Association of risk of malnutrition with adverse outcomes and early support on discharge in acute stroke patients without prestroke disability: a multi-centre registry-based cohort study

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Statement of Authorship

T. S. H. reviewed the topic related literature and performed the study concept and analysis design. G. G., B. A. and P. K. performed the study coordination and data collection. T. S. H. and D. F. wrote the first draft, interpreted the data and revised the manuscript. C. H. F. edited the manuscript. G. G., B. A., J. R., D. F., P. K. and P. S. checked, interpreted results and commented on the manuscript. All authors critically revised the manuscript, agree to be fully accountable for ensuring the integrity and accuracy of the work, and read and approved the final manuscript.

ABSTRACT

Background: Malnutrition in hospitals remains highly prevalent. As part of quality improvement initiatives, the RCP recommends nutrition screening for all patients admitted with acute stroke. We aimed to examine the associations of patients at risk of malnutrition with outcomes following an acute stroke and their requirements of early support on discharge.

Methods: We analysed prospectively collected data from four hyperacute stroke units (HASU) (2014-2016). Nutritional status was screened in 2962 acute stroke patients without prestroke disability (1,515 men, mean age±SD=73.5yr ±13.1, and 1,447 women, 79.2yr±13.0). The risk of malnutrition was tested against stroke outcomes and support on discharge, adjusted for age, sex, and comorbidities using logistic regression.

Results: Risk of malnutrition was identified in 25.8% of patients; all of whom were reviewed by a dietitian by 1.3days (IQR=0.3-3.2). Compared to well-nourished patients, those at risk of malnutrition had, within 7days of admission, increased risk of poststroke adverse outcomes including: LOS on HASU>14 days, OR=9.9 (7.3-11.5); disability on discharge, OR=8.1 (6.6-10.0); worst level of consciousness in the first 7-days (score≥1), OR=7.5 (6.1-9.3); mortality, OR=5.2 (4.0-6.6); pneumonia, OR= 5.1 (3.9-6.7) and urinary tract infection, OR =1.5 (1.1-2.0). They also required greater support on discharge including: palliative care, OR =12.3 (8.5-17.8); discharge to new care home, OR=3.07 (2.18-4.3); activities of daily living support, OR=1.8 (1.5-2.3); planned joint-care, OR=1.5 (1.2-1.8) and weekly visits, OR=1.4 (1.1-1.8).

Conclusions: Patients at risk of malnutrition more commonly have multiple adverse outcomes following acute stroke and greater need for early support on discharge.

INTRODUCTION

Malnutrition in hospitals remains prevalent in high-income countries, ranging between 20 and 50%.[1] It is a major cause of in-patient mortality[2, 3] and is associated with a number of adverse outcomes including nosocomial infections, pressure ulcers,[3-5] impaired mobility and prolonged length of stay (LOS) in hospital.[3, 6, 7] Malnutrition also incurs enormous costs to healthcare services. In 2011, the additional costs of disease-related malnutrition in adult patients were estimated at €170 billion *per annum* in Europe.[8]

Among patients with an acute stroke, there is an additional risk of malnutrition, especially if oropharyngeal dysphagia is present, which occurs in 8-80% of patients hospitalised with acute stroke.[9] Dysphagia screening within four hours of stroke admission is crucial to allow prompt and appropriate nutritional support;[10] even a short delay can lead to increased risk of death, disability and nosocomial infections.[11] Recognising this risk, the Royal College of Physicians introduced the Malnutrition Universal Screening Tool (MUST), as part of quality improvement initiatives, to ensure that the nutritional status of all patients admitted with an acute stroke is assessed and seen by a dietitian if the risk of malnutrition is identified.[12, 13]

Nutritional status is thus an important prognostic indicator for the recovery potential of an acute stroke.[14] To prevent and reduce the risk of malnutrition, early nutritional risk screening of patients admitted to hospital has universally become a routine practice.[15, 16] However, the ESPEN Consensus Statement suggested that “the general acceptance of the prevailing malnutrition screening tools relies on the fact that fulfilling the criteria for risk of malnutrition imposes negative clinical outcomes”.[17] In this study of adults admitted to hospital with an acute stroke, we examined the association of patients at risk of malnutrition with stroke-related adverse outcomes during hospitalisation, and with requirements for higher levels of early support on discharge.

METHODS

Study design, participants and setting

We performed an analysis of prospectively collected data from the national register of stroke care. The data contain clinical characteristics and care quality determinants of patients admitted to acute care hospitals.[10] Data from this study were gathered from 3309 patients consecutively admitted with an acute stroke to four hyperacute stroke units (HASU) between January 2014 and February 2016.[18, 19] A total of 3,137 completed nutritional screening. In order to focus on malnutrition in hospital, 175 (5.6%) patients with prestroke disability (high risk of malnutrition before admission) were excluded. The remaining 2962 patients were available for subsequent analysis.

SSNAP has approval from the Confidentiality Advisory Group of the Health Research Authority to collect patient data under section 251 of the NHS Act 2006; thus no additional ethical approval was required.

Socio-demographic factors and medical history

Demographic data were collected and documented by stroke consultants and nurse specialists; including age at arrival, gender and coexisting morbidities: congestive heart failure (CHF), atrial fibrillation (AF), previous stroke, hypertension (HT), and diabetes mellitus (DM).[10, 18, 19]

Stroke diagnosis and severity

Stroke was diagnosed based on clinical presentation and brain imaging.[10, 18, 19] The severity of stroke symptoms at arrival was assessed by the National Institutes of Health for Stroke Scale (NIHSS) with a score range from no symptoms to severe stroke symptoms (NIHSS score = 0 to 42).[20]

Nutritional status

The same MUST protocol was used by all four hospitals to identify patients at risk of malnutrition.[21-23] The information for MUST was recorded routinely by healthcare professionals during hospital admission. This procedure comprises three independent variables: BMI score (BMI >20.0 = 0, BMI 18.5-20.0 = 1, BMI <18.5 = 2); unplanned weight loss in the previous 3-6 months (weight loss <5% = 0, weight loss 5-10% = 1 and weight loss >10% = 2); and acute disease effect score (a score of 2 was added if a patient was recently affected by a disease and there was no nutritional intake or likely to be no nutritional intake for more than 5 days). A total sum of scores was used to categorise nutrition status: well-nourished (MUST score = 0) and at risk of malnutrition (MUST score ≥1).[24, 25] Referral to dietitians was made where risk of malnutrition was identified for appropriate nutritional support.

Adverse outcomes

Nosocomial infections including urinary tract infection (UTI) and pneumonia acquired in hospital within 7-days of admission were recorded. The level of consciousness (LOC) was monitored four times a day during the first two to three days followed by once or twice a day thereafter. The *worst LOC scores in the first 7-days following initial admission for stroke* were used for analysis and graded as: 0 = Alert keenly responsive, 1 = Not alert but arousable by minor stimulation, 2 = Not alert but require repeated stimulation to attend, and 3 = Respond only with reflex motor or autonomic effects/totally unresponsive.[10] The length of stay on HASU as well as in-patient mortality were also documented. *Changes in severity* of *stroke* after thrombolysis were calculated as the difference between NIHSS score at 24-hours minus NIHSS score on arrival.

Prestroke and poststroke disability was assessed by the modified Rankin Scale (mRS). This was conducted within the first 24 hours of hospital admission and on discharge, respectively. The mRS scores indicate the patients' degree of disability or dependence on daily activities: 0 = no symptoms at all; 1 = no significant disability despite symptoms, able to carry out all usual duties and activities; 2 = slight disability, unable to carry out all previous activities but able to look after their own affairs without assistance; 3 = moderate disability; requiring some help, but able to walk without assistance; 4 = moderately severe disability, unable to walk without assistance and unable to attend to own bodily needs without assistance; 5 = severe disability, bedridden, incontinent and requiring constant nursing care and attention.[26, 27]

Level of support planned on discharge

The planned levels of support were assessed by a multidisciplinary team of stroke specialists including doctors, nurses, physiotherapists, occupational therapists, social service workers, as well as palliative care specialists when required. The support included: help for activities for daily living (ADL); the frequency of home visits per week provided by social services for those who needed support; joint care-planning between health and social care for post-discharge management. Information on the decision to introduce palliative care by discharge date, as well as discharge to a new care home was also documented.[26]

Categorisation of variables

Dichotomisation was applied for CHF, AF, previous stroke, and HT, and in-patient infections and mortality according to the presence or absence of any history of the condition. Moderately-severe to severe disability on discharge was defined as an mRS score ≥4. Moderately-severe to severe stroke on arrival was defined as an NIHSS score ≥16. Prolonged LOS on HASU was defined as those who stayed >14 days. Severity of LOC scale during the first 7-days of initial admission was dichotomised into two groups: group 1 with a score of 0 (alert, keenly responsive), and group 2 with a score of ≥1.

Statistical analysis

Multivariable logistic regression was conducted to examine the association of "at risk of malnutrition" (dependent variable) with adverse outcomes of stroke including UTI, pneumonia and severity in LOC scale within 7-days of admission, LOS on HASU >14 days, disability on discharge and mortality (independent variables). Associations were also sought with support needed on discharge including palliative care by discharge date, new care home placement, ADL support or joint care plan and weekly visits as dependent variables. The results are presented as two models: model 1, unadjusted; model 2, adjusted for age, sex, comorbidities (CHF, AF, recurrent stroke, HT and DM), NIHSS and haemorrhage stroke. Results are expressed as odds ratios (OR) and 95% confidence intervals (CI). Analyses were performed using IBM SPSS Statistics for Windows, V.23.0 (IBM Corp., Armonk, NY, USA).

RESULTS

A total 2962 acute stroke patients without prestroke disability were analysed. Gender distribution was similar: 1,515 men (51.1%) and 1,447 women (48.9%). Men were younger (mean =73.5 yr, SD ±13.1) than women (mean =79.2 yr, SD±13.0). Of all patients, 85% presented with ischaemic stroke, 14.9% with intracranial haemorrhage and 0.9% with unspecified stroke (*i.e.* patients who did not undergo neuroimaging). There were 25.8% of patients considered to be at risk of malnutrition, all of whom were reviewed by a dietitian. The median time interval between arrival to HASU and dietitian review was 1.3 days (IQR = 0.3-3.2).

Table 1 shows that the proportions of patients at risk of malnutrition were higher in those over 80 years, females and those with co-existing AF. Malnutrition was also more common in patients with stroke-related adverse outcomes than those without, including intracranial haemorrhagic stroke: 20.7% vs 13.1%; moderately-severe to severe stroke on admission (NHSS >16): 13.6% vs 3.1%; UTI: 10.0% vs 5.2%; pneumonia: 25.8% vs 4.9%; lower LOC (≥1): 53.8% vs 11.2%; moderately-severe to severe disability on discharge (mRS >4): 62.3% vs 14.5%; and death: 32.6% vs 6.1%. Malnutrition was associated with prolonged LOS on HASU (>14 days): 76.4% vs 22.9%. Compared with the median LOS on HASU of 4.8 days (IQR = 2.2-12.9) for well-nourished patients, the corresponding value for those at risk of malnutrition was 28.9 days (IQR 14.6-52.5); Mann-Whitney U test: P <0.001. Furthermore, there were high proportions of patients at risk of malnutrition who required support planned on discharge including palliative care planning: 25% vs 1.9%; discharge to a new care home: 11.0% vs 3.3%; ADL support: 29.2% vs 16.5%; joint-care plan: 29.0% vs

22.2%; and weekly visits: 13.1% vs 9.4%. We proceeded to logistic regression analysis to determine unadjusted and adjusted ORs for the association the association the risk of malnutrition with these outcomes (see below and **Table 2**).

Risk of malnutrition and stroke-related adverse outcomes: Logistic regression analysis with adjustment for age, sex, co-morbidities, NIHSS and haemorrhage stroke (**Table 2**) showed that the adjusted OR for the risk of malnutrition was highest for LOS on HASU >14 days, OR = 9.85 (7.28-11.50); followed by disability on discharge, OR = 8.12 (6.63-9.95); worst LOC in the first 7-days (score ≥1), OR = 7.50 (6.07-9.26); mortality, OR = 5.17 (4.03-6.64); pneumonia, OR = 5.11 (3.92-6.66) and UTI, OR = 1.54 (1.12-2.00) within 7 days of admission.

Risk of malnutrition and support planned on discharge: The adjusted OR for the risk of malnutrition was highest for palliative care, OR = 12.33 (8.52-17.83); followed by new care home discharge, OR = 3.07 (2.18-4.33); ADL support, OR = 1.84 (1.45-2.33); joint-care, OR = 1.45 (1.19-1.76) and weekly visits, OR = 1.38 (1.06-1.80).

Stepwise multiple regression was conducted to select the most significant variables associated with malnutrition. In this model, all variables for adverse outcomes of stroke were analysed simultaneously (*i.e.* adjusting for one another). Compared to patients without stroke-related adverse outcomes, the adjusted risk of malnutrition was greater for severity of stroke on arrival (NIHSS >16): OR =2.93 (1.59-5.38), pneumonia: OR =1.88 (1.24-2.86), worst LOC in the first 7-days (score ≥1): OR =2.84 (2.09-3.87), LOS >14 days: OR =5.99, (4.64-7.73), and disability on discharge (mRS >4): OR =2.48, (1.88-3.28). Variables eliminated from the model were age, sex, haemorrhagic stroke, CHF, AF, previous stroke, hypertension, diabetes and UTI (**Table 3**).

Stepwise logistic regression was also conducted analysing all variables for support on discharge simultaneously with adjustment for age, sex, co-morbidities, NIHSS on arrival and haemorrhagic stroke. Malnutrition was associated most strongly with palliative care planning: OR = 16.09 (5.89-43.97), followed by new care home discharge: OR = 3.52 (2.43-5.09), joint-care: OR = 1.90 (1.51-2.40), and weekly visits: OR = 1.41 (1.04-1.92) (**Table 4**).

The proportions of patients at risk of malnutrition risk rose progressively with the number of adverse outcomes after stroke (moderately severe-severe stroke (NIHSS >16), pneumonia, worst LOC in the first 7-days (score ≥1), LOS on HASU >14 days and moderately severe-severe disability on discharge (mRS >4)), from 5.2% in those without a complication to 28.2% in those with any 1 adverse outcome, 61.1% with any 2 adverse outcomes and 65.8% with any 3 or more adverse outcomes (**Figure 1A**). There was also a rise in the proportions of patients at risk of malnutrition with the level of support (palliative care planned, new care home discharge, joint-care planning, and weekly visits), from 17.0% in those without support needs to 41.1% in those requiring any 1 support, 37.0% in those requiring any 2 supports and 56.1% in those requiring any 3 or 4 supports (**Figure 1B**).

DISCUSSION

We observed that among acute stroke patients without prestroke disability, those who were at risk of malnutrition had increased risk of a wide range of adverse outcomes.

The proportions of individuals at risk of malnutrition rose progressively with the number of poststroke adverse outcomes. Our findings are in line with previous reports in patients admitted with an acute stroke[27-30] and other acute conditions.[3-5] In addition, we report the novel finding that stroke patients at risk of malnutrition also required a higher level of support on discharge.

The ESPEN Consensus Statement recommended that “risk of malnutrition” could be considered as a diagnosis with its own Classification of Diseases (ICD) Code, and needs to be reimbursed in the ICD and Disease Related Group (DRG) systems. This Consensus also suggested that the general acceptance of malnutrition screening tools should fulfil the criteria, for risk of malnutrition imposes adverse clinical outcomes, including death.[17] Our findings of the association of risk of malnutrition with adverse outcomes therefore lend further support for the use of the MUST protocol for identifying patients at increased risk of malnutrition. Like other health screening tools, the MUST protocol helps identify patients at different levels of risk of malnutrition at an early stage, to enable healthcare workers to prevent, diagnose and manage at-risk patients. The MUST protocol would therefore include a range of patients, from those with early stages of malnutrition to others with actual malnutrition. We did not collect data on patients with actual malnutrition as it would deviate from the SSNAP protocol. All patients at risk of malnutrition identified by MUST had evidence of poor health (BMI <20 kg/m^2 or unintentional weight loss >5% of body weight).

One of the most profound effects of malnutrition is prolonged LOS in hospital, which in turn increases a number of adverse outcomes such as nosocomial infections and sarcopenia from the lack of mobility, as muscle strength declines by about 5% for each day of treatment in a hospital bed.[31] All patients who were identified to be at risk of malnutrition in our study were seen by a dietitian, which is in line with the national guidelines.[12] We observed that those who were identified to be at risk of malnutrition were seen by a dietitian within the first few days of arrival on HASU. This suggests that malnutrition was likely to precede adverse stroke outcomes and support on discharge. There is also evidence that malnutrition develops progressively with the LOS in hospital. In a study of 584 adult patients (mean age 57.2 ±17.3 yrs) in a Dutch hospital, the prevalence of moderate/suspected malnutrition or severely malnourished was 31% at admission, which increased to 56% on day 5, 66% on day 10, and 79% on day ≥15. On discharge, 30% of well-nourished patients on admission became malnourished while 82% of malnourished patients remained unchanged.[32]

Malnutrition commonly occurs in older individuals in the community setting, particularly those with neuropsychiatric disorders, ranging between 15 and 65%.[33, 34] Identifying these patients and supporting them in the community prior to admission may benefit this group. In this study, the nutritional status prior to stroke was unknown therefore patients with prestroke disability were excluded since they were more likely to have pre-stroke malnutrition; *i.e.* malnutrition in the remaining group without prestroke disability was more likely to occur following the stroke. This is supported by data from our study; compared to those without prestroke disability, the proportions of those at risk of malnutrition with prestroke disability were significantly higher (3.7% vs 10.6, $\chi^2 = 55.0$, $p < 0.001$). Inclusion of those with prestroke disability would therefore have inflated the ORs for the association of malnutrition and outcome measures. When analysis was performed using the entire sample including those with prestroke disability, the association of risk of malnutrition with outcomes was substantially greater than that when patients with prestroke disability were excluded. This suggests the possibility of adverse outcomes was over-estimated if patients with prestroke disability were not excluded. This therefore justified our choice of exclusion criteria.

Prospective interventional studies are necessary to assess the effectiveness of intensive nutritional support on the reduction of poststroke adverse outcomes.[35] Kruizenga et al conducted an intervention study of malnourished patients admitted to two mixed medical and surgical wards in Dutch hospital. Compared control group (n = 291) who received standard hospital clinical care, early support with additional 600 kcal and 12 g of protein to daily intake led to a reduction in hospital LOS by one day.[36] In a more recent study of 69,934 patients admitted to Swiss general medical units, nutritional support (dietary advice and nutritional therapy, enteral infusion of concentrated nutrients, and parenteral infusion of concentrated nutrient solutions) was shown to reduce mortality and readmission rates, as well as less frequent discharge to post-acute care facilities.[37] These findings are timely since increasingly more people are living with stroke and related complications including physical and cognitive impairment.[38, 39] Such health consequences have profound effects on the patients and their carers such as high burden of care,[40] stress and strain[41] as well as depression;[42] overall imposing enormous pressures on social and health care systems. [43, 44]

Strengths and limitations

The present study comprised a large cohort of patients derived from one of the largest regions, with similar characteristics to stroke population in the country's population.[10] The data were collected in accordance with the national SSNAP protocol used standardised outcome measures including NIHSS for stroke severity[20] and mRS for disability,[26] as well as with other measures commonly used in national stroke surveys such as nosocomial infection and LOC in the first 7 days of admission for acute stroke.[10] Nutritional status was assessed using the standard MUST protocol commonly used to identify patients at risk of malnutrition.[24] The present study is limited by its cross-sectional nature, therefore causal links between malnutrition and poststroke outcomes could not be established. These factors are likely to be reciprocally related but it not certain how much each of them exerting on the other, *i.e.* malnutrition may have a greater effects on outcomes than vice versa.

In conclusion, acute stroke patients at risk of malnutrition are more likely to be associated with multiple adverse outcomes and greater need for early support on discharge.

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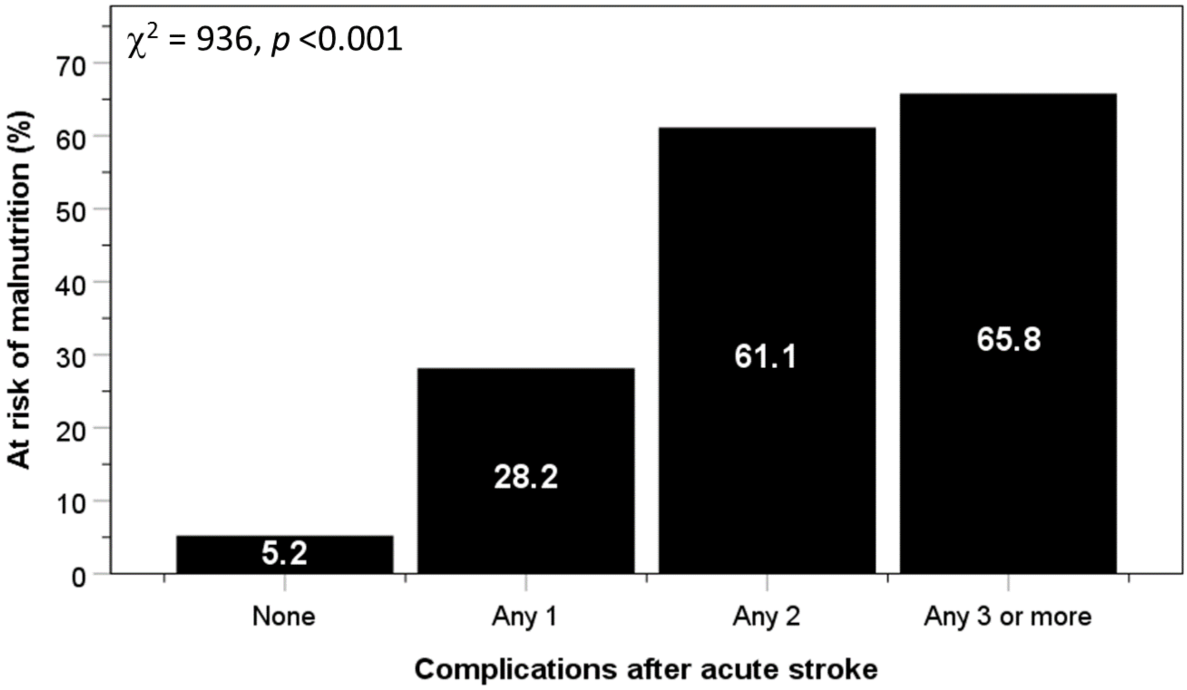
LEGENDS

Figure 1. Proportions of patients at risk of malnutrition in relation to: **A**, increasing numbers of poststroke adverse outcomes (moderately severe/severe stroke on admission (NIHSS >16), pneumonia, and worst level of consciousness (score ≥1) in the first 7-days): **B**, Level of support on discharge (palliative care planned, new care home discharge, joint-care planning between health and social care for post-discharge management and discharge visits).

Figure 1.

(**A**)


χ^2 = 936, *p* <0.001
At risk of malnutrition (%)
0
10
20
30
40
50
60
70
5.2
28.2
61.1
65.8
None
Any 1
Any 2
Any 3 or more
Complications after acute stroke

(**B**)

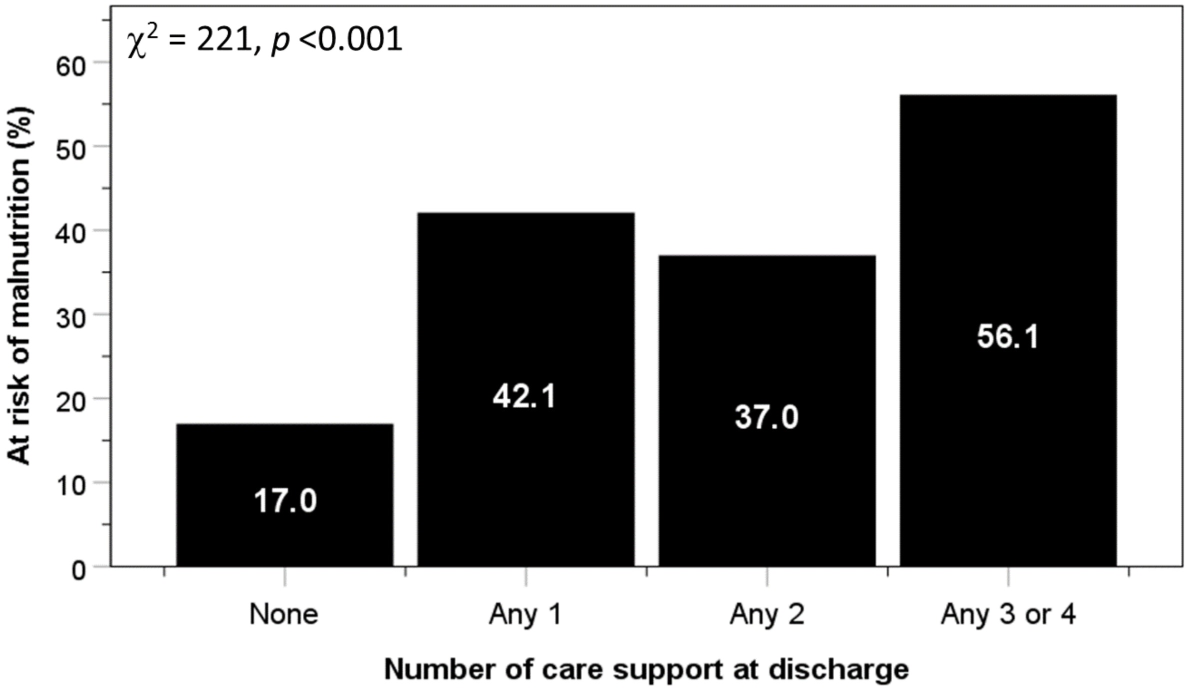

χ^2 = 221, *p* <0.001
At risk of malnutrition (%)
0
10
20
30
40
50
60
17.0
42.1
37.0
56.1
None
Any 1
Any 2
Any 3 or 4
Number of care support at discharge

Table 1. Nutritional status and stroke outcomes.

		Proportions within nutritional status			
	Proportions of all patients	Well-nourished (72.8%)	At risk of malnutrition (27.2%)	Differences between nutritional groups	
Demographics and comorbidities	%	%	%	χ^2	p
>80 years	46.5	41.6	60.4	90.6	<0.001
Females	48.9	46.6	55.4	17.8	<0.001
Congestive heart failure	5.5	5.5	5.5	0.0	0.964
Atrial fibrillation	19.3	16.9	26.3	32.6	<0.001
Previous stroke	22.0	21.6	23.3	1.0	0.308
Hypertension	52.5	50.0	53.9	0.8	0.368
Diabetes mellitus	15.9	15.9	15.9	0.0	0.994
Stroke adverse outcomes on arrival					
Intracranial haemorrhagic stroke	15.0	13.1	20.7	25.8	<0.001
Severity of stroke on arrival (NIHSS >16)	5.8	3.1	13.6	115.0	<0.001
Stroke outcomes during hospitalisation					
UTI within 7-days	6.7	5.2	10.0	30.2	<0.001
Pneumonia within 7-days	10.3	4.9	25.8	267.9	<0.001
Worst LOC in the first 7-days (score ≥1)	22.1	11.2	53.8	588.7	<0.001
LOS on HASU >14 days	33.8	22.9	76.4	517.5	<0.001
Disability on discharge (mRS >4)	26.8	14.5	62.3	658.2	<0.001
Mortality	12.9	6.1	32.6	354.4	<0.001
Level of support planned on discharge					
Palliative care planning	7.6	1.9	25.0	400.1	<0.001
New care home discharge	5.3	3.3	11.0	67.9	<0.001
Activities of daily living support	19.1	16.5	29.2	42.1	<0.001
Joint-care planning between health and social care for post-discharge management	24.0	22.2	29.0	14.1	<0.001
Discharge visits	10.3	9.4	13.1	8.6	0.002

UTI, urinary tract infection; LOC, level of consciousness; LOS, length of stay, HASU; hyperacute stroke units.

Table 2. Association of risk of malnutrition with adverse outcomes of stroke and support on discharge.

	Univariable logistic regression analysis of at risk of malnutrition					
	Unadjusted			Adjusted for age, sex, co-morbidities*, NIHSS and haemorrhage stroke		
Adverse outcomes of stroke	OR	95% CI	P	OR	95% CI	P
UTI within 7-days	2.24	1.67-3.01	<0.001	1.54	1.12-2.00	0.008
Pneumonia within 7-days	6.74	5.23-8.67	<0.001	5.11	3.92-6.66	<0.001
Worst LOC in the first 7-days (score ≥1)	9.12	7.51-11.08	<0.001	7.50	6.07-9.26	<0.001
LOS on HASU >14 days	10.87	8.64-13.68	<0.001	9.85	7.28-11.50	<0.001
Disability on discharge (mRS >4)	9.72	8.05-11.74	<0.001	8.12	6.63-9.95	<0.001
Mortality	7.47	5.93-9.41	<0.001	5.17	4.03-6.64	<0.001
Support needed on discharge						
Palliative care	17.35	12.15-24.78	<0.001	12.33	8.52-17.83	<0.001
New care home discharge	3.66	2.64-5.07	<0.001	3.07	2.18-4.33	<0.001
Activities of daily living support	2.08	1.66-2.61	<0.001	1.84	1.45-2.33	<0.001
Joint-care planning between health and social care for postdischarge management	1.43	1.18-1.72	<0.001	1.45	1.19-1.76	<0.001
Discharge visits	1.46	1.13-1.89	0.003	1.38	1.06-1.80	0.018

*Co-morbidities include congestive heart failure, atrial fibrillation, previous stroke, hypertension, and diabetes. UTI, urinary tract infection; LOC, level of consciousness; LOS, length of stay, HASU; hyperacute stroke units.

Table 3. Association of malnutrition in hospital with demographic factors and comorbidities on arrival using stepwise regression analysis.

	Risk of malnutrition		
Variables selected†	OR	95% CI	*P*
Moderately severe-severe stroke (NIHSS >16)	2.93	1.59-5.38	0.001
Pneumonia	1.88	1.24-2.86	0.003
Worst LOC in the first 7-days (score ≥1)	2.84	2.09-3.87	<0.001
LOS on HASU >14 days	5.99	4.64-7.73	<0.001
Moderately severe-severe disability on discharge (mRS >4)	2.48	1.88-3.28	<0.001

LOC, level of consciousness; LOS, length of stay, HASU; hyperacute stroke units. †Variables eliminated by stepwise regression procedure: age; sex; haemorrhagic stroke; congestive heart failure; atrial fibrillation, previous stroke hypertension, diabetes mellitus.

Table 4. Association of adverse outcomes of stroke and support on discharge with risk of malnutrition using stepwise regression analysis.

	Adjusted for age, sex, co-morbidities*, NIHSS and haemorrhage stroke		
Support needed on discharge†	OR	95% CI	*P*
Palliative care	16.09	5.89-43.97	<0.001
New care home discharge	3.52	2.43-5.09	<0.001
Joint-care planning between health and social care for post-discharge management	1.90	1.51-2.40	<0.001
Discharge visits	1.41	1.04-1.92	0.028

*Co-morbidities include congestive heart failure, atrial fibrillation, previous stroke, hypertension, and diabetes; †Eliminated by stepwise regression procedure: activities of daily living support.