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Comparison of the Mini-Nutritional Assessment short and long form and serum albumin as prognostic indicators of hip fracture outcomes

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ABSTRACT

Introduction: Malnutrition is common among older hip fracture patients and associated with adverse outcomes. We examined Mini Nutritional Assessment short (MNA-SF) and long form (MNA-LF) and serum albumin as prognostic indicators of mobility, living arrangements and mortality after hip fracture.

Methods: Population-based prospective data were collected on 594 hip fracture patients aged 65 and over. MNA-SF, MNA-LF and serum albumin were assessed on admission. Outcomes were poorer mobility; transfer to more assisted living accommodation and mortality one month, four months and one year post fracture. Logistic regression analyses for mobility and living arrangements with odds ratios (OR) and Cox proportional hazards model for mortality with hazard ratios (HR) and 95% confidence intervals (CI) were used, adjusted for age, gender, ASA grade and fracture type.

Results: All measures predicted mortality at all time-points. Risk of malnutrition and malnutrition measured by MNA-LF predicted mobility and living arrangements within four months of hip fracture. At one year, risk of malnutrition predicted mobility and malnutrition predicted living arrangements, when measured by MNA-LF. Malnutrition, but not risk thereof, measured by MNA-SF predicted living arrangements at all time-points. None of the measures predicted one-month mobility.

Conclusions: All measures were strong indicators of short- and long-term mortality after hip fracture. MNA-LF was superior in predicting mobility and living arrangements, particularly at four months. All measures were relatively poor in predicting short-term outcomes of mobility and living arrangements.

INTRODUCTION

Protein and energy malnutrition are common among older adults (1-5), with malnutrition and risk thereof especially high in hospitalized and institutionalized elderly patients. Two-thirds of older people may be at nutritional risk or malnourished (6, 7). Over half of hip fracture patients have a poor nutritional status (1,3,4, 8). Malnutrition is acknowledged to be under-recognized and undertreated in health care (9). With widespread rising life expectancy, more elderly individuals mean more hip fractures. (10). Malnutrition contributes to falls and fractures (1). Furthermore, malnourished patients are at increased risk of perioperative complications (4, 11, 12). Malnutrition also impairs immunity, patients' tolerance of surgical stress, wound healing, physical recovery and increases the risk of infections (2, 4, 11, 12). Complications prolong the length of hospital stay, increase readmission rates and medical costs (13). Patients' functional outcome and quality of life are impaired and the risk of mortality increases (4, 14, 15).

Nutritional status is assessed by body mass index (BMI), calf circumference (CC), arm circumference (AC), Geriatric Nutritional Risk Index (GNRI), Malnutrition Universal Screening Tool (MUST), Mini Nutritional Assessment short (MNA-SF) and long form (MNA-LF), Nutritional Risk Screening 2002 (NRS 2002), biochemical markers like albumin and lymphocyte count and anthropometric indices. So far we have no `gold standard` for screening nutritional risk (16).

The MNA test was validated in 1994 and subsequently used in hundreds of studies. It is a highly specific, reliable and validated nutrition screening tool for older patients in various care settings (17). MNA-SF was developed in 2000 as a screening instrument to assess nutritional status (18). It is simple, noninvasive, cheap and user-friendly. In the past three years both long and short forms of the MNA have been used to examine the association of nutritional status with outcomes in hip fracture patients. (4, 19-21). Gumiero et al. (19) established that MNA-LF is good for predicting gait status and mortality. In a study by Bell and associates (20) MNA-SF and the International Classification of Disease 10th Revision Australian Modification (ICD10-AM) correlated with discharge destination and mortality. Koren-Hakim et al. (21) used MNA-SF to assess in-hospital length of stay, complications, readmissions and mortality. Nuotio et al. (4) examined MNA-SF as an independent predictor of the outcomes of mobility, institutionalization and mortality.

The liver produces albumin, the most substantial plasmatic protein. Nutrition is very important for albumin levels. Cabrerizo et al. recently stated that albumin is a good marker of nutritional status in clinically stable individuals, while hypoalbuminemia predicts a prognostic factor of mortality in older patients. Age does not necessarily induce low albumin level (22). Even though MNA has been widely used and tested in various geriatric settings, only albumin is commonly used, e.g. in acute surgical care.

With worldwide population ageing more surgical in-patients are likely to be old. Hip fracture serves as a tracer condition representing old and frail acutely hospitalized patients. This population-based prospective cohort study aimed to compare nutritional status according to MNA-SF, MNA-LF and serum albumin as predictors of mobility, institutionalization and mortality outcomes at one, four and twelve months in older hip fracture patients.

MATERIAL AND METHODS

Study population

Seinäjoki Central Hospital is the only hospital in the Southern Ostrobothnia providing acute surgical care. Its catchment area is approximately 200,000 and all hip fractures are treated there. The study material consists of all 634 consecutive patients aged over 65 sustaining first hip fracture between December 2011 and November 2014. Pathological or periprosthetic fractures were excluded. Five patients were excluded due to institutionalization and pre-fracture inability to walk. MNA scores were missing in 10 cases and albumin results in 35 cases, leading to exclusion. Our final comparison analyses therefore included 594 patients.

Data collection and variables

MNA-SF consists of six sections: appetite or eating problem, recent weight loss, mobility impairment, acute illness/stress, dementia or depression and body mass index. Its scores are 0-7 points malnourished, 8-11 points at risk of malnutrition and 12-14 points normal nutritional status. Patients scoring below 12 are recommended further nutritional screening with MNA-LF (17, 18).

MNA-LF consists of twelve more sections: living arrangements, medications, presence of pressure ulcers, quality and number of meals, fluid intake, autonomy of feeding, self-perception about health and nutrition, mid-upper arm and calf circumferences. MNA-LF scores below 17 indicate malnourished, 17-23.5 at risk of malnutrition and 24-30 normal nutritional status. (17).

American Society of Anesthesiologists (ASA) scores were used to assess general health status and severity of physical comorbidity (23) in five classes: 1) healthy < 65 years, 2) mild systemic disease, 3) severe systemic disease, 4) severe systemic disease that is a constant threat to life and 5) moribund and not expected to survive without surgery. In our study ASA scores were categorized as 2, 3 and a combined class 4-5. A diagnosis of memory disorder was defined according to the national guideline, set by a specialist in geriatric medicine or neurology (24).

A geriatric nurse elicited baseline data from patients, their representatives or hospital staff and using the medical records during the perioperative period on the orthopedic ward. The MNA assessments were completed by the same geriatric nurse and serum albumin was also measured on admission. Median hospitalization was five days (interquartile range 3-7 days), with surgery performed on 85% of patients within 48 h of admission.

The follow-up data were collected by telephone interviews at one, four and twelve months after surgery by the same geriatric nurse with the same informants. All the patients or their representatives gave informed consent. The ethics committee of our hospital district approved the study design.

Prefracture, one-month, four-month and twelve-month mobility and living arrangements were elicited by similar questions. Mobility was classified as 1) ability to walk outdoors unaided, 2) ability to walk outdoors with help, indoors unaided, 3) ability to walk indoors with help and 4) inability to walk. Living arrangements were classified as 1) living independently at home, 2) living at home with organized home care, 3) living in

assisted living accommodation and 4) living in an institution. Outcome measures of mobility and living arrangements from fracture to one, four and twelve months were defined as impaired or unchanged mobility and more supported or same living arrangements. Death dates were extracted from the hospital electronic patients' files with no losses to mortality follow-up.

Statistical analysis

Baseline data distribution including MNA-LF and albumin are presented according to MNA-SF in Table 1. Differences between normal nutrition, risk of malnutrition and malnourished were tested with Pearson's chi-square test or Fisher`s exact test and skewed distributions by independent samples Kruskall-Wallis test.

Distributions of nutritional status were described by three different methods (MNA-SF, MNA-LF and albumin) at baseline and according to the follow-up outcomes of mobility, institutionalization and mortality at the chosen time-points. Logistic regression analyses for mobility and living arrangements with odds ratios (OR) and Cox proportional hazards model for mortality with hazard ratios (HR) and 95% confidence intervals (CI) were conducted as crude analyses and analyses adjusted for age, gender, ASA grade and fracture type. Patients immobile at baseline were excluded from mobility analyses and already institutionalized patients were excluded from living arrangements analyses. Statistical analyses were carried out with SPSS (SPSS Inc, IBM Corp, Armonk, NY, USA), Version 23.0. The p-value <0.05 was considered statistically significant.

Sensitivity analyses for the measures were performed using website https://www.medcalc.org/calc/diagnostic_test.php.

RESULTS

At the time of the fracture 42 (7%) patients were malnourished, 236 (40%) were at risk of malnutrition and 316 (53%) had normal nutritional status according to MNA-SF. According to MNA-LF 38 (7%) patients were malnourished, 347 (58%) at risk of malnutrition, 209 (35%) had normal nutritional status and 273 (46%) had albumin < 34 g/l.

Of the patients 60 (10%), 119 (20%) and 154 (26%) had died one month, four months and one year after the fracture. Among the survivors, the mobility level had declined in 374 (72%), 197 (43%) and 79 (20%) patients one month, four months and one year after the fracture respectively. The corresponding figures for moving into more supported living arrangements were 186 (44%), 189 (32%) and 157 (26%). All nutritional measures were significantly associated with mortality at all time-points. Being at risk of malnutrition or malnourished according to MNA-LF were significantly associated with impaired mobility at four months and one year, but according to MNA-SF only being at risk of malnutrition was associated with impaired mobility. Malnutrition according to MNA-SF or MNA-LF was significantly associated with more supported living arrangements at all time-points; risk of malnutrition predicted this at four months and one year after the fracture. (Tables 2-3).

According to MNA-SF, the probability that a test result will be positive when the disease is present (sensitivity) or being at risk of malnutrition or malnourished at baseline and having declined mobility one

year after hip fracture was 57 (95% CI 51-63). Sensitivity values for supported living and for mortality were 58 (95% CI 52-64) and 67 (95% CI 59-74).

Correspondingly, sensitivity proportions were best according to MNA-LF: 77 (95% CI 72-82) for impaired mobility, 76 (95% CI 70-81) for supported living and 86 (95% CI 80-91) for 1 year mortality. According to the albumin cut-off value of under 34, sensitivity values were poorest, 52 (95% CI 47-58) for impaired mobility one year after hip fracture, 55 (95% CI 49-62) for supported living and 60 (95% CI 55-65) for mortality.

DISCUSSION

Our findings demonstrate that hip fracture patients` nutritional status influences outcomes like mortality, mobility level and living arrangements. Poor outcomes and death concern especially the malnourished group, but there is also a significant difference in these parameters between those at risk of malnutrition and the normal.

According to our findings MNA-SF does not detect all patients at risk of malnutrition on MNA-LF. However, MNA-SF classifies some patients as being malnourished, who on MNA-LF are at risk of malnutrition. Both instruments identify true malnutrition efficiently. If in our tests the limit for risk of malnutrition on MNA-SF had been 13 not 12, the results from MNA-SF and MNA-LF would have been very close to each other; 342 (58%) at risk of malnutrition on MNA-SF and 347 (58%) on MNA-LF; 210 (35%) had normal nutritional status on MNA-SF and 209 (35%) on MNA-LF. Nevertheless, we had acute trauma patients in our nutritional screening comparison and it may be less harmful to overestimate the nutritional risk than underestimate it. In this study low serum albumin only predicted mortality.

Few studies have compared MNA-SF and MNA-LF in community dwelling older people. MNA-SF was slightly better in one (25), MNA-LF in another (26) and the instruments were equally good in a third (27). Murphy et al. (28) tested MNA and albumin in elderly orthopedic patients and found that MNA sensitivity and specificity were comparable to albumin levels. JunDe et al. (29) compared MNA-SF, NRS2002, anthropometric measures and biochemical tests among elderly patients in a general surgery department and reported that MNA-SF may be a suitable tool for nutritional assessment. Myoung-Ha et al. (30) evaluated five different nutrition tests (MNA-LF, MNA-SF, GNRI, MUST and NRS2002) and reported that MUST is the best and that MNA-SF overestimated nutritional risk in a geriatric care hospital.

Malnutrition or risk of malnutrition is very common among old people living in institutions. In our study two thirds of institutionalized elderly patients were malnourished or at risk of malnutrition. This finding is consistent with previous reviews by Kaiser et al. and Guigoz (6, 7). Over half of the patients needing assistance in walking before the hip fracture were at risk of malnutrition, which also corroborates previous observations (4). ASA scores reflect pre-existing medical conditions and are higher in malnourished patients, which is likely due to a greater number of comorbidities. Memory disorders were significantly less common in patients with normal nutritional status, again corroborating previous reports (3, 4, 7, 14)

Nurses are key to successful screening. Malnutrition is difficult to spot on the basis of appearance alone. Suominen et al. screened nutritional status among Finnish older patients in long-term care hospitals (1,043 patients) using MNA and BMI. MNA showed that 57% were malnourished, but the nurses' estimate was only 15%. If BMI was < 20 and MNA < 17, 30% of elderly patients were deemed malnourished, but if BMI was >24 and MNA <17 only 2% were deemed malnourished (9).

The strengths of this study include the large and representative population, prospective and consecutive design, and use of standardized instruments to measure nutritional status. The systemic data collection including the MNA was carried out mainly by a single nurse, which enhances the reliability of the data. Patients were not excluded from the investigation on the basis of any comorbidity, for example, memory disorder or being institutionalized.

Some limitations are also conceded. Weight and height are difficult to measure perioperatively in hip fracture patients because of pain. Consequently the nurse on the orthopedic ward estimated BMI. However, height and weight were estimated again about four months after the fracture and at that time the patients were also measured. These two BMI results were very close to each other, thus the estimates were fairly accurate. BMI was only one part of MNA and we did not study the effect of BMI separately.

Many studies recommend measuring nutritional status in geriatric patients (1, 3, 5-7, 19, 20), although the screening benefits remain uncertain in the Cochrane Database 2013 (16). An increase in the nutritional intake during hip fracture care and reduction in complications and improvement in the quality of life have been shown (31,32). However, it was concluded in the latest Cochrane Review on nutritional supplementation for hip fracture aftercare in older people conducted in 2016 that only weak evidence for the effectiveness of protein and energy feeds on mortality and complications exists (33). It is worth noting that the methodology between the studies varied considerably.

Nutritional supplementation is included in many standardized hip fracture care programs, as also in our hospital. All hip fracture patients are advised to have the nutritional assessment and receive the same nutritional care regardless of the results of the assessment. We believe it is important to make the assessment in order to estimate the severity of the nutritional problem and also to follow up the nutritional status and the effect of the intervention over time.

MNA-SF is very simple and takes less than four minutes to administer. MNA-LF takes just over 10-15 minutes. Assessment of nutritional status is difficult on the basis of the patient's appearance. MNA tests are good assessment instruments. The tests can serve to point out the risk of malnutrition. Optimal nutrition care is just as important as exercise rehabilitation. It is important to identify malnutrition and risk of malnutrition and to take prompt actions to treat them. Similar findings are likely in other older surgical patients.

CONCLUSIONS

The short and long forms of MNA and serum albumin were strong prognostic indicators of short- and long-term mortality after hip fracture. MNA-LF was superior in predicting impaired mobility and more supportive living arrangements at four months and one year post-fracture. If the limit value for risk of malnutrition in the MNA-SF test were 13, both MNA tests would detect malnutrition risk equally well. All measures were relatively poor in predicting short-term outcomes of mobility and living arrangements.

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Table 1. Distribution of baseline patient characteristics according to MNA-SF (N=594).

	Normal		Risk of malnutrition		Malnourished		P-value
	n=316 (53%)		n=236 (40%)		n=42 (7%)		
Women, n (%)	215	(68)	182	(77)	28	(67)	0.050
Age, median (range)	83	(65-97)	85	(65-100)	86	(65-95)	<0.001
ASA, n (%)							<0.001
Grade 1-2	68	(22)	19	(8)	2	(5)	
Grade 3	196	(62)	147	(63)	29	(70)	
Grade 4-5	51	(16)	69	(29)	10	(24)	
Alb, median (range)	34	(20-43)	33	(18-42)	33	(19-42)	0.066
BMI, median (range)	26	(20-43)	24	(15-43)	21	(15-31)	<0.001
Fracture type, n (%)							0.224
Neck of femur	192	(61)	141	(59)	28	(67)	
Intertrochanteric	105	(33)	84	(36)	9	(21)	
Subtrochanteric	18	(6)	11	(5)	5	(12)	
Pre-fracture diagnosis of memory disorder, n (%)	52	(16)	120	(51)	17	(40)	<0.001
Pre-fracture mobility, n (%)							<0.001
Independent	229	(73)	64	(27)	7	(17)	
Non-independent	85	(27)	172	(73)	35	(83)	
Pre-fracture living arrangement, n (%)							<0.001
Home	268	(85)	131	(55)	26	(62)	
Other than home	48	(15)	105	(45)	16	(38)	
MNA-LF points, median (range)	24.5	(15.5-30)	20.5	(15-25)	15.5	(10.5-18.5)	<0.001

Abbreviations: ASA, American Society of Anesthesiologists; MNA-SF, Mini-Nutritional Assessment short form, MNA-LF, Mini-Nutritional Assessment long form. Missing values are not shown, but were tested and included in the percentages. Differences between groups were analysed with Pearson's chi-square test or Fisher`s exact test or Kruskal-Wallis test. The p-value < 0.05 was considered statistically significant.

Table 2. Association of nutritional status measured by MNA-SF, MNA-LF and serum albumin with declined mobility 1 month, 4 months and 1 year after hip fracture.

	Declined mobility											
Follow-up time	1 month (n=374, N=517)				4 months (n=197, N=462)				1 year (n=146, N=385)			
	N	n (%)	OR	(95% CI)	N	n (%)	OR	(95% CI)	N	n (%)	OR	(95% CI)
MNA-SF baseline												
Crude												
Normal	289	217 (75)	1.00		274	103 (38)	1.00		236	76 (32)	1.00	
At risk of malnutrition	196	132 (67)	0.68	(0.46-1.02)	164	81 (49)	1.62	(1.09-2.40)	132	61 (46)	1.81	(1.17-2.80)
Malnourished	32	25 (78)	1.19	(0.49-2.86)	24	13 (54)	1.96	(0.85-4.54)	17	9 (53)	2.37	(0.88-6.38)
Adjusted												
Normal	289	217 (75)	1.00		274	103 (38)	1.00		236	76 (32)	1.00	
At risk of malnutrition	196	132 (67)	0.51	(0.33-0.79)	164	81 (49)	1.31	(0.87-1.98)	132	61 (46)	1.44	(0.91-2.29)
Malnourished	32	25 (78)	0.98	(0.39-2.46)	24	13 (54)	1.64	(0.68-3.95)	17	9 (53)	1.99	(0.70-5.67)
MNA-LF baseline												
Crude												
Normal	200	141 (71)	1.00		194	60 (31)	1.00		172	45 (27)	1.00	
At risk of malnutrition	290	214 (74)	1.18	(0.79-1.76)	246	124 (50)	2.27	(1.53-3.37)	200	92 (46)	2.33	(1.51-3.61)
Malnourished	27	19 (70)	0.99	(0.41-2.40)	22	13 (59)	3.23	(1.31-7.96)	13	8 (62)	4.38	(1.36-14.1)
Adjusted												
Normal	200	141 (71)	1.00		194	60 (31)	1.00		172	45 (27)	1.00	
At risk of malnutrition	290	214 (74)	0.93	(0.60-1.45)	246	124 (50)	1.84	(1.21-2.79)	200	92 (46)	1.88	(1.18-2.99)
Malnourished	27	19 (70)	0.83	(0.32-2.09)	22	13 (59)	2.40	(0.94-6.12)	13	8 (62)	3.28	(0.97-11.0)
Albumin baseline												
Crude												
Normal 34-45	289	212 (73)	1.00		268	114 (43)	1.00		237	85 (36)	1.00	
28-33	182	128 (70)	0.86	(0.57-1.30)	164	69 (42)	0.98	(0.66-1.45)	126	50 (40)	1.18	(0.75-1.84)
<28	46	34 (74)	1.03	(0.57-2.09)	30	14 (47)	1.18	(0.55-2.52)	22	11 (50)	1.79	(0.74-4.30)
Adjusted												
Normal 34-45	289	212 (73)	1.00		268	114 (43)	1.00		237	85 (36)	1.00	
28-33	182	128 (70)	0.79	(0.51-1.22)	164	69 (42)	0.90	(0.59-1.36)	126	50 (40)	1.16	(0.72-1.87)
<28	34	34 (74)	0.97	(0.46-2.04)	30	14 (47)	1.04	(0.47-2.30)	22	11 (50)	1.52	(0.60-3.86)

Immobile patients at baseline (n=9), mobility not known and deceased patients were excluded from analyses. N=survivals. n=number of impaired mobility patients during follow-up. OR =incidence odds ratio, CI =confidence interval. Adjusted =model was adjusted by age, sex, ASA score and fracture type. p-values p<0.10 are given in bold face.

Table 3. Association of nutritional status measured by MNA-SF, MNA-LF and serum albumin with moving to more supported living arrangements 1 month, 4 months and 1 year after hip fracture.

Follow-up time	Moving to more supported living arrangements											
	1 month (n=186, N=427)				4 months (n=79, N=389)				1 year (n=90, N=334)			
	N	n (%)	OR	(95% CI)	N	n (%)	OR	(95% CI)	N	n (%)	OR	(95% CI)
MNA-SF baseline												
Crude												
Normal	269	108 (40)	1.00		259	41 (16)	1.00		225	49 (22)	1.00	
At risk of malnutrition	134	60 (45)	1.21	(0.80-1.84)	113	28 (28)	1.75	(1.02-3.01)	94	30 (32)	1.68	(0.98-2.88)
Malnourished	24	18 (75)	4.47	(1.72-11.6)	17	10 (59)	7.60	(2.73-21.1)	15	11 (73)	9.88	(3.01-32.4)
Adjusted												
Normal	269	108 (40)	1.00		259	41 (16)	1.00		225	49 (22)	1.00	
At risk of malnutrition	134	60 (45)	1.10	(0.71-1.70)	113	28 (28)	1.59	(0.91-2.77)	94	30 (32)	1.38	(0.79-2.43)
Malnourished	24	18 (75)	3.85	(1.44-10.3)	17	10 (59)	8.20	(2.70-24.9)	15	11 (73)	7.70	(2.17-27.3)
MNA-LF baseline												
Crude												
Normal	196	78 (40)	1.00		191	28 (15)	1.00		172	37 (22)	1.00	
At risk of malnutrition	211	95 (45)	1.24	(0.83-1.84)	183	44 (24)	1.84	(1.09-3.12)	151	46 (31)	1.60	(0.97-2.64)
Malnourished	20	13 (65)	2.81	(1.07-7.36)	15	7 (47)	5.09	(1.71-15.2)	11	7 (64)	6.39	(1.77-23.0)
Adjusted												
Normal	196	78 (40)	1.00		191	28 (15)	1.00		172	37 (22)	1.00	
At risk of malnutrition	211	95 (45)	1.12	(0.74-1.71)	183	44 (24)	1.67	(0.96-2.90)	151	46 (31)	1.25	(0.73-2.14)
Malnourished	20	13 (65)	2.43	(0.89-6.61)	15	7 (47)	4.77	(1.51-15.1)	11	7 (64)	4.19	(1.05-16.6)
Albumin baseline												
Crude												
Normal 34-45	245	101 (41)	1.00		233	46 (20)	1.00		210	51 (24)	1.00	
28-33	145	66 (46)	1.19	(0.79-1.80)	129	23 (18)	0.88	(0.51-1.54)	104	31 (30)	1.32	(0.78-2.24)
<28	37	19 (51)	1.51	(0.75-3.01)	27	10 (37)	2.39	(1.03-5.57)	20	8 (40)	2.08	(0.80-5.37)
Adjusted												
Normal 34-45	245	101 (41)	1.00		233	46 (20)	1.00		210	51 (24)	1.00	
28-33	145	66 (46)	1.21	(0.78-1.86)	129	23 (18)	0.98	(0.55-1.74)	104	31 (30)	1.85	(1.03-3.31)
<28	37	19 (51)	1.60	(0.78-3.30)	27	10 (37)	2.61	(1.07-6.33)	20	8 (40)	2.11	(0.75-5.94)

Patients institutionalized at baseline (n=118) were excluded from the analyses. Patients whose living arrangements were unknown at baseline and deceased patients were also excluded. N=survivals. n=number of patients with more supported living arrangements during follow-up. OR =incidence odds ratio, CI =confidence interval. Adjusted =model was adjusted by age, sex, ASA score and fracture type. P-value p<0.10 are presented in bold face.

Table 4. Association of nutritional status measured by MNA-SF, MNA-LF and serum albumin with mortality 1 month, 4 months and 1 year after hip fracture.

Follow-up time		Deceased											
		1 month (n=60/N=594)				4 months (n=119/N=594)				1 year (n=154/N=594)			
	N	n	(%)	HR	(95% CI)	n	(%)	HR	(95% CI)	n	(%)	HR	(95% CI)
MNA-SF baseline													
Crude													
Normal	316	19	(6)	1.00		37	(12)	1.00		51	(16)	1.00	
At risk of malnutrition	236	32	(14)	2.29	(1.30-4.05)	66	(28)	2.61	(1.74-3.90)	82	(35)	2.43	(1.71-3.45)
Malnourished	42	9	(21)	3.84	(1.74-8.49)	16	(38)	3.83	(2.13-6.88)	21	(50)	3.92	(2.35-6.51)
Adjusted													
Normal	316	19	(6)	1.00		37	(12)	1.00		51	(16)	1.00	
At risk of malnutrition	236	32	(14)	1.64	(0.92-2.95)	66	(28)	1.90	(1.26-2.87)	82	(35)	1.88	(1.32-2.69)
Malnourished	42	9	(21)	2.80	(1.24-6.33)	16	(38)	2.76	(1.51-5.05)	21	(50)	2.95	(1.75-4.98)
MNA-LF baseline													
Crude													
Normal	209	4	(2)	1.00		14	(7)	1.00		21	(10)	1.00	
At risk of malnutrition	347	46	(13)	7.24	(2.60-20.1)	90	(26)	4.34	(2.47-7.62)	112	(32)	3.77	(2.36-6.00)
Malnourished	38	10	(26)	15.8	(4.94-50.3)	15	(40)	7.39	(3.57-15.3)	21	(55)	7.66	(4.18-14.0)
Adjusted													
Normal	209	4	(2)	1.00		14	(7)	1.00		21	(10)	1.00	
At risk of malnutrition	347	46	(13)	5.03	(1.77-14.4)	90	(26)	2.92	(1.64-5.19)	112	(32)	2.73	(1.70-4.40)
Malnourished	38	10	(26)	10.6	(3.20-34.9)	15	(40)	4.69	(2.23-9.86)	21	(55)	5.11	(2.75-9.50)
Albumin baseline													
Crude													
Normal 34-45	321	22	(7)	1.00		43	(13)	1.00		57	(18)	1.00	
28-33	221	33	(15)	2.26	(1.31-3.87)	54	(24)	1.97	(1.32-2.94)	70	(32)	2.01	(1.41-2.85)
<28	52	5	(10)	1.37	(0.52-3.63)	22	(42)	3.39	(2.03-5.67)	27	(52)	3.46	(2.19-5.48)
Adjusted													
Normal 34-45	321	22	(7)	1.00		43	(13)	1.00		57	(18)	1.00	
28-33	221	33	(15)	2.06	(1.19-3.57)	54	(24)	1.83	(1.22-2.75)	70	(32)	1.88	(1.31-2.68)
<28	52	5	(10)	0.95	(0.35-2.56)	22	(42)	2.47	(1.46-4.18)	27	(52)	2.60	(1.62-4.16)

N=patients; n= number of patients who died during follow-up; HR=hazard ratio, CI=confidence interval; Adjusted =model was adjusted by age, sex, ASA score and fracture type; P-value p<0.10 are given in bold face.