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Early complications related to swallowing disorders after ischemic stroke: predictive factors?

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Abstract

Background

In stroke patients, early complications such as swallowing disorders (SD) and bronchopneumonia (BP) are reported to be frequent and may worsen outcome. The aim of this study was to evaluate the prevalence of SD in patients with acute ischemic stroke during the 7 first days of their hospitalisation and their risk of BP, and to try to identify early predictors for these conditions.

Methodology

A retrospective study evaluating patients suffering from acute ischemic stroke, admitted to the Stroke Unit of Lausanne (Switzerland) during one year or the year 2015. In this unit, each patient undergoes a standardised protocol for early detection of SD. The following factors have been analysed: demographic characteristics, stroke features, dental status, presence of a feeding tube, SD and BP, and mortality rate.

Results

Out of 343 patients (157 women, mean age 72±14), SD were identified early in 81 patients (23.6%); 24 (29.6%) patients with SD and 15 (5.7%) without SD developed BP. SD were more frequently seen in patients suffering from an anterior stroke, or a more severe stroke, or with cardio-embolic stroke. When we compared patients with and without SD, the SD group more frequently had a dental prosthesis (16.1% vs 3.8%) or a feeding tube (55.6% vs 4.2%).
SD associated with BP were more frequently seen in patients with a posterior stroke or with simultaneous anterior and posterior strokes. They had a higher NIHSS score (14.6±8.5 SD), more dental prostheses (4, 16.7%) and more feeding tubes (18, 75.0%).
The multivariate analysis demonstrates that the association of a NIHSS score above 4, bulbar stroke and wearing a dental prosthesis can predict 76% of patients with SD. The association of a NIHSS score greater than 4, male sex, bilateral hemispheric lesions, an enteral feeding tube and SD can predict 84% of the risk of BP.

Conclusion

We have identified some independent predictive factors that can significantly increase the risk of SD and of BP after an ischemic stroke. Their early identification could predict these complications, and lead to prevent them by earlier management by a speech therapist and monitoring of respiratory function.

Key words: swallowing disorders, acute ischemic stroke, bronchopneumonia, speech therapy

Introduction

Despite an improving outcome in stroke patients treated in stroke units, early complications such as swallowing disorders (SD) and bronchopneumonia (BP) remain frequent. They play an important role as morbidity factors, prolonging the hospital stay, are life-threatening and may alter patients' autonomy [1,2]. The severity of theses complications is reported to be linked to several factors such as the type of stroke, the location of the cerebral lesion, the age or the associated comorbidities [1-4].

Although there is no international consensus about the choice of SD screening [2,5], it is recognised that early identification and multidisciplinary management of SD during the first two weeks after stroke enable a reduction in their complications, an improvement in medium and long-term prognosis, reduced hospitalisation and healthcare costs [5-7]. SD increase the risk of BP related to broncho-aspiration, but they are not responsible for these secondary infections alone [1,2]. The patient's own chronic illnesses, altered oral status and his functional autonomy also play a role [8]. In order to reduce the risk of respiratory infections, the management of SD includes rehabilitation with a speech therapist.

Several studies sought to identify independent predictive factors for the risk of developing SD or BP after stroke in order to decrease their occurrence rate, without finding the same statistic associations. Theses variable results could be attributed to differences in selected factors, definitions and the sample size of patients studied. Up to now, the factors associated are age, sex, stroke severity, bilateral lesions or of the brainstem [1], delays in the identification and clinical signs of dysphagia (wet voice, cough after swallowing) [9], tube feeding [10], alteration in autonomy and of the immune status of the patient [11,12].

In this study, we aim to assess the prevalence of SD in consecutive acute ischemic stroke patients during the 7 first days of their hospitalisation, as well as their risk of developing BP during the entire hospital stay; we also evaluated the mortality rate in case of SD or of BP, and sought to identify predictors for SD and BP.

Methods

This is a retrospective study based on medical records and data from the ASTRAL registry (Acute STroke Registry and Analysis of Lausanne [13]) of acute ischemic stroke patients admitted consecutively to the Stroke Unit of the Neurology Department at the Lausanne University Hospital, between 1 January and 31 December 2015. Of the 346 patients initially recorded, 3 patients were excluded: one suffered from ischemic stroke after a traumatic brain injury and 2 suffered from bronchopneumonia before admission. A total of 343 patients were included, 157 women (45.8%) and 186 men (54.2%) aged between 21 and 96 years old (mean 72±14 SD), and the length of stay ranged from 0 to 50 days (mean 10.8±8.7 SD).

The patients were identified as suffering from SD if a positive screening test was found in their medical records (N.B. only 43.2% of patients benefited from this test), when their food texture had to be adapted or when speech therapy had to be involved during their first 7 days of hospitalisation. Patients suffering from SD before hospitalisation were excluded. In the Stroke unit at the CHUV, the care of swallowing disorders of stroke patients is standardised : during the first 72 hours of hospitalisation the SD screening test is performed daily ; it is performed by a nurse, at the bedside, and consists of a water swallowing test modified from the Burke dysphagia screening test by DePippo [14]. The patient must be alert, sit upright or lie on his unaffected side. In short, the test consists of giving 3 times 1 mL of water with a teaspoon; the result is pathological if there is a cough or voice change after swallowing. If successful, the patient should drink alone 90mL of water in a cup, at his own rhythm; if he manages without coughing, the test is negative, and the patient can receive a normal diet. If he fails, the patient then has to swallow 3 times 3mL of jellified water; if he fails (cough or voice change after swallowing), he remains fasting; if successful, he can receive mixed foods and thickened liquids; if he fails this test, he remains fasting (hydration by perfusion). The complete test is repeated on three consecutive days and the oral diet is readjusted depending on its results. Speech therapy rehabilitation begins after three days if the screening tests remain pathological. A nasogastric tube (NGT) is inserted on admission if medication needs to be enterally administered; otherwise its insertion is delayed and avoided if possible.

The second variable studied was bronchopneumonia. Its identification in the medical records is only based on medical clinical notes during the entire hospitalisation. Cases of BP present before admission were not included.

The remaining variables collected are: age, sex, body mass index (BMI), NIHSS score on admission, stroke mechanism (according to TOAST classification [15]), the side affected, vascular territories incriminated, cerebral structures affected, previous clinical stroke or transient ischemic attack (TIA), dental prosthesis, presence of a NGT or PEG (percutaneous gastrostomy), mortality [table 1].

Statistical analyses

The statistical analyses were performed using STATA 14.1 (StataCorp. 2017. Stata Statistical Software: Release 15. College Station, TX: StataCorp LLC). The SD and BP were analysed by logistic regression models. Their correlation with selected variables were estimated by the *Odds-Ratio* (OR), the *p*-value and the confidence intervals at 95% (CI 95%). After adjustment of the variables, the multivariable models retained were tested by the « *Pearson or Hosmer-Lemeshow goodness-of-fit test* ». Finally, the power of prediction for the complications of each model was evaluated by the area under the roc curve (AUC) [figures 1 and 2]. A p-value <0.05 was considered as significant.

Ethics approval

The local ethics committee (Canton Vaud, Switzerland) approved the protocol of this study on 30.05.16 (project ID: 2016-00523).

Results

Swallowing disorders

Out of 343 patients included in our study, 81 (23.6%) suffered from early identified SD by a bedside swallowing test. Seventy-four SD patients (91.4%) benefited from a speech therapy during their hospitalisation. The 7 remaining patients could not receive speech therapy because of a transfer back to the hospital they came from, or they were receiving only palliative care, or they died before to begin a speech therapy. The SD patients displayed significantly higher neurologic deficits on admission than patients without SD (NIHSS score between 5 and 15: 50.0% vs 37.9%, $p<0.001$; and NIHSS score above 16: 37.2% vs 17.1%, $p<0.001$). There were no significant differences among the vascular territories involved, but the anterior circulation was more frequently affected in the SD group (80.8% vs 71.4% without SD; $p=0.106$). Of the 107 patients whose stroke had a cardioembolic origin, 32 (42.7%) suffered from SD. The lesions localised in the temporal and bulbar regions were significantly more frequent in SD patients (respectively 56.9% patients with SD vs 38.1% without SD, $p=0.008$ and 6.3% vs 1%, $p=0.031$). Fourteen (16.1%) patients with SD wore dental prostheses against 10 (3.8%) patients without SD ($p<0.001$). The presence of SD lead to insert an enteral feeding tube (SNG or PEG) for 45 (55.6%) patients.

Bronchopneumonia

In total, 39 patients (11.4%) developed BP during their hospitalisation. Among them, 24 (29.6%) had identified SD (vs 15, 5.7% without SD): 3 had speech therapy or a modified diet and 21 had a recorded water swallowing test. Of 24 patients with BP and SD, 22 benefited from treatment with a speech therapist; the two patients without treatment were part of patients who did not have speech therapy for the reasons previously mentioned. Patients with BP and SD (24 out of 343) was predominantly composed of men in comparison with the group of BP patients without SD (15 of 343) (70.8% vs 66.6%). The BP patients with SD compared with those without SD displayed a higher mean NIHSS score (14.6±8.5 vs 13.2±6.2). The stroke cause mainly identified was an embolus of cardiac origin (45.7% for the patients with BP alone and 50% for the patients with BP and SD). Of 5 patients wearing dental prostheses in the BP

group, 4 were dysphagic (16.7%). The presence of an enteral feeding tube was significantly more frequent in patients of the BP group suffering from SD (p<0.001).

Deaths

In total, 29 patients died in the entire cohort, which represents 8.5%. Of 7 patients (8.8%) deceased in the group suffering from SD alone, 6 had an enteral feeding tube. Among the 39 patients suffering from BP, 6 (15.8%) died, 4 had BP associated with SD; 5 had an enteral feeding tube.

Multivariable analyses

According to our multivariable analyses, the predictive factors which significantly increase the risk of SD that we have been able to identify are the following [table 2]: a moderate to severe neurological deficit on admission (NIHSS score between 5 and 15 (OR 6.17, p<0.001) and above 16 (OR 9.35; p<0.001), wearing a dental prosthesis (OR 3.04; p<0.038), bulbar lesions (OR 20.11; p=0.003). After variable adjustments with the statistical test, the temporal lesions have been removed from this model. In this model, the association of these variables has a predictive value for SD as shown by an AUC of 75.8%.

We also identified the following factors as being significantly associated with the risk of BP [table 3]: the male sex (women: OR 0.43, p=0.043), a NIHSS score corresponding to a moderate to severe neurological deficit on admission (NIHSS score between 5 and 15, OR 21.16 and p=0.004, and above 16, OR 23.14 and p=0.004), bilateral hemispheric lesions (OR 4.13; p=0.013), SD identified upon admission by the screening test (OR 3.40; p=0.010). The presence of an enteral feeding tube does not significantly influence the risk of developing BP in our regression models (p=0.074). In this multivariable model, the association of these variables (including the enteral feeding tube) has a predictive value for the BP as shown by an AUC of 84.4%.

All other variables did not demonstrate any statistical significance with SD or BP.

Discussion

The main aim of this study was to define predictive factors able to recognise early after diagnosis the patients more at risk of suffering from swallowing disorders, or of developing bronchopneumonia after an ischemic stroke. It was hoped that the association of these factors would enable closer criteria to be defined to identify these patients at risk.

Out of 343 patients in our cohort, only 148 (43.2%) benefited from a “water swallowing test” at the bedside during their hospitalisation and 51 of these patients were identified as suffering from SD; the other 30 patients were clinically identified by their alimentary resumption (cough, aspiration). In total, 81 patients (23.6%) of our study suffered from SD in the first 7 days of their admission, which confirms the high prevalence of this complication in the acute phase of an ischemic stroke. This result is consistent with previous studies based on clinical screening [2,16,17]. Our results are lower than those studies using technical screening methods which are more sensitive for SD, such as videofluoroscopy, flexible endoscopic evaluation of swallowing. Additionally, we must still deplore an insufficient application of our screening protocol and the SD assessment needs to be systematically and early performed by the nurses. These data emphasize the necessity to assess dysphagia in the early phase of acute stroke to reduce associated complications [12,18].

All BP occurring in patients with or without SD were diagnosed during the entire hospitalisation, the mean length stay being 12 days. Our overall BP rate of 11.4% is close to those of reported studies [1,7].

The male sex is frequently recognized as a risk factor of SD or of BP [9,19]. Although we did not find a correlation with the SD, our univariate and multivariate analyses confirm a significant higher risk of BP in male gender [12]. *Kwon et al.* [19] describes the involvement of female hormones (estrogen, progesterone) in the protection of the nervous system and the immune response in young patients. *Bogousslavsky et al.* [20] explained their findings due to a differential distribution of risk factors (oral contraception, hypertension, diabetes mellitus, smoking, hypercholesterolemia).

The statistical association between SD and BP is already recognised [12,18,19] and confirmed in our study. In our multivariate analyses and according with *Henke et al.*[12], we retrieved a significant association for early-onset of SD with BP. Although in our research every patient

suffering from SD was able to benefit from speech therapy (apart from the 7 patients previously mentioned), 22 of them had BP, showing the complexity of the treatment of these complications. *Langmore et al.* [8] explain that non-dysphagic patients could aspirate small quantities of saliva or of secretions in the case of altered consciousness. Our rate of patients without SD developing BP (5.7%) is lower than the study of *Smithard et al.* [21].

A NIHSS score above 7 is frequently reported as a contributing factor to SD and BP [11,22]. In our study, after we stratified the NIHSS score, we confirm this association with SD as well as BP in our univariate and multivariate analyses [2]. *Henke et al.*[12] showed that a moderate stroke severity (NIHSS score above 4.5 for SD) was able to differentiate dysphagic and non-dysphagic patient. Indeed, altered consciousness (concentration or cognitive disorders) increases the risk of choking, and hence the risk of broncho-aspiration as the cause of BP.

The authors' views on the importance of the topography of stroke lesions in the occurrence of SD or of BP differs: some do not find a significant association [2,12,22]. Others, however, identify the cerebral regions mainly involved in the swallowing process, namely the brainstem and medullar (medially and laterally) regions, as predictive factors for SD [17,23]. Our multivariate analyses specifically highlight a statistical association of medullar lesions with SD. The representation of cortical areas involved in the swallowing process is described as bilateral and asymmetrical by *Hamdy et al.* [24]. This could explain why some patients with the same localisation of cerebral injuries are not all dysphagic. In our study and contrasting with previous studies [14,25], there is no significant association between the side affected and dysphagia. However, we found a statistical correlation in the univariate and multivariate analyses between bilateral hemispheric lesions and BP. *Hilker et al.* [26] explain that the patients with multiple stroke locations had altered consciousness and hence more likely broncho-aspiration due to SD.

We also found that use of enteral feeding tubes is a significant risk factor of BP in univariate analyses, confirming results of previous studies [1,27]. In contrast of the significant association retrieved in the univariate analyses and as *Arnold et al*. [2] showed, the feeding tubes ceased to be significantly associated in the multivariate analyses. The role of NGTs in the post-stroke phase is still debated: preventing SD and contributing to BP [19,25,28]. Additionally, the choice between the insertion of a NGT or a PEG is discussed, but it tends to be in favour of a PEG if

the alimentary support is likely to persist for more than 3 weeks. *Gomes et al.* [29] showed that there are not any significant differences between the two methods in terms of mortality, pneumonia, weight, quality of life, length of hospitalisation and costs.

In our study, 23 patients wore dental prostheses, 13 with SD (of which 4 developed BP), 5 with BP (of which 1 without SD), and 5 who did not suffer from SD or BP. In our multivariate analyses, we showed that dental prosthesis is a predictive risk factor of SD. To our knowledge, there are no studies which report the impact of dental prosthesis on SD in the acute phase after stroke. However, several studies highlighted that edentation and poor oral hygiene are contributory factors to developing pneumonia, and the authors recommend maintaining good mouth care during hospitalisation. This would increase the sensitivity of sensory nerves in the mouth, improve the cough reflex, reduce bacterial colonisation in the oral cavity, and hence the number of pathogens broncho-aspirated. Good oral hygiene can ensure a 60% reduction in the occurrence of BP [4,10].

Finally, the mortality rate (29, 8.6%) found in our study is lower than studies with a 30-days follow-up [1,18]. This study confirms the poor prognosis in post-stroke patients with a higher mortality rate (8.9%) in the case of SD and the even higher (4, 17.4%) in the case of SD associated with BP. Although some measures can be taken to prevent these two complications and reduce this rate, there are other causes which are life-threatening after an acute ischemic stroke [18].

Limitations

Our study has several limitations: the main one is that it is a retrospective study using medical records collected manually. In addition, the comorbidities and the evolution of SD in the medium and long-term have not been statistically studied. Finally, the difficulty of retrospectively identifying patients with SD and it not being systematically documented on computerised records lead to underestimate the prevalence of swallowing disorders.

Conclusion

Our study has succeeded in identifying three factors associated with significantly increasing the risk of swallowing disorders: a NIHSS score above 4, location of the stroke in the medulla and wearing dental prostheses. When these factors are combined, it is possible to predict up to 76% of patients at risk of presenting swallowing disorders. As for the risk of developing bronchopneumonia, it is significantly higher in patients who have an NIHSS score greater than 4, male, those presenting a bilateral stroke location and suffering from early-onset swallowing disorders. When these four factors are combined, and by adding the presence of an enteral feeding tube, it is possible to predict up to 84% of patients at risk of developing bronchopneumonia.

Highlighting of these predictive factors will enable us to identify more quickly the patients with a high risk of developing these complications after an acute ischemic stroke, to intensify their monitoring and to introduce a preventive programme of speech therapy and rehabilitation straight after the admission of the patient to hospital.

Future studies will enable us to evaluate the appropriateness of these early measures.

Annexes

Table 1. Demographic and baseline characteristics.

Total, N=343	***Without SD***	***With SD***	***With BP***	***With SD and BP***
Number of patients, n (%)	**262 (76.4)**	**81 (23.6)**	**39 (11.4)**	**24 (7.0)**
Age (mean ± SD)	72.3 ± 14.5	74.1 ± 13.6	75.8 ± 14.2	73.6 ± 16.6
Sex (women)	116 (44.27)	41 (50.6)	12 (30.7)	7 (29.2)
BMI (kg/m^2) (mean ± SD)	25.8 ± 4.6	25.7 ± 5.5	26.1 ± 5.6	25.4 ± 5.8
Mortality, n (%)	22 (8.4)	7 (8.9)	6 (15.8)	4 (17.4)
NIHSS at admission, n (%)				
Mean ± SD	7.9 ± 7.3	12.5 ± 7.3	14.1 ± 7.6	14.6 ± 8.5
[0 – 4]	113 (45.0)	10 (12.8)	1 (2.6)	1 (4.2)
[5 – 15]	95 (37.9)	39 (50.0)	22 (56.4)	12 (50.0)
> 15 [16-36]	43 (17.1)	29 (37.2)	16 (41.0)	11 (45.8)
Mechanism (modified TOAST), n (%)				
Atherosclerosis	32 (14.4)	12 (16.0)	6 (17.1)	4 (18.2)
Cardioembolism	75 (33.8)	32 (42.7)	16 (45.7)	11 (50.0)
Small-vessel occlusion	20 (9.0)	4 (5.3)	1 (2.9)	1 (4.5)
Other determined etiology	24 (10.8)	9 (12.0)	3 (8.6)	2 (9.1)
Undetermined etiology	71 (32.0)	18 (24.0)	9 (25.7)	4 (18.2)
Side affected, n (%)				
Unilateral	227 (90.4)	73 (91.3)	29 (78.4)	17 (73.9)
Bilateral	24 (9.6)	7 (8.7)	8 (21.6)	6 (26.1)
Vascular territory, n (%)				
Anterior circulation	170 (71.4)	63 (80.8)	28 (73.7)	16 (69.6)
Posterior circulation	51 (21.4)	10 (12.8)	7 (18.4)	4 (17.4)
Simultaneous anterior and posterior	9 (3.8)	4 (5.1)	3 (7.9)	3 (13.0)
Previous clinical stroke (or TIA), n (%)	59 (23.9)	14 (17.7)	8 (21.05)	6 (26.1)
Dental prosthesis, n (%)	10 (3.8)	13 (16.1)	5 (12.8)	4 (16.7)
Swallowing disorders, n (%)	-	81 (100)	24 (61.5)	24 (100)
NGT or PEG, n (%)	11 (4.2)	45 (55.6)	20 (51.3)	18 (75.0)
Cerebral structure affected, n (%)				
- Frontal lobe	121 (60.2)	47 (72.3)	19 (67.9)	13 (68.4)
- Temporal lobe	77 (38.1)	37 (56.9)	16 (57.1)	12 (63.2)
- Parietal lobe	110 (54.5)	46 (70.8)	20 (71.4)	15 (79.0)

Total, N=343	***Without SD***	***With SD***	***With BP***	***With SD and BP***
- Occipital lobe	24 (11.7)	5 (7.8)	5 (17.2)	3 (16.7)
- Lacunar	14 (6.9)	3 (4.6)	2 (6.9)	0 (0)
- Borderzone				
Anterior borderzone	0 (0)	0 (0)	0 (0)	0 (0)
Posterior borderzone	7 (3.5)	1 (1.5)	0 (0)	0 (0)
Deep borderzone	1 (0.5)	1 (1.5)	1 (3.6)	1 (5.3)
Combinations of borderzone	7 (3.5)	1 (1.5)	1 (3.6)	1 (5.3)
- Thalamic	18 (8.8)	3 (4.7)	1 (3.7)	1 (5.6)
- Mesencephalic	15 (7.4)	5 (7.7)	4 (14.3)	4 (21.0)
- Pontic	13 (6.4)	6 (9.2)	5 (17.9)	4 (21.0)
- Medulla oblongata	2 (1)	4 (6.3)	3 (11.1)	2 (11.1)
- Cerebellar	18 (8.9)	8 (12.3)	4 (14.3)	3 (15.8)
- Multiple territories	9 (4.5)	5 (7.7)	3 (10.7)	3 (15.8)
- Undetermined localization	10 (5.0)	1 (1.6)	0 (0)	0 (0)

Percent refers to recorded values only and missing values have been excluded ; BMI=Body Mass Index; NIHSS=National Institutes of Health Stroke Scale ; TOAST=Trial of Org 10172 in Acute Stroke Treatment; SD=swallowing disorders; BP=bronchopneumonia

Table 2. Factors associated with swallowing disorders in the multivariate analysis

	Without SD *versus* With SD		
Associated factors	**OR**	**95% CI**	***p value***
NIHSS at admission			
[0 – 4]	-	-	-
[5 – 15]	6.166	2.43-15.65	<0.001
> 15 [16-36]	9.351	3.44-25.41	<0.001
Medulla involvement	20.107	2.87-140.89	0.003
Dental prosthesis	3.041	1.06-8.72	0.038
AUC for SD prediction: 0.76			

NIHSS=National Institutes of Health Stroke Scale; SD=swallowing disorders; OR= odd ratio; 95% CI=95% confidence interval; AUC=area under cover

Table 3. Factors associated with bronchopneumonia in the multivariate analysis

	Without BP *versus* with BP		
Associated factors	**OR**	**95% CI**	***p value***
Women	0.427	0.19-0.98	0.043
NIHSS at admission			
[0 – 4]	-	-	-
[5 – 15]	21.159	2.62-170.66	0.004
> 15 [16-36]	23.135	2.76-193.60	0.004
Bilateral cerebral lesion	4.130	1.36-12.58	0.013
Swallowing disorders	3.401	1.34-8.61	0.010
NGT or PEG	2.425	0.92-6.41	0.074
AUC for BP prediction: 0.84			

NIHSS=National Institutes of Health Stroke Scale; BP=bronchopneumonia; NGT=nasogastric tube; PEG=percutaneous gastrostomy; OR= odds ratio; 95%CI=95% confidence interval; AUC=area under cover

Figure 1. ROC-curves for NIHSS above 4, bulbar injuries, and wearing dental prosthesis predicting dysphagia

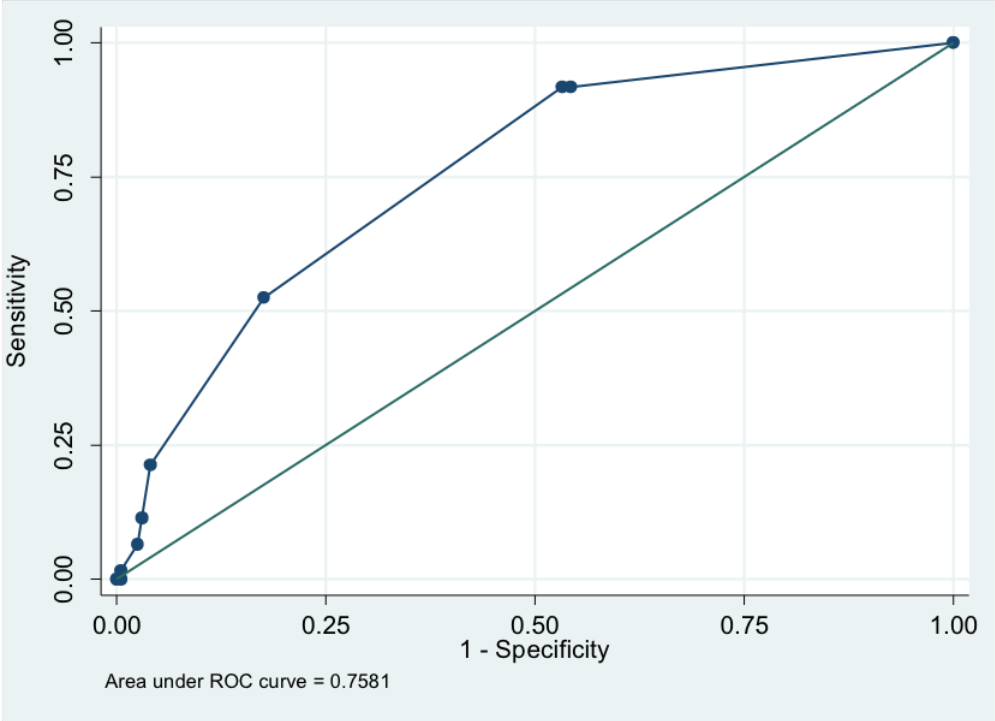
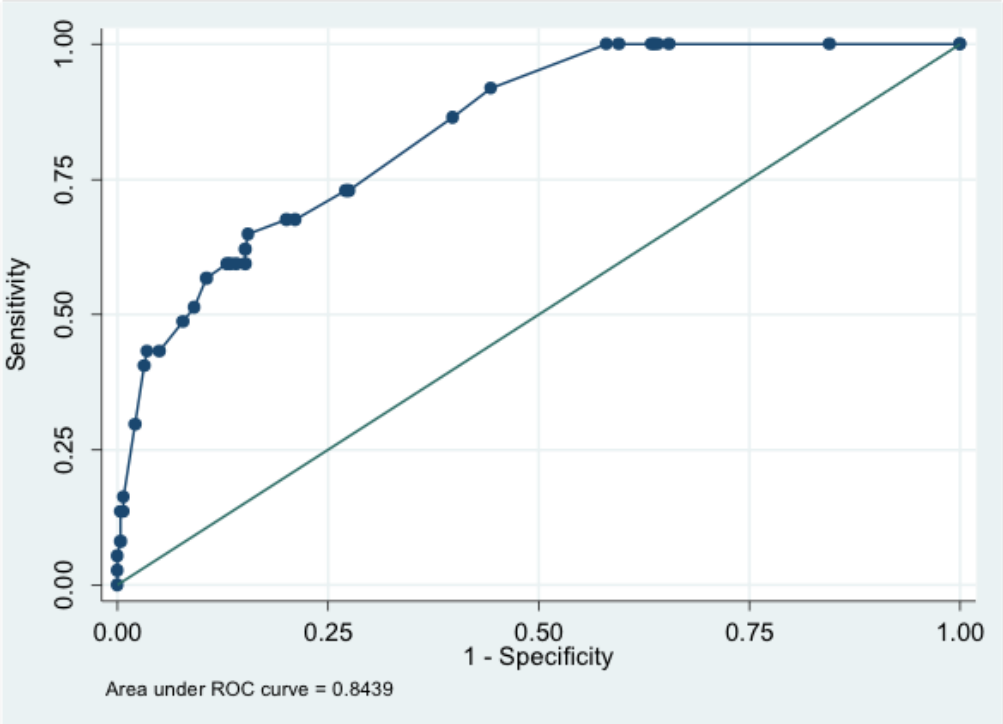


Figure 2. ROC-curves for NIHSS above 4, male sex, bilateral stroke location, swallowing disorder on admission screening, and an enteral feeding tube predicting bronchopneumonia



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