

Post-stroke dysphagia rehabilitation in the old and oldest old: outcome and relevance for discharge home

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We assessed the outcome of dysphagia rehabilitation in all the 139 patients with post-stroke dysphagia admitted to our Neurorehabilitation Unit during 2 years (2017 and 2018), divided into two groups: old (aged 65–84 years) and oldest-old (aged 85 or above). We studied which factors predicted dysphagia improvement in the two groups. The potential association of improvement with type of discharge was also evaluated. On admission, 'old' patients had more frequently aphasia ($P = 0.02$) and less frequently dysarthria ($P = 0.03$); 'oldest old' had more severe pressure ulcers ($P = 0.008$), higher levels of c reacting protein ($P = 0.01$) and more heart problems ($P = 0.004$). None of these factors was associated with the outcome of dysphagia. We found no difference between the two groups in the severity of dysphagia, as measured with Dysphagia Outcome and Severity Scale on admission and discharge, but due to minor differences, the degree of improvement was higher in the 'old' group ($P = 0.02$). The number of patients discharged with improved swallowing was also comparable. Cognitive impairment had a negative predicting role in the 'old' group (odds ratio 0.270, 95% confidence interval 0.101–0.725, $P = 0.007$).

Norton Scale score predicted dysphagia improvement in the 'oldest old' group (odds ratio 1.611, 95% confidence interval 1.102–2.355, $P = 0.007$). Dysphagia improvement was associated with discharge home in general ($P = 0.011$) and in the 'old' group ($P = 0.04$). Our data, though preliminary, could give a contribution to implement patient-specific rehabilitation strategies; these could increase swallowing improvement in post-stroke dysphagia. *International Journal of Rehabilitation Research* 43: 55–61 Copyright © 2019 Wolters Kluwer Health, Inc. All rights reserved.

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Introduction

Dysphagia can be considered a geriatric syndrome and is often a consequence of stroke (Baijens *et al.*, 2016). Swallowing problems are known to occur in up to two-thirds of stroke patients and can be responsible for aspiration pneumonia (Martino *et al.*, 2005), which in turn is associated with their later persistence (Ickenstein *et al.*, 2012). Dysphagia can also cause dehydration and malnutrition (Crary *et al.*, 2013) and it has a considerable impact on clinical outcome, mortality and institutionalization (Arnold *et al.*, 2016). It is also known to worsen self-esteem and quality of life (Ekberg *et al.*, 2002), to increase health care costs (Bonilha *et al.*, 2014) and to reduce the probability of being discharged home (Nguyen *et al.*, 2015).

Many factors affect the severity of post-stroke dysphagia. First, lesion localization seems to have a relevant effect on swallowing impairment occurring after an acute stroke. A worse swallowing impairment appears to be associated with lesions in the right hemisphere (Wilmskoetter *et al.*, 2019), infratentorial lesions (Daniels *et al.*, 2017), and lesions in the white matter (Moon *et al.*, 2017) and their location (Moon *et al.*, 2019).

Failing dysphagia screening appears to be a strong predictor of poor swallowing recovery in patients with post-stroke dysphagia and is also associated with a number of poor outcomes as severe disability and 1-year mortality (Joundi *et al.*, 2017).

In a logistic regression model, it has been demonstrated that aspiration, bihemispheric infarcts, dysarthria, intubation, and a low baseline National Institutes of Health Stroke Scale score, but not age and sex were significant predictors of persistent dysphagia (Kumar *et al.*, 2012).

Although age itself does not seem of great importance in predicting the outcome of dysphagia, it has recently been demonstrated that prolonged placement of nasogastric tube has a negative impact on the process of swallowing in elderly patients with post-stroke dysphagia (Wang *et al.*, 2019). This is known to be true also for elderly subjects in general (Pryor *et al.*, 2015).

However, age could play a role in the severity and outcome of post-stroke dysphagia rehabilitation, in consideration of the fact that certain conditions as cognitive impairment, which can affect the outcome of dysphagia

following a major neurologic event (Castagna *et al.*, 2019) are more frequent in elderly persons. Moreover, advancing age itself can be associated with a higher prevalence of swallowing disorders (Baijens *et al.*, 2016), in the absence of an acute aetiology, a condition often referred to as presbyphagia.

Therefore, older patients could have a baseline disadvantage when they undergo rehabilitation for post-stroke dysphagia, though this could be small, since, as compared to young healthy people, older healthy subjects have only very few specific changes in the swallowing process. These include a significantly delayed swallow response time and longer duration of upper esophageal sphincter opening, but bolus transit time does not appear to be affected by age (Namasivayam-MacDonald *et al.*, 2018).

Although many studies are available on the differences between younger and older dysphagic patients, when only older patients are taken into consideration little is known on the possibility that different age groups behave differently. This knowledge could be important both for a better prognostic definition and for designing tailored interventions in different age groups.

We have carried out this study to begin to address the issue of possible differences in the rehabilitative outcome of post-stroke dysphagia between old and oldest-old patients. We also evaluated if a better dysphagia rehabilitation outcome could be associated with a greater probability of being discharged home.

Methods

Patients

We enrolled all the 207 dysphagic patients admitted to our Neurorehabilitation Unit from 1 January 2017 to 31 December 2018. Of these, 19 died shortly after admission. Of the remaining 188 subjects, 14 were discarded because they were not elderly persons (age < 65 years); five more patients were not considered because they stayed less than 15 days. This left 169 patients, among whom 30 had dysphagia as a consequence of causes other than stroke. The remaining 139 subjects were older patients with post-stroke dysphagia and entered the study. The flowchart in Fig. 1 summarizes the selection procedure. Patients were divided into two groups on the basis of their age: old (<85 years, N = 82) and oldest-old (≥85 years, N = 57).

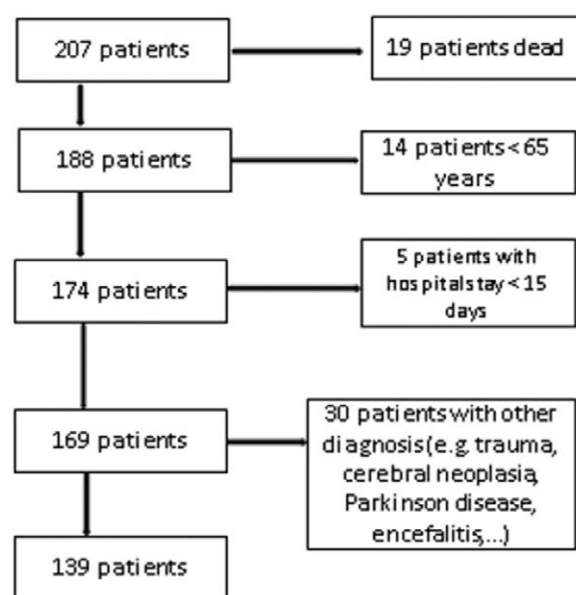
Methods

For each patient, we collected the following data.

- (1) Age and sex.
- (2) Severity of dysphagia.

On admission, all patients were evaluated by a speech therapist who evaluated facio-oral sensory and motor functions, oral cavity conditions, and faryngeo-laryngeal somatomotor function. In addition, each patient

Fig. 1



Flowchart illustrating the selection steps for the patients entering the study.

underwent the water swallowing test with increasing swallowing volumes (Daniels *et al.*, 1997). An Ear, Nose, and Throat (ENT) specialist also evaluated the patients and performed flexible endoscopic examination of swallowing. Dysphagia Outcome and Severity Score (DOSS) (O'Neil *et al.*, 1999) was used to quantify the severity of dysphagia. This scale ranges from one (severe dysphagia) to seven (no dysphagia at all); patients are considered dysphagic with a score ≤5.

- (3) Characteristics of the lesion: type, localization, days from onset.
- (4) Functional conditions.

We used the Modified Barthel Index (Shah *et al.*, 1989) because it is more specific than the original version when measuring functional ability after a stroke; the score is based on the sum of the scores of 10 items; it ranges from 0 to 100 (complete independence). Functional independence measure (FIM) (Granger *et al.*, 1989) was also used. It is an 18-item of physical, psychological, and social function scale, and it is widely accepted to assess a patient's level of disability and the changes occurring during rehabilitation; its score ranges from 18 (complete dependence) to 126 (complete independence).

To evaluate the health status of our patients we used the Cumulative Illness Rating Scale (CIRS) scores-Comorbidity Index (CI) and Severity Index (SI) (Linn *et al.*, 1968); CIRS is a scale comprising 14 items, each with a score from 0 to 4, exploring the pathology of the different organs and systems and is especially used in geriatric settings. Higher scores are associated with

poorer health conditions (SI) and a higher number of comorbidities (CI).

Norton Scale score (Norton *et al.*, 1965) is made of five items (five risk factors). It was designed to evaluate the risk of developing pressure ulcers by inpatients (a score of 10 or less indicates a very high risk), but it is now used to predict more in general the outcome of inpatients, and we used it for this purpose.

We also evaluated the presence and severity of pressure ulcers, presence of aphasia, dysarthria and cognitive impairment, presence of nasogastric feeding tube, or percutaneous endoscopic gastrostomy.

- (5) Laboratory tests suggesting conditions with a potential negative impact on rehabilitation outcome (anemia, inflammation, malnutrition, renal failure).
- (6) Pre-existing diseases (hypertension, diabetes, cardiac disease, stroke in the past).

All the patients underwent rehabilitation with two different therapists, one for motor rehabilitation and a speech therapist for dysphagia. The latter was carried out in accordance with the findings of the speech therapist and ENT specialist's examinations, using validated rehabilitation techniques (Shaker *et al.*, 2013).

Post-treatment evaluation was carried out in all the patients, also in those who were discharged after 31 December 2018 and included the following:

- (1) Duration of hospital stay;
- (2) Presence of a care-giver at discharge;
- (3) DOSS score, DOSS improvement, Modified Barthel Index and FIM score at discharge;
- (4) Presence and type of enteral nutrition at discharge;
- (5) Type of discharge.

Statistical analysis

Data are expressed as mean $\pm$ SD. Chi-square test, *t*-test, and Wilcoxon-Mann-Whitney *U*-test were used when appropriate to compare the two groups of patients.

To evaluate if factors present on admission could be related to the outcome of dysphagia rehabilitation, a logistic regression model was fitted for each group of variables (i.e. features of the lesion, functional status of the patient, laboratory tests, pre-existing medical conditions). In this model, an improvement in DOSS score at discharge was the dichotomous response (1: better; 0: worse or unchanged).

The predictive value of DOSS score on admission on DOSS score at discharge was also tested in association with the other functional measurements (Modified Barthel Index, FIM score, and Norton scale score) in a multiple regression model.

Association of DOSS score improvement with need for enteral nutrition and possibility to be discharged home was evaluated with Chi-square test.

All calculations were performed with Analyse-it version 5.30.4 (Leeds, UK).

Ethics

The design of the study was submitted to our local ethics committee at San Gerardo University Hospital in Monza; being only observational, it was not given a reference number.

At admission, every patient or his/her next of kin signed an informed consent form allowing the use of their data for research purposes. Data were completely and permanently anonymized.

The study was conducted in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Results

Table 1 shows the clinical features of our patients. Apart from age, differences between the two groups were seen

Table 1 Baseline characteristics of patients at admission (N = 139)

	<85 years (N = 82)	≥85 years (N = 57)	P value
Age (years $\pm$ SD)	78.5 $\pm$ 4.6	89.1 $\pm$ 3.1	<0.0001
Female, n (%)	41 (50.0)	36 (63.2)	0.1
Diagnosis, n (%)			0.2
Ischaemic stroke	48 (58.5)	40 (70.2)	
Ischaemic with secondary bleeding	11 (13.4)	9 (15.8)	
Haemorrhagic stroke	23 (28.1)	8 (14.0)	
Localization, n (%)			.3
Right	31 (37.8)	28 (49.1)	
Left	46 (56.1)	24 (42.1)	
Bilateral	5 (6.1)	5 (8.8)	
Days from event, $\pm$ SD	23.9 $\pm$ 25.4	17.8 $\pm$ 7.6	0.08
Modified Barthel Index at admission, $\pm$ SD	10.9 $\pm$ 8.2	10.0 $\pm$ 6.4	0.5
Modified Barthel Index at discharge, $\pm$ SD	30.3 $\pm$ 18.5	25.8 $\pm$ 12.2	0.1
FIM at admission, $\pm$ SD	28.8 $\pm$ 9.2	27.6 $\pm$ 8.0	0.4
FIM at discharge, $\pm$ SD	40.1 $\pm$ 17.8	36.2 $\pm$ 13.4	0.2
CIRS-SI, $\pm$ SD	1.2 $\pm$ 0.3	1.2 $\pm$ 0.4	0.08
CIRS-CI, $\pm$ SD	4.9 $\pm$ 1.6	5.1 $\pm$ 1.9	0.5
Norton Score, $\pm$ SD	8.9 $\pm$ 2.1	8.3 $\pm$ 1.9	0.1
Pressure ulcers, n (%)			0.008
None	45 (54.9)	17 (29.8)	
I-II degree	35 (42.7)	35 (61.4)	
III-IV degree	2 (2.4)	5 (8.8)	
Aphasia, n (%)	38 (46.3)	21 (36.8)	0.02
Dysarthria, n (%)	28 (34.1)	30 (52.6)	0.03
Cognitive impairment, n (%)	21 (25.6)	16 (28.1)	0.8
Tube enteral feeding at admission, n (%)	41 (50.0)	19 (33.3)	0.1
Tube enteral feeding at discharge, n (%)	19 (23.2)	14 (24.6)	0.2
Haemoglobin, g/dl $\pm$ SD	12.7 $\pm$ 1.9	12.3 $\pm$ 1.8	0.2
Serum creatinine, mg/dl $\pm$ SD	1.0 $\pm$ 0.5	1.1 $\pm$ 0.6	0.2
C reacting protein, mg/dl $\pm$ SD	25.5 $\pm$ 22.7	39.7 $\pm$ 44.3	0.01
Total proteins, g/dl $\pm$ SD	6.5 $\pm$ 0.8	6.4 $\pm$ 0.7	0.3
Diabetes, n (%)	16 (19.2)	11 (19.3)	1.0
Hypertension, n (%)	67 (81.8)	55 (91.2)	0.1
Previous stroke, n (%)	22 (26.8)	20 (35.1)	0.3
Cardiac disease, n (%)	42 (51.2)	46 (80.7)	0.004
Hospital stay, days $\pm$ SD	57.8 $\pm$ 17.6	57.1 $\pm$ 14.9	0.8
Caregiver at discharge, n (%)	63 (76.8)	43 (75.4)	0.9

CIRS-CI, Cumulative Illness Rating Scale-Comorbidity Index; CIRS-SI, Cumulative Illness Rating Scale-Severity Index; FIM, functional independence measure.

for the following: pressure ulcers, aphasia, dysarthria, history of heart disease, and c reacting protein (CRP). None of them had a significant weight in the fitted models; we also evaluated them separately for a possible association with DOSS improvement and found none (*P*-value always >0.1 in both groups). No significant difference was found between the two groups for the findings of the speech therapist and the ENT specialist at admission. These included, in order of frequency: reduced tongue base retraction, reduced pharyngeal shortening, reduced vertical and lateral hyoid movement, and reduced laryngeal elevation.

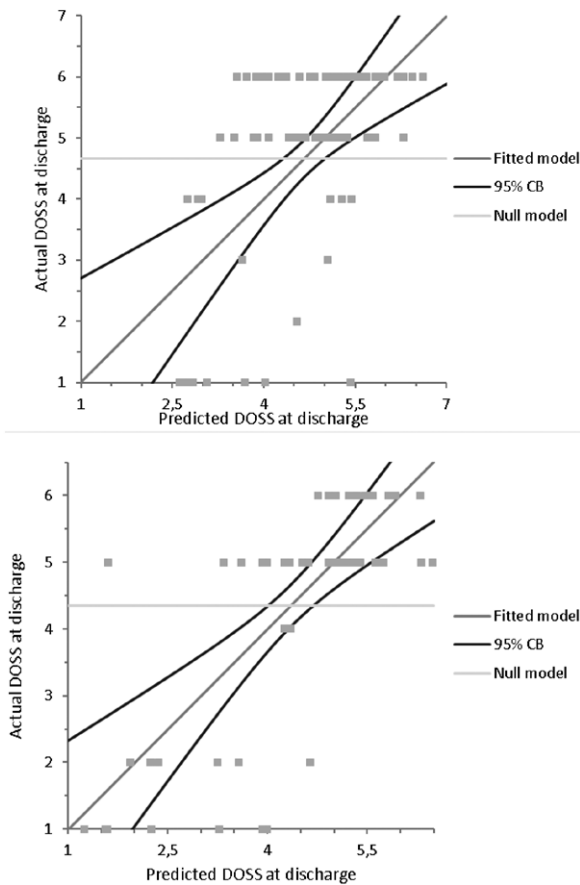
Table 2 shows the results of the evaluation of dysphagia on admission and after rehabilitation. As can be seen, DOSS scores were comparable in the two groups, but, due to minor differences, the gap between discharge score and admission score was significantly higher in the ‘old’ group. Also, more patients improved their DOSS score in the ‘old’ group than in the ‘oldest old’ group, though this difference was not statistically significant.

To detect factors potentially able to predict the outcome of rehabilitation, we used both a binary logistic model and a multiple regression model, as explained above. The first could identify two different factors in the two groups with a good predictive value for DOSS improvement (Table 3). Analyzing these two factors separately confirmed their different relevance in the two groups. Among ‘oldest old’, patients discharged with an improved DOSS had an admission Norton score of 9.1 ± 1.6 , compared to the remaining patients scoring 7.6 ± 1.8 (*P* = 0.001). In the ‘old’ group, 30 out of 39 subjects without cognitive impairment were discharged with an improved DOSS score, whereas among the 43 patients with cognitive impairment only 21 had an improvement (*P* = 0.009).

The multiple regression model fitting DOSS, Norton and FIM scores, and Modified Barthel Index at admission on DOSS score at discharge was significant for both groups

(Fig. 2); however the amount of variation detected by the model was small in the ‘old’ group (adjusted r^2 = 34.8%) and higher in the ‘oldest old’ group (adjusted r^2 = 53.7%). DOSS score gave a high contribution in both groups (‘old’: estimate = 0.539, *P* < 0.0001; ‘oldest old’: estimate = 0.645, *P* = 0.0002), but in the latter a significant contribution was also given by the Norton Scale score (estimate = 0.331, *P* < 0.0008); this did not happen in the ‘old’ group (estimate = 0.107, *P* = 0.299). It is interesting to note that, though in both groups the r^2 was not very high, it was

Fig. 2



Multiple regression model of functional data at admission (DOSS, FIM and Norton scores, and Modified Barthel Index) on DOSS score at discharge. Top: ‘old’ group: difference between fitted model and null model: *F* 11.81, *P* < 0.0001. Bottom: ‘oldest old’ group: difference between fitted model and null model: *F* 17.24, *P* < 0.0001. DOSS, Dysphagia Outcome Severity Score; FIM, functional independence measure.

Table 2 Dysphagia Outcome Severity Score changes between admission and discharge, by age

	<85 years	≥85 years	<i>P</i> value
DOSS score at admission, mean ± SD	3.6 ± 1.5	3.9 ± 1.3	0.2
DOSS score at discharge, mean ± SD	4.7 ± 1.7	4.4 ± 1.7	0.3
Δ DOSS, mean ± SD	1.0 ± 1.5	.4 ± 1.3	0.02
DOSS improved, n of patients (%)	51 (62.2)	27 (47.4)	0.08

Δ DOSS, DOSS score at discharge–DOSS score at admission; DOSS, Dysphagia Outcome Severity Score.

Table 3 Factors with predictive positive value on Dysphagia Outcome Severity Score improvement, binary logistic model

	<85 years			≥85 years		
	Odds ratio	95% CI	<i>P</i> value	Odds ratio	95% CI	<i>P</i> value
Cognitive impairment	0.270	0.101–0.725	0.007	0.303	0.086–1.071	0.057
Norton Score	1.146	0.837–1.576	0.397	1.611	1.102–2.235	0.007

CI, confidence interval.

Table 4 Type of discharge at the end of rehabilitation by Dysphagia Outcome Severity Score improvement

	<85 years		≥85 years		All patients	
	Home	Other	Home	Other	Home	Other
DOSS not improved	7	24	9	21	16	45
DOSS improved	23	28	14	13	37	41
<i>P</i>	0.040		0.093		0.011	

DOSS, Dysphagia Outcome and Severity Score.

higher than that obtained in a simple regression model of DOSS score alone at admission on DOSS score at discharge ('old': adjusted $r^2 = 0.337$ vs. 0.348 ; 'oldest old': $r^2 = 0.443$ vs. 0.537).

DOSS score improvement was significantly associated with discharge home both in the general population of the study and in the 'old' group; we noted the same trend also in the 'oldest old' group, but without reaching significance, perhaps due to the lower number of patients (Table 4).

Discussion

In this study, we evaluated the outcome of post-stroke dysphagia rehabilitation and its impact on the type of discharge in two groups of elderly patients: one aged 65–84 years, the other 85 or above.

We are aware that the study has some limitations. For example, we focused our attention only on the period in which the patients stayed in our ward for rehabilitation (approximately 8–9 weeks), so we can say nothing of potential changes occurring after discharge. However, no major improvements can be expected later, since it is known that recovery after stroke occurs mainly within 3 months and it is more rapid during the first four weeks of rehabilitation (Lee *et al.*, 2015). Another limitation is the smaller number of oldest old. This could be a consequence of the fact that very old stroke patients are discharged from acute hospitals to other facilities than rehabilitation wards, though it cannot be affirmed for sure since many factors have a role in this process (Mees *et al.*, 2016).

Even with these limitations, some conclusions can be drawn.

First, both groups of patients seemed to benefit from rehabilitation, though oldest patients had a slightly smaller degree of recovery. The latter appears to depend in both groups on the severity of dysphagia at admission as measured by DOSS score, whereas it is not affected by some different features observed at baseline in the two groups. These differences were seen for pressure ulcers, aphasia, dysarthria, history of heart disease, and levels of CRP. On the contrary, additional factors on admission seemed to also have a role in predicting improvement of dysphagia at discharge: cognitive impairment in the 'old' group and Norton Scale score in the 'oldest old' group.

An explanation of the role of these two factors in the two groups is not simple. Cognitive impairment could be responsible for an earlier plateau phase. This phase of rehabilitation occurs a few weeks after a stroke and entails a dramatic slowing down of the motor recovery process (Lee *et al.*, 2015). Dysphagia recovery could follow a comparable pattern. A decreased self-consciousness and a reduced chewing attention, which is known to affect swallowing (Ashiga *et al.*, 2019) could both be responsible.

For Norton Scale score, its importance could be explained considering that post-stroke recovery can be split into neurologic recovery and functional recovery, and the latter has long been known to be influenced by many factors (Anderson *et al.*, 1974). It is also known that younger patients are more likely to be discharged home, whereas older ones frequently need to be discharged to rehabilitation facilities (Hakkennes *et al.*, 2011). Therefore, it is possible that in the oldest Norton Scale score detects better than other scores highly compromised subjects with limited collaborating capacities.

Finally, we observed that improvement of dysphagia was associated with a higher frequency of discharge home, especially in the 'old' group.

Early and intensive rehabilitation targeting motor and sensory functions is important to reduce neurologic impairments and to maximize functional recovery in stroke survivors (Lee *et al.*, 2015).

Things appear to be less clear for the specific problem of dysphagia. Though many treatments are available for post-stroke dysphagia, their beneficial effects are sometimes unclear (Cohen *et al.*, 2016). Recently, the Cochrane Library has suggested that further trials are needed to assess which treatments are really effective (Bath *et al.*, 2019). Our study was not aimed at evaluating the effectiveness of rehabilitation, but only possible factors affecting it. Thus it can give useful information when planning efficacy studies, since these factors can contribute to the final outcome of treatments.

The first factor to be considered is the severity of dysphagia, and this was true in both groups of patients. Other factors are cognitive impairment and Norton Scale score.

The first appears to be important for all patients, possibly with a greater contribution in younger adults. This is in keeping with our previous observation in an unselected population of dysphagic patients (Castagna *et al.*, 2019). Norton Scale score seems to be a significant predictor of dysphagia improvement in the very old. This scale was designed to detect patients at risk of developing pressure ulcers, but it has been demonstrated to be sensitive in predicting the outcome of hospitalized patients in a variety of clinical situations (Leshem-Rubinow *et al.*, 2013; Segal *et al.*, 2015; Díez-Mangano

et al., 2018). On the basis of our observations, it seems possible that Norton Scale score is also suitable for predicting the outcome of post-stroke dysphagia, especially in very old patients.

It is known that in stroke survivors, the possibility to be discharged home is associated with many factors (Mees *et al.*, 2016; Everink *et al.*, 2016). These are related both to the patient and to the environment and can be different between younger and older patients; for example, the presence of a spouse is associated with discharge home in older patients after a stroke (Dutrieux *et al.*, 2016). Dysphagia has been demonstrated to reduce the rate of discharge home after a stroke (Nguyen *et al.*, 2015). Our observation that an improvement of dysphagia determines a higher percentage of discharge home points in the same direction. This underlines the importance of screening for dysphagia all the patients undergoing post-stroke rehabilitation. The screening should comprise both speech therapist's assessment and flexible endoscopic evaluation of swallowing, as we did in the present study. This rapid evaluation can allow to recognize and treat dysphagia, thus avoiding many negative consequences (Joundi *et al.*, 2017).

In conclusion, dysphagia screening and rehabilitation seems worth to be implemented both in old and very old patients. In fact, also the latter can benefit from this treatment, though to a lesser extent. Moreover, it seems likely that treating dysphagia gives post-stroke patients more chances to be discharged home.

Finally, it should be considered that different factors might have an impact on the outcome of dysphagia rehabilitation in old and very old patients, as demonstrated by our data on cognitive impairment and Norton Scale score. If the importance of different factors in different groups of patients is confirmed, more tailored rehabilitation strategies could be implemented.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

References

- Anderson TP, Bourestom N, Greenberg FR, Hildyard V G (1974). Predictive factors in stroke rehabilitation. *Arch Phys Med Rehabil* **55**:545–553.
- Arnold M, Liesirova K, Broeg-Morvay A, Meisterernst J, Schlager M, Mono ML, *et al.* (2016). Dysphagia in acute stroke: incidence, burden and impact on clinical outcome. *Plos One* **11**:e0148424.
- Ashiga H, Takei E, Magara J, Takeishi R, Tsujimura T, Nagoya K, Inoue M (2019). Effect of attention on chewing and swallowing behaviors in healthy humans. *Sci Rep* **9**:6013.
- Baijens LW, Clavé P, Cras P, Ekberg O, Forster A, Kolb GF, *et al.* (2016). European Society for Swallowing Disorders-European Union Geriatric Medicine Society white paper: oropharyngeal dysphagia as a geriatric syndrome. *Clin Interv Aging* **11**:1403–1428.
- Bath PM, Lee HS, Everton LF (2019). Swallowing therapy for dysphagia in acute and subacute stroke. *Stroke* **50**:e46–e47.
- Bonilha HS, Simpson AN, Ellis C, Mauldin P, Martin-Harris B, Simpson K (2014). The one-year attributable cost of post-stroke dysphagia. *Dysphagia* **29**:545–552.
- Castagna A, Ferrara L, Asnaghi E, Rega V, Fiorini G (2019). Functional limitations and cognitive impairment predict the outcome of dysphagia in older patients after an acute neurologic event. *NeuroRehabilitation* **44**:413–418.
- Cohen DL, Roffe C, Beavan J, Blackett B, Fairfield CA, Hamdy S, *et al.* (2016). Post-stroke dysphagia: a review and design considerations for future trials. *Int J Stroke* **11**:399–411.
- Crary MA, Humphrey JL, Carnaby-Mann G, Sambandam R, Miller L, Silliman S (2013). Dysphagia, nutrition, and hydration in ischemic stroke patients at admission and discharge from acute care. *Dysphagia* **28**:69–76.
- Daniels SK, McAdam CP, Brailey K, Foundas AL (1997). Clinical assessment of swallowing and prediction of dysphagia severity. *Am J Speech Lang Pathol* **6**:17–23.
- Daniels SK, Pathak S, Mukhi SV, Stach CB, Morgan RO, Anderson JA (2017). The relationship between lesion localization and dysphagia in acute stroke. *Dysphagia* **32**:777–784.
- Diez-Manglano J, Arnal-Longares MJ, Al-Cheikh-Felices P, Garcés-Horna V, Pueyo-Tejedor P, Martínez-Rodés P, *et al.*; en representación de los investigadores del estudio IMPIMI (2018). Norton scale score on admission and mortality of patients hospitalised in internal medicine departments. *Rev Clin Esp* **218**:177–184.
- Dutrieux RD, van Eijk M, van Mierlo ML, van Heugten CM, Visser-Meily JM, Achterberg WP (2016). Discharge home after acute stroke: differences between older and younger patients. *J Rehabil Med* **48**:14–18.
- Ekberg O, Hamdy S, Woisard V, Wuttge-Hannig A, Ortega P (2002). Social and psychological burden of dysphagia: its impact on diagnosis and treatment. *Dysphagia* **17**:139–146.
- Everink IHJ, van Haastregt JCM, van Hoof SJM, Schols JMGA, Kempen GJM (2016). Factors influencing home discharge after inpatient rehabilitation. of older patients: a systematic review. *BMC Geriatrics* **16**:5.
- Granger C, Hamilton BB, Kayton R (1989). *Guide for the use of the Functional Independence Measure (WeeFIM) of the Uniform Data Set for Medical Rehabilitation*. Buffalo: Research Foundation of the State University of New York.
- Hakkennes SJ, Brock K, Hill KD (2011). Selection for inpatient rehabilitation after acute stroke: a systematic review of the literature. *Arch Phys Med Rehabil* **92**:2057–2070.
- Ickenstein GW, Höhlig C, Prosiegel M, Koch H, Dziawas R, Bodechtel U, *et al.* (2012). Prediction of outcome in neurogenic oropharyngeal dysphagia within 72 hours of acute stroke. *J Stroke Cerebrovasc Dis* **21**:569–576.
- Joundi RA, Martino R, Saposnik G, Giannakeas V, Fang J, Kapral MK (2017). Predictors and outcomes of dysphagia screening after acute ischemic stroke. *Stroke* **48**:900–906.
- Kumar S, Doughty C, Doros G, Selim M, Lahoti S, Gokhale S, Schlaug G (2014). Recovery of swallowing after dysphagic stroke: an analysis of prognostic factors. *J Stroke Cerebrovasc Dis* **23**:56–62.
- Lee KB, Lim SH, Kim KH, Kim KJ, Kim YR, Chang WN, *et al.* (2015). Six-month functional recovery of stroke patients: a multi-time-point study. *Int J Rehabil Res* **38**:173–180.
- Leshem-Rubinow E, Vaknin A, Sherman S, Justo D (2013). Norton scale, hospitalization length, complications, and mortality in elderly patients admitted to internal medicine departments. *Gerontology* **59**:507–513.
- Linn BS, Linn MW, Gurel L (1968). Cumulative illness rating scale. *J Am Geriatr Soc* **16**:622–626.
- Martino R, Foley N, Bhogal S, Diamant N, Speechley M, Teasell R (2005). Dysphagia after stroke: incidence, diagnosis, and pulmonary complications. *Stroke* **36**:2756–2763.
- Mees M, Klein J, Yperzele L, Vanacker P, Cras P (2016). Predicting discharge destination after stroke: asystematic review. *Clin Neurol Neurosurg* **142**:15–21.
- Moon HI, Nam JS, Leem MJ, Kim KH (2017). Periventricular white matter lesions as a prognostic factor of swallowing function in older patients with mild stroke. *Dysphagia* **32**:480–486.
- Moon HI, Kim GS, Lee E (2019). Is the location of white matter lesions important in the swallowing function of older patients with mild stroke? *Dysphagia* **34**:407–414.
- Namasivayam-MacDonalda AM, Barbona CEA, Steele CM (2018). A review of swallow timing in the elderly. *Physiology and Behavior* **184**:12–26.
- Nguyen VQ, PrvuBettger J, Guerrier T, Hirsch MA, Thomas JG, Pugh TM, Rhoads CF 3rd (2015). Factors associated with discharge to home versus discharge to institutional care after inpatient stroke rehabilitation. *Arch Phys Med Rehabil* **96**:1297–1303.
- Norton D, McLaren R, Exton-Smith AN (1962). *An Investigation of Geriatric Nursing Problems in Hospital*. London, UK: National Corporation for the Care of Old People (now Centre for Policy on Ageing).
- O'Neil KH, Purdy M, Falk J, Gallo L (1999). The dysphagia outcome and severity scale. *Dysphagia* **14**:139–145.

- Pryor LN, Ward EC, Cornwell PL, O'Connor SN, Finnis ME, Chapman MJ (2015). Impact of nasogastric tubes on swallowing physiology in older, healthy subjects: a randomized controlled crossover trial. *Clin Nutr* **34**: 572–578.
- Segal O, Hassin-Baer S, Kliars I, Cale' KS, Segal G (2015). Low Norton scale score predicts worse outcomes for Parkinson's disease patients hospitalized due to infection. *Gerontol Geriatr Med* **1**:2333721415608139.
- Shah S, Vancley F, Cooper B (1989). Improving the sensitivity of the Barthel index for stroke rehabilitation. *J Clin Epidemiol* **42**:703–709.
- Shaker R, Belafsky PC, Postma GN, Easterling C (2013). *Principles of Deglutition: A Multidisciplinary Text for Swallowing and its Disorders*. New York: Springer.
- Wang ZY, Chen JM, Ni GX (2019). Effect of an indwelling nasogastric tube on swallowing function in elderly post-stroke dysphagia patients with long-term nasal feeding. *BMC Neurol* **19**:83.
- Wilmskoetter J, Bonilha L, Martin-Harris B, Elm JJ, Horn J, Bonilha HS (2019). Mapping acute lesion locations to physiological swallow impairments after stroke. *Neuroimage Clin* **22**:101685.