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The severity of nutrition and pneumonia predicts survival in patients with aspiration pneumonia: A retrospective observational study

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Abstract

Introduction: Aspiration pneumonia is a common problem among older adults; it has a high mortality rate and the prevalence is increasing. Reports on the risk factors for mortality in patients with aspiration pneumonia are limited. This study aimed to evaluate the risk factors for 90-day survival in patients with aspiration pneumonia.

Methods: This retrospective observational study was conducted at Seirei Mikatahara General Hospital between 1 April 2015 and 31 March 2016. Patients with aspiration pneumonia who had dysphagia or aspiration confirmed by modified water swallow test or VideoEndoscopic examination of swallowing were included. The primary endpoint was 90-day survival. We performed univariate and multivariate logistic regression analyses with survival and non-survival at 90 days as the independent variables.

Results: A total of 276 patients were recruited for this study. The A-DROP score (odds ratio [OR] = 2.440; 95% confidence interval [CI], 1.400–4.270; $p < 0.01$), Geriatric Nutritional Risk Index score (OR = 0.383; 95% CI, 0.178–0.824; $p < 0.05$) and sex (OR = 0.365; 95% CI, 0.153–0.869; $p < 0.05$) were independent early predictors of mortality.

Conclusion: The results suggest that nutritional status and the severity of pneumonia are important factors that predict life expectancy in patients with aspiration pneumonia.

KEYWORDS
aspiration pneumonia, mortality, nutritional status, severity of illness index

1 | INTRODUCTION

Aspiration pneumonia is a common problem among older people; it has a high mortality rate and an increasing prevalence. The incidence of aspiration pneumonia is difficult to determine because there are few diagnostic markers for aspiration and most studies do not distinguish between aspiration pneumonia and aspiration

pneumonitis.[1] The majority of cases of aspiration pneumonia in the elderly are community-acquired pneumonia (CAP) and nursing- and healthcare-associated pneumonia (NHCAP). More than 60% of elderly patients hospitalised with CAP are considered to have aspiration pneumonia, and almost all hospitalised patients with NHCAP are considered to have aspiration pneumonia.[2] In fact, when hospitalised cases in Japan were classified into aspiration pneumonia and non-aspiration pneumonia according to the aetiology, 80.1% of pneumonia patients over the age of 70 were found to have aspiration pneumonia, and the proportion of aspiration pneumonia increased with age.[2] Consequently, aspiration pneumonia is a dominant form of CAP and healthcare-associated pneumonia (HCAP) and a leading cause of death in an ageing society. According to a previous systematic review, aspiration pneumonia was associated with significantly increased in-hospital and 30-day mortality compared with non-aspiration pneumonia.[3] A study of 47 hospitalised patients reported that the mortality rate was 90% if two or more lobes of the lung were involved and 41% if only one lobe was affected.[4]

Risk factors for the development of aspiration pneumonia include advanced age, hypoalbuminemia, chronic obstructive pulmonary disease, chronic heart failure, multiple chronic diseases, dementia, mental confusion and the number of medications.[5] However, reports on the risk factors of mortality for aspiration pneumonia are limited. This is because there is no gold standard for the definition of aspiration pneumonia, and it is difficult to distinguish between aspiration pneumonia and typical pneumonias of CAP, NHCAP and HCAP. The prognosis of aspiration pneumonia may be related to the severity of pneumonia and respiratory failure and the nutritional status resulting from feeding disorders. This study aimed to evaluate the risk factors for 90-day survival in patients with aspiration pneumonia. The 90-day survival has been defined in several earlier studies as late survival. Therefore, we chose to evaluate 90-day survival, because we wanted to confirm the longer term effects of the risk factors.

2 | METHODS

2.1 | Study population

This retrospective observational study was registered with the University Hospital Medical Information Network Clinical Trial Registry (UMIN 000046923).

Consecutive patients who were admitted to Seirei Mikatahara General Hospital (Shizuoka, Japan) with a diagnosis of aspiration pneumonia (International Statistical Classification of Diseases, 10th Revision, code J69) between 1 April 2015 and 31 March 2016 were enrolled. The diagnosis of aspiration pneumonia was established in cases of dysphagia and aspiration according to the Japanese guidelines,[6] performed by three or more physicians at a conference. That the three or more physicians reviewed the cases sitting together in conference, not separately. Dysphagia and aspiration were examined using modified water swallow test or VideoEndoscopic examination of swallowing. The exclusion criteria were the disagreement with non-purpose use of medical records, complete analysis data and bedridden level before admission.

2.2 | Measurements

The primary endpoint was 90-day survival, and several clinical variables were compared between the survival and non-survival groups. A total of 28 items were surveyed. We adopted the information at the time of admission for basic subject characteristics and disease information and the information during hospitalisation for treatment details and progress. These assessments are routinely performed on patients admitted to Seirei Mikatahara General Hospital. C-reactive protein (CRP) and white blood cell (WBC) levels were evaluated as inflammatory biomarkers.

In terms of activity of daily living (ADL), 'freestanding gait' was defined as the ability to walk both indoors and outdoors; 'assistance gait' was defined as the ability to walk with the use of an assistive device; 'wheelchair' was defined as the ability to stand and ride in a wheelchair; and 'bedridden' was defined as the inability to sit in a wheelchair on a daily basis. Performance status was rated from 0 to 4 using the Eastern Cooperative Oncology Group Performance Status Scale.[7] The Nishimura Geriatric Rating Scale for Mental Status (NM scale)[8] was used to classify dementia. The NM scale is a 12-item rating scale used to observe the behaviour of patients with dementia in their daily lives from multiple perspectives. It does not require communication and can be used to assess the severity of the disease at five levels. The A-DROP was used to classify the severity of pneumonia. The A-DROP score, consisting of age $\geq$ 70 years in men or $\geq$75 years in women, blood urea nitrogen (BUN) $\geq$ 21 mg/dl or dehydration, oxyhaemoglobin saturation measured by pulse oximetry $\leq$ 90% or partial oxygen pressure in the arterial blood $\leq$ 60 mmHg, confusion and systolic blood pressure $\leq$ 90 mmHg, is a modified version of the CURB-65 score proposed by the Japanese Respiratory Society in 2006.[9] Its predictive power is similar to that of the CURB-65 and Pneumonia Severity Index (PSI).[10,11]

Survival curves for 90-day mortality were calculated for the risk factors A-DROP, GNRI and sex obtained by multivariate regression analysis. To determine the survival curve using the Geriatric Nutritional Risk Index (GNRI), the patients were classified into three groups: low GNRI (GNRI < 82) with severe nutritional risk, middle GNRI (82 ≤ GNRI < 92) with moderate nutritional risk and high GNRI (92 ≤ GNRI) with low or no nutritional risk, according to a previous report.[12] The GNRI was calculated from the serum albumin and body mass index (BMI) obtained on hospital admission:

$$\begin{aligned}\text{GNRI} &= 14.89 \times \text{serum albumin}\,(\text{g/dl}) + 41.7 \\ &\quad \times \text{per cent body weight}/\left([\text{height}]^2\,[\text{m}^2] \times 22\right) \\ &= 14.89 \times \text{serum albumin}\,(\text{g/dl}) + 41.7 \\ &\quad \times \text{BMI}\,(\text{kg/m}^2)/22.\end{aligned}$$

2.3 | Statistical analyses

Differences in continuous variables were compared using the *t*-test for normally distributed variables and the Mann–Whitney *U*-test for non-normally distributed variables. Categorical variables were compared using the Chi-squared test.

We performed univariate and multivariate logistic regression analyses with survival and non-survival at 90 days as the independent variables. Among all items, univariate logistic analysis was performed, except for outcome and ADL at discharge.

Multivariate logistic regression analysis was performed by adding age to the seven items that showed significant differences in the univariate regression analysis and using the six items, except BUN and serum albumin, which had high variance inflation factor values, as dependent variables among the combinations suspected of showing multicollinearity. Multivariate logistic regression analysis was performed using the forced imputation method.

The survival curve for 90-day mortality after hospital admission was estimated using the Kaplan–Meier method and compared using the log-rank test.

IBM SPSS Statistics for Windows Version 24.0 (IBM Japan, Ltd., Tokyo, Japan) was used for the analyses. The significance level for multivariate analysis was set at 5%, and 1% for other analyses.

3 | RESULTS

3.1 | Patient characteristics

In total, 333 consecutive patients with aspiration pneumonitis were screened for eligibility, of whom 276 (82.9%) were recruited for the study (Figure 1). The mean age of the patients was 80.8 ± 12.9 years, and 181 (65.6%) were men.

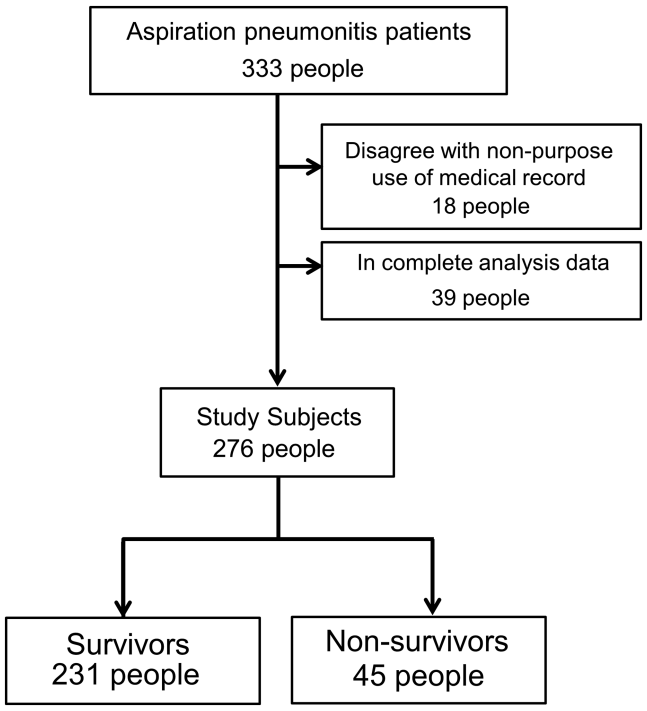

FIGURE 1 Patient selection

3.2 | Comparison between the survival and non-survival groups

There were 231 survivors and 45 non-survivors (Table 1). There were significant differences in 11 items in the comparison between the two groups. There was no significant difference in age between the two groups. There was also no difference in the length of hospitalisation or the history of hospitalisation within a year. However, the non-survival group had a higher disease severity and percentage of males than the survival group. Inflammation levels (CRP and WBC) were high, and dehydration was observed.

3.3 | Examination of risk factors for mortality

Univariate logistic regression analysis showed that the GNRI score, sex, A-DROP score, BUN, total protein, serum albumin and CRP levels were associated with survival or non-survival (Table 2). Subsequently, all of the above parameters that showed statistical significance in

TABLE 1 Patient characteristics

	$n = 276$	Survivors ($n = 231$)	Non-survivors ($n = 45$)	p-value
Age, years	80.8 (12.9)	80.6 (13.6)	81.9 (8.3)	0.548
Height, m	1.59 (0.72)	1.54 (0.10)	1.53 (0.11)	0.999
BMI, kg/m^2	17.2 (3.8)	17.3 (3.8)	17.5 (3.9)	0.128
GNRI	76.6 (12.8)	78.1 (12.7)	68.6 (10.1)	<0.001
Male, *n* (%)	181 (65.6)	144 (62.3)	37 (82.2)	0.010
Length of hospital stay, stay	30.6 (26.6)	30.6 (26.1)	30.2 (29.3)	0.919
Hospitalisation method				0.109
Walk-in, *n* (%)	140 (50.7)	122 (52.8)	18 (40.0)	
Emergency transportation, *n* (%)	136 (49.3)	109 (47.2)	27 (60.0)	
Medical examination subject				0.805
Respiratory, *n* (%)	122 (44.2)	100 (43.3)	22 (48.9)	
Emergency, *n* (%)	42 (15.2)	37 (16.0)	5 (11.6)	
General examination, *n* (%)	35 (12.7)	30 (13.0)	5 (11.6)	
Others, *n* (%)	77 (27.9)	64 (27.7)	13 (28.9)	
Aspiration episode				0.148
None, *n* (%)	167 (60.5)	141 (61.0)	26 (57.8)	
Vomiting, *n* (%)	47 (17.0)	43 (18.6)	4 (8.9)	
Muze, *n* (%)	44 (15.9)	33 (14.3)	11 (24.4)	
Aspiration, *n* (%)	4 (1.4)	2 (0.9)	2 (4.4)	
Gastrostomy, *n* (%)	9 (3.3)	8 (3.5)	1 (2.2)	
Others, *n* (%)	5 (1.9)	4 (1.7)	1 (2.2)	
Lifestyle before hospitalisation				0.346
Home, *n* (%)	151 (54.7)	128 (55.4)	23 (51.1)	
Facility (nursing-care home), *n* (%)	112 (40.6)	94 (40.7)	18 (40.0)	
Hospital, *n* (%)	13 (4.7)	9 (3.9)	4 (8.9)	
ADL before hospitalisation				0.431
Freestanding gait, *n* (%)	70 (25.4)	62 (26.8)	8 (17.8)	
Assistance gait, *n* (%)	73 (26.4)	61 (26.4)	12 (26.7)	
Wheelchair, *n* (%)	90 (32.6)	75 (32.5)	15 (33.3)	
Bedridden, *n* (%)	43 (15.6)	33 (14.3)	10 (22.2)	
Performance status				0.766
0, *n* (%)	3 (1.1)	3 (1.3)	0 (0.0)	
1, *n* (%)	30 (10.9)	27 (11.7)	3 (6.7)	
2, *n* (%)	57 (20.7)	48 (20.8)	9 (20.0)	
3, *n* (%)	66 (23.9)	55 (23.8)	11 (24.4)	
4, *n* (%)	120 (43.4)	98 (42.4)	22 (48.9)	
Dementia				0.389
Normal, *n* (%)	11 (4.0)	9 (3.9)	2 (4.5)	
Boundary, *n* (%)	33 (12.0)	31 (13.4)	2 (4.5)	
Mild, *n* (%)	33 (12.0)	26 (11.3)	7 (15.6)	
Moderate, *n* (%)	91 (33.0)	73 (31.6)	18 (40.0)	
Severe, *n* (%)	108 (39.0)	92 (39.4)	16 (35.6)	

(Continues)

TABLE 1 (Continued)

	$n = 276$	Survivors ($n = 231$)	Non-survivors ($n = 45$)	p-value
A-DROP				<0.01
Mild, *n* (%)	0 (0.0)	0 (0.0)	0 (0.0)	
Moderate, *n* (%)	151 (54.7)	139 (60.2)	12 (26.7)	
Severe, *n* (%)	103 (37.3)	79 (34.2)	24 (53.3)	
Extremely severe, *n* (%)	22 (8.0)	13 (5.6)	9 (20.0)	
Hemiplegia, *n* (%)	53 (19.2)	46 (19.9)	7 (15.6)	0.489
Hospitalisation within 1 year, *n* (%)	148 (53.6)	128 (55.4)	20 (44.4)	0.177
Oxygen therapy, *n* (%)	189 (68.5)	154 (66.7)	35 (77.8)	0.063
Laboratory values				
BUN, mg/dl	26.2 (20.2)	23.9 (15.7)	37.9 (33.2)	<0.001
Total protein, g/dl	6.6 (0.9)	6.7 (0.9)	6.2 (0.8)	<0.001
Serum albumin, g/dl	3.0 (0.6)	3.1 (0.5)	2.5 (0.6)	<0.001
CRP, mg/dl	10.2 (10.7)	9.3 (10.5)	14.3 (10.6)	<0.01
WBC, $10^3/\mu l$	11.0 (5.2)	11.2 (5.1)	10.4 (5.6)	0.347
Physical therapy (physiotherapy), *n* (%)	228 (82.6)	195 (84.4)	33 (73.3)	<0.01
Initial mobilisation, days	3.6 (2.9)	3.6 (3.0)	3.3 (2.4)	0.153
First-time antibiotic				0.011
SBT/ABPC, *n* (%)	203 (73.6)	173 (74.9)	30 (66.7)	
CTRX, *n* (%)	33 (12.0)	26 (11.3)	7 (15.6)	
TAZ/PIPC, *n* (%)	20 (7.2)	12 (5.2)	8 (17.7)	
MEPM, *n* (%)	14 (5.1)	14 (6.1)	0 (0.0)	
Others, *n* (%)	6 (2.1)	6 (2.6)	0 (0.0)	
Outcome				<0.001
Home, *n* (%)	79 (28.6)	79 (34.2)	0 (0.0)	
Facility (nursing-care home), *n* (%)	77 (27.9)	77 (33.3)	0 (0.0)	
Hospital, *n* (%)	75 (27.2)	75 (32.5)	0 (0.0)	
Death, *n* (%)	45 (16.3)	0 (0.0)	45 (100.0)	
ADL at discharge				<0.001
Freestanding gait, *n* (%)	45 (16.3)	45 (19.5)	0 (0.0)	
Assistance gait, *n* (%)	48 (17.3)	48 (20.8)	0 (0.0)	
Wheelchair, *n* (%)	91 (33.0)	91 (39.4)	0 (0.0)	
Bedridden, *n* (%)	92 (33.4)	47 (20.3)	45 (100.0)	

Note: Values were reported as the mean (SD) or number and percentage of subjects.
Abbreviations: ADL, activity of daily living; BMI, body mass index; BUN, blood urea nitrogen; CRP, C-reactive protein; CTRX, Ceftriaxone; GNRI, Geriatric Nutritional Risk Index; MEPM, Meropenem; SBT/ABPC, Sulbactam/Ampicillin; TAZ/PIPC, Tazobactam/Piperacillin; WBC, white blood cell.

the univariate analysis, plus age, were incorporated into a multivariate logistic regression model for in-depth analysis. The results showed that the A-DROP score (odds ratio [OR] = 2.440; 95% confidence interval [CI], 1.400–4.270; $p < 0.01$), GNRI score (OR = 0.383; 95% CI, 0.178–0.824; $p < 0.05$) and sex (OR = 0.365; 95% CI, 0.153–0.869; $p < 0.05$) were the independent early predictors of mortality (Table 3).

3.4 | Survival curves for 90-day survival

Kaplan–Meier analysis was performed for A-DROP, GNRI and sex. A-DROP had significantly higher mortality rates with increasing severity of illness (log-rank test, $p < 0.001$; Figure 2). The GNRI showed significantly higher mortality rates with an increasing risk of nutritional disorders (log-rank test, $p < 0.01$; Figure 3). Men

TABLE 2 Univariate logistic regression analysis with 90-day mortality as the dependent variable

	Univariate analysis	
	Odds ratio (95% CI)	***p*-value**
Age	1.010 (0.982–1.040)	0.547
Height	1.880 (0.151–23.3)	0.143
BMI	0.935 (0.858–1.020)	0.13
GNRI	0.944 (0.919–0.969)	<0.001
Sex		
Male	Reference	
Female	0.358 (0.159–0.804)	0.0128
Hospitalisation method		
Walk-in	Reference	
Emergency transportation	1.710 (0.892–3.270)	0.106
Medical examination subject		
Respiratory	Reference	
Emergency	0.655 (0.243–1.77)	0.405
General examination	0.806 (0.296–2.200)	0.674
Others	1.200 (0.601–2.410)	0.600
Aspiration episode		
None	Reference	
Vomiting	0.427 (0.145–1.250)	0.122
Muze	1.940 (0.896–4.210)	0.092
Aspiration	5.330 (0.730–38.80)	0.099
Gastrostomy	0.634 (0.077–5.190)	0.671
Others	1.290 (0.141–11.80)	0.822
Lifestyle before hospitalisation		
Home	Reference	
Facility (nursing-care home)	0.972 (0.506–1.860)	0.931
Hospital	2.410 (0.708–8.180)	0.16
ADL before hospitalisation		
Freestanding gait	Reference	
Assistance gait	1.010 (0.492–2.090)	0.971
Wheelchair	1.040 (0.528–2.050)	0.91
Bedridden	1.710 (0.775–3.790)	0.183
Performance status		
0	Reference	
1	0.540 (0.156–1.860)	0.329
2	0.953 (0.430–2.110)	0.906
3	1.040 (0.492–2.180)	0.927
4	1.300 (0.684–2.460)	0.424
Dementia		
Normal	Reference	
Boundary	0.300 (0.069–1.300)	0.108
Mild	1.450 (0.588–3.590)	0.418

(Continues)

TABLE 2 (Continued)

	Univariate analysis	
	Odds ratio (95% CI)	***p*-value**
Moderate	1.440 (0.747–2.790)	0.275
Severe	0.834 (0.429–1.620)	0.592
A-DROP		
Mild	None	
Moderate	Reference	
Severe	2.200 (1.150–4.190)	0.0168
Extremely severe	4.190 (1.670–10.500)	0.00227
Hemiplegia		
None	Reference	
Hemiplegia	0.741 (0.311–1.770)	0.498
Hospitalisation within 1 year		
None	Reference	
Hospitalisation within 1 year	1.550 (0.817–2.950)	0.179
Oxygen therapy		
None	Reference	
Oxygen therapy	1.550 (0.743–3.220)	0.244
Laboratory values		
BUN	1.030 (1.010–1.040)	<0.001
Total protein	0.502 (0.337–0.747)	<0.001
Serum albumin	0.157 (0.0799–0.307)	<0.001
CRP	1.040 (1.0100–1.070)	0.011
WBC	1.000 (1.000–1.000)	0.347
Physical therapy (physiotherapy)		
Physical therapy	Reference	
None	1.970 (0.930–4.170)	0.076
Initial mobilisation	0.953 (0.804–1.130)	0.58
First-time antibiotic		
SBT/ABPC	Reference	
CTRX	1.450 (0.588–3.590)	0.418
TAZ/PIPC	3.950 (1.510–10.30)	0.507
MEPM	<0.000 (0.000–inf)	0.988
Others	<0.000 (0.000–inf)	0.988

Note: Values were reported as the mean (SD) or number and percentage of subjects.
Abbreviations: ADL, activity of daily living; BMI, body mass index; BUN, blood urea nitrogen; CI, confidence interval; CRP, C-reactive protein; CTRX, Ceftriaxone; GNRI, Geriatric Nutritional Risk Index; MEPM, Meropenem; SBT/ABPC, Sulbactam/Ampicillin; TAZ/PIPC, Tazobactam/Piperacillin; WBC, white blood cell.

had a significantly lower survival rate than women (log-rank test, $p = 0.012$).

4 | DISCUSSION

In this study, we investigated the factors affecting 90-day survival in patients hospitalised for aspiration pneumonia. Patients with aspiration pneumonia who had dysphagia or aspiration confirmed by modified water swallow test or VideoEndoscopic examination of swallowing were included. Three factors were extracted by multivariate logistic regression analysis: the A-DROP score, GNRI score and sex. There are few reports on mortality risk factors for aspiration pneumonia.

TABLE 3 Multivariate logistic regression analysis with 90-day mortality as the dependent variable

Model $p < 0.001$, VIF = 1	Odds ratio	SE	z	$p > \|z\|$	95% CI
Dependent variable: 90-day mortality, $n = 276$					
A-DROP	2.839	0.3979	2.622	0.0087	1.3226–6.3621
GNRI	0.303	0.4889	−2.439	0.0147	0.1061–0.7439
Sex	0.361	0.4367	−2.329	0.0199	0.1443–0.8151

Abbreviations: CI, confidence interval; GNRI, Geriatric Nutritional Risk Index; VIF, variance inflation factor.

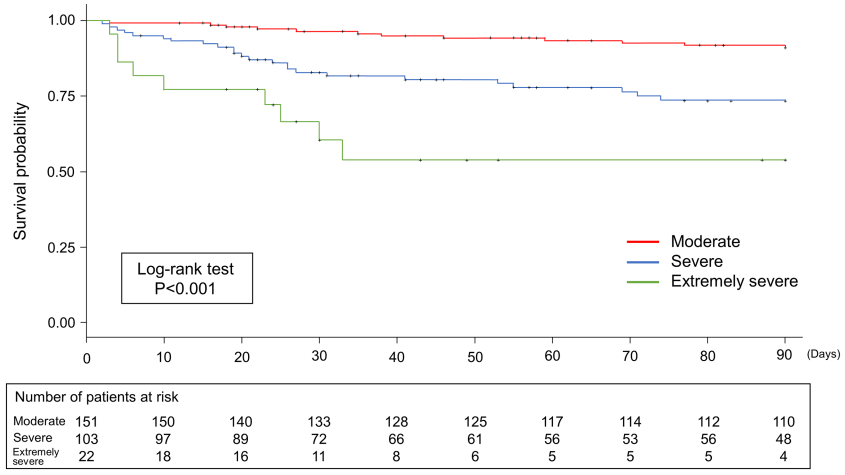

FIGURE 2 Kaplan–Meier analysis of 90-day mortality according to the A-DROP. Classified into three groups according to severity of illness

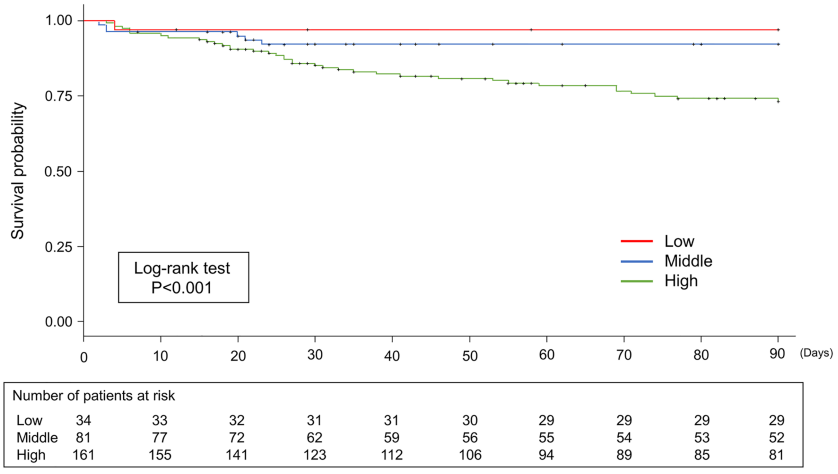

FIGURE 3 Kaplan–Meier analysis of 90-day mortality according to the Geriatric Nutritional Risk Index. Classified into three groups according to nutritional risk

Maruyama et al. reported malnutrition, high PSI score and initial treatment failure as mortality risks in patients with CAP and HCAP.[13] Our results were similar to those of Maruyama et al. in terms of malnutrition and GNRI, PSI and A-DROP scores.

The GNRI is an indicator for predicting complications such as bedsores and infections related to malnutrition and mortality in hospitalised elderly patients.[12] It can be calculated using only the serum albumin level, current weight and ideal weight. GNRI is significantly correlated with anthropometric and biochemical markers of nutritional status such as grip strength and lymphocytes.[14,15] The GNRI is not a nutritional indicator; rather, it is an indicator of nutritional disorder-related complications such as infectious complications, bedsores and death. Moreover, it can predict the risk of mortality, infection and pressure ulcers with more sensitivity than nutritional indicators, such as serum albumin and BMI.[12]

The results of this study revealed that the GNRI is a risk factor for 90-day survival. Malnutrition in the elderly population is associated with adverse medical

consequences, contributing to frailty, sarcopenia, morbidity and mortality.[16] Low nutrition is one of the factors associated with the development, refractoriness and severity of infectious diseases. Low nutritional status has been reported to cause a decrease in acquired immunity, such as a decrease in helper T cell activity and antibody production,[17] and low nutrition is a risk factor for infections.[18] Low BMI and serum albumin levels, which are indicators of low nutrition, have been reported to affect life expectancy in the elderly.[19,20] In elderly hospitalised patients with low malnutrition, there is a risk of infection, such as sepsis,[21] and it is also a risk of nosocomial infection.[22] Furthermore, systemic inflammation caused by aspiration pneumonia may elevate muscle protein catabolism, which depletes muscle mass and leads to further muscle decline and weakness.[23] This extensive loss of protein may ultimately lead to death. A decrease in skeletal muscle mass in patients with aspiration pneumonia can predict mortality rate for 90 days.[24] In addition, according to a previous study, the undernourished group had higher hospitalisation costs and complications compared with the non-undernourished group,[25] suggesting that the effect of undernutrition is significant.

In patients with aspiration pneumonia, factors related to feeding may influence low nutrition. In the past, Ney et al. reported that dysphagia increased the risk of hyponutrition in the elderly.[26] However, the association between dysphagia and death from aspiration pneumonia has not yet been reported, and this association needs to be further studied.

This study presented the clinical significance of nutritional risk assessment using the GNRI in patients with aspiration pneumonia. The results showed that low GNRI scores were significantly associated with increased mortality. GNRI score is a useful indicator for stratifying the risk of death in hospitalised patients with aspiration pneumonia. GNRI consists of simple objective measurements such as BMI and serum albumin levels, which can be easily measured on admission for patients with aspiration pneumonia. The GNRI consists of simple objective measurements, BMI and serum albumin, which can be easily obtained on admission in patients with aspiration pneumonia. The GNRI is a significantly useful index for the prognostic prediction of patients with aspiration pneumonia.

Severity of illness was an important risk factor and was associated with increased mortality, similar to the results of other studies.[27] The A-DROP score is a modified version of the CURB-65 score proposed by the Japanese Respiratory Society in 2006.[9] Although Maruyama et al. used the PSI score as a severity classification, we used the A-DROP score in this study. The PSI score divides patients into five classes based on a total score of 20 factors, including age, history, abnormalities in physical examination and laboratory findings, and it is the most accurate way to determine the severity of the disease.[28] However, it is inconvenient because of its large number of items. With the A-DROP, an immediate decision can be made because it is a five-item assessment. The predictive power of the A-DROP as a pneumonia severity classification is similar to that of the PSI.[10,29] In a study of 1875 patients with CAP, the 30-day mortality rate increased with increasing severity in A-DROP (0%, mild; 3.1%, moderate; 9.9%, severe; 19.6%, extremely severe).[29] The guidelines recommend modifying the treatment according to the severity of the disease. In fact, an association between the pneumonia guideline-recommended treatment group and lower hospital mortality has been reported.[30] The results suggest the necessity of treatment selection according to the severity of the A-DROP.

This study has the following limitations: This was a single-centre study, and because it was a retrospective study, only data at the time of hospitalisation were collected. To improve the care and rehabilitation of the increasing number of patients with aspiration pneumonia, it is necessary to collect detailed data in a multicentre, prospective study.

Moreover, we investigated the risk factors that affect 90-day survival in patients with aspiration pneumonia. Three factors were extracted by multivariate logistic regression analysis: the A-DROP score, GNRI score and sex.

In conclusion, the results of this study suggest that nutritional status and the severity of pneumonia are important factors that predict life expectancy in patients with aspiration pneumonia. While it is natural to assess the severity of the disease at the time of admission, nutritional status should also be assessed to predict the patient's outcome.

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CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

This study was registered with the University Hospital Medical Information Network Clinical Trial Registry (UMIN 000046923).

ETHICS STATEMENT

This study was approved by the Ethics Committee of Seirei Mikatahara General Hospital (Approval Number 17-50). At Seirei Mikatahara General Hospital, we explained the unintended use of medical records at the time of the first visit both verbally and in writing. In this study, we only included patients who provided informed consent for the unintended use of medical records.

AUTHOR CONTRIBUTIONS

Yorihide Yanagita: Conceptualisation; data curation; formal analysis; funding acquisition; investigation; methodology; project administration; resources; software; validation; writing—original draft; writing—review and editing. **Shinichi Arizono**: Conceptualisation; formal analysis; methodology; project administration; supervision; validation; writing—review and editing. **Yuichi Tawara**: Supervision; writing—review and editing. **Masaki Oomagari**: Data curation; formal analysis; investigation; writing—review and editing. **Hikaru Machiguchi**: Data curation; formal analysis; investigation; writing—review and editing. **Koshi Yokomura**: Data curation; resources; supervision; writing—review and editing. **Norimasa Katagiri**: Supervision; writing—review and editing. **Yuki Iida**: Conceptualisation; formal analysis; funding acquisition; methodology; project administration; supervision; validation; writing—review and editing.

DATA AVAILABILITY STATEMENT

The data that support the finding of this study are available from the corresponding author upon reasonable request.

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