Risk of Exclusion From Stroke Rehabilitation in the Oldest Old

Published Version:
Forti, P., Maioli, F., Magni, E., Ragazzoni, L., Piperno, R., Zoli, M., et al. (2018). Risk of Exclusion From Stroke Rehabilitation in the Oldest Old. ARCHIVES OF PHYSICAL MEDICINE AND REHABILITATION, 99(3), 477-483 [10.1016/j.apmr.2017.08.469].

Availability:
This version is available at: https://hdl.handle.net/11585/623501 since: 2018-02-22

Published:
DOI: http://doi.org/10.1016/j.apmr.2017.08.469

Accepted Manuscript

Risk of exclusion from stroke rehabilitation in the oldest-old

Paola Forti, MD, Fabiola Maioli, MD, Elisabetta Magni, MD, Letizia Regazzoni, MD, Roberto Piperno, MD, Marco Zoli, MD, Maura Coveri, MD, Gaetano Procaccianti, MD

PII: S0003-9993(17)31074-2
DOI: 10.1016/j.apmr.2017.08.469
Reference: YAPMR 57003

To appear in: *ARCHIVES OF PHYSICAL MEDICINE AND REHABILITATION*

Received Date: 27 April 2017
Revised Date: 5 July 2017
Accepted Date: 2 August 2017

Please cite this article as: Forti P, Maioli F, Magni E, Regazzoni L, Piperno R, Zoli M, Coveri M, Procaccianti G, Risk of exclusion from stroke rehabilitation in the oldest-old, *ARCHIVES OF PHYSICAL MEDICINE AND REHABILITATION* (2017), doi: 10.1016/j.apmr.2017.08.469.

Risk of exclusion from stroke rehabilitation in the oldest-old

Paola Forti, MD; Fabiola Maioli, MD; Elisabetta Magni, MD; Letizia Regazzoni, MD; Roberto Piperno, MD; Marco Zoli, MD; Maura Coveri, MD; Gaetano Procaccianti, MD

From: Department of Medical and surgical Sciences, University of Bologna, Italy (PF, LR, MZ); Geriatric Stroke Unit, Medical Department (FM), Rehabilitation Medicine, Emergency Department (EM, RP), Neurology Stroke Unit, Institute of Neurological Sciences – IRCCS (GP), Maggiore Hospital, Bologna, Italy.

Funding: This work was supported by the Basic Oriented Research grant RFO14 by the University of Bologna.

Conflict of interest: The authors have no potential conflicts of interest relevant to this manuscript and have not received support or benefits from commercial sources for the work reported.

Corresponding author: Paola Forti, Department of Medical and surgical Sciences, University of Bologna, Via Massarenti 9, 40138 Bologna, Italy (tel.; +39 051 214 2700; fax: +39 051 214 2210; email: paola.forti@unibo.it)

Risk of exclusion from stroke rehabilitation in the oldest-old

Abstract

Objective: To investigate whether oldest-old age (≥85 yr) is an independent predictor of exclusion from stroke rehabilitation.

Design: Retrospective cohort study.

Setting: Stroke Unit (SU) of an Italian tertiary hospital.

Participants: 1055 elderly patients (age 65-74 yr, n=230; age, 75-84 yr, n=432; age ≥ 85 yr, n=393), who, between 2009 and 2012, were admitted to SU with acute stroke and evaluated by a multiprofessional team for access to rehabilitation. The study excluded patients for whom rehabilitation was unnecessary or inappropriate.

Interventions: Not applicable.

Main Outcome Measures: Access to an early mobilization (EM) protocol during SU stay and subsequent access to post-acute rehabilitation after SU discharge. Analyses were adjusted for prestroke and stroke-related characteristics.

Results: 32.2% of patients were excluded from EM. Multivariable-adjusted Odds Ratio (OR) of EM exclusion was 1.30 (95% CI: 0.76, 2.21) for age 75-84 yr and 2.07 (95% CI: 1.19, 3.59) for age ≥85 yr compared to age 65-74 yr. Of 656 patients admitted to EM and who, at SU discharge, had not yet fully recovered their prestroke functionally status, 18.4% were excluded from post-acute rehabilitation. For patients able to walk unassisted at SU discharge, probability of exclusion did not change across age groups. For patients unable to walk unassisted at SU discharge, OR of exclusion from post-acute rehabilitation was 3.74 (95% CI: 1.26, 11.13) for age 75-84 yr and 9.15 (95% CI: 3.05, 27.46) for age ≥85 yr compared to age 65-74 yr.

Conclusion: Oldest-old age is an independent predictor of exclusion from stroke rehabilitation.

MeSH Keywords:

Aged, 80 and over

Stroke, Rehabilitation

Ageism

Cohort Studies

List of Abbreviations:

EM, early mobilization

ICH, intracerebral hemorrhage

IS, ischemic stroke

mRS, modified Rankin Scale

NHS, National Health System

SU, Stroke Unit

Stroke incidence is high in the elderly (age ≥65 yr) and reaches a peak in the oldest-old (age ≥ 85 yr).[1,2] Oldest-old persons represent the fastest growing segment of the population in developed countries and are characterized by a great heterogeneity in their health status and ability to withstand acute illnesses.[3]

Compared to younger elderly patients, stroke in the oldest-old is associated with higher severity and worse outcomes.[1,4] However, the oldest-old can benefit from early organized multidisciplinary stroke care (Stroke Unit [SU]) as effectively as younger stroke patients [5]

Post-acute rehabilitation is a major component of SU care.[6–8] A growing literature also supports the safety and efficacy of early mobilization (EM).[6], The term EM broadly refers to any rehabilitation intervention aimed at getting the patients out of bed already within the first 24 to 72 hours after an acute stroke.[6]

According to current evidence, age per se is not considered a reason for exclusion from stroke rehabilitation.[9–12] However, studies of hospital resource use in Western countries show that oldest-old patients admitted to SU are not investigated nor provided medical treatment as actively as younger elderly patients because of age discrimination.[13,14] Existing literature suggests that ageism also influences access to stroke rehabilitation, but specific information about oldest-old is scant.[15-18] An Australian[15]and an European study[16] reported an inverse association between age and access to stroke rehabilitation. Both studies were multicentric but neither provided age-specific rates of exclusion and one did not even include oldest-old patients.[16] In a study of Italian patients admitted to hospital with acute stroke, risk of exclusion from rehabilitation was higher for those aged ≥80 yr compared to younger patients.[17] Similar findings were reported in a French population-based study based on data from a stroke registry.[18] None of these studies, however made any attempt to identify those patients for whom rehabilitation would be unnecessary or inappropriate. Therefore, risk of exclusion for the oldest-old might have been overestimated, because prevalence of many conditions that can actually impede rehabilitation increases with age.[19-22]

The present study investigated whether, in a cohort of elderly stroke patients admitted to an Italian SU, oldest-old age was a predictor of exclusion from EM and post-acute rehabilitation independent of confounding from prestroke and stroke-related conditions.

Methods

Design and Setting

Data for this study were drawn from a prospective computer-based registry of 1514 patients aged ≥ 65 who, between 2007 and 2012, were consecutively admitted to the Stroke Unit of the Maggiore Hospital (20 beds) with diagnosis of acute stroke.[23,24] The Maggiore Hospital is a tertiary hospital, located in Bologna, Emilia Romagna Region, Italy. Stroke diagnosis (either ischemic stroke or spontaneous intracerebral hemorrhage) was based on clinical criteria[25] and at least one brain CT-scan performed within 24 hours after hospital admission. The registry did not include: (1) patients with ischemic stroke who underwent thrombolysis (in Italy, this treatment has been licensed for age ≥ 80 yr only since April 2016); (2) patients with hemorrhagic stroke due to trauma, brain tumor, infections, vascular malformations, vasculitis, and hemorrhagic transformation of ischemic stroke. Data about rehabilitation decisions during SU stay were regularly recorded in medical charts starting from January 1, 2009. Therefore, we considered eligible for the present study only the 1395 patients admitted to the Maggiore SU after this date. Of these, we excluded: (1) patients for whom any rehabilitation intervention would be inappropriate because of severe prestroke disability,defined as score 5 at the modified Rankin Scale[26] ([mRS], n=47); (2) patients with concurrent bone fractures impeding mobilization (n=6); (3) patients who did not need any rehabilitation because admitted to SU with minimal neurologic impairment (n=267). Italy has a publicly financed National Health System (NHS) that fully covers rehabilitation expenses for all stroke patients discharged with a rehabilitation plan. Inpatient stroke rehabilitation is provided in rehabilitation wards of public or private accredited hospital facilities. However, the Italian NIHSS does not cover rehabilitation expenses for stroke patients already institutionalized before stroke. Therefore, for the purposes of this study we additionally patients living in institution before SU admission (n=20).The Maggiore Hospital Ethics Committee approved the study. All subjects (or their legally authorized representatives) provided written informed consent.

Rehabilitation triage process

The multiprofessional team of the Maggiore SU included a neurologist, a geriatrician, a physiatrist, nurses, and physiotherapists. Within 48 hours from SU admission all patients were evaluated by the SU-team to identify those who could benefit from an early mobilization (EM) protocol under the physioterapists' supervision. The EM protocol aimed to assist the patient to be out of bed (sitting, standing, or walking as able) as soon as 24 hours after stroke onset. Before SU discharge, patients admitted to EM were reassessed by the SU team to identify those who could benefit from a post-acute rehabilitation plan (either home-based or inpatient). According to available literature for selection of potential rehabilitation patients in acute hospitals,[19-22] EM and post-acute rehabilitation were considered inappropriate for SU patients with the following conditions: medical instability due to organ failure or severe sepsis; life expectancy < 3 months; severe prestroke disability; and severe dementia with behavioral disorders.

Covariates

Covariates for multivariable-adjusted analyses involving EM included a large number of prestroke and stroke-related characteristics (listed and defined in **Table 1**). According to existing literature, all of these characteristics are associated with poor functional prognosis and may influence the stroke rehabilitation triage.[21,22,27-29] Multivariable-adjusted analyses involving post-acute rehabilitation additionally included mRS score at SU discharge as a measure of post-stroke functional damage, which is known to affect decisions about post-acute rehabilitation.[8] All information was derived from SU medical records. Data about aphasia and weekend admission or discharge were also available but we chose to not include them in the present report because corollary analyses showed that these covariates did not modify results.

Statistical analyses

Age was analyzed as a categorical variable (65-74, 75-84, and ≥85 yr).[3] Univariate associations of the covariates with admission to EM and post-acute rehabilitation were assessed using χ^2-test for categorical predictors and Student t-test for continuous variables. The association of age with exclusion from EM and post-acute rehabilitation was investigated using logistic regression. Analyses for post-acute rehabilitation were limited to patients admitted to EM who, at SU discharge, had not yet fully recovered to their prestroke functional status. All analyses were performed using SPSS software.[40] Models were tested for interactions. Significance tests were 2-tailed. Significance was set at $p<0.05$ for univariate analyses and $p<0.025$ for logistic regression (Bonferroni's adjustment for two sets of models). Study power was 0.85 to identify an Odds Ratio (OR) of 1.3 at $p=0.05$.

Results

EM protocol

The final study sample included 1055 patients (all of white race; age range 65-103 yr). Of these, 340 (32.2%) were excluded from EM after the first evaluation by the SU team. Univariate analyses (**Table 2**) showed that excluded patients were older (84±7 yr vs 80±7 yr, p< 0.001) and more likely to have unfavorable prestroke characteristics, ICH, and more severe stroke on admission. The most frequently reported reason for exclusion was medical instability (93.2%), followed by dementia (5.5%) and prestroke disability (4.3%). Of those excluded because of medical instability, 61.9% died during SU stay.

In logistic regression analyses using age 65-74 yr as the reference group, (**Table 3**), unadjusted odds of EM exclusion were significantly increased for both age 75-84 and ≥85 yr; the increase remained statistically significant after adjustment for prestroke characteristics. After further adjustment for stroke-related characteristics, odds of EM exclusion with respect to age 65-74 yr did not vary for age 75-74 yr but doubled for age ≥85 yr. Results for age ≥85 yr did not change after exclusion of patients who died in SU (OR: 4.14; 95% CI: 1.78, 9.58).

Post-acute rehabilitation

Of the 715 patients admitted to EM, two died in SU, three were transferred to other acute care settings because of complications, and 41 fully recovered to prestroke functional status during SU stay and were directly discharged home. Of the remaining 656 patients, 121 (18.4%) were excluded from post-acute rehabilitation. Noteworthy, none of these patients had developed major conditions impeding rehabilitation and the final decision of the SU team, as recorded in the patients' medical record, did not state a specific reason for rehabilitation exclusion. Among patients admitted to post-acute rehabilitation, 94.2% were transferred to inpatient facilities and only a minority (n=31) were discharged with an outpatient rehabilitation plan. Among patients excluded from post-acute rehabilitation, 55.4% (n=67) went back home (17 after a temporary stay in long-term care services) and 44.6% were transferred to long-term-care services for definitive institutionalization. Univariate analyses (**Table 4**) showed that patients excluded from post-acute rehabilitation were older (83±8 yr vs 79±7 yr, p<0.001) and more likely to have prestroke urinary incontinence, diabetes mellitus, more severe stroke-related characteristics, and higher mRS both prestroke and at SU discharge. Multivariable-adjusted logistic regression analyses for exclusion from post-acute rehabilitation showed a significant interaction of age with discharge mRS (p-value = 0.006). To explore the nature of this interaction, we graphed predicted probabilities of exclusion from post-acute rehabilitation by discharge mRS and age group. **Figure 1** shows how, for age 65-74 yr, probability of exclusion decreased across increasing levels of discharge mRS. The corresponding OR for increase in one level of discharge mRS was 0.42; 95% CI: 0.30,0.59. A similar association found for age 75-84 yr (OR: 0.56; 95% CI: 0.43,0.72), although average probability of exclusion tended to be higher than age 64-75 yr. By contrast, no association between probability of exclusion and discharge mRS was found for age ≥85 yr (OR: 0.81; 95% CI: 0.56,1.19). **Table 5** further illustrates how odds of exclusion did not vary across age groups among patients able to walk unassisted at SU discharge (mRS ≤ 3) but increased with age and were highest for age ≥85 yr among patients unable to walk unassisted at SU discharge (mRS > 3).

Discussion

This study shows that, in an elderly cohort with acute stroke admitted to an Italian SU, oldest-old age was a predictor of exclusion from both EM and post-acute rehabilitation. The association was independent of several socio-demographic and medical characteristics known to affect the stroke rehabilitation triage.[21,22,27–29] Our findings contrasts with growing evidence that rehabilitation should not be denied based on age alone.[9–12] However, they agree with existing evidence of ageism for other core elements of stroke treatment in SU of Western countries.[13,14] Previous studies of ageism and stroke rehabilitation are few, circumscribed to post-acute rehabilitation, and lacking specific and reliable information about the oldest-old.[15-18] Therefore, our findings may be useful to promote equal access to all aspects of specialized stroke care regardless of age.

A first result of our study is that risk of EM exclusion doubled for age ≥85 yr compared to age 65-74 yr. The most frequently reported reason for EM exclusion was medical instability and only a few patients were excluded because of prestroke geriatric conditions such as disability and dementia. There is agreement that rehabilitation is inappropriate for medically instable patients.[6,20] Our findings for EM, however, did not change when excluding from analysis the patients who died during SU stay. Therefore, some of our oldest-old stroke patients might have been denied EM because age per se negatively influenced the decision of the SU team about the patient's potential for functional improvement.

A second result is that, among the elderly stroke patients who, at SU discharge, had not yet recovered their prestroke functional level, age modified the association between risk of exclusion from post-acute rehabilitation and level of post-stroke functional damage as measured by mRS at SU discharge. For both age 65-74 yr and 75-84 yr , probability of exclusion decreased with increasing discharge mRS. This inverse association reflects a basic concept of stroke rehabilitation: the expected functional gain is highest for patients with severe disability and lowest for those with mild disability because of a "ceiling effect".[8] Therefore, in a real-world clinical practice with limited resources, patients with more severe disability are likely to be favored over patients with minimal disability. The inverse association between probability of exclusion and discharge mRS, however, disappeared for age ≥ 85 yr. This suggests that oldest-old patients did not receive post-acute rehabilitation according to their actual postroke disability level. In particular, among patients unable to walk unassisted at SU discharge, risk of exclusion from post-acute rehabilitation was highest for age ≥ 85 yr. Absolute values for risk estimates should be taken with caution, because of the wide confidence intervals, but they clearly suggest an increase across age groups.

Our findings for post-acute rehabilitation can be explained by several factors. First, limited availability of beds in inpatients rehabilitation facilities might favor younger patients over the oldest-old. Second, although the SU multidisciplinary team included a geriatrician and conducted a joint evaluation, in Italy only the physiatrist can actually plan a rehabilitation intervention and authorize transfer to a rehabilitation facility. Age is allegedly one of the lower ranked prognostic features in studies investigating decision-making by rehabilitation assessors.[29] However, an analysis of responses to simulated case scenarios showed that advanced age of the patients was associated with the highest variability in the physiatrists' final decision about rehabilitation potential after stroke.[41] Moreover, older age is still frequently an explicit exclusion factor in stroke rehabilitation studies.[42] Third, in order to be feasible and effective, rehabilitation interventions for oldest-old stroke patients should be highly customized. The rehabilitation plan should take into account the patient's strengths and limitations across multiple (clinical, functional, psycho-cognitive, social) dimensions and target the problem that can mostly jeopardize the patient's vitality and ability to return home.[43] This level of personalization, however, is not currently attained in most rehabilitation services with financial coverage from the Italian NHS. Although elderly stroke patients admitted to Italian rehabilitation services usually undergo shorter daily therapy sessions than young patients (only one hour instead of three), some of the oldest-old patients of this cohort may have been deemed too frail even to sustain a standard low intensity regimen. Fourth, programs to promote health and wellbeing of oldest-old persons represent a significant part of the Italian public welfare expenditures,[44] but Italian society is not immune from negative stereotypes of aging that may influence the rehabilitation triage of oldest-old persons.[45] Finally, we cannot exclude that our findings reflect a failure of our study design to adequately measure and account for all the age-related conditions that, in the individual patient, can justify exclusion from rehabilitation. This is currently an intrinsic bias of all rehabilitation studies because there is no standardized model for objectively determining a patient's potential to benefit from rehabilitation.[29,46] Our study, however, took into account a large number of prestroke and stroke-related characteristics known to influence access to rehabilitation in clinical practice.[21,22,27–29] Moreover, analyses for risk of exclusion from post-acute rehabilitation were performed on a subset of patients who had been previously admitted to EM and, therefore, had already been screened for major conditions precluding rehabilitation.

Limitations of the Study

This study has several limitations. First, this was a retrospective, single center study and the results may not apply outside of Italy because provision of stroke rehabilitation by different national healthcare systems strongly depends on local organization and resources.[16] However, our data are of interest because they provide a contemporary representation of the stroke rehabilitation triage process in elderly patients admitted to the SU of a tertiary hospital. Second, reasons for exclusion from post-acute rehabilitation were not recorded in the patients' medical charts and we cannot exclude confounding from unmeasured covariates. Socio-demographic information was limited to prestroke living situation and we lack information about the actual willingness and ability of existing relatives to take care of the patients after hospital discharge. This information is relevant because the Italian NHS does not cover rehabilitation expenses when stroke patients are discharged with a plan of definitive institutionalization. Therefore, for these patients, we ignore whether the actual reason for exclusion from post-acute rehabilitation was lack of rehabilitation potential or lack of alternatives to institutionalization because of an insufficient social network. Moreover, the Maggiore SU did not perform any formal assessment of balance and cognitive impairment, which are included in some rehabilitation scales for elderly persons,[46] The stroke scales used in this study are well validated in both clinical and research settings but mostly focus on walking and motor ability. Moreover, we lack information about need for a walking device and the patient's ability to use it, which may also have influenced the final decisions of the SU team. However, our analyses took into account prestroke diagnosis of dementia. Finally, we defined prestroke malnutrition based upon serum albumin, which is an acknowledged indicator of nutritional status in the elderly, but did not include information about anthropometric parameters such as body mass index.[35] A third reason for caution in the interpretation of our findings is the uncertainty still surrounding determinants and predictors of EM.[6] Fourth, our exclusion criteria may have penalized older patients and lead to underestimation of the association between age and exclusion from stroke rehabilitation. Finally, the study design does not allow inferences about the cost-effectiveness of EM and post-acute rehabilitation in our cohort.

Conclusions

This study shows that, among patients admitted to SU with acute stroke, oldest-old age is an independent predictor of exclusion from EM. Moreover, among stroke patients who at SU discharge are unable to walk unassisted, older age per se is associated with a higher probability of not accessing post-acute rehabilitation. Currently, the stroke rehabilitation triage process mainly relies on subjective clinical judgment.[20,41,47] A strong argument has been made for the viewpoint that defining formal criteria for access to rehabilitation may either increase stroke costs (by selecting inappropriate patients) or create self-filling prophecies (by excluding appropriate patients). [47,48] However, when oldest-old stroke patients are concerned, lack of explicit guidelines often lead to therapeutic inertia.[49] We hypothesize that the current lack of evidence-based recommendations for rehabilitation of oldest-old stroke patients is likely to favor age discrimination for access to rehabilitation interventions.

References

1. Chen R-L, Balami JS, Esiri MM, Chen L-K, Buchan AM. Ischemic stroke in the elderly: an overview of evidence. Nat Rev Neurol 2010;6:256–65.
2. Van Asch CJ, Luitse MJ, Rinkel GJ, van der Tweel I, Algra A, Klijn CJ. Incidence, case fatality, and functional outcome of intracerebral haemorrhage over time, according to age, sex, and ethnic origin: a systematic review and meta-analysis. Lancet Neurol 2010;9:167–76.
3. Baltes PB, Smith J. New frontiers in the future of aging: from successful aging of the young old to the dilemmas of the fourth age. Gerontology 2003;49:123–35.
4. Camacho E, LoPresti MA, Bruce S, Lin D, Abraham M, Appelboom G, Taylor B, McDowell M, Dubois B, Sathe M, Sander Connolly E. The role of age in intracerebral hemorrhages. J. Clin Neurosci 2015;22:1867-70.
5. Saposnik G, Kapral MK, Coutts SB, Fang J, Demchuk AM, Hill MD. Do all age groups benefit from organized inpatient stroke care? Stroke 2009;40:3321–7.
6. Bernhardt J, English C, Johnson L, Cumming TB. Early mobilization after stroke: early adoption but limited evidence. Stroke 2015;46:1141–6.
7. Dewey HM, Sherry LJ, Collier JM. Stroke rehabilitation 2007: what should it be? Int J Stroke 2007;2:191–200.
8. Teasel R, Hussein N, Foley N. Evidence-Based Review of Stroke Rehabilitation: Managing the stroke rehabilitation triage process [Internet]. 2013;Available from: http://www.ebrsr.com/evidence-review/4-managing-stroke-rehabilitation-triage-process. Last accessed: September 5, 2016.
9. Bagg S, Pombo AP, Hopman W. Effect of age on functional outcomes after stroke rehabilitation. Stroke 2002;33:179–85.
10. Denti L, Agosti M, Franceschini M. Outcome predictors of rehabilitation for first stroke in the elderly. Eur J Phys Rehabil Med 2008;44:3–11.

11. Kugler C, Altenhöner T, Lochner P, Ferbert A. Does age influence early recovery from ischemic stroke? A study from the Hessian Stroke Data Bank. J Neurol 2003;250:676–81.

12. Lieberman D, Lieberman D. Rehabilitation following stroke in patients aged 85 and above. J Rehabil Res Dev 2005;42:47–53.

13. Rudd AG, Hoffman A, Down C, Pearson M, Lowe D. Access to stroke care in England, Wales and Northern Ireland: the effect of age, gender and weekend admission. Age Ageing 2007;36:247–55.

14. Russo T, Felzani G, Marini C. Stroke in the very old: a systematic review of studies on incidence, outcome, and resource use. J Aging Res 2011;2011:108785.

15. Ilett PA, Brock KA, Graven CJ, Cotton SM. Selecting patients for rehabilitation after acute stroke: are there variations in practice? Arch Phys Med Rehabil 2010;91:788–93.

16. Putman K, De Wit L, Schupp W, Beyens H, Dejaeger E, de Weerdt W, Feys H, Jenni W, Louckx F, Leys M. Inpatient stroke rehabilitation: a comparative study of admission criteria to stroke rehabilitation units in four European centres. J Rehabil Med 2007;39:21–6.

17. Denti L, Scoditti U, Tonelli C, Saccavini M, Caminiti C, Valcavi R, Benatti M, Ceda GP. The poor outcome of ischemic stroke in very old people: a cohort study of its determinants. J Am Geriatr Soc. 2010;58:12–7.

18. Béjot Y, Troisgros O, Gremeaux V, Lucas B, Jacquin A, Khoumri C, Aboa-Eboulé C, Benaim C, casillas JM, Giroud M. Poststroke disposition and associated factors in a population-based study: the Dijon Stroke Registry. Stroke 2012;43:2071–7.

19. Langhorne P, Bernhardt J, Kwakkel G. Stroke rehabilitation. Lancet 2011;377:1693–702.

20. New PW. The assessment and selection of potential rehabilitation patients in acute hospitals: a literature review and commentary. Open Rehabil J. 2009;2:24–34.

21. Veerbeek JM, Kwakkel G, van Wegen EEH, Ket JCF, Heymans MW. Early prediction of outcome of activities of daily living after stroke: a systematic review. Stroke 2011;42:1482–8.

22. Van Almenkerk S, Smalbrugge M, Depla MFIA, Eefsting JA, Hertogh CMPM. What predicts a poor outcome in older stroke survivors? A systematic review of the literature. Disabil Rehabil 2013;35:1774–82.
23. Forti P, Maioli F, Arnone G, Nativio V, Zagnoni S, Riva L, Pedone C, Pirazzoli GL, Coveri M, Zoli M, Di Pasquale G, Procaccianti G. Mortality after admission to stroke unit for intracerebral hemorrhage: effect of age 80 and older and multimorbidity J Am Geriatr Soc 2015;63:812–3.
24. Forti P, Maioli F, Procaccianti G, Nativio V, Lega MV, Coveri M, zoli M, Sacquegna T. Independent predictors of ischemic stroke in the elderly: prospective data from a stroke unit. Neurology. 2013;80:29–38.
25. Hatano S. Experience from a multicentre stroke register: a preliminary report. Bull World Health Organ 1976;54:541–53.
26. Van Swieten JC, Koudstaal PJ, Visser MC, Schouten HJ, van Gijn J. Interobserver agreement for the assessment of handicap in stroke patients. Stroke 1988;19:604–7.
27. Dutrieux RD, van Eijk M, van Mierlo ML, van Heugten CM, Visser-Meily JMA, Achterberg WP. Discharge home after acute stroke: Differences between older and younger patients. J Rehabil Med 2016;48:14-8.
28. Van der Cruyssen K, Vereeck L, Saeys W, Remmen R. Prognostic factors for discharge destination after acute stroke: a comprehensive literature review. Disabil Rehabil 2015;37:1214–27.
29. Hakkennes S, Hill KD, Brock K, Bernhardt J, Churilov L. Selection for inpatient rehabilitation after severe stroke: what factors influence rehabilitation assessor decision-making? J Rehabil Med 2013;45:24–31.
30. Wade DT, Collin C. The Barthel ADL Index: a standard measure of physical disability? Int. Disabil Stud 1988;10:64–7.

31. American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes Care. 2013;36 Suppl 1:S67–74.

32. American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition: DSM-IV-TR®. American Psychiatric Pub; 2000.

33. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis 1987;40:373–83.

34. Goldstein LB, Samsa GP, Matchar DB, Horner RD. Charlson Index comorbidity adjustment for ischemic stroke outcome studies. Stroke 2004;35:1941–5.

35. Cabrerizo S, Cuadras D, Gomez-Busto F, Artaza-Artabe I, Marín-Ciancas F, Malafarina V. Serum albumin and health in older people: Review and meta analysis. Maturitas. 2015;81:17–27.

36. Schepers VPM, Ketelaar M, Visser-Meily AJM, de Groot V, Twisk JWR, Lindeman E. Functional recovery differs between ischaemic and haemorrhagic stroke patients. J Rehabil Med 2008;40:487–9.

37. Brott T, Adams HP Jr, Olinger CP, Marler JR, Barsan WG, Biller J, Spilker J, Holleran R, Eberle R, Hertzberg V. Measurements of acute cerebral infarction: a clinical examination scale. Stroke 1989;20:864–70.

38. Duncan PW, Zorowitz R, Bates B, Choi JY, Glasberg JJ, Graham GD, Katz RC, Lamberty K, Reker D. Management of adult stroke rehabilitation care: a clinical practice guideline. Stroke 2005;36:e100–43.

39. Teasdale G, Jennett B. Assessment of coma and impaired consciousness. A practical scale. Lancet 1974;2:81–4.

40. SPSS Statistics for Windows [computer program]. Version 22.0. Armonk, NY: IBM Corp; 2013.

41. Kennedy GM, Brock KA, Lunt AW, Black SJ. Factors influencing selection for rehabilitation after stroke: a questionnaire using case scenarios to investigate physician perspectives and level of agreement. Arch Phys Med Rehabil 2012;93:1457–9.
42. Gaynor EJ, Geoghegan SE, O'Neill D. Ageism in stroke rehabilitation studies. Age Ageing 2014;43:429–31.
43. Hiragami F, Nonaka T, Saitoh K, Suzuki Y. The utility of a care model to individualize rehabilitation in adults aged over 80 years. Top Stroke Rehabil 2015;22:102–15.
44. Italian Ministry of Health. Report on the Health Status of Country 2012-2013 [Internet]. Available from: http://www.salute.gov.it. Last accessed: March 18, 2017.
45. Dionigi RA. Stereotypes of aging: their effects on the health of older adults. J Geriatrics 2015;2015 DOI 10.1155/2015/954027.
46. Kalra L, Crome P. The role of prognostic scores in targeting stroke rehabilitation in elderly patients. J Am Geriatr Soc 1993; 41:396-400.
47. Wade DT. Selection criteria for rehabilitation services. Clin Rehabil 2003;17:115–8.
48. Dennis M. Predictions models in acute stroke: potential uses and limitations. Stroke 2008;39:1665–6.
49. Lee M, Ovbiagele B. Navigating the gray zones of stroke management for a graying population. Cerebrovasc Dis 2010;29:523–7.

Figure 1. Probability of exclusion from post-acute rehabilitation by age groups and modified Rankin Scale score at discharge from Stroke Unit.

Estimates are from a logistic regression model adjusted for prestroke and stroke-related characteristics (see Table 1 for a detailed list of covariates). The model included 656 patients admitted to early mobilization and who had not yet recovered their prestroke functional level at discharge from Stroke Unit. Number of patients was 171 for age 65-74 yr, 281 for age 75-84 yr, and 204 for age ≥85 yr.

Table 1. Characteristics of patients admitted to Stroke Unit with acute stroke

Characteristics	**Definition**
Prestroke	
Sex, race, living alone	
Disability	Modified Rankin Scale[26] in the week before SU admission. Full range for this scale is 0-5 (no symptoms-severe disability requiring constant nursing care and attention, bedridden, incontinent) but patients with severe prestroke disability (score 5) were considered ineligible for this study.
Urinary incontinence	Bladder item of Barthel Index Score < 10[30] in the week before SU admission
Heart failure, hypertension	Documented prior diagnosis or current specific treatment
Atrial fibrillation	Documented prior diagnosis of chronic/paroxysmal atrial fibrillation or positive EKG during SU stay
Diabetes mellitus	Documented prior diagnosis, current treatment, or glycated hemoglobin ≥ 6.5%[31] (routine blood tests at SU admission)
Dementia	Documented prior diagnosis, current treatment, or clinical criteria[32] for at least six months before SU admission
Comorbidity	Charlson Comorbidity Index (CCI)[33] ≥2[34] (range 0-37, no comorbidity, very severe comorbidity)
Malnutrition	Serum albumin < 3.5 mg/dl[35] (routine blood tests at SU admission)
Stroke-related	
Stroke type	Categorized as lacunar ischemic stroke, non-lacunar ischemic stroke, and intracerebral hemorrhage[36]
Stroke severity	National Institutes of Health Stroke Scale score[37] on Stroke Unit

	admission, categorized as 0-6, 7-15, ≥ 16[38] (range, 0-42, no stroke symptoms-very severe stroke)
Coma	Glasgow Coma Scale score 3-8[39] on Stroke Unit admission
Severe dysphagia	Need for nasogastric tube during Stroke Unit stay

All information was derived from the patients' medical records. For prestroke characteristics, information was recorded as provided by the patient or their primary caregiver unless otherwise specified.

Table 2. Characteristics of elderly stroke patients by access to early mobilization

Characteristics	**Admitted** (n = 715)	**Excluded** (n = 340)	**P-value**
Prestroke			
Age group, yr			<0.001
65-74	184 (25.7)	46 (13.5)	
75-74	301 (42.1)	131 (38.5)	
≥85	230 (32.3)	163 (47.9)	
Female sex	404 (56.5)	209 (61.5)	0.126
Living alone	216 (30.2)	77 (22.6)	0.010
Modified Rankin Scale score			<0.001
0	437 (61.1)	141 (41.5)	
1	89 (12.4)	44 (12.9)	
2	71 (9.9)	25 (7.4)	
3	79 (11.0)	78 (22.9)	
4	39 (5.5)	52 (15.3)	
Urinary incontinence	39 (5.5)	37 (10.9)	0.001
Charlson Comorbidity Index ≥2	278 (38.9)	165 (48.5)	0.003
Chronic heart failure	42 (5.9)	34 (10.0)	0.015
Diabetes mellitus	223 (31.2)	97 (28.5)	0.380
Hypertension	549 (76.8)	248 (72.9)	0.175
Dementia	99 (13.8)	96 (28.2)	<0.001
Atrial fibrillation	175 (24.8)	127 (37.4)	<0.001
Serum albumin < 3.5 gr/dl	321 (44.9)	172 (50.6)	0.083

Stroke-related			
Stroke type			<0.001
Lacunar ischemic stroke	159 (22.5)	3 (0.9)	
Non-lacunar ischemic stroke	347 (48.5)	161 (47.4)	
Intracerebral Hemorrhage	209 (29.2)	176 (51.8)	
Coma	24 (3.4)	136 (40.0)	< 0.001
National Institutes of Health Stroke Scale score			< 0.001
0-6	314 (43.9)	22 (6.5)	
7-15	241 (33.7)	45 (13.2)	
≥16	160 (22.5)	273 (80.3)	
Severe dysphagia	157 (22.0)	247 (72.6)	0.001

Data are reported as number (%). P-values are for χ^2-test. Abbreviations NIHSS, National Institutes of Health Stroke Scale, SU, stroke unit.

Table 3. Association of age with exclusion from an early mobilization protocol in elderly stroke patients

	65-74 yr (n=230)	**75-84 yr** (n=432)	**≥85 yr** (n=393)
Excluded, n (%)	46 (13.5)	131 (38.5)	163 (47.9)
Unadjusted OR (95% CI)	1.00	1.74 (1.19-2.55)	2.84 (1.94-4.15)
Model 1 OR (95% CI)	1.00	1.58 (1.05-2.36)	2.26 (1.49-3.41)
Model 2 OR (95% CI)	1.00	1.30 (0.76-2.21)	2.07 (1.19-3.59)

Odds Ratios (OR) and 95% Confidence Intervals (CI) are from logistic regression. Model 1 was adjusted for prestroke characteristics whereas Model 2 was additionally adjusted for stroke-related characteristics on SU admission (see Table 1 for a detailed list of covariates).

Table 4. Characteristics of elderly stroke patients by admission to post-acute rehabilitation

Characteristics	**Admitted** (n = 535)	**Excluded** (n = 121)	**P-value**
Prestroke			
Age group, yr			<0.001
65-74	153 (28.6)	18 (14.9)	
75-74	234 (43.7)	47 (38.8)	
≥85	148 (27.7)	56 (46.3)	
Female sex	297 (55.5)	72 (59.5)	0.424
Living alone	167 (31.2)	32 (26.4)	0.303
Modified Rankin Scale score			0.147
0	348 (65.0)	66 (54.5)	
1	60 (11.2)	21 (17.4)	
2	50 (9.3)	10 (8.3)	
3	53 (9.9)	17 (14.0)	
4	24 (4.5)	7 (5.8)	
Urinary incontinence	20 (3.7)	11 (9.1)	0.012
Charlson Comorbidity Index ≥ 2	209 (39.1)	46 (38.0)	0.831
Chronic heart failure	33 (6.4)	3 (2.5)	0.095
Diabetes	182 (34.0)	28 (23.1)	0.021
Hypertension	419 (78.3)	87 (71.9)	0.129
Dementia	68 (12.7)	17 (14.0)	0.692
Atrial fibrillation	128 (23.9)	36 (29.8)	0.181
Serum albumin < 3.5 gr/dl	230 (43.0)	57 (47.1)	0.410

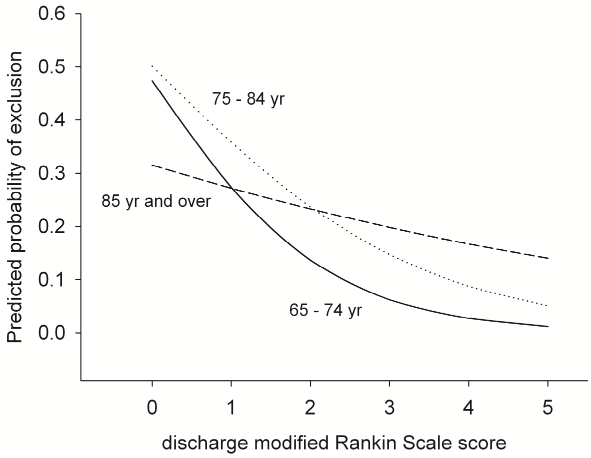
Stroke-related			
Stroke type			0.140
Lacunar ischemic stroke	109 (20.4)	31 (25.6)	
Non-lacunar ischemic stroke	261 (48.8)	63 (52.1)	
Intracerebral hemorrhage	165 (30.8)	27 (22.3)	
Coma	12 (2.2)	11 (9.1)	0.001
National Institutes of Health Stroke Scale score			0.023
0-6	227 (42.4)	50 (41.3)	
7-15	193 (36.1)	32 (26.4)	
≥16	115 (21.5)	39 (32.2)	
Severe dysphagia	105 (19.6)	39 (32.2)	0.002
Modified Rankin Scale score at discharge from Stroke Unit			<0.001
0	10 (1.9)	2 (1.7)	
1	20 (3.7)	22 (18.2)	
2	25 (4.7)	10 (8.3)	
3	84 (15.7)	11 (9.1)	
4	230 (43.0)	28 (23.1)	
5	166 (31.0)	48 (39.7)	

Data are reported as number (%) unless otherwise specified. P-values are for χ^2-test.

Table 5. Association of age with exclusion from post-acute rehabilitation in elderly stroke patients stratified by ability to walk unassisted at discharge from Stroke Unit

		65-74 yr	**75-84 yr**	**≥85 yr**
Able to walk unassisted		(n=68)	(n=81)	(n=35)
	Excluded, n (%)	13 (19.1)	21 (25.9.5)	11 (31.4)
	OR (95% CI)	1.00	1.93 (0.77-4.83)	1.70 (0.52-5.58)
Unable to walk unassisted		(n=103)	(n=200)	(n=169)
	Excluded, n (%)	5 (4.8)	26 (13.0)	45 (26.6)
	OR (95% CI)	1.00	3.74 (1.26-11.13)	9.15 (3.05-27.46)

Odds Ratios (OR) and 95% Confidence Intervals (CI) are from logistic regression. The final model was adjusted for prestroke and stroke-related characteristics on Stroke Unit admission (see Table 1 for a detailed list of covariates). According to their modified Rankin Scale score at Stroke Unit discharge, patients were stratified as able (score 0-3) or unable to walk unassisted (score 4-5).


0.6
0.5
0.4
0.3
0.2
0.1
0.0
Predicted probability of exclusion
75 - 84 yr
85 yr and over
65 - 74 yr
0
1
2
3
4
5
discharge modified Rankin Scale score