 patients.

Table 5. Nutritional status of stroke patients (n 51) who remained in hospital during the study period
(Mean values with standard deviations)

	Week 0		Week 2		Week 4		
	Mean	SD	Mean	SD	Mean	SD	P value*
BMI (kg/m^2)	22·51	4·5	21·4	4·4	21·65	4·1	0·006
Weight (kg)	62·7	13·6	61·4	13·2	61·6	12·5	0·026
TSF (mm)	9·3	1·7	8·1	1·8	6·7	1·7	0·0001
BSF (mm)	5·7	1·6	4·9	1·5	4·2	1·5	0·0001
MAC (mm)	258	34	252	37	252	34	0·001
Albumin (range 35–55 g/l)	38·0	3·8	35·5	4·2	34·8	4·0	0·0001
Transferrin (range 2–4 g/l)	2·76	0·65	2·61	0·58	2·6	0·47	0·023
Iron (range 14–28 µmol/l)	9·6	0·74	8·9	0·72	8·7	0·53	0·893

TSF, triceps skinfold; BSF, biceps skinfold; MAC, mid-arm circumference.
* Repeated measures ANOVA.

Table 6. Serum albumin concentrations (g/l) of stroke patients (n 51) according to their residence in the community before admission
(Mean values with standard deviations)

	Week 0		Week 2		Week 4		
	Mean	SD	Mean	SD	Mean	SD	P value*
Living with a spouse (n 15)	38·6	3·8	36·3	3·3	35·4	3·9	< 0·001
Living alone (n 18)	38·1	3·6	36·1	4·5	35·1	3·0	0·007
In institution or sheltered accommodation (n 18)	37·6	3·5	35·1	4·8	33·8	5·2	< 0·001

* After adjusting for age and stroke severity (Rankin score) using ANOVA method. Differences between the cumulative changes were not statistically significant.

Table 7. Cumulative changes in nutritional variables of stroke patients measured at 2-week intervals after hospital admission (Mean values with standard deviations)

	Men					Women				
	Week 2 (*n* 44)		Week 4 (*n* 23)			Week 2 (*n* 52)		Week 4 (*n* 28)		
	Mean	SD	Mean	SD	Net change	Mean	SD	Mean	SD	Net change
BMI (kg/m^2)	−0·5	0·7	0·0	3·9	−0·5	−1·1	0·7	−0·2	3·2	−1·3
Weight (kg)	−1·4	2·4	−0·2	1·7	−1·6	−2·0	2	0·9	1·8	−1·1
TSF (mm)	−0·5	1·1	−0·4	1·3	−0·9	−0·4	1·2	−1·03	1·4	−1·43
MAC (mm)	−7	17	8	11	1	−2	15	−2	12	−4
Albumin (g/l)*	−2·1	3·3	−2·2	2·8	−4·3	−2·6	3·6	−0·1	3·1	−2·7
Transferrin (g/l)	−0·06	0·6	0·01	0·4	−0·05	−0·1	0·6	−0·13	0·4	−0·23
Iron (μmol/l)	0·0	0·5	−1·3	0·6	−1·3	−0·5	0·6	0·6	0·7	0·1

TSF, triceps skinfold; MAC, mid-arm circumference.
*$P = 0{\cdot}03$ for the difference between the cumulative changes in serum albumin levels in men and women. For the rest of the variables, differences between the cumulative changes in men and women were not statistically significant.

Table 8. Nutritional status in stroke patients (*n* 201) according to their ability to swallow on admission (Mean values with standard deviations)

	Able to swallow				Unable to swallow			
	Week 0 (*n* 178)		Week 2 (*n* 83)		Week 0 (*n* 23)		Week 2 (*n* 13)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Weight (kg)	64·1	13·3	62·8	13·3	60·7	15·5	60·5	16·6
MAC (mm)	257	32	254	33	244	34	235	39
TSF (mm)	7·6	1·9	7·1	1·9	6·6	1·7	5·7	1·4
Albumin (g/l)*	38·1	3·7	36·3	4·0	37·8	4·1	33·4	4·1
Transferrin (g/l)	2·8	0·7	2·7	0·6	2·5	0·5	2·4	0·6

MAC, mid-arm circumference; TSF, triceps skinfold.
*$P = 0{\cdot}0001$ for the difference in serum albumin levels in each group separately during the hospital stay, but $P > 0{\cdot}05$ for the difference between the changes in the two groups.

Table 9. Baseline haemoglobin, urea and electrolyte levels and approximate osmolality of stroke patients (*n* 201) according to their ability to swallow on admission. (Mean values with standard deviations)

	Able to swallow (*n* 178)		Unable to swallow (*n* 23)		
	Mean	SD	Mean	SD	*P* value
Haemoglobin (g/dl)	13·7	1·9	13·5	1·4	0·376
Sodium (mmol/l)	138	4·0	140	4·5	0·033
Urea (mmol/l)	7·4	6·5	8·7	2·8	0·002*
Creatinine (mmol/l)	97	34	99	25	0·492*
Plasma osmolality (mosmol/kg)†	298	10	303	12	0·191

* Mann Whitney test.
† Approximated from (sodium × 2) + urea + glucose.

Table 10. Multiple logistic regression analysis of stroke outcome at 3 months on serum albumin concentration and other prognostic variables at admission of 201 stroke patients.

Variable	Regression coefficient	SE	*P* value	Odds ratio for unit change	95% CI
Incontinence of urine*	0·9583	0·4698	0·0414	2·61	1·04–6·55
Serum albumin (g/l)	0·1234	0·0584	0·0346	1·13	1·01–1·27
Age (years)	0·0869	0·0271	0·0013	1·09	1·03–1·15
Modified Rankin (0–5)	0·3784	0·2085	0·0696	1·46	0·97–2·20
Previous illnesses†	0·1093	0·2030	0·5903	1·12	0·75–1·66
Drugs†	0·0140	0·1357	0·9178	1·01	0·78–1·32
Sex	0·1466	0·4104	0·7210	1·16	0·52–2·59

* Yes = 2, No = 1.
† Drug intake and history of any previous illness on admission.

concentration on admission revealed a significant association with outcome. After adjusting for age, incontinence of urine, Rankin score, sex, previous illnesses and drug intake on admission, the variables incontinence of urine, serum albumin and age were significantly and independently related to risk of death at three months (odds ratios 2·61 (95% CI 1·04–6·55), 1·13 (95% CI 1·01–1·27) and 1·09 (95% CI 1·03–1·15) respectively; Table 10). In stroke patients, a 1 g/l lower serum albumin concentration on admission to hospital was associated with 1·13-fold increase in risk of death at 3 months. We found no statistically significant important interactions between variables.

Discussion

The major findings of this study were that a high proportion of stroke patients had low anthropometric and biochemical values on admission. Baseline nutritional status was worse among those who later died or remained in hospital compared with those discharged, and most patients who remained in hospital showed marked and significant deterioration in all measures of nutritional status within 4 weeks of hospitalization. After adjusting for age, stroke severity and co-morbidity, low serum albumin concentrations in hospital were a strong and independent predictor of risk of death following acute stroke.

The higher proportion of stroke patients with low baseline TSF compared with those with low baseline values for MAC and AMC may be explained by the lack of regional reference anthropometric data. It may also be due to the variability in the precision of measurements. However, this is unlikely for the following reasons: all anthropometric measurements were performed by a single observer (SEG); to minimize intra-observer variability the mean of three consecutive measurements was recorded, and our measurements' variability and findings were broadly in agreement with previous published work (Axelsson *et al.* 1988; Unosson *et al.* 1994; Potter *et al.* 1995).

On admission, for most nutritional status indices women had lower values compared with men, except for BMI, TSF, transferrin and B_{12}. These findings were in agreement with those of Potter *et al.* (1995) for BMI and MAC and those of Unosson *et al.* (1994) for body weight and AMC. Following hospitalization, however, men lost more weight and their serum albumin concentration was significantly lower compared with that of women. These findings were broadly in agreement with those of Axelsson *et al.* (1988) who studied the nutritional status of 100 consecutive stroke patients on admission and at discharge and found that on admission, women exhibited a poor nutritional status more than twice as often as men, but the proportion of men with poor nutritional status was significantly higher at discharge.

On admission, body weight, MAC and AMC were significantly lower among institutionalized patients and those who lived alone compared with those living with a spouse, but after adjusting for age most differences between groups were not statistically significant. Nutritional status deteriorated significantly, however, during the hospital stay for those who had lived in institutions or sheltered accommodation, but less so for those who had lived in the community alone or with a spouse, even after adjusting for age and stroke severity. The difference between cumulative changes in groups was not statistically significant which may be a reflection of the sample size. Despite the lack of statistical significance this difference could still be of clinical significance, as we have shown (p. 485) that a serum albumin concentration 1 g/l lower after acute stroke was associated with a significantly higher risk of death. There is also some evidence that adverse social and environmental factors including poverty, social isolation and loneliness, lack of help in the home and inadequate cooking facilities may have adverse effects on nutritional status (Exton-Smith, 1980).

Stroke patients who presented with difficulty in swallowing had a worse nutritional status on admission compared with those without difficulty in swallowing; despite further deterioration in hospital the difference between the changes in the nutritional status indices in the two groups was not statistically significant. This may be due to the small sample size of stroke patients with difficulty in swallowing during the hospital stay. However, a possible explanation for the poorer nutritional status of stroke patients with difficulty in swallowing on admission is dehydration among this group. This is supported by the significantly higher baseline plasma Na and urea in stroke patients with difficulty in swallowing compared with those stroke patients with intact swallowing mechanisms. Dehydration is another complication of disease and hospitalization which shares similar risk factors to those of undernutrition, and if left untreated mortality may be high (Weinberg *et al.* 1995). Besides swallowing difficulties, stroke patients are vulnerable to dehydration for many other reasons including immobility, poor communication and visual acuity, reduced sensitivity to thirst due to old age, fever, chest infection, hyperglycaemia, or diuretic therapy which increases fluid loss (O'Neill & McLean, 1992; Warlow *et al.* 1996). Clinical signs of dehydration are also not so reliable in older patients. Weinberg *et al.* (1995) reviewed the literature concerning dehydration in the elderly population from MEDLINE from 1976–1995. They reported that early diagnosis is sometimes difficult because the classical physical signs of dehydration may be absent or misleading in an older patient. There have been no randomized trials designed to determine whether adequate rehydration after stroke influences outcome. However, it seems sensible, until this question has been answered, to maintain a reasonable degree of hydration after acute stroke.

No statistically significant relationship was found between the nutritional status and the number of drugs that stroke patients were taking, including cardiovascular drugs either on admission or during hospitalization.

Among the various markers of nutritional status used in this study only low serum albumin concentrations on admission predicted a higher mortality within 3 months after acute stroke independent of other adverse prognostic factors. The value of serum albumin as a measure of nutritional status during acute illness has been criticized (McWhirter & Pennington, 1994) because many conditions such as undernutrition, catabolism, and liver and renal disease may reduce serum albumin concentrations. In this study we made an attempt to control a number of non-nutritional factors likely to affect outcome, including age, stroke severity (urinary incontinence, Rankin score) and co-morbidity (previous illnesses, number of medications). We have also excluded stroke patients with conditions such as heart, liver, gastrointestinal and kidney disease, neoplasm or sepsis, which might be responsible for low serum albumin concentrations on admission. A number of studies (Agarwal *et al.* 1988; Rich *et al.* 1989; Aptaker *et al.* 1994; Sullivan & Walls, 1994; Davalos *et al.* 1996) have shown that for patients in acute and non-acute care settings there is a strong correlation between the levels of specific clinical markers of protein–energy undernutrition such as serum albumin concentrations and an increased risk of morbidity and mortality. There is also evidence that nutrition is probably the single most important factor regulating albumin synthesis (Rothschild *et al.* 1972).

In conclusion, a significant number of stroke patients included in this study were undernourished on admission, especially those who later died or remained in hospital compared with those discharged, and nutritional status deteriorated further for those who remained in hospital. Low serum albumin concentration in hospital was a strong and independent predictor of risk of death. Whether nutritional supplementation removes or mitigates the hazard of death associated with low serum albumin concentrations following acute stroke needs to be determined.

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