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Acute Stroke Care in Dementia: A Cohort Study from the Swedish Dementia and Stroke Registries

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Abstract.
Background: Previous studies have shown that patients with dementia receive less testing and treatment for stroke.
Objectives: Our aim was to investigate hospital management of acute ischemic stroke in patients with and without dementia.
Methods: Retrospective analysis of prospectively collected data 2010–2014 from the Swedish national dementia registry (SveDem) and the Swedish national stroke registry (Riksstroke). Patients with dementia who suffered an acute ischemic stroke (AIS) ($n = 1,356$) were compared with matched non-dementia AIS patients ($n = 6,755$). Outcomes included length of stay in a stroke unit, total length of hospitalization, and utilization of diagnostic tests and assessments.
Results: The median age at stroke onset was 83 years. While patients with dementia were equally likely to be directly admitted to a stroke unit as their non-dementia counterparts, their stroke unit and total hospitalization length were shorter (10.5 versus 11.2 days and 11.6 versus 13.5, respectively, $p < 0.001$). Dementia patients were less likely to receive carotid ultrasound (OR 0.36, 95% CI [0.30–0.42]) or undergo assessments by the interdisciplinary team members (physiotherapists, speech therapists, occupational therapists; $p < 0.05$ for all adjusted models). However, a similar proportion of patients received CT imaging (97.4% versus 98.6%, $p = 0.001$) and a swallowing assessment (90.7% versus 91.8%, $p = 0.218$).

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Conclusions: Patients with dementia who suffer an ischemic stroke have equal access to direct stroke unit care compared to non-dementia patients; however, on average, their stay in a stroke unit and total hospitalization are shorter. Dementia patients are also less likely to receive specific diagnostic tests and assessments by the interdisciplinary stroke team.

Keywords: Cohort studies, dementia, hospital management, ischemic stroke

INTRODUCTION

Dementia, stroke, and limb paralysis or weakness are the three conditions which most contribute to disability and dependency worldwide [1–4]. Functional prognosis after stroke in dementia is poor [5–9] and patients with dementia are older, have more severe strokes, and more comorbidities [5, 6, 10, 11]. Pre-stroke dementia is an independent predictor of a poor functional outcome and patients with pre-stroke dementia are often treated less aggressively [5–7, 10, 12].

In the acute phase of stroke, reperfusion treatment, direct admission to a stroke unit, and prompt testing for dysphagia upon arrival to hospital have been shown to improve patient outcomes [13, 14]. In later phases, secondary pharmaceutical prevention treatment, carotid surgery, rehabilitation during and after hospitalization, and providing better psychosocial support have additionally been emphasized in Swedish guidelines [15]. Similar aspects of stroke care have been used as quality indicators in a Canadian study [7].

Hospitals may have their own predefined 'set' of investigations, and stroke care and its outcomes might be influenced by various factors, such as patients' sex, age, physician's beliefs, or even day of the week [16–18]. Clinical and radiological findings direct further investigations to determine the presumed stroke mechanism, which in turn aids to predict prognosis and optimize further preventive and treatment strategies (e.g., carotid procedure) [19].

Our aim is to evaluate hospital management of acute ischemic stroke (AIS) among Swedish patients with and without pre-existing dementia. We focus on stroke interventions, hospitalization in specialized stroke units, and performance of specific diagnostic tests.

METHODS

Study population, registries, and variables

This study cohort has been previously described in detail [5, 6]. Briefly, a longitudinal observational cohort study was performed, consisting of 1356 patients with pre-existing dementia and first AIS and 6,755 patients with first AIS and no dementia, matched in age (±3 years), sex, year of stroke, and geographic region. Patients with dementia were identified from SveDem, the Swedish national dementia registry [20], while the occurrence of AIS was identified using Riksstroke, the Swedish national registry for acute stroke, presented in detail at the Riksstroke website (http://www.riksstroke.org/eng/). Data on medication and diagnoses other than dementia were obtained from the Swedish Prescribed Drug Registry and National Patient Registry (NPR) respectively. Patients diagnosed 2010–2014 were included.

The Charlson Comorbidity Index (CCI) was calculated using NPR [21]. The Reaction Level Scale (RLS), ranging from 1 to 8, was used to assess the level of consciousness at admission to the hospital and also served as a proxy for stroke severity. Patients with RLS 1 are defined as alert (Glasgow coma scale–GCS 15), RLS 2–3 lethargic (GCS 9–14), and RLS 4–8 unconscious (GCS 3–8) [22]. Diagnostic imaging of the brain, brain vessels, or extracranial vessels consisted of variable combination of the following: 1) computerized tomography (CT); 2) magnetic resonance imaging (MRI); 3) CT angiography (CTA); 4) magnetic resonance angiography (MRA); and/or 5) ultrasound of extracranial vessels (with a focus on carotid ultrasound). The distinction between extra- and intracranial CTA was not available. Management in a stroke unit was defined as an admission to a designated ward with a multidisciplinary stroke care team.

Longitudinal electrocardiogram (ECG) monitoring is performed to discover paroxysmal arrhythmias, most commonly atrial fibrillation (AF), in patients with no previous record of them [23]. Patients with no prior AF were identified according to the NPR. Swallowing was assessed with a water swallowing bedside test. Patients in which testing was unnecessary or impossible due to their condition were excluded from the analysis.

We introduced the variable "total number of all tests" for stroke assessment and management, which

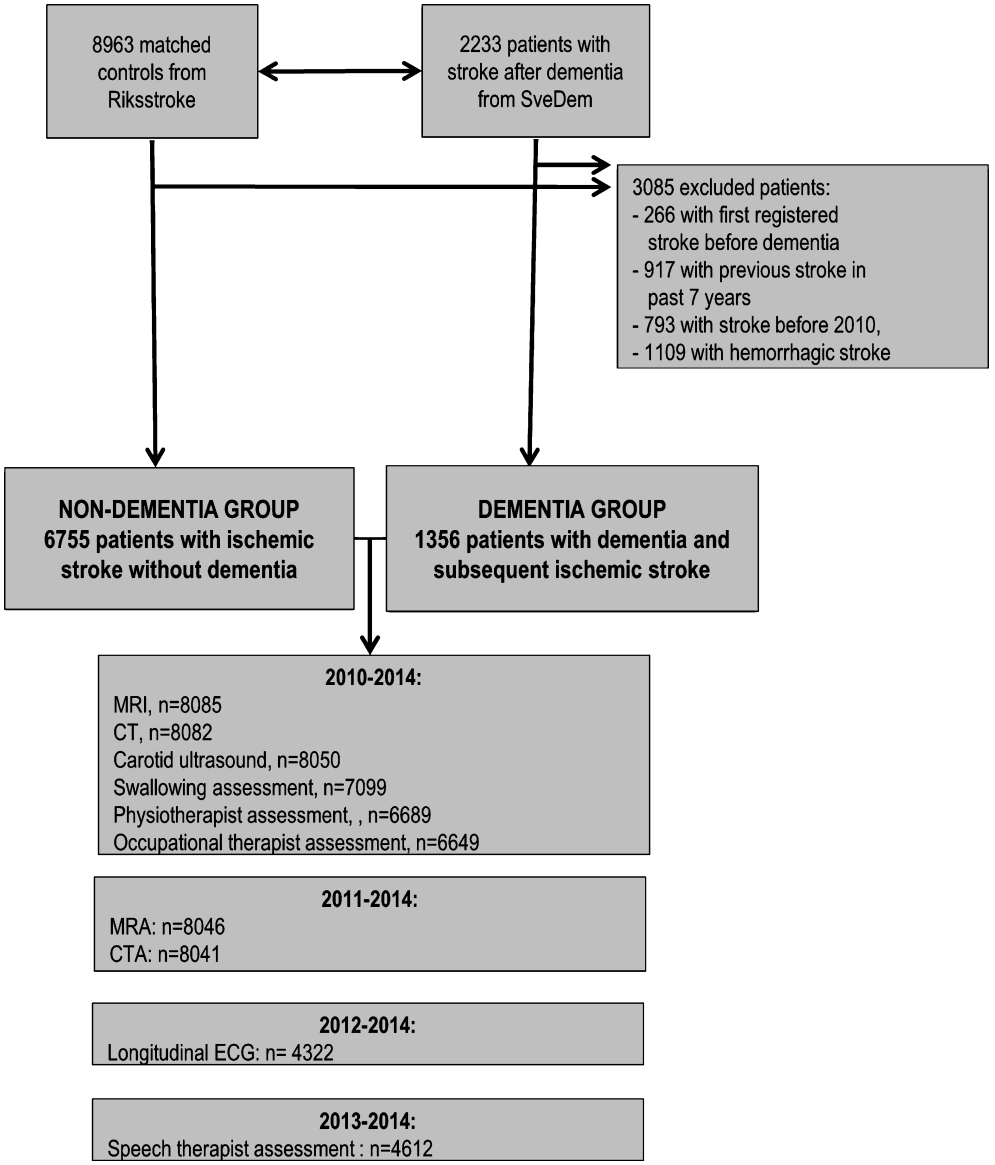

Fig. 1. Patient selection process. We used data from years 2010–2014. Where data was not available for the whole study period (MRA, CTA, longitudinal ECG, and speech therapist assessment), we used shorter time periods as indicated.

is the sum of all tests performed, including CT, MRI, CTA, MRA, carotid ultrasound, longitudinal ECG, and physiotherapist, occupational therapist, speech therapist, and swallowing assessments. All tests were performed during hospitalization, except for longitudinal ECG registration, which was sometimes planned during hospitalization and performed at a later date. Data from years 2010–2014 were used, except for MRA, CTA, longitudinal ECG, and speech therapist assessment, where data was not available for the whole study period (Fig. 1).

Statistical analysis

Categorical variables are presented as number of cases and percentages, and continuous variables are summarized as mean (±Standard Deviation—SD) or as median (±interquartile range—IQR). For calculating significant differences, Student's *t*-test and Mann-Whitney's U-test are used for continuous and Chi-square for categorical variables, where appropriate.

The length of stay (LOS) in a stroke unit and of the whole hospitalization (total LOS, comprising

Table 1
Characteristics of patients with and without dementia and acute ischemic stroke

	Dementia Group ($n = 1,356$)	Non-Dementia Group ($n = 6,755$)	p
Age at first stroke, median (IQR)	83 (8)	83 (9)	0.077
Female sex	764 (56.3)	3838 (56.8)	0.747
Nursing home placement	423 (31.5)	504 (7.5)	**<0.001**
ADL-independence	674 (52.8)	5785 (87.1)	**<0.001**
Smoking	54 (4.4)	514 (8.3)	**<0.001**
Number of medication, median (IQR)	6 (4)	4 (5)	**<0.001**
Charlson comorbidity index, median (IQR)	2 (2)	1 (3)	**<0.001**
The Reaction Level Scale (RLS):			
1	1040 (78.0)	5674 (84.9)	**<0.001**
2-3	241 (18.1)	771 (11.5)	**<0.001**
4–8	52 (3.9)	238 (3.6)	0.544
Dementia type:			
Alzheimer's dementia	320 (23.6)		
mixed dementia	308 (22.7)		
vascular dementia	311 (22.9)		
other dementias	417 (30.8)		

Results are presented as number of cases (n) and percentage proportion (%), if not stated otherwise. In variables where n (%) are reported, p-values were obtained by chi-square, whereas in variables where median (IQR) are reported, p-values were obtained by Mann-Whitney test. **The Reaction Level Scale:** proxy for stroke severity measuring level of consciousness, where patients with RLS 1 are defined as alert, RLS 2–3 lethargic, and RLS 4–8 unconscious. **ADL:** activities of daily living; independence in mobility, dressing and toilet visits. **Other dementias:** dementia with Lewy bodies, frontotemporal dementia, Parkinson's disease dementia, unspecified dementias and other dementias. **Variables with missing data, *n* (%):** nursing home placement: 42 (0.5), ADL-independence: 192 (2.4), smoking: 712 (8.8), RLS: 95 (1.2).

acute phase and continued hospitalization after acute phase), was analyzed using Cox regressions. These results are presented as hazard ratios (HRs) with 95% CIs. To assess the relationship between dementia status and investigations performed at hospital, multivariate logistic regression analyses were used. Adjusted odds ratios (ORs) with 95% CIs are presented. Model 1 of regression analyses is adjusted for age and sex. Model 2 is additionally adjusted for CCI and nursing home placement prior to stroke, level of consciousness, and treatment in a stroke unit. Covariates were chosen to reflect the burden of comorbidities and living situation before stroke, stroke severity, and type of hospitalization. Model 3 was adjusted for propensity scores, calculated from multiple logistic regression in which dementia status was predicted by age, sex, smoking, number of medication, antiaggregants, antipsychotics, antidepressants, lipid lowering agents, antihypertensives, AF, diabetes, hip fracture, ischemic heart disease, heart failure, renal failure, and liver failure. We conducted *post-hoc* sensitivity analyses in the dementia subgroup on MMSE and time from dementia diagnosis to stroke event, however, we did not include them as they were not significant in final models (results not presented).

All tests were 2-tailed with p value <0.05 considered significant. STATA® version 14 (StataCorp, College Station, TX, USA) and IBM Statistical Package for Social Sciences (IBM SPSS) for Windows, Sciences software version 23 (IBM Corporation, Armonk, NY, USA) were used.

Standard protocol approvals and patient consent

This study was approved by the regional ethical review board in Stockholm, Sweden (dnr 2015/743-31/4) and it complies with the Declaration of Helsinki. Patients and relatives were informed on at the time of registration in SveDem and/or Riksstroke and could decline participation or withdraw their information from the registries at a later date. Data were de-identified before analyses.

RESULTS

Characteristics of patients with and without dementia and acute ischemic stroke are presented in Table 1. In both groups, the median age at stroke onset was 83 years, and there was a similar proportion of women (56.3% in dementia versus 56.8% in non-dementia group, $p = 0.747$).

Table 2
Aspects of hospitalization in acute ischemic stroke in patients with and without dementia

	Number of patients	Dementia Group ($n = 1356$)	Non-Dementia Group ($n = 6755$)	p
Thrombolysis	8074	94 (7.0)	639 (9.5)	**0.003**
Patient hospitalized	8111	1344 (99.1)	6731 (99.6)	**0.007**
Inhospital stroke	8101	47 (3.5)	318 (4.7)	**0.046**
Admitted first to another hospital	7335	25 (2.1)	253 (4.1)	**0.001**
Admitting hospital department				
Stroke unit	8055	975 (72.8)	4898 (72.9)	0.931
Intensive care unit		47 (3.5)	307 (4.6)	0.084
Neurosurgery		1 (0.1)	5 (0.1)	0.998
Observation room in the emergency department		78 (5.8)	356 (5.3)	0.438
Other departments		238 (17.8)	1150 (17.1)	0.565
Stroke unit admittance (direct or later)	7850	1093 (83.6)	5793 (88.5)	**<0.001**
Continued hospitalization after acute phase	8111	187 (13.8)	1205 (17.8)	**<0.001**
Discharged home	7135	413 (35.0)	3653 (61.6)	**<0.001**
Length of stay (LOS):				
Total, mean ± SD	8087	11.6 ± 10.9	13.5 ± 13.7	**<0.001**
In a nursing home prior to stroke	927[a]	7.9 ± 8.5 ($n = 423$)	11.1 ± 9.5 ($n = 504$)	**<0.001**
Not in a nursing home prior to stroke	7142[a]	13.7 ± 14.0 ($n = 921$)	13.3 ± 11.5 ($n = 6221$)	0.337
[b]In acute care, mean ± SD	8087	9.5 ± 8.8	10.3 ± 10.7	**0.001**
In a stroke unit, any stay, mean ± SD	6886	10.5 ± 9.4	11.2 ± 11.5	**0.016**
In a nursing home prior to stroke	727[c]	7.8 ± 6.9 ($n = 331$)	9.9 ± 9.1 ($n = 396$)	**<0.001**
Not in a nursing home prior to stroke	6144[c]	11.6 ± 10.1 ($n = 760$)	11.3 ± 11.7 ($n = 5384$)	0.448
In continued care, mean ± SD	1365	15.8 ± 11.5	18.2 ± 13.7	**0.009**

Results are presented for years 2010–2014 as number of cases (n) and percentage proportion (%), if not stated otherwise. In variables where n (%) are reported, p-values were obtained by chi-square, whereas in variables where mean and SD are reported, p-values were obtained by Student t-test. **Discharged home:** results are presented for survivors of hospitalization ($n = 7135$). **Days of hospitalization in stroke unit:** including patients who were subsequently transferred. **Variables with missing data, n (%):** thrombolysis: 37 (0.5); inhospital stroke: 10 (0.1); admitted first to another hospital: 776 (9.6); admitting hospital department: 56; (0.7); later stroke unit admittance: 261 (3.2); days of hospitalization in stroke unit: 349 (4.3); days of hospitalization, acute and altogether: 24 (0.3); discharge home: 23 (0.3); [a]nursing home placement in total LOS: 42 (0.5), [c]nursing home placement in LOS in a stroke unit: 15 (0.2). [b]Including stroke unit care.

Different aspects of hospitalization are presented in Table 2. Thrombolysis was administered to 94 (7.0%) dementia and 639 (9.5%) non-dementia patients ($p = 0.003$). More than 99.0% of patients from both groups were hospitalized and direct admission to a stroke unit was equal (72.8% versus 72.9%, $p = 0.931$). However, when all hospitalizations in stroke unit were considered (both direct admission and admission at a later stage), dementia patients were less likely to be placed in a stroke unit (83.6% versus 88.5%, $p < 0.001$). On average, dementia patients' LOS in a stroke unit was shorter than their non-dementia counterparts (10.5 versus 11.2, $p = 0.016$). We observed no significant differences in admission to other hospital wards between the two groups (observation room in the emergency department, intensive care unit, neurosurgery, other departments; $p > 0.05$ for all). The total LOS was 2 days shorter for dementia patients (11.6 versus 13.5, $p < 0.001$). LOS was associated with prior nursing home placement; the mean total LOS was 9.7 days in patients coming from a nursing home compared to 13.7 days for those without prior nursing home placement ($p < 0.001$), while the mean stroke unit LOS was 7.4 days in patients with and 10.2 days for those without prior nursing home placement ($p < 0.001$) (results not presented in a table). After stratifying for previous stroke unit placement, the difference between dementia and non-dementia patients was present only among those who were nursing home residents before stroke ($p < 0.001$ for total and stroke unit LOS), but not among non-nursing home residents ($p = 0.337$ for total LOS and $p = 0.448$ for stroke unit LOS).

Table 3
Investigations and assessments in hospital management of acute ischemic stroke in patients with and without dementia

	Years included	Number of patients	Dementia Group ($n = 1356$)	Non-Dementia Group ($n = 6755$)	p
CT	2010–2014	8082	1312 (97.4)	6644 (98.6)	**0.001**
MRI	2010–2014	8085	54 (4.0)	743 (11.1)	**<0.001**
CTA	2011–2014	8041	107 (8.9)	1009 (16.6)	**<0.001**
MRA	2011–2014	8046	6 (0.5)	104 (1.7)	**0.002**
Carotid ultrasound	2010–2014	8050	238 (17.7)	2856 (42.6)	**<0.001**
Longitudinal ECG – completed during hospitalization	2012–2014	4322	268 (39.6)	2098 (57.6)	**<0.001**
Longitudinal ECG – completed or planned during hospitalization	2012–2014	4322	661 (97.6)	3453 (94.7)	**0.001**
Swallowing assessment	2010–2014	7099	1060 (90.7)	5442 (91.8)	0.218
Physiotherapist assessment	2010–2014	6689	902 (82.8)	4963 (88.6)	**<0.001**
Occupational therapist assessment	2010–2014	6649	842 (78.1)	4763 (85.5)	**<0.001**
Speech therapist assessment	2013-2014	4612	223 (30.1)	1430 (38.1)	**<0.001**
Total number of tests, median (IQR)	2010–2014	8092	4 (2)	5 (2)	**<0.001**

Results are presented as number of cases (n) and percentage proportion (%), if not stated otherwise. In variables where n (%) are reported, p-values were obtained by chi-square, whereas in variables where median (IQR) are reported, p-values were obtained by Mann-Whitney test. The years for which the variables are available are reported. Total number of tests is a sum of tests reported above (CT, MRI, CTA, MRA, carotid ultrasound, and longitudinal ECG investigations, swallowing, physiotherapist, occupational therapist, and speech therapist assessments). Swallowing assessment: patients in which testing was not possible or unnecessary were excluded from the analysis. Longitudinal ECG is reported for patients with previously unknown atrial fibrillation. **Variables with missing data, *n* (%):** CT: 29 (0.4); MRI: 53 (0.7); CTA: 70 (1.0); MRA: 65 (0.9); carotid ultrasound: 61 (0.8); longitudinal ECG: 108 (1.7); swallowing assessment: 433 (5.3); physiotherapist assessment: 1422 (17.5); occupational therapist assessment: 1462 (18.0); speech therapist assessment: 114 (2.5); total number of tests: 19 (0.2).

Investigations and assessments are presented in Table 3. Almost all patients received CT imaging (97.4% versus 98.6%, $p = 0.001$). The greatest difference between dementia and non-dementia patients was observed in the utilization of MRI, CTA, and carotid ultrasound, with smaller proportion of dementia patients receiving these investigations. Patients with dementia were also less likely to be assessed by the interdisciplinary stroke-oriented team, including physiotherapist, occupational therapist, or a speech therapist (all $p \leq 0.001$). The proportion of missing data was too high for analyses of variables on implementation of rehabilitation measures, so these data are not presented. Prior to stroke, 453 (33.4%) dementia and 1,874 (27.7%) non-dementia patients had AF ($p < 0.001$, results not presented in a table). Longitudinal ECG was less often completed in dementia patients during hospitalization (39.6% versus 57.6%, $p < 0.001$), however, when we included planned investigations after the hospitalization course, patients with dementia had more referrals and completed ECG investigations compared to non-dementia patients (97.6% versus 94.7%, $p = 0.001$). Overall, dementia patients received a median of 4 (IQR 2) hospital tests while non-dementia patients received a median of 5 (IQR 2). There were no differences in the frequency of swallowing assessment (90.7% versus 91.8%, $p = 0.218$) between the two groups.

Cox hazard regressions and logistic regression models are presented in Table 4. After adjusting for 4 possible confounders (level of comorbidity and living situation before stroke, stroke severity, and stroke unit hospitalization), patients with dementia had higher HR of faster discharge (1.11, 95% CI [1.04–1.18]), lower odds of receiving carotid ultrasound (OR 0.36, 95% CI [0.30–0.42]) and speech therapist assessment (0.70 [0.58–0.84]). On the other hand, patients with dementia were almost twice as likely to receive longitudinal ECG (1.89 [1.09–3.30]). In model 3 (propensity scores), similar trends were observed, with the exception of physiotherapist and occupational therapist assessments, where the difference between dementia and non-dementia patients was no longer present.

DISCUSSION

The principal findings of this study are: 1) patients with dementia have equal direct access to stroke

Table 4
Performance of investigations after stroke in patients with dementia

	Model 1	Model 2	Model 3
COX HAZARD REGRESSION FOR TIME TO DISCHARGE			
Total days of hospitalization	1.16 (1.09–1.23)***	1.11 (1.04–1.18)***	1.15 (1.08–1.22)***
Days of hospitalization in a stroke unit	1.06 (0.98–1.13)	1.025 (0.95–1.10)	1.06 (0.99–1.13)
LOGISTIC REGRESSION FOR RECEIVING TESTS			
Hospitalization in a stroke unit	1.0 (0.88–1.14)	1.0 (0.91–1.21)	1.06 (0.93–1.22)
Carotid ultrasound	0.28 (0.24–0.33)***	0.36 (0.30–0.42)***	0.34 (0.29–0.39)***
Longitudinal ECG	2.22 (1.33–3.73)*	1.89 (1.09–3.30)*	2.02 (1.23–3.31)**
Speech therapist assessment	0.70 (0.59–0.83)*	0.70 (0.58–0.84)***	0.69 (0.58–0.83)***
Physiotherapist assessment	0.63 (0.53–0.75)***	0.80 (0.65–0.98)*	0.94 (0.79–1.11)
Occupational therapist assessment	0.61 (0.52–0.72)***	0.82 (0.68–0.99)*	0.86 (0.73–1.02)

For total days of hospitalization and days of hospitalization in a stroke unit, results are presented as hazards ratios (HRs) with 95% CI. For all other variables, results are presented as odds ratio (ORs) with 95% CI. Longitudinal ECG is reported for patients with previously unknown atrial fibrillation, either completed or planned during hospitalization. In binary logistic regression models, model 1 is adjusted for age and sex, model 2 is adjusted for age, sex, level of consciousness, treatment in stroke unit, nursing home placement prior to stroke, and Charlson comorbidity index (CCI) before stroke, and model 3 is adjusted for propensity scores of dementia. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p \leq 0.001$.

unit care, however, on average, their stay there is shorter, 2) patients with dementia have 2 days shorter hospitalization length, and 3) dementia patients receive fewer diagnostic tests and assessments by the interdisciplinary stroke team.

The American [23], European [24], and Swedish national [25] guidelines for stroke management state that acute stroke patients should be treated in a dedicated stroke unit. Management in stroke units should be a priority since it carries the greatest population benefit (lives saved from death or dependency), surpassing the benefits of intravenous thrombolysis [14]. In Sweden, stroke unit management has been one of the top priorities, and by 2011, 85% of acute stroke patients under 75 years were treated in a stroke unit [26], which is similar to our study cohort (84% of dementia and 89% of non-dementia patients) with a median age of 83 years. This proportion is higher than in a 2003–2008 Canadian study where 52% of dementia and 55% of non-dementia patients were hospitalized in a dedicated stroke unit [7]. The difference might be due to the Canadian study being older, differences in stroke unit definition and access and/or differences in stroke care organization between Canada and Sweden.

Both dementia and non-dementia patients had equal direct access to a stroke unit but dementia patients' length of stay (LOS) in a stroke unit was shorter. Moreover, the total LOS was 2 days shorter in the dementia group, which is in a disagreement with previous studies reporting no difference [27] or a longer LOS in stroke patients with dementia [7]. Dementia patients are less likely to be discharged to geriatric rehabilitation programs [5] and they might also be excluded from subacute inhospital rehabilitation, which could partly explain longer LOS in non-dementia patients. Another explanation could be that non-dementia patients might have longer hospital LOS waiting for a nursing home bed, or for home adaptations and home help to be in place. Prior to stroke, more dementia patients had either been nursing home residents and dependent in everyday activities, and some might have already been receiving help, which could have facilitated their transfer back to their previous residence. Indeed, LOS was shorter in prior nursing home residents. However, the interesting finding is that the difference between dementia and non-dementia patients was apparent only among prior nursing home residents and not those who were living at home. It is possible that non-dementia nursing home residents might have been less functionally impaired, making them better candidates for rehabilitation which could consequently explain longer LOS compared to dementia patients.

Even severely cognitively impaired patients have been shown to benefit from post-stroke rehabilitation programs [28, 29]. In our study, after adjusting for possible confounders, patients with dementia had 20–30% lower odds of receiving speech therapist, physiotherapist, and occupational therapist assessments. This differs from previous reports, where dementia patients were more likely to receive physiotherapy (91% versus 87%) [7]. Even though cognitively normal post-stroke patients achieve better functional outcomes, absolute motor gains appear to be independent of cognition [29]. Longer or

specialized rehabilitation programs might be required for dementia patients, and these could reduce long-term health-care costs, caregiver burden, and nursing home placements [29].

Carotid evaluation aids in determining the mechanism of stroke and allows identification of candidates for a carotid procedure. In patients with focal neurological symptoms corresponding to the internal carotid artery territory, carotid ultrasound is recommended to detect carotid stenosis, unless CTA or MRA have already been performed in the acute phase [30]. Fewer such investigations were performed in dementia patients. The difference in utilization of carotid ultrasound between dementia and non-dementia patients persisted even after adjusting for age and level of consciousness (independent predictors in another Riksstroke study [31]), and sex, treatment in stroke unit, nursing home placement prior to stroke, and comorbidities. Even though more dementia patients had AF (33.4% versus 27.7%, $p < 0.001$), this should not preclude these patients from carotid imaging [31]. Possible explanations could be presence of dementia, stroke and/or dementia severity, or shorter hospitalization length (although, the relationship could also be reversed; because fewer investigations are performed, patients with dementia are discharged sooner). Whatever the reason, if a patient is not a candidate for a carotid procedure, the investigation might be excessive.

An important goal in secondary stroke prevention is the detection and treatment of AF. Longitudinal ECG is performed only in one third of non-AF patients after stroke [32], and less often in patients with dementia [7]. Encouragingly, in our study, a great majority of patients with no previous AF received or were referred for longitudinal ECG monitoring. Surprisingly, dementia patients had around 2-fold increased odds of being referred to this investigation even after adjusting for possible confounders; however, the absolute percentage difference in performance was 3% and a statistically significant difference between the groups might not mean a clinically relevant difference. One possible explanation could be that the healthier non-dementia cohort would be less likely to have an AF diagnosis in hospital or specialist care (which the NPR registers) and more likely to have a primary care AF diagnosis (which does not appear in the NPR). Physicians caring for stroke patients do have access to these primary care diagnoses, and they could have been aware of a previous primary care AF diagnosis that we cannot detect in our study. Thus, these differences in investigations for AF might be due to a bias in our study.

Dysphagia, detected in 25–67% of strokes, influences the discharge destination [33] and increases the incidence of aspiration pneumonia 3-fold [34]. Swallowing assessment is recommended before the patient begins with oral intake of fluids, food, or oral medication after AIS. Initial screening of swallowing, using, e.g., a water swallow test, is safe, can be performed before a more detailed assessment by a speech therapist, and is a key step in early identification of patients at high risk for aspiration [23]. It is reassuring that we did not find any differences between dementia and non-dementia groups in evaluation for swallowing difficulties. In AIS, dysphagia is more common in patients with dementia [8], and although many AIS patients spontaneously regain swallowing function within the first month post-stroke, recovery in dementia might be worse because of limited neuroplasticity reserve [33].

This study has several limitations. First, frail old people with dementia and other chronic disorders, residing in a nursing home, may not be referred to a hospital in case of AIS. Thus, they are probably underrepresented in this study, as Riksstroke does not cover out-of-hospital stroke events. Nevertheless, in Sweden, only a small percent of acute stroke patients are treated outside of hospitals [26]. Second, while Riksstroke's coverage is excellent (>90%) [35], SveDem's coverage (which entails diagnostics in memory clinics and primary care facilities across Sweden) was estimated to be 36% in 2012 [36], which is based on the number of registered patients in relation to the estimated incidence of dementia in Sweden. It is uncertain to which extent our sample represents the whole Swedish dementia population. Variables from Riksstroke have a high inter-rater reliability as Riksstroke validation process demonstrated >15% disagreement in only 4 out of 81 variables (day of stroke onset, delay from onset to arrival in hospital, swallowing assessment, and CTA or MRA) [37]. The proportion of missing surpassed 30% in the variables on implementation of rehabilitation, so we excluded these from analyses and used physiotherapist, speech therapist, and occupational therapist assessments instead. Strengths of this study are the large dementia and stroke population obtained from national quality registries and the high quality and detail of procedures registered in Riksstroke.

It is encouraging that we found no or small differences in most aspects of stroke care (CT,

swallowing assessment, longitudinal ECG). For other aspects of stroke care, such as assessments by the interdisciplinary stroke team, there is still room for improvement in patients with dementia, as they received fewer investigations and rehabilitation assessments overall. The lower use of carotid ultrasound or imaging is harder to evaluate since it does not make sense to test if the patient is not a candidate for vascular or stent procedure. Since it is impossible to ascertain dementia severity at the time of stroke, we adjusted for MMSE and time from dementia diagnosis to stroke event in our *post-hoc* sub-group analyses in dementia patients, however, these variables were non-significant. Stroke severity in combination with preexistent dementia can predefine the care/management decisions and this could, at least partly, explain the differences. However, some types of care may not be appropriate for patients with dementia or for certain dementia subtypes, as they might carry different disease-specific effects or risks [11]. Until dementia-specific risks are characterized, patients should not be excluded from post-stroke investigations and rehabilitation solely because of dementia diagnosis. A careful consideration of each individual's previous functioning and type and severity of stroke is critical for prognostication and for deciding level and type of care and testing.

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