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Original Study

Prestroke Mobility and Dementia as Predictors of Stroke Outcomes in Patients Over 65 Years of Age: A Cohort Study From The Swedish Dementia and Stroke Registries

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A B S T R A C T

Objectives: To explore the association between prestroke mobility dependency and dementia on functioning and mortality outcomes after stroke in patients>65 years of age.
Design: Longitudinal cohort study based on SveDem, the Swedish Dementia Registry and Riksstroke, the Swedish Stroke Registry.
Participants: A total of 1689 patients with dementia >65 years of age registered in SveDem and suffering a first stroke between 2007 and 2014 were matched with 7973 controls without dementia with stroke.
Measurements: Odds ratios (ORs) and 95% confidence intervals (CIs) for intrahospital mortality, and functioning and mortality outcomes at 3 months were calculated. Functioning included level of residential assistance (living at home without help, at home with help, or nursing home) and mobility dependency (independent, needing help to move outdoors, or needing help indoors and outdoors).
Results: Prestroke dependency in activities of daily living and mobility were worse in patients with dementia than controls without dementia. In unadjusted analyses, patients with dementia were more often discharged to nursing homes (51% vs 20%; $P < .001$). Mortality at 3 months was higher in patients with dementia (31% vs 23% $P < .001$) and fewer were living at home without help (21% vs 55%; $P < .001$). In adjusted analyses, prestroke dementia was associated with higher risk of 3-month mortality (OR 1.34; 95% CI 1.18−1.52), requiring a higher level of residential assistance (OR 4.07; 3.49−.75) and suffering from more dependency in relation to mobility (OR 2.57; 2.20−3.02). Patients with dementia who were independent for mobility prestroke were more likely to be discharged to a nursing home compared with patients without dementia with the same prestroke mobility (37% vs 16%; $P < .001$), but there were no

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differences in discharge to geriatric rehabilitation (19% for both; $P = .976$). Patients, who moved independently before stroke, were more often discharged home (60% vs 28%) and had lower mortality. In adjusted analyses, prestroke mobility limitations were associated with higher odds for poorer mobility, needing more residential assistance, and death.

Conclusions: Patients with mobility impairments and/or dementia present a high burden of disability after a stroke. There is a need for research on stroke interventions among these populations.

Stroke is a common cause of morbidity and mortality in patients with dementia.[1–3] Prestroke dementia is associated with worse outcomes,[4–7] including lower likelihood of home discharge, and a higher rate of disability[4] and mortality.[5–7] Physical frailty and impaired cognition both lead to negative outcomes,[8–10] although it can be hard to distinguish the causal order between many interacting factors in the pathway leading to disability and dependency.

Impaired mobility is one of the main determinants of frailty and predicts changes in frailty status, disability, and death.[11] Baseline mobility is an important predictor of functioning and mortality after stroke.[12–14] With an increasingly aging population, clinicians often face the challenge of managing stroke in patients who are frail, have mobility limitations, or have dementia. In such patients, prognosis is an important consideration.[3] This study is part of a larger project using a cohort obtained from the Swedish Dementia and Stroke registries to examine all aspects of stroke care in relationship with dementia status.[15] The aim of this specific study is to assess the role of mobility and dementia as predictors of level of residential assistance, dependency for mobility, and mortality in older patients with stroke.

Methods

The Swedish Dementia and Stroke Quality Registries and Patient Selection

The personal identity number enabled the linkage of data from the Swedish Dementia Registry (SveDem)[16] and the Swedish Stroke Register (Riksstroke).[15,17] In addition, variables were added from other registries: dispensed drugs from the Swedish Prescribed Drug Register,[18] mortality from the Population Registry,[19] and comorbidities [as *International Classification of Diseases, Tenth Revision* (ICD-10) codes] from the year 1998 onward from the National Patient Register, which contains all in-hospital and specialist diagnoses.[20]

SveDem is a national quality register,[16] recording incident dementia diagnosis made according to the ICD-10.[21] Information about demographics, social aspects, medication, and cognition measured by the Mini-Mental State Examination (MMSE)[22] at the time of dementia diagnosis are included.[9] Riksstroke has a coverage for acute stroke events >90%.[23] Ischemic and hemorrhagic strokes were included (ICD-10 codes I61, I63, and I64). The baseline registration includes demographics, social situation, some activities of daily living (help with clothing, toilet visits), and mobility dependency, together with detailed information on chain-of-care, treatments, and complications. Follow-up information at 3 months is collected through forms sent to the patient's home, filled by patients or their main caregivers, and includes information on mobility, other aspects of dependency and required level of residential assistance (living at home without help, at home with help or in a nursing home).

From 2007 to 2014, 58,154 patients were registered in SveDem. Of these, 2233 patients with dementia had suffered a stroke and been registered in Riksstroke. These were matched by age, sex, year of stroke, and geographical region with 8963 control patients without dementia from Riksstroke. Controls were excluded if they had ever had a registered diagnosis of dementia or delirium (ICD-10 codes F00–F09, G30–G32) or used antidementia medications (Anatomical Therapeutic Chemical Classification System codes N06DX and N06DA). Patients ≤65 years of age were excluded. Because ascertainment and differentiation of quickly repeating strokes could be difficult in a population with dementia, patients who had stroke in the previous 7 years were excluded. This resulted in 1689 patients with dementia patients and 7973 patients without dementia stroke controls available for analyses.

Variables

Age at the time of diagnosis of dementia and stroke, was obtained from SveDem and Riksstroke, respectively. The number of drugs taken by the patient was obtained from the Prescribed Drug Register at 2 separate time points corresponding with the dementia and stroke diagnoses, and was used as a proxy for comorbidity.[9,24] SveDem also contributed dementia type and MMSE score at the time of dementia diagnosis. The time in days from dementia diagnosis to stroke diagnosis is shown. Functioning level prior to stroke was obtained from Riksstroke, including information on needing assistance with clothing, toilet visits, and mobility. Mobility was classified in 3 categories: independent, dependent on help outdoors, or dependent indoors and outdoors. The presence or absence of diabetes and atrial fibrillation were obtained from Riksstroke and from the National Patient Register (ICD-10 codes I48 and E10-E13, respectively), and the disease was considered present if it was registered in any of these 2 sources. Previous hip fracture (S72) was considered as a possible covariate because it could be related to mobility. Level of residential assistance (living at home with no help, at home with help, nursing home) at the time of stroke was obtained from Riksstroke. Consciousness at arrival to the emergency department was assessed by the Reaction Level Scale (RLS), a tool to record severity of brain injury. The RLS is coded in Riksstroke as RLS 1: fully responsive; 2–3: drowsy but still responds to stimuli; and 4–8: unconscious.[25]

Outcomes were obtained from Riksstroke. Short-term outcomes included (1) in-hospital deaths and (2) accommodation at discharge, which was classified as: home, nursing home, geriatric in-patient rehabilitation, and other (including those still hospitalized and other living situations). Outcomes at 3 months included (1) required level of residential assistance (at home without help, at home with help, nursing home), (2) mobility dependency, and (3) death. This 3-month follow-up was available for 89% of patients.

Statistics Analyses

Continuous, not normally distributed variables (age, number of drugs, MMSE score, and time from dementia diagnosis to stroke) were described with medians and interquartile range, using Mann Whitney U tests to obtain P values. For categorical variables, percentages are shown, and Pearson χ^2 or Fishers exact test with P values were calculated.

Binary logistic regressions were performed for the outcomes for mortality, and ordinal logistic regression for level of residential assistance and for mobility at 3 months. For ordinal logistic

regressions, the proportional odds/parallel-lines assumption was tested using generalized ordinal regression model with the STATA command GOLOGIT2 (Richard Williams: https://www.stata.com/meeting/4nasug/gologit2.pdf) with a gamma parameterization. No significant violations of the assumptions were found. Models adjusted for age and sex were performed. The final adjusted models were arrived at by testing any variables that presented baseline differences between the groups with $P < .25$ in univariate comparisons. Atrial fibrillation and diabetes mellitus were tested as covariates because they were found to be valuable by other authors working with Riks-stroke.[26] Variables were kept in the model if they were significant or improved the model. Age was included as a continuous variable, the rest of covariates were categorical. Because dementia could cause lower responsiveness on arrival to hospital independent of stroke severity, level of consciousness was not included as a covariate. Post-hoc analyses were conducted on the group with dementia, additionally adjusting for MMSE results at the time of dementia diagnosis. Odds ratios (OR) with confidence intervals (CIs) are reported. Two-tailed P values of $< .05$ were considered to be statistically significant in all analytical procedures. Analyses were performed using the Statistical Package for the Social Sciences software v 22 (IBM Corporation, Armonk, NY) and STATA v 12.1 (StataCorp, College Station, TX).

This study was approved by the regional ethical review board in Stockholm, Sweden (dnr 2015/743-31/4). Patients and relatives were informed of inclusion in the registries at the time of diagnosis and could decline participation or withdraw consent. Data were deidentified before analysis.

Results

As expected from case-control matching, there were no significant differences in age and sex, as is shown in Table 1. There was a significant difference in prestroke functioning ability between patients with dementia patients and controls without dementia. A greater percentage of dementia patients (32%) lived in nursing homes compared with controls (8%); and patients with dementia were also less likely to live at home without help (32% vs 71% of controls). Regarding mobility, 61% of patients with dementia moved independently compared with 89% of control without dementia. Consciousness at admission differed: 20.7% of patients with dementia were drowsy at arrival compared with 12.8% of controls.

Characteristics of patients at the time of dementia diagnoses are shown in the Supplementary Table 1 (Appendix). Alzheimer disease (23.6%), mixed dementia (24.3%), and vascular dementia (23.3%) were equally frequent. The median time between dementia and stroke diagnosis was 1.4 years (512 days, standard deviation 690).

Dementia status and previous mobility in relationship to stroke outcomes are presented in Tables 2 and 3. Patients with dementia were more likely to be discharged to a nursing home (51% vs 20%; $P < .001$) and less likely to be discharged to geriatric rehabilitation (15% vs 18%; $P = .003$) (Table 2). New nursing home placement occurred in 37% patients with dementia compared to 13% of stroke patients without dementia ($P < .001$; not presented in tables). Mobility at 3 months was worse in patients with dementia patients than in controls (37% independent vs 66% of controls; $P < .001$). Patients who moved independently before stroke had lower in-hospital mortality rates (13% vs 23% in patients dependent outdoors; $P < .001$) and were more often discharged home (60% vs 28% of previously dependent outdoors; $P < .001$) (Table 3).

Outcomes in patients with dementia and without dementia stratified by prestroke mobility are shown in Table 4. Patients with dementia who were dependent before stroke had lower in-hospital mortality rates than patients without dementia with similar prestroke mobility dependency (19% in patients with dementia vs 28% in patients without dementia who were dependent indoors and outdoors before stroke; $P = .016$). Among patients who had independent mobility prestroke, patients with dementia were less likely to be discharged home (43% vs 63%; $P < .001$), but the rates of discharge to geriatric rehabilitation were equal (19%). The need for residential assistance and mobility at 3 months were worse in patients with dementia compared with patients without dementia with the same prestroke mobility level.

Table 1
Functional and Demographic Characteristics at the Time of Stroke

	Dementia n = 1689 (100%)	No Dementia n = 7973 (100%)	*P* Value
Age median, y (IQR)	83 (8)	83 (9)	.690
Sex women n (%)	980 (58.0%)	4518 (56.7%)	.307
Number of drugs median (IQR)	6 (4)	4 (5)	<.001
Diabetes mellitus n (%)	373 (22.1%)	1731 (21.8%)	.788
Atrial fibrillation n (%)	660 (39.1%)	2920 (36.6%)	.058
Warfarin treatment n (%)	86 (13.4%)	521 (19.0%)	.001
Hip fracture before stroke n (%)	232 (13.7%)	684 (8.6%)	<.001
Mobility n (%)			
Moves independently	972 (61.1%)	6961 (89.0%)	<.001
Dependent outdoors	403 (25.3%)	564 (7.2%)	
Completely dependent	217 (13.6%)	295 (3.8%)	
Help clothing n (%)	568 (36.6%)	670 (8.6%)	<.001
Help with toileting n (%)	482 (31.1%)	537 (6.9%)	<.001
Level of residential assistance n (%)			
Lives at home without help	543 (32.4%)	5656 (71.3%)	<.001
Lives at home with help	586 (34.9%)	1657 (20.9%)	
Nursing home	533 (31.8%)	602 (7.6%)	
Others	15 (0.9%)	15 (0.2%)	
Consciousness at admission n (%)*			
Awake	1208 (72.7%)	6454 (81.8%)	<.001
Drowsy but responsive	345 (20.7%)	1009 (12.8%)	
Unconscious	110 (6.6%)	424 (5.4%)	

IQR, interquartile range
χ^2 and independent samples Mann-Whitney U test performed as appropriate.
Missing data: prestroke mobility: 250 (2.6%), help clothing: 326 (3.4%), help toileting: 321 (3.3%), level or residential assistance: 55 (0.6%), stroke severity: 112 (1.2%). None missing for other variables.
*Stroke severity is assessed by level of consciousness by Reaction Level Scale: 1: fully responsive; 2-3 to drowsy; 4 to unconscious

Table 2
Prestroke Dementia in Relationship to Functional and Mortality Outcomes

	All	Dementia	No dementia	*P* Value
	n = 9662	n = 1689	n = 7973	
In-hospital deaths	1495 (16%)	287 (17%)	1208 (15%)	.057
Survivors from hospitalization n = 8167				
Place of discharge				
Home	4465 (55%)	457 (33%)	4008 (60%)	<.001
Nursing home	2047 (25%)	712 (51%)	1335 (20%)	<.001
Geriatric rehabilitation	1453 (18%)	210 (15%)	1243 (18%)	.003
Other/still hospitalized	175 (2.1%)	14 (1%)	161 (2.4%)	<.001
Follow-up at 3 mo				
Deaths at 3 mo	2364 (25%)	526 (31%)	1838 (23%)	<.001
Survivors at 3 mo, n = 7298				
Level of residential assistance at 3 mo				
Home without help	3168 (49%)	198 (21%)	2970 (55%)	<.001
Home with help	1811 (29%)	274 (29%)	1537 (28%)	.654
Nursing home	1296 (20%)	458 (49%)	838 (16%)	<.001
Other	84 (1.3%)	12 (1.3%)	72 (1.3%)	.891
Mobility at 3 mo				
Independent	3871 (61%)	343 (37%)	3528 (66%)	<.001
Dependent outdoors	1251 (20%)	1003 (19%)	248 (27%)	<.001
Dependent indoors and outdoors	1188 (19%)	844 (16%)	344 (37%)	<.001

P values obtained from χ^2 tests. Dead at 3 months includes in-hospital deaths and deaths occurring up to 3 months after the stroke. Missing data. Mortality: none; accommodation at discharge 27 (<1%); level of residential assistance at 3 months: 939 (13%); mobility at 3 months: 988 (14%).

Table 3
Prestroke Mobility in Relationship to Functional and Mortality Outcomes

	Previous Mobility	Independent n = 7933	*P* Value*	Dependent Outdoors n = 967	*P* Value†	Dependent Indoors and Outdoors n = 512
In-hospital deaths		1017 (13%)	<.001	224 (23%)	.649	124 (24%)
Survivors from hospitalization n = 8047						
Place of discharge						
	Home	4171 (60%)	<.001	207 (28%)	<.001	65 (17%)
	Nursing home	1276 (19%)	<.001	415 (56%)	<.001	289 (75%)
	Geriatric rehabilitation	1297 (19%)	.007	109 (15%)	.004	34 (9%)
	Other/still hospitalized	162 (2.3%)	.082	10 (1.3%)	.019	0 (0%)
Follow-up at 3 mo						
Dead at 3 mo		1538 (19%)	<.001	392 (41%)	<.001	264 (52%)
Survivors at 3 mo n = 7216‡						
Level of residential assistance at 3 mo						
	Home without help	3094 (55%)	<.001	51 (11%)	.087	13 (7%)
	Home with help	1604 (28%)	.066	150 (33%)	.002	40 (21%)
	Nursing home	871 (15%)	<.001	252 (55%)	<.001	137 (71%)
	Other	71 (1.3%)	.211	9 (1.9%)	1.00	4 (2.1%)
Mobility at 3 mo						
	Independent	3762 (67%)	<.001	87 (19%)	<.001	8 (4.1%)
	Dependent outdoors	1035 (19%)	<.001	164 (36%)	<.001	33 (17%)
	Dependent indoors and outdoors	801 (14%)	<.001	206 (45%)	<.001	152 (79%)

Missing data: prestroke mobility: 250 (2.6%); place of discharge 12 (<1%); level of residential assistance at 3 months: 920 (12.7%); mobility at 3 months: 968 (13.4%); dead at 3 months includes both intrahospital deaths and other deaths occurring up to the 3 month time point.

*P value from χ^2 tests for the difference between independent and dependent outdoors.

†P value for the difference between dependent outdoors and dependent indoors and outdoors.

‡Two patients were reported dead in-hospital in Riksstroke but were missing a date of death at 3-month follow-up in the population registry and have been excluded from this figure.

Odds ratio for functional and mortality outcomes after stroke in regards to prestroke mobility and dementia status are presented in Table 5. Age- and sex-adjusted models were calculated (not presented). The fully adjusted models included age, sex, number of drugs, atrial fibrillation, and prior history of hip fracture. Because prestroke mobility was a probable mediator of the effects of dementia, separate models are presented for dementia and for mobility. Dementia status was not significantly associated with in-hospital death (OR 1.00, 95% CI 0.85–1.17). In both age- and sex-adjusted and the fully adjusted model, worse prestroke mobility was associated with higher mortality

Table 4
Outcomes for Patients With Dementia and Without Dementia Stratified by Prestroke Mobility

N = 9412	Prestroke Independent Mobility			Prestroke Dependent Outdoors			Prestroke Dependent Indoors and Outdoors		
	Dementia n = 972	*P* Value*	No Dementia n = 6961	Dementia n = 403	*P* Value†	No Dementia n = 564	Dementia n = 217	*P* Value‡	No Dementia n = 295
In-hospital deaths	128 (13.2%)	.728	889 (12.8%)	76 (18.9%)	.007	148 (26.2%)	41 (18.9%)	.016	83 (28.1%)
Survivors from hospitalization = 8047									
Place of discharge									
Home	364 (43.2%)	<.001	3807 (62.8%)	60 (18.4%)	<.001	147 (35.4%)	24 (13.6%)	.134	41 (19.3%)
Nursing home	309 (36.7%)	<.001	967 (15.6%)	223 (68.4%)	<.001	192 (46.3%)	144 (81.8%)	.003	145 (68.4%)
Geriatric rehabilitation	158 (18.7%)	.976	1139 (18.8%)	41 (12.6%)	.146	68 (16.4%)	8 (4.5%)	.007	26 (12.3%)
Other/still hospitalized	12 (1.4%)	.059	150 (2.5%)	2 (0.6%)	.124	8 (1.9%)	0		0
Follow-up at 3 mo									
Dead at 3 mo	80 (9.5%)	.025	443 (7.3%)	73 (22.3%)	.868	95 (22.8%)	69 (39.2%)	.243	71 (33.5%)
Survivors at 3 mo = 7216§									
Level of residential assistance at 3 mo									
Home without help	179 (28.3%)	<.001	2915 (58.2%)	13 (6.5%)	.006	38 (14.6%)	4 (5.0%)	.427	9 (7.9%)
Home with help	208 (32.9%)	.008	1396 (27.9%)	47 (23.4%)	<.001	103 (39.5%)	12 (15.0%)	.105	28 (24.6%)
Nursing home	239 (37.8%)	<.001	632 (12.6%)	137 (68.2%)	<.001	115 (44.1%)	62 (77.5%)	.078	75 (65.8%)
Other	6 (0.9%)	.459	65 (1.3%)	4 (2.0%)	1‖	5 (1.9%)	2 (2.5%)	1‖	2 (1.8%)
Mobility at 3 mo follow-up									
Independent	305 (48.4%)	<.001	3457 (69.6%)	32 (16.2%)	.185	55 (21.2%)	2 (2.5%)	.473‖	6 (5.3%)
Dependent outdoors	161 (25.6%)	<.001	874 (17.6%)	67 (34.0%)	.467	97 (37.3%)	13 (16.3%)	.792	20 (17.7%)
Dependent indoors and outdoors	164 (26.0%)	<.001	637 (12.8%)	98 (49.7%)	.081	108 (41.5%)	65 (81.3%)	.476	87 (77.0%)

Missing data: prestroke mobility: 250 (2.6%); place of discharge 12 (<1%); level of residential assistance at 3 months: 920 (12.7%); mobility at 3 months: 968 (13.4%).

P values obtained from χ^2 tests unless otherwise indicated.

P value for the difference between dementia and no dementia groups:

*in patients who were independent for mobility,

†in patients who were dependent for mobility outdoors, and

‡in patients who were dependent for mobility indoors and outdoors before the stroke.

§Two patients were reported dead in-hospital in Riksstroke but were missing a date of death at 3-month follow-up in the population registry and have been excluded from this figure.

‖Fisher exact test.

Table 5
Functional and Mortality Outcomes After Stroke in Relationship to Prestroke Dementia and Mobility

	In-Hospital Death	Death at 3 Mo	Level of Residential Assistance*	Mobility at 3 Mo†
All patients				
Dementia	1.00 (0.85–1.17)	1.34 (1.18–1.52)	4.07 (3.49–4.75)	2.57 (2.20–3.02)
Mobility				
Independent	Ref	ref	Ref	ref
Dependent outdoors	1.59 (1.34–1.89)	2.11 (1.82–2.45)	3.54 (2.84–4.41)	4.53 (3.64–5.63)
Dependent indoors and outdoors	1.69 (1.35–2.11)	3.41 (2.81–4.13)	5.21 (3.38–8.04)	NA
Adjusted for MMSE in patients with prestroke dementia (n = 1689)‡				
Mobility				
Independent	Ref	Ref	Ref	ref
Dependent outdoors	1.41 (1.01–1.96)	1.85 (1.41–2.43)	1.99 (1.32–2.98)	2.72 (1.84–4.04)
Dependent indoors and outdoors	1.28 (0.84–1.97)	3.21 (2.29–4.51)	2.25 (1.04–4.85)	NA

ORs and 95% CIs calculated from binary logistic regressions (in-hospital death and death at 3 months) and ordinal logistic regressions (level of residential assistance and mobility dependency at 3 months). Models are adjusted for age, sex, number of drugs, atrial fibrillation, and prior history of hip fracture.
For the latter 2 outcomes, OR from ordinal regression represent the odds of a step-wise increase in level of residential assistance (home without help, home with help, nursing home) or mobility dependency (independent, dependent outdoors, dependent indoors and outdoors).
*Of 7218 patients who had survived to 3 months poststroke, 922 (13%) were missing information on level or residential assistance. Patients with residential assistance classified as "other" and who had already been living in a nursing home before the stroke were also excluded, leaving 5800 patients available for analyses for this outcome.
†Patients who were dependent indoors and outdoors prestroke and with missing information on mobility (970; 13%) were excluded, leaving 5704 patients analyzed for this outcome.
‡Adjusted as described above and for results from MMSE at the time of dementia diagnosis. Only patients with prestroke dementia included. Number of observations: in-hospital death and death at 3 months: 1490; accommodation at 3 months: 675; mobility at 3 months: 635.

after stroke; this risk increased with the degree of dependency (Table 5). For the outcome "mortality at 3 months," patients with dementia presented an OR of 1.34 (95% CI 1.18–1.52) compared with patients without dementia in the fully adjusted model. Compared with independent patients, patients who needed help outdoors presented an OR of 2.11 (95% CI 1.82–2.45), whereas fully dependent patients had an OR of 3.41 (2.81–4.13). In models where both mobility and dementia were introduced as covariates, dementia became associated nonsignificantly to mortality at 3 months, indicating a possible mediator effect of mobility (OR for dementia 1.05, 95% CI 0.91–1.19; OR for dependency outdoors 2.09, 1.79–2.43; OR for dependency indoors and outdoors 3.36, 2.76–4.09; results not presented in tables).

The level of residential assistance at 3 months was classified into living at home without help, at home with help, nursing home, or other. Ordinal regression was used, considering living at home without help, home with help, and in a nursing home as stepwise increases in need for care-intensive residential assistance. Dementia was associated with increased OR of requiring home care or a nursing home, with an OR for each step increase in care level of 4.07 (3.49–4.75). Compared with independent patients, those who needed help outdoors presented an OR of 3.54 (2.84–4.41) of requiring a higher level of residential assistance, whereas patients dependent indoors and outdoors had an OR of 5.21 (3.38–8.04). The results did not change substantially when both dementia status and previous mobility were introduced into the models (dementia OR 3.50 (2.99–4.11); dependent indoors and outdoors OR 3.98 (2.54–6.23); results not presented in tables).

Patients with dementia had an OR of 2.57 (2.20–3.02) of losing a level of mobility, compared with controls without dementia, whereas patients who were previously dependent outdoors had an OR of 4.53 (3.64–5.63). The results were similar when both dementia and mobility were introduced into the model [dementia OR 2.18 (1.85–2.57); dependent outdoors OR 3.77 (3.02–4.71); not presented in tables].

Discussion

In the present study, patients with dementia had worse functioning than controls without dementia before the onset of stroke. This is logical if we consider that dementia itself leads to dependency and need of either direct help or supervision of activities of daily living. Restricted mobility outside the home in patients with dementia could reflect severity of cognitive impairment and not only physical disability. Thus, the degree of physical disability may be less severe in a patient where cognitive impairment also contributes to restricted mobility. This could explain the surprising finding of lower mortality rates among dependent patients with dementia, compared with dependent dementia-free controls, if mobility limitations in the latter group reflected greater physical disability and comorbidities. Comorbidity, as reflected by the number of medication, was slightly higher in patients with dementia, although the presence of psychiatric symptoms requiring control and antidementia medication could explain part of this difference.[27] Hip fractures were also significantly more frequent in dementia patients, possibly a consequence of their greater risk for falls.[28]

The differences in stroke severity, assessed with RLS, are difficult to interpret in this population as patients with cognitive impairment frequently suffer from confusional syndrome or hypoactive delirium,[29] which could be wrongly attributed to more severe stroke. This group of patients with dementia was old (83 years median) with seriousness of disease that was mild to moderate at the time of diagnosis with a median MMSE at of 22 (interquartile range 7). By the time stroke occurred, patients would have likely declined further.

Prestroke dementia and poor prior mobility were associated with worse outcomes after stroke. In adjusted analyses, dementia was associated with excess mortality risk at 3 months. However, this was at least partially mediated by their poorer prestroke mobility: when mobility was included in the model, dementia became associated nonsignificantly with death at 3 months, suggesting that mobility mediated the effects of dementia on mortality risk. Furthermore, while dementia increased the odds of death by 35%, poor prestroke mobility was associated with a 200%–300% increase. Both dementia and prestroke mobility were strongly associated with functioning after stroke. The results on prestroke mobility are consistent with those described in a large cohort from 15 years ago,[14] although the OR for poststroke mobility impairment in our cohort was not as large (OR 4.53 in our study vs 9.88). It is possible that improvements in stroke care over time have improved outcomes in prestroke mobility impaired patients.

As shown in Table 2, patients with dementia received geriatric rehabilitation slightly less frequently after stroke and were more often discharged to nursing homes directly, but prestroke mobility was responsible for some of the difference. In analyses stratified by this

factor, discharge to geriatric rehabilitation was equally frequent in prestroke independent patients with dementia and controls without dementia (Table 4). Access to and success of rehabilitation in patients with dementia is understudied.[30] Furthermore, despite the relatively small increase in mortality in our cohort, patients with dementia experienced a disproportionate increase in disability after stroke. Prior research with Riksstroke suggests that functioning outcomes at 3 months predict long-term mortality.[26] The decrease in functioning seen in our study translates a tremendous burden both in terms of human suffering and from a cost perspective. To our knowledge, previous literature has not addressed the costs associated with caring for patients with dementia and with stroke. It is also unclear if effective interventions exist to limit disability and need for nursing home placement.[3,30]

The large longitudinal cohort, national character, and high coverage for stroke are strengths of this study, as is the availability of information on dementia type and MMSE at the time of diagnosis. The matching of patients with dementia and controls without dementia by age, sex, geographic region, and year of stroke should control factors related to regional and temporal differences in stroke care. A weakness of this study is the measure of mobility dependency, which is lacking a more detailed clinical assessment.[3] We assume that the individuals who had mobility impairments had at least some impairment in gait speed or lower body strength but this was not measured specifically. Furthermore, in patients with dementia, restrictions on outdoor independence could be related with cognitive problems (ie, risk of getting lost), instead of physical limitations. In addition, it has been argued that lack of mobility is a necessary cause, but not in itself sufficient,[11] to classify a patient as frail. Nevertheless, it is the best isolated parameter available and easily assessed in the emergency department. Another weakness is the lack of information on cognitive status at the time of stroke, which would be expected to progress between the diagnosis of dementia and the stroke event. This temporal decline explains the difference in rates of nursing home placement, from 9% at the time of dementia diagnosis to 32% just before the stroke. The MMSE was available for the time of dementia diagnosis, and 28% of patients had an MMSE>24, which is higher than described in other cohorts.[31] A number of factors in Sweden could contribute to the relatively high MMSE, including high educational attainment and extensive social welfare that could incentivize individuals to seek help promptly. Although the coverage of SveDem is increasing, it is not perfect, and patients with dementia not included could differ from those in our study. Dementia is underdiagnosed: a suspicion of previous cognitive impairment is frequent in patients suffering from stroke, at which point a diagnosis of dementia cannot be made because of the recent acute stroke event. The excellent coverage of Riksstroke should insure that the great majority of diagnosed strokes were included.

Dementia is a stigmatized disorder, and issues of access to care are important, particularly given the worldwide push to diagnose this condition earlier in the disease process.[3] Large gains can be made in stroke prevention in dementia: in a previous study from our group, only a minority of patients with dementia and atrial fibrillation were anticoagulated before suffering a stroke,[15] and there are large regional differences in Europe in care and medication consumption in patients with dementia.[31] In our study, prestroke mobility was a strong predictor for functional and mortality outcomes and should be considered, alongside dementia, when evaluating prognosis after stroke.

Conclusions

Prestroke mobility and dementia were highly associated with poor functional and mortality outcomes 3 months after stroke. However, the risk of requiring a more care-intensive living arrangement (OR 4.07) and of impaired mobility (OR 2.57) in patients with dementia was disproportionately greater than the risk of death (absolute death rate 31% vs 23% in controls without dementia, OR 1.34). In comparison, previous mobility was a stronger predictor of death (19% in previously independent vs 52% dependent patients 3 months after stroke). Once prestroke mobility was accounted for, patients with dementia were equally likely to be discharged to geriatric rehabilitation. These findings translate a high burden of disability for dementia and patients with mobility disability suffering from stroke and highlight the need for stroke research interventions among these populations.

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Appendix

Supplementary Table 1
Characteristics of Patients With Dementia at the Time of Dementia Diagnosis

	Patients with Dementia Diagnosis N = 1689 (100%)
Age median (IQR)	82 (9)
Sex women n (%)	980 (58.0%)
N drugs median (IQR)	5 (5)
Dementia diagnosis n (%)	
Alzheimer disease	399 (23.6%)
Mixed dementia	411 (24.3%)
Vascular dementia	393 (23.3%)
Others	486 (28.8%)
MMSE score median (IQR)	22 (7)
MMSE<20 n (%)	596 (37.6%)
MMSE 20–24 n (%)	549 (34.7%)
MMSE > 24 n (%)	439 (27.7%)
Nursing home at diagnosis	149 (8.9%)
Time from diagnosis to stroke median days (IQR)	512 (689.5)

IQR, interquartile range.
Missing data: MMSE score 105 (6.2%), nursing home 6 (0.4%), none missing for other variables.