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Original article

Signs of dysphagia and associated outcomes regarding mortality, length of hospital stay and readmissions in acute geriatric patients: Observational prospective study

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SUMMARY

Background and aims: Dysphagia is a prevalent disorder in acute geriatric patients. This observational prospective study aimed at investigating adverse clinical outcomes linked to signs of dysphagia, including mortality, length of hospital stay (LOS), readmissions, among patients aged ≥ 65 years at a Danish acute medical unit (AMU).

Methods: Signs of dysphagia were assessed using bedside screening tools including the Eating Assessment Tool (EAT-10), a 30 mL Water Swallowing Test (WST) and the Gugging Swallowing Screen tool (GUSS), as described in the preceding cross-sectional study. Data for the follow-up was twice retrieved from electronic medical charts 30 days and 90 days after the patients' primary admission to the hospital. Statistical analysis included non-parametric tests of independence and proportional hazards modelling.

Results: 444 patients were recruited, 334 of whom completed the dysphagia screening with 144 (43.1 %) showing signs of dysphagia. Patients with signs of dysphagia, compared to those without, experienced higher mortality after 30 days (12.5 % vs. 1.6 %, $p < 0.001$) and 90 days (21.5 % vs. 5.8 %, $p < 0.001$), longer LOS (median [Q1; Q3]: 4 [2; 8] vs. 3 [1; 6] days, $p = 0.004$), more total hospital days (THD) during both the 30-day and 90-day follow-up (for 90d: median [Q1; Q3]: 6 [2.25; 12] vs. 4 [2; 9] days, $p = 0.007$), but no significant difference in frequency of readmissions. Multivariate proportional hazards modelling revealed signs of dysphagia, low performance status and high comorbidity to be independent risk factors for mortality. High comorbidity and low hemoglobin, but not signs of dysphagia, were revealed as independent risk factors for readmission.

Conclusion: Dysphagia is a notable risk factor linked to increased mortality and length of hospital stay (LOS) for acute geriatric patients in general, not just those suffering from stroke, head and neck cancer or neurodegenerative diseases. Further research is needed to investigate the effectiveness and feasibility of systematic dysphagia screening within this population.

1. Introduction

Dysphagia is a clinical symptom defined as difficult or disordered swallowing [1]. A recent study of geriatric patients (age ≥ 65 years) admitted to a Danish acute medical unit (AMU) revealed a prevalence of signs of dysphagia of 43.1 % (n: 144 of 334) [2]. Previous studies of similar populations set the prevalence of dysphagia at between 26.2 % and 56.7 % [3–10].

Dysphagia has been described as a geriatric syndrome associated with multiple diseases such as dehydration [11], pneumonia [12], and malnutrition [3] as well as increased mortality [3,5,10,13], length of hospital stay (LOS) (Attrill 2018, Patel 2018), readmissions with pneumonia and aspiration [10], and increased health care costs [14–16].

The preventative effects of systematic dysphagia screening have mainly been studied in acute stroke patients, finding that early

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dysphagia screening reduces incidence of stroke-associated pneumonia [17,18], mortality [18] and LOS [18]. Searching the PubMed® database the authors of this current study failed to identify any study investigating plausible preventative effects of systematic dysphagia screening of acute geriatric patients without stroke. Meanwhile, a range of interventions seem promising although further research is generally needed: Expiratory muscle strength training (EMST) may reduce risk of aspiration in patients with stroke, Parkinson's disease (PD), or self-reported voice-problems [19]. Transcranial magnetic stimulation (TMS) has shown good qualitative results in improving dysphagia in stroke-patients across studies with heterogeneous protocols and measures [20–22]. Conversely, a long-running Cochrane Collaboration review of multiple swallowing therapies in stroke patients, including TMS, found no reduction in mortality, disability, or penetration aspiration score (PAS), while swallowing therapies may have reduced LOS and the incidence of chest infections, improved swallowing abilities and reduced the proportion of patients with dysphagia at the end of trials [23].

When contemplating the feasibility of implementing systematic screening for any disease, decision makers will likely be interested in these four factors: prevalence, severity of outcomes, treatability, and health care economics.The aim of this study is to investigate clinical outcomes associated with signs of dysphagia among acute geriatric patients (age $\geq$ 65) admitted to a general AMU. These outcomes include mortality, LOS, total hospital days (THD), overall readmissions, and readmissions with dysphagia-associated diagnoses (pneumonia, COPD exacerbation, malnutrition or dysphagia) within the 30-day and 90-day follow-up period.

2. Materials and methods

2.1. Setting

This prospective cohort study is based on the study population of a previous cross-sectional study, consisting of geriatric patients admitted to the acute medical unit (AMU) at Aalborg University Hospital (AAUH) in february 2020 [2]. The AMU is a non-specialized unit that serves a broad range of patients, yet it de facto excludes patients requiring highly specialized treatment, e.g. for acute stroke, acute heart disease, and also for most orthopedic conditions. In 2019, the AMU received 12,094 patients, an average of 33 patients per day.

2.2. Participants

From the 1st to the 29th of February, researchers completed bidaily rounds of the AMU to enroll patients fulfilling the inclusion criteria, being aged 65 years or older, into the study. Of these some participants did not complete the interview or the screening for reasons such as prescribed 'nil per os' or communication being impaired by unresponsiveness, somnolence or cognitive impairment. Additionally, some patients were relocated to other hospital wards between time of enrollment and the interview/screening. These participants were allocated into the Incomplete Screening group in order to account for selection bias. The remaining patients who did complete the interview and screening were allocated to the Complete Screening group.

2.3. Screening procedure

Signs of dysphagia were identified according to the protocol first described by Olesen et al. [2]. Patients were initially assumed to have normal swallowing capacity if their response to the modified Eating Assessment Tool (EAT-10) suggested no swallowing problems and if they had not experienced weight loss within three months leading up to their hospital admission. These patients were asked to perform a 30 mL Water Swallowing Test (WST). If the WST was successfully completed the patient was determined to have normal swallowing capacity. Conversely, if a patient reported swallowing problems, recent weight loss or failed the WST, then Gugging Swallowing Screen tool (GUSS) was performed. Patients who achieved a GUSS score of 20 points were assumed to retain normal swallowing capacity, while a GUSS score of 19 points or less was interpreted as a sign of dysphagia. Thus, the Complete Screening group was divided into the Normal Swallowing group and the Signs of Dysphagia group.

2.4. Electronic data collection

Data collection was performed by accessing electronic medical records as described by Olesen et al. [2]. Data categories initially collected were sex, age, dates of admission, admission diagnoses (ICD-10), treatment diagnoses (ICD-10), medical history (CCI categories), and blood results including plasma C-reactive protein (CRP, mg/L), blood hemoglobin (Hb, mmol/L), and plasma albumin (Alb, g/L).

The follow-up was carried out by reviewing electronic medical records 30 days and 90 days after the date of screening. Data categories collected were date of primary discharge, admission diagnosis for readmissions, dates of readmissions and discharges and date of death.

2.5. Data analysis

Statistical analysis was carried out using IBM SPSS statistics 26.Statistical analysis included non-parametric tests of independence, since the scaled datasets were all non-normally distributed, as assessed by the Kolmogorov–Smirnov test of normality. Non-normally distributed scaled data was compared using the Mann Whitney U test and reported as median [Q1; Q3]. Binary data was compared using the Pearson Chi Square Test of independence and reported as *n* (%). Dependent and independent risk factors for mortality and readmission were identified using Cox' proportional hazards modeling. A statistical significance was set at $p < 5$ %.

3. Results

Based on their inclusion criteria Olesen et al., 2021 enrolled 444 patients into the study. Of these, 334 were part of the Complete Screening group, while 110 patients were placed in the Incomplete Screening group, based on whether the patients completed the interview and screening.

3.1. Incomplete vs. Complete Screening

During the 30-day follow-up, the Incomplete Screening group experienced higher mortality than the Complete Screening group (17.3 % vs. 6.3 %, $p < 0.001$), while no significant differences were found in terms of LOS, THD, frequency of readmission, or frequency of readmission with a dysphagia-associated diagnosis (pneumonia, COPD exacerbation, malnutrition, or dysphagia) (Table 1).

The results were similar for the 90-day follow-up as the Incomplete Screening group experienced a higher mortality (27.3 % vs. 12.6 %, $p < 0.001$), while no other significant differences were found (Table 2). Survival plots of these groups are seen in Fig. 1.

3.2. Signs of dysphagia vs. normal swallowing

The Complete Screening group was further divided into the Signs of Dysphagia group (n = 144, 43.1 %) and the Normal Swallowing

Table 1
30-day Clinical outcomes based on the patients' ability to complete the interview and protocol.

Variables	Overall (n = 444)	Incomplete screen (n = 110)	Complete screen (n = 334)	*p* value
Length of stay (days)[b]	4 [2; 7]	5 [2; 7]	4 [1.75; 7]	0.318
Total hospital days (days)[b]	4 [2; 8]	5 [2; 8]	4 [2; 8.25]	0.625
Readmitted (*n*)[a]	77 (17.3 %)	15 (13.6 %)	62 (18.6 %)	0.237
Readmission with dysphagia-associated diagnosis (*n*)[a]	18 (4.1 %)	5 (4.5 %)	13 (3.9 %)	0.763
with pneumonia (*n*)[a]	10 (2.3 %)	5 (4.5 %)	5 (1.5 %)	–
with COPD exacerbation (*n*)[a]	6 (1.4 %)	0 (0.0 %)	6 (1.8 %)	–
with Malnutrition (*n*)[a]	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	–
with Dysphagia (*n*)[a]	2 (0.5 %)	0 (0.0 %)	2 (0.6 %)	–
Mortality (*n*)[a]	40 (9.0 %)	19 (17.3 %)	21 (6.3 %)	< **0.001**

Significant level is set at 5 % and marked with **bold font**.
[a] n (%), Pearson Chi−Square test.
[b] Median [Q1; Q3], Mann−Whitney U test.

Table 2
90-day Clinical outcomes based on the patients' ability to complete the interview and protocol.

Variables	Overall (n = 444)	Incomplete screen (n = 110)	Complete screen (n = 334)	*p* value
Length of stay (days)[b]	4 [2; 7]	5 [2; 7]	4 [1.75; 7]	0.318
Total hospital days (days)[b]	5 [2; 10]	6 [2.75; 8.25]	5 [2; 10]	0.478
Readmitted (*n*)[a]	129 (29.1 %)	29 (26.4 %)	100 (29.9 %)	0.474
Readmission with dysphagia-associated diagnosis (*n*)[a]	24 (5.4 %)	6 (5.5 %)	18 (5.4 %)	0.979
with pneumonia (*n*)[a]	14 (3.2 %)	5 (4.5 %)	9 (2.7 %)	–
with COPD exacerbation (*n*)[a]	9 (2.0 %)	1 (0.9 %)	8 (2.4 %)	–
with Malnutrition (*n*)[a]	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	–
with Dysphagia (*n*)[a]	2 (0.5 %)	0 (0.0 %)	2 (0.6 %)	–
Mortality (*n*)[a]	72 (16.2 %)	30 (27.3 %)	42 (12.6 %)	< **0.001**

Significant level is set at 5 % and marked with **bold font**.
[a] n (%), Pearson Chi−Square test.
[b] Median [Q1; Q3], Mann−Whitney U test.

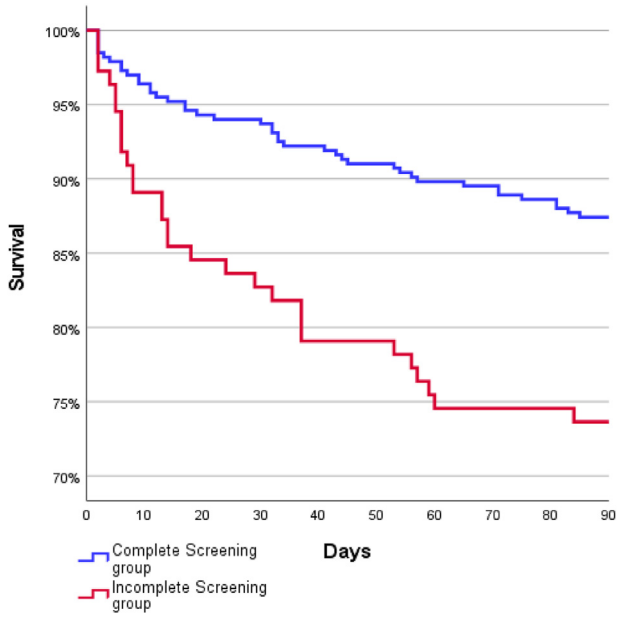

Fig. 1. Survival plot of the Complete Screening group (blue) and the Incomplete Screening group (red).

group (n = 190, 56.9 %) based on the screening procedure. During the 30-day follow-up, the Signs of Dysphagia group experienced higher mortality compared to the Normal Swallowing group (12.5 % vs. 1.6 %, p < 0.001). Furthermore, the Signs of Dysphagia group had greater median LOS (4 days vs. 3 days, p = 0.004), THD (5 days vs. 4 days, p = 0.011) (Fig. 2), and a higher frequency of readmission with dysphagia-associated diagnosis (6.9 % vs. 1.6 %, p = 0.012), meanwhile there were not enough data to statistically evaluate differences in frequencies of readmission with diagnosed pneumonia, COPD exacerbation, malnutrition, or dysphagia. There was no significant difference in overall readmissions during the 30-day follow-up (Table 3).

The results were similar for the 90-day follow-up period. The Signs of Dysphagia group had higher mortality (21.5 % vs 5.8 %, p < 0.001), LOS (4 days vs. 3 days, p = 0.004), median THD (6 days vs. 4 days, p = 0.007) (Fig. 5), and higher frequency of readmission with dysphagia-associated diagnosis (9.0 % vs. 2.6 %, p = 0.012). There was no significant difference in overall readmissions during the 90-day follow-up (Table 4). Survival and Readmission plots of the Signs of Dysphagia Group and the Normal Swallowing group are seen in Figs. 3 and 4.

3.3. Proportional hazards of mortality

A range of univariate and multivariate proportional hazards regressions were completed to identify factors increasing the daily risk of death during the 90 days follow up period (Table 5). Factors included in the analysis were: sex, age (years exceeding 65), signs of dysphagia, nutritional risk (NRS ≥ 3 points), low performance status (ECOG ≥ 3 points), CCI (points), high CRP (>10 mg/L), low albumin (male: < 8.3 mM, female: < 7.3 mM), and low hemoglobin (<34 g/L).

The univariate analysis revealed significant risk factors: age *x* years in excess of 65 (HR = 1.046^x, 95%CI = [1.005; 1.089], *p* = 0.029), signs of dysphagia (HR = 4.126, 95%CI = [2.073; 8.210],

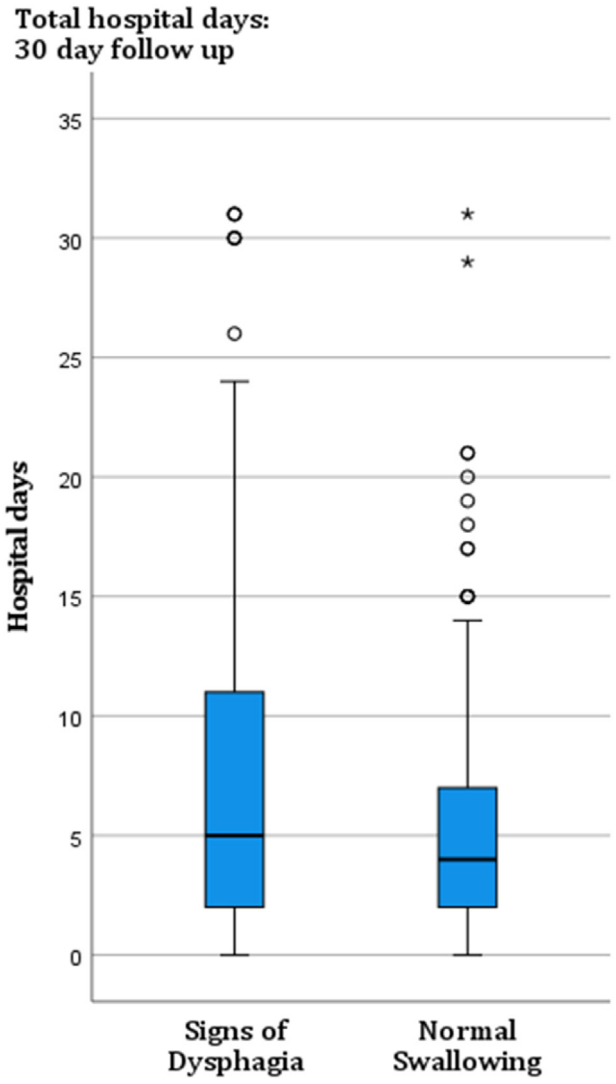

Fig. 2. Boxplot comparing the Signs of Dysphagia and Normal Swallowing groups in terms of total hospital days during the 30-day follow up period. Circles mark outliers deviating more than 1.5 IQR from the median. Asterisks mark extreme outlines more than 3 IQR from median.

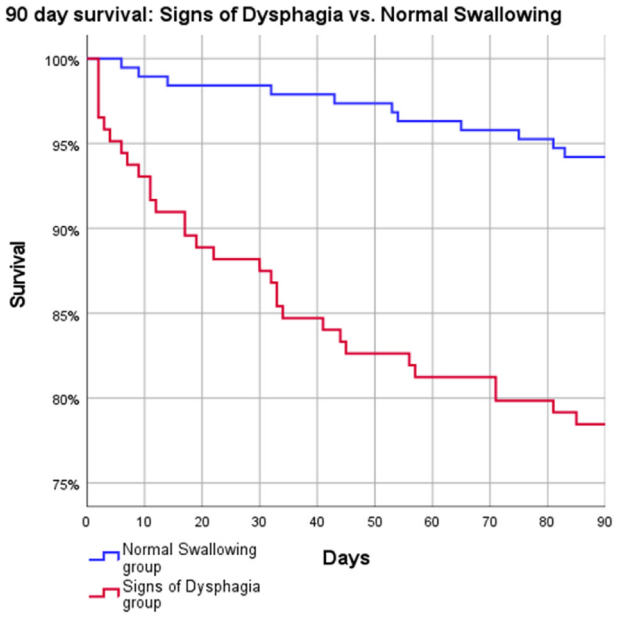

Fig. 3. Survival plot of the Normal Swallowing group (blue) and the Signs of Dysphagia group (red).

$p = 0.001$), nutritional risk (HR = 2.019, 95%CI = [1.074; 3.795], $p = 0.029$), low performance status (HR = 5.961, 95%CI = [3.134; 11.338], $p < 0.001$), CCI score x (HR = 1.287^{x}, 95%CI = [1.152; 1.438], $p < 0.001$), high CRP (HR = 2.157, 95%CI = [1.032; 4.508], $p < 0.001$). The non-trivial interpretation of the age and CCI factors will be covered within the Strength and Limitations section.

The multivariate analysis revealed significant independent risk factors: signs of dysphagia (HR = 2.856, 95%CI = [1.403; 5.815], $p = 0.004$), low performance status (HR = 5.016, 95%CI = [2.567; 9.805], $p < 0.001$), CCI score x (HR = 1.264^{x}, 95%CI = [1.116; 1.433], $p < 0.001$). None of the other parameters were significant in either analysis.

Furthermore, the multivariate model provided an estimate of the baseline hazard experienced by any hypothetical patient who is female, 65 years old, with normal swallowing capacity, well nourished, fully physically active, with no comorbidities and with normal levels of plasma-CRP, plasma-albumin, and blood-hemoglobin. Such a hypothetical patient was estimated to have an $8.747 \bullet 10^{-5}$ daily risk of death equivalent to a 90-day risk of 0.7842 %, assuming an exponential survival curve.

3.4. Proportional hazards of readmission

Another range of proportional hazards regressions were completed to identify factors increasing the daily risk of readmission during follow-up (Table 6). The univariate analyses

Table 3
30-day Clinical outcomes based on presence of signs of dysphagia.

Variables	Signs of dysphagia (n = 144)	Normal swallowing (n = 190)	*p* value
Length of stay (days)[b]	4 [2; 8]	3 [1; 6]	**0.004**
Total hospital days (days)[b]	5 [2; 11]	4 [2; 7]	**0.011**
Readmitted (*n*)[a]	30 (20.8 %)	32 (16.8 %)	0.353
Readmission with dysphagia-associated diagnosis (*n*)[a]	10 (6.9 %)	3 (1.6 %)	**0.012**
with pneumonia (*n*)[a]	4 (2.8 %)	1 (0.5 %)	–
with COPD exacerbation (*n*)[a]	4 (2.8 %)	2 (1.1 %)	–
with Malnutrition (*n*)[a]	0 (0.0 %)	0 (0.0 %)	–
with Dysphagia (*n*)[a]	2 (1.4 %)	0 (0.0 %)	–
Mortality (*n*)[a]	18 (12.5 %)	3 (1.6 %)	< **0.001**

Significant level is set at 5 % and marked with **bold font**.
[a] n (%), Pearson Chi–Square test.
[b] Median [Q1; Q3], Mann–Whitney U test.

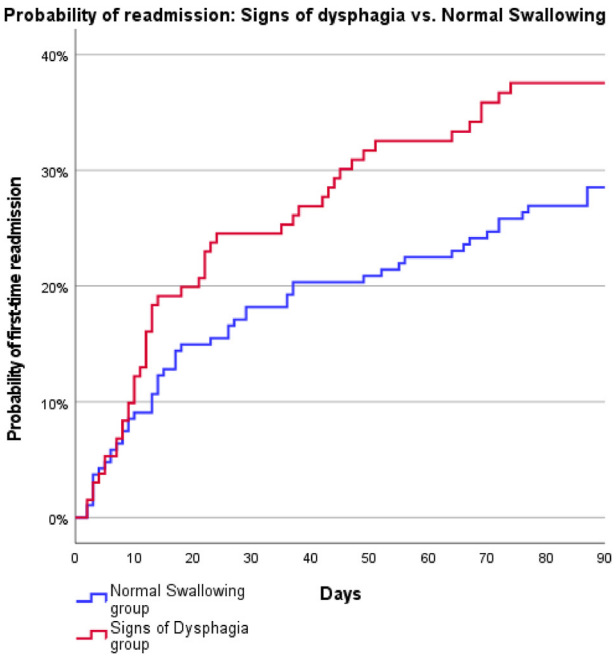

Fig. 4. Probability of readmission in the Normal Swallowing group (blue) and the Signs of Dysphagia group (red). Based on life tables with readmission defined as the event and death as cause for termination, this plot displays the probability of first-time readmission during the 90-day follow-up period.

revealed two significant risk factors: CCI score x (HR = 1.121^{x}, 95% CI = [1.037; 1.213], $p = 0.004$) and low hemoglobin (HR = 2.094, 95%CI = [1.384; 3.169], $p < 0.001$). These were also revealed to be independently significant in the multivariate analysis: CCI score x (HR = 1.100^{x}, 95%CI = [1.013; 1.194], $p = 0.024$) and low hemoglobin (HR = 2.094, 95%CI = [1.158; 2.749], $p = 0.009$). None of the other parameters were significant in either analysis.

The multivariate model also provided an estimate of the baseline hazard experienced by any hypothetical patient who is female, 65 years old, with normal swallowing capacity, well nourished, fully physically active, with no comorbidities and with normal levels of plasma-CRP, plasma-albumin and blood-hemoglobin. Such a hypothetical patient was estimated to have a $3.462 \bullet 10^{-3}$ daily risk of death equivalent to a 90-day risk of 26.81 %, assuming an exponential survival curve.

4. Discussion

4.1. Mortality

This observational cohort study shows that the incidence of mortality, among 334 patients aged 65 or older admitted to the AMU at Aalborg University Hospital (AAUH) between the 1st to the 29th of February 2020, clearly is correlated with the presence of signs of dysphagia. At the end of the 30-day follow-up, 12.5 % of patients showing signs of dysphagia had died compared to 1.6 % of patients with normal swallowing capacity ($p < 0.001$). The mortality rose to 21.5 % vs. 5.8 % during the 90-day follow-up ($p < 0.001$). Using univariable proportional hazards modeling we also found higher age, nutritional risk, low performance status, comorbidities, and elevated levels of CRP to be associated with increased mortality. No correlation was found regarding sex, low albumin, or low hemoglobin. In the multivariate model, only signs of dysphagia, low performance status and comorbidities were found to be independently associated with mortality.

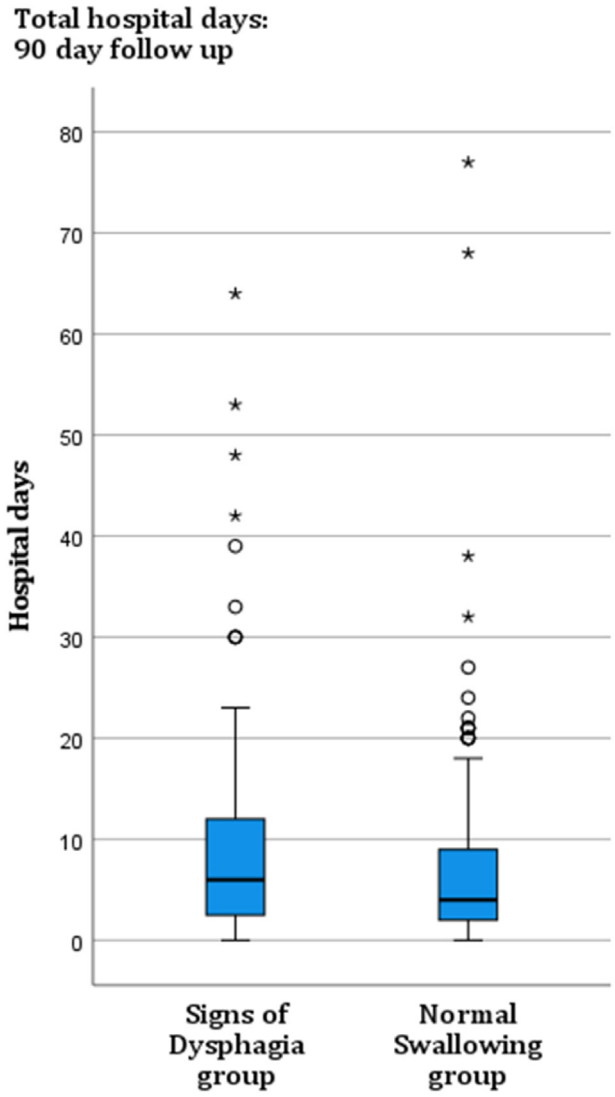

Fig. 5. Boxplot comparing the Signs of Dysphagia and Normal Swallowing groups in terms of total hospital days during the 90-day follow up period. Circles mark outliers deviating more than 1.5 IQR from the median. Asterisks mark extreme outlines more than 3 IQR from median.

These findings are supported by previous studies of similar patients. These used other tools for assessing presence of dysphagia, nutritional status, performance status etc., while also attempting to isolate the dysphagia-associated risk using multivariate analysis [3,5,10,13]. Collectively dysphagia is associated with increased risk of mortality from the point of admission and several years beyond.

4.2. Readmissions

This study found no association between signs of dysphagia and overall readmissions. Readmission with plausibly dysphagia-associated diagnosis (pneumonia, COPD exacerbation, malnutrition, or dysphagia) were significantly higher for patients with signs of dysphagia, while each of the four readmission diagnoses were too infrequent to justify individual tests of independence.Using proportional hazards modeling comorbidities and low blood hemoglobin were found to be independently associated with increased risk of readmission. No association was found between

Table 4
90-day Clinical outcomes based on presence of signs of dysphagia.

Variables	Signs of dysphagia (n = 144)	Normal swallowing (n = 190)	*p* value
Length of stay (days)[b]	4 [2,8]	3 [1,6]	**0.004**
Total hospital days (days)[b]	6 [2.25; 12]	4 [2,9]	**0.007**
Readmitted (*n*)[a]	48 (33.3 %)	52 (27.4 %)	0.238
Readmission with dysphagia-associated diagnosis (*n*)[a]	13 (9.0 %)	5 (2.6 %)	**0.010**
with pneumonia (*n*)[a]	7 (4.9 %)	2 (1.1 %)	–
with COPD exacerbation (*n*)[a]	5 (3.5 %)	3 (1.6 %)	–
with Malnutrition (*n*)[a]	0 (0.0 %)	0 (0.0 %)	–
with Dysphagia (*n*)[a]	2 (1.4 %)	0 (0.0 %)	–
Mortality (*n*)[a]	31 (21.5 %)	11 (5.8 %)	< **0.001**

Significant level is set at 5 % and marked with **bold font**.
[a] n (%), Pearson Chi–Square test.
[b] Median [Q1; Q3], Mann–Whitney U test.

Table 5
Univariate and multivariate proportional hazards models for mortality.

Variables	Univariate HR	95 % CI	*p* value	Multivariate HR	95 % CI	*p* value
Male sex	0.915	0.500–1.675	0.744	1.193	0.630–2.258	0.588
Age (years)[a]	1.046[x]	1.005–1.089	**0.029**	1.031[x]	0.991–1.074	0.132
Signs of dysphagia	4.126	2.073–8.210	**0.001**	2.856	1.403–5.815	**0.004**
Nutritional risk (NRS≥3)	2.019	1.074–3.795	**0.029**	1.285	0.660–2.504	0.461
Low performance status (ECOG≥3)	5.961	3.134–11.338	**<0.001**	5.016	2.567–9.805	**<0.001**
CCI (points)[a]	1.287[x]	1.152–1.438	**<0.001**	1.264[x]	1.116–1.433	**<0.001**
High CRP (>10 mg/L)	2.157	1.032–4.508	**0.041**	1.833	0.737–4.562	0.193
Low albumin (<34 g/L)	0.619	0.337–1.137	0.122	0.820	0.380–1.768	0.612
Low hemoglobin (Male: <8.3 mM, female: <7.3 mM)	1.534	0.823–2.860	0.178	1.138	0.580–2.235	0.707

Significant level is set at 5 % and marked with **bold font**. Regarding age, x is years exceeding 65.
[a] Regarding CCI, x is the score. As such the model assumes the daily hazard to rise exponentially with increasing age or CCI points relative to the respective baselines of 65 years and 0 points.

Table 6
Univariate and multivariate proportional hazards models for first time readmissions.

Variables	Univariate HR	95 % CI	*p* value	Multivariate HR	95 % CI	*p* value
Male sex	1.464	0.981–2.184	0.062	1.338	0.874–2.050	0.180
Age (years)[a]	0.985[x]	0.959–1.011	0.253	0.979[x]	0.953–1.006	0.128
Signs of dysphagia	1.445	0.975–2.139	0.066	1.299	0.862–1.959	0.212
Nutritional risk (NRS≥3)	1.234	0.834–1.826	0.294	1.078	0.710–1.636	0.726
Low performance status (ECOG≥3)	1.591	0.850–2.978	0.147	1.617	0.857–3.053	0.138
CCI (points)[a]	1.121[x]	1.037–1.213	**0.004**	1.100[x]	1.013–1.194	**0.024**
High CRP (>10 mg/L)	1.216	0.803–1.839	0.355	0.885	0.486–1.612	0.690
Low albumin (<34 g/L)	0.693	0.468–1.026	0.067	0.630	0.556–1.118	0.114
Low hemoglobin (Male: <8.3 mM, female: <7.3 mM)	2.094	1.384–3.169	**<0.001**	1.184	1.158–2.749	0.009

Significant level is set at 5 % and marked with **bold font**. Regarding age, x is years exceeding 65.
[a] Regarding CCI, x is the score. As such the model assumes the daily hazard to rise exponentially with increasing age or CCI points relative to the respective baselines of 65 years and 0 points.

risk of readmission and sex, age, signs of dysphagia, nutritional status, performance status or CRP levels.

In a study of 2359 patients discharged from an acute geriatric unit, Cabré et al. found no association between dysphagia and readmissions. Conversely, patients with dysphagia had increased incidence rate of readmission for pneumonia, non-aspiration pneumonia, aspiration pneumonia, and bronchoaspiration [10].

Despite utilizing a broad definition of 'dysphagia-associated diagnosis', these constituted a minority of diagnoses given to patients with signs of dysphagia on their first readmission. Likewise, Cabré et al. found that readmission for pneumonia and bronchoaspiration constituted only a small fraction of overall readmissions, also among patients with dysphagia [10]. Reviewing Table 4, the fraction of first-time readmissions among patients with signs of dysphagia attributable to signs of dysphagia can be calculated as 17.9 %, while 8.6 % of overall first-time readmissions were attributable to signs of dysphagia. Cabré et al. found that among patients with dysphagia nearly 5 % of readmissions were attributable to dysphagia [10]. Noting their statement of incidence rates of readmission, it may be calculated that 2.5 % of overall readmissions were attributable to dysphagia. Thus, it may be concluded that the link between dysphagia and increased risk of readmission is weak and statistically insignificant.

4.3. Length of hospital admissions

Patients showing signs of dysphagia had significantly longer length of stay (LOS) compared to patients with normal swallowing: median [Q1; Q3] 4 [2,8] vs. 3 [1,6] days and mean (SD) 6.6 (8.0) vs. 4.5 (4.7) days.Total hospital days (THD) during the 90-day follow-up (and 30-day follow-up) was significantly higher in terms of

median [Q1; Q3] (6 [2.25; 12] vs. 4 [2,9] days) and mean (SD) (9.2 (10.4) vs. 6.9 (9.3) days).

Atrill et al. did a meta analysis of studies including patients with stroke, brain trauma, head and neck cancer, cervical spine surgery and vagus nerve injury due to vestibular schwannoma. They found a 2.99 days (95%CI [2.72; 3.35]) increase in LOS among patients with dysphagia compared to those with normal swallowing [14]. A retrospective study by Patel et al. compared mean LOS among patients with and without a diagnosis of dysphagia: 8.8 days (95%CI = [8.66; 8.90]) vs. 5.0 days (95% CI = [4.97; 5.05]) [15].

4.4. Strengths and limitations

The concept of counting readmissions with 'dysphagia associated diagnosis' was inherently unspecific since pneumonia, COPD exacerbations, and malnutrition can appear in absence of dysphagia. On the other hand, clinicians do not routinely screen for dysphagia at the AMU, while unspecified pneumonia and unspecified COPD exacerbation are diagnoses that would likely be given to patients who had in fact contracted bacterial pneumonia because of aspiration. This is a limit of extracting data from clinical records.

The Incomplete Screening group experienced higher mortality than those who completed the screening protocol. A main reason for not completing the screening was decreased awareness and responsiveness, plausibly correlated with more severe illness. Exclusion of these patients may have resulted in Olesen et al. underestimating the prevalence of signs of dysphagia [2], while this study may have underestimated the severity of dysphagia-associated outcomes, thus a possible selection bias.

The proportional hazard models were set up with age and CCI-score as scale-variables, while other variables were dichotomized. This carried the implicit assumption that each additional year of age or CCI-point, could be correlated with a specific percentage increase in absolute risk of mortality or readmission, thus an exponential relationship between exposure and risk. The internal validity of the proportional hazard models is dependent on the accuracy of these assumptions. Likewise, the proportional hazards model assumes the quotient of hazards to be constant over time, this was not fulfilled in the analysis of readmissions, thus limiting its validity.

Uncertainty remains about the plausible effects of the COVID-19 pandemic on our study population. No patient was diagnosed with COVID-19, prior to or during their participation in this study. On the other hand, systematic screening of all patients for SARS-CoV-2 at Aalborg University Hospital was not implemented until April 21st, 2020. Denmark introduced the first lockdown restrictions on March 11th. The patient-specific study period ended between May 2nd to May 30th, when a total of 11633 COVID-19 cases and 571 COVID-19 related deaths had been identified in Denmark [24].

5. Conclusion

Signs of dysphagia were associated with greater mortality and increased length of hospital stay for the primary admission as well as more time spent in hospital during the 90-day follow up period. No increased frequency of overall readmission was observed, yet signs of dysphagia were associated with more readmissions for either pneumonia, COPD exacerbation, malnutrition, or dysphagia. These findings align with previous literature using different methodology in the study of similar patients.

Impaired swallowing is a marked problem for acute geriatric patients in general, not just those suffering from stroke, head and neck cancer or neurodegenerative diseases. Worsened outcomes and prolonged hospital stays are costly both on the human and health economic level. Further research is needed to investigate the effectiveness and feasibility of systematic dysphagia screening within this population.

Statement of authorship

SHP, PMR, RMM, and MDO: Methodology, Investigation, Formal analysis, and Writing- original draft. HHR: Writing- Reviewing & Editing. MH: Conceptualization, Methodology, Project administration, Resources, Writing- Reviewing & Editing.

Ethical approval

The study was approved by the Northern Denmark Regional Committee on Health Research Ethics and the Danish Patient Safety Authority.

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Declaration of competing interest

The authors declare that they have no conflicts of interest regarding this manuscript.

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