BMJ Open

Performance-based functional impairment and readmission and death: a prospective study

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2017-016207
Article Type:	Research
Date Submitted by the Author:	31-Jan-2017
Complete List of Authors:	Aubert, Carole; Inselspital, Bern University Hospital, University of Bern, General Internal Medicine Folly, Antoine; HFR Fribourg Hopital cantonal, General Internal Medicine Mancinetti, Marco; HFR Fribourg Hopital cantonal, General Internal Medicine Hayoz, Daniel; HFR Fribourg Hopital cantonal, General Internal Medicine Donzé, Jacques; Inselspital, Bern University Hospital, University of Bern, General Internal Medicine; Brigham and Women's Hospital Department of Medicine, General Medicine and Primary Care
Primary Subject Heading:	General practice / Family practice
Secondary Subject Heading:	Epidemiology, Geriatric medicine, Public health, Rehabilitation medicine
Keywords:	readmission, death, functional status, Timed Up and Go

Performance-based functional impairment and readmission and death: a prospective study

Running head: Functional status, readmission and death

Authors: Carole E Aubert, MD[1,2], Antoine Folly[2], Mancinetti Marco, MD[2], Daniel Hayoz, MD[2], Jacques D Donzé, MD, MSc[1,3,4].

Authors affiliations: [1] Department of General Internal Medicine, Inselspital, Bern University Hospital, University of Bern, Bern, Switzerland. [2] Department of General Internal Medicine, Fribourg Cantonal Hospital, Fribourg, Switzerland. [3] Division of General Medicine and Primary Care, Brigham and Women's Hospital, Boston, Massachusetts, USA. [4] Harvard Medical School, Boston, Massachusetts, USA.

Corresponding author:

Carole E Aubert, MD, Department of General Internal Medicine, Inselspital, Bern University Hospital, Freiburgstrasse, 3010 Bern, Switzerland.

Email: caroleelodie.aubert@insel.ch; phone: +41 31 632 21 11; fax: +41 31 632 88 85.

Authors contribution: All authors had access to the data during the study. Dr Aubert takes responsibility for the integrity of the data and the accuracy of the data analysis and is the guarantor. *Study concept and design:* Aubert, Donzé, Hayoz, Mancinetti. *Acquisition of data:* Aubert, Folly, Mancinetti. *Analysis and interpretation of data:* Aubert, Donzé. *Drafting of the manuscript:* Aubert, Donzé. *Critical revision of the manuscript for important intellectual content:* Hayoz, Folly, Mancinetti.

Funding source: This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Conflict of interest and acknowledgment: Nothing to declare.

Word count: 2434.

Abstract word count: 247.

Key words: readmission, death, functional status, Timed Up and Go.

Category: Original Article.

ABSTRACT

Objectives

Readmission and death are frequent after a hospitalization and difficult to predict. While many risk factors have been identified, only few studies have focused on functional status. We assessed whether functional impairment at discharge is associated with readmission and death after an acute medical hospitalization.

Design, setting and participants

We prospectively included patients aged ≥50 years admitted to the Department of General Internal Medicine of a large community hospital. Functional status was assessed shortly before discharge using the Timed Up and Go test performed twice in a standard way by trained physiotherapists, and defined functional impairment as a test duration ≥15 seconds.

Primary and secondary outcome measures

The primary and secondary outcome measures were unplanned readmission and death, respectively, within 6 months after discharge.

Results

Within 6 months after discharge, 107/338 (31.7%) patients had an unplanned readmission and 31/338 (9.2%) died. Functional impairment was associated with higher risk of death (OR 2.44, 95% CI 1.15-5.18), but not with unplanned readmission (OR 1.34, 95% CI 0.84-2.15). No significant association was found between functional impairment and the total number of unplanned rehospitalizations (adjusted OR 1.59, 95%CI 0.95-2.67). The most frequent causes of readmission were cardiovascular, oncological, and infectious diseases, and were similar regardless of the functional status.

Conclusions

Functional impairment at discharge of an acute medical hospitalization was associated with higher risk of death, but not of unplanned readmission within 6 months after discharge. Simple performance-based assessment may represent a better prognostic measure for mortality than for readmission.

ARTICLE SUMMARY

Strengths and limitations of this study

- ❖ Largest prospective cohort study evaluating the association of performance-based assessment with readmissions and death
- ❖ Long follow-up time of 6 months without loss to follow-up
- ❖ Assessment of both readmissions and deaths, separately
- ❖ Single center study including only medical patients

DATA SHARING STATEMENT: There are no unpublished data from the study.

INTRODUCTION

After an acute care hospitalization, readmissions are frequent, affecting 14-22% of the patients within 30 days after hospital discharge, and are associated with significant costs as well for the patients themselves as for the healthcare systems.[1-3] Factors that contribute to readmission are manifolds, including multimorbidity, complication of medical treatment, length of hospital stay, number of previous hospitalizations, socio-economic factors, care coordination, monitoring, follow-up care, and/or home support.[1,4,5] In this complex equation, patient's functional impairment could intuitively be considered as a potential risk factor for readmission. However, only few studies assessed the association between functional impairment and readmission.[6-15] Although those studies reported mainly a significant association between functional impairment and readmission,[7-15] they were often limited by a retrospective design,[7-10,12,15] and by the use of self-reported functional assessment, such as Activities of Daily Life (ADL) or Instrumental ADL (IADL).[7,8,10,11,13-15]

Performance-based functional methods have been shown to perform better than self-reported assessment.[16] One of the former is the Timed Up and Go (TUG) test, a brief, objective and simple performance-based assessment of functional status that doesn't require any special competence or equipment, allowing a wide use in everyday practice.[17] This test has been particularly associated with the risk of falls,[18-22] and is included in clinical guidelines to assess balance, gait, mobility, and risk of falls.[23-25]

In summary, the association between functional impairment and readmission is lacking high-level evidence such as prospective studies, using reliable performance-based assessment of functional status. Evidence on its association with mortality after discharge is even scarcer and more controversia.[26,27] Our aim was therefore to assess the association of performance-based functional impairment at discharge of an acute medical hospitalization with unplanned readmission and death in a prospective cohort study.

MATERIALS AND METHODS

Reporting is in accordance with the *STrengthening the Reporting of OBservational studies in Epidemiology (STROBE)* statement. [28]

Study design and population

In a prospective cohort study, we included all consecutive patients aged ≥50 years admitted to the Department of General Internal Medicine of a large secondary care hospital in Switzerland (Fribourg Cantonal Hospital), between April and September 2013. Our exclusion criteria were: 1) discharge the day of admission; 2) discharge to another acute care clinic, a rehabilitation setting, a palliative care clinic or another division of the same hospital; 3) death during the index hospitalization; 4) refusal or inability to give informed consent. The study complies with the Declaration of Helsinki and local ethics committee approved the study. For this observational cohort without intervention, we didn't perform a sample size calculation, and limited the sample size due to the resources available.

Outcomes

We defined our primary outcome as the first unplanned readmission to any division of any acute care hospital, and our secondary outcome as death, both within 6 months after discharge of index hospitalization. We defined planned readmission as scheduled hospitalization for investigation (e.g. elective bronchoscopy) or for not emergent treatment (e.g. planned radiotherapy for oncological treatment). All patients were contacted by phone call 6 months after discharge, in order to record our outcomes. If we failed to reach the patient directly, we phoned the general practitioner, a next of kin, or the nursing home, depending on each situation. To increase reliability, we additionally checked in the electronic health record for any readmission or death recorded within the network of Fribourg hospitals, which includes the 3 acute care hospitals of the

same region (Fribourg, Riaz, and Tavel), and four rehabilitation centers (Billens, Murten, Riaz, Tavel).

Causes of unplanned readmission and death were retrieved from medical records and classified into 10 categories, according to the system affected: 1) osteoarticular disease; 2) gastrointestinal disease; 3) infection; 4) neuropsychiatric disease (including dementia, alcohol disorder and intoxication); 5) respiratory disease; 6) oncological disease; 7) endocrine or metabolic disease; 8) renal disease; 9) cardiovascular disease; 10) other.

Functional status assessment

Patients performed the TUG test before discharge, according to its original description.[17] They were instructed to stand up from a chair without using their arms, walk 3 meters ahead (distance was marked on the floor), turn around, walk back to the chair and sit down. The duration to complete the test was timed by a stopwatch and recorded in seconds, beginning on the command "go" given to the patient, and ending after he/she had sit down and leaned against the back of the chair. The test was performed twice and the shortest time, indicating the best performance, was used for the analyses. Patients were allowed to use routine walking aids if needed (e.g. crutches or walker), but did not receive any physical assistance. Only three different trained physiotherapists performed the TUG test to all the cohort population. As we found no agreement in the literature for a specific duration to sort out patients with functional impairment,[18] we used the receiver operating characteristic (ROC) curve to define the optimal cutoff level associated with our outcomes. For this purpose, we used the point closest to the top left corner of the ROC curve, because it represents the best compromise between sensitivity and specificity.[29] Functional impairment was defined as a TUG test duration longer than the cutoff level that we identified. The areas under the ROC curves were 0.57 (95% confidence interval [CI] 0.51-0.64) for 6-months unplanned readmission and 0.63 (95% CI 0.54-0.73) for 6-months death. Both ROC curves identified the optimal cutoff level at 15 seconds. At this cutoff level, the sensitivity was 39.2% and 58.1% for unplanned readmission and death, respectively, and the specificity 66.1% and 64.1%.

Covariates

Socio-demographic data, number of hospitalizations during the 6 months before index admission and clinical information were recorded at baseline. Comorbidity was assessed by the Charlson comorbidity index, which attributes points a number of 1,2,3 or 6 to different medical conditions, depending on their severity,[30] and multimorbidity was defined as the presence of at least 2 chronic diseases according to this index. The main diagnoses of index admission were retrieved from medical records and divided into the same 10 categories as for diagnoses of readmission and death.

Data analysis

We presented continuous variables as median with interquartile range (IQR) because of their non-normal distribution, and compared them using nonparametric K-sample test on the equality of medians. Categorical variables were presented as frequency and percentage and compared using Pearson's chi-squared test.

Univariate logistic regression analysis was used to assess the association between functional impairment and unplanned readmission and death, respectively, within 6 months after hospital discharge. Multivariate analysis was adjusted for age and gender. We performed two sensitivity analyses including eight patients with missing data for the TUG test. We defined the duration of their non-performed TUG test as ≥15 seconds in the first one (i.e. functional impairment), and as <15 seconds in the second one (i.e. no functional impairment).

A two sided $P < .05$ was considered to indicate statistical significance. All analyses were performed using STATA release 13.0 (StataCorp LP, College Station, Texas).

RESULTS

We included 338 patients (Figure 1) and had no lost to follow-up. Median age was 73 (IQR 65-83) years with 168 (49.7%) men. Median Charlson comorbidity index was 5 (IQR 7-9) and 302 (89.4%) of the patients had multimorbidity. Median length of stay for index hospitalization was 7 (IQR 4-12) days. Within 6 months after discharge, 107 (31.7%) patients had an unplanned readmission and 31 (9.2%) died. Among the 31 patients who died, 23 (74.2%) had been previously readmitted. Table 1 shows the baseline characteristics of the patients according functional impairment. Patients with functional impairment were older and more likely to be women and to have been admitted to hospital within the 6 months before index admission (P <0.003 for all). They had also a higher comorbidity index and a longer length of stay (P <0.001 for all).

Association of functional impairment with unplanned readmission and death

The median duration of the TUG test was 13.1 (IQR 10.0-19.1) seconds for patients with an unplanned readmission, and 11.8 (IQR 8.1-17.7) seconds for those without any unplanned readmission (P = 0.34). The TUG test duration was significantly longer among patients who died (median [IQR] duration: 17 [11-21] versus 12 [8-18] seconds, P = 0.04). The duration of the TUG test was ≥15 seconds in 46 (43.0%) of the 107 patients with an unplanned readmission and in 18 (58.1%) of the patients who died within 6 months after hospital discharge. Functional impairment was associated with a higher risk of death within 6 months after discharge (odds ratio [OR] 2.44, 95% CI 1.15-5.18), while the risk of unplanned readmission was not significantly increased (OR 1.34, 95% CI 0.84-2.15). After adjusting for age and gender, the association was even stronger for death (OR 3.55, 95%CI 1.52-8.25), but remained unchanged for unplanned readmission (OR 1.58, 95%CI 0.94-2.64). We found no significant association between functional impairment and the absolute total number of unplanned rehospitalizations within 6 months (unadjusted OR 1.34, 95%CI 0.84-2.15, adjusted OR 1.59, 95%CI 0.95-2.67). In both sensitivity analyses including the

8 patients with missing data for the TUG test, results remained similar, with a significant increased risk of death, but not of readmission: sensitivity analysis defining patients with missing data as functional impaired (TUG test duration ≥15 seconds): adjusted OR 3.57, 95% 1.57-8.08 for death, adjusted OR 1.77, 95% CI 1.07-2.92. Sensitivity analysis defining patients with missing data as non-functional impaired (TUG test duration <15 seconds): adjusted OR 2.93, 95%CI 1.31-6.56 for death, adjusted OR 1.43, 95%CI 0.86-2.37 for readmission.

Primary causes of admission, unplanned readmission and death

Cardiovascular, infectious and neuropsychiatric diseases were the 3 most frequent main diagnoses of index hospitalizations, with 91 (27%), 67 (20%), and 65 (19%) cases, respectively.

The causes of unplanned readmissions are described in table 2, according to the duration of the TUG test. Cardiovascular, oncological and diseases accounted for 56 (52.3%) of all unplanned readmissions. Overall, we found more readmissions due to oncological, osteoarticular or gastrointestinal diseases among patients without, in comparison to those with functional impairment. Conversely, readmissions due to infection were more prevalent in patients with a TUG test duration ≥15 seconds than in those with a TUG test duration <15 seconds. The main cause of death was related to an oncological disease (n=17, 54,8%), followed by infectious (n=4, 12.9%) and respiratory diseases (n=3, 9.7%). Death due to oncological disease was more frequent among patients without functional impairment (61.5 vs 50.0%), and death due to infection among those with functional impairment (22.2 vs 7.7%).

CONCLUSIONS

In this prospective cohort study, we found that functional impairment measured by the validated performance-based method "Timed Up and Go test" before acute care hospital discharge, was associated with an almost 150% increase in the risk of death within 6 months after hospital discharge. Conversely, functional impairment was not associated with an increased risk of unplanned readmission.

These findings contrast with previous studies in which functional impairment was mostly positively associated with a higher risk of readmission.[7-15] Several reasons may explain this difference. First, unlike most previous studies, we used a performance-based assessment of functional status (TUG test) as opposed to a self-reported assessment. The TUG test has been largely validated as a simple, quick, and reliable clinical method to assess functional status.[17,22,31-34] Unlike self-reported evaluations often used in previous studies,[7,8,10,11,13-15] it is objective and its very high inter-rater and test-retest reliability allows better comparability.[17,22,35] Although this measure is very simple, it is actually constituted of several complex sequences (e.g. moving from the sitting to the standing position), each of which evaluating multiple aspects needed for adequate functional status, including balance, mobility and coordination.[36] Moreover, as opposed to other tools used to assess performance status,[37-39] the TUG test does not suffer from ceiling or floor effects in healthy older adults.[40] Owing in part to its sensitivity, this test is recommended by the American Geriatrics Society, the British Geriatrics Society, and the Society of Nordic Geriatricians to assess balance, gait, functional ability necessary to perform ADL and risk of falls.[23-25,41] Second, we included only patients discharged directly home or to a nursing home, while others focused on patients discharged to or from a rehabilitation care facility.[7,9,10,15] Patients discharged to a rehabilitation clinic may be more functionally impaired than other patients at discharge from the acute care settings, may have a higher morbidity level, and may of course have their risk influenced by the rehabilitation. Third, we focused on medical patients, while others included any types of patients.[7,8,10,11,15] Fourth and finally, we included only unplanned

readmissions, while many previous studies included elective readmissions in the primary outcome.[8,10-12]

Two other findings in our study support the absence of association between functional impairment and readmission. First, the number of hospitalizations in the 6 months following discharge was not significantly higher in the group of patients with functional impairment. Second, the causes of readmissions didn't vary according to functional status. Indeed, one may expect to see differences in the causes of readmission in case of an association between functional status and readmission. To our knowledge, previous studies recorded diagnoses of admission, but did not assess diagnoses of readmission or death according to functional status.

Interestingly, we found a significant association between functional impairment and death within 6 months after hospital discharge. Only few studies looked at this relationship between functional impairment and mortality. One, which included 269 geriatric patients, was negative,[14] while a most recent study found a significant association between higher frailty and death.[27] Larger studies are needed on this topic to confirm an association and to evaluate if interventions on functional status, e.g. home care or introduction of walking aids, could improve patients' outcome. All these findings together support that functional impairment may rather be a prognostic factor for mortality than a risk factor for readmissions.

Our findings should be considered in light of some limitations. First, our sample was relatively small. However, it is a prospective study, and, to our knowledge, the largest using this design and a performance-based assessment. Second, the study was conducted in a single center and included only medical patients, limiting the generalizability of our results; however, except for age, our population was otherwise unselected. Our study has some strengths. First, we studied both readmissions and deaths, separately. Second, we had a long follow-up time of 6 months and had no loss to follow-up during this whole period. Third, we included only unplanned readmissions. Fourth, we had no lost to follow-up, very few missing data, and in the sensitivity analyses including patients with missing data, results remained unchanged.

In conclusion, in this prospective cohort study, functional impairment was associated with an increased risk of death within 6 months after hospital discharge, but not with a significant risk of readmission. Simple performance-based assessment may represent a better prognostic measure for mortality than for readmission.

.

REFERENCES

1. Donzé J, Aujesky D, Williams D, Schnipper JL. Potentially avoidable 30-day hospital readmissions in medical patients: derivation and validation of a prediction model. JAMA internal medicine 2013;173:632-8.

2. Donzé J, Lipsitz S, Bates DW, Schnipper JL. Causes and patterns of readmissions in patients with common comorbidities: retrospective cohort study. BMJ (Clinical research ed) 2013;347:f7171.

3. Jencks SF, Williams MV, Coleman EA. Rehospitalizations among patients in the Medicare fee-for-service program. The New England journal of medicine 2009;360:1418-28.

4. Librero J, Peiro S, Ordinana R. Chronic comorbidity and outcomes of hospital care: length of stay, mortality, and readmission at 30 and 365 days. Journal of clinical epidemiology 1999;52:171-9.

5. Kansagara D, Englander H, Salanitro A, et al. Risk Prediction Models for Hospital Readmission: A Systematic Review. JAMA 2011;306(15):1688-1698.

6. Greysen SR, Covinsky KE. Functional status--an important but overlooked variable in the readmissions equation. Journal of hospital medicine 2014;9:330-1.

7. Hoyer EH, Needham DM, Miller J, Deutschendorf A, Friedman M, Brotman DJ. Functional status impairment is associated with unplanned readmissions. Archives of physical medicine and rehabilitation 2013;94:1951-8.

8. Depalma G, Xu H, Covinsky KE, et al. Hospital readmission among older adults who return home with unmet need for ADL disability. The Gerontologist 2013;53:454-61.

9. Burke RE, Whitfield EA, Hittle D, et al. Hospital Readmission From Post-Acute Care Facilities: Risk Factors, Timing, and Outcomes. Journal of the American Medical Directors Association 2016;17:249-55.

10. Hoyer EH, Needham DM, Atanelov L, Knox B, Friedman M, Brotman DJ. Association of impaired functional status at hospital discharge and subsequent rehospitalization. Journal of hospital medicine 2014;9:277-82.

11. Greysen SR, Stijacic Cenzer I, Auerbach AD, Covinsky KE. Functional impairment and hospital readmission in Medicare seniors. JAMA internal medicine 2015;175:559-65.

12. Nguyen HQ, Rondinelli J, Harrington A, et al. Functional status at discharge and 30-day readmission risk in COPD. Respiratory medicine 2015;109:238-46.

13. Tonkikh O, Shadmi E, Flaks-Manov N, Hoshen M, Balicer RD, Zisberg A. Functional status before and during acute hospitalization and readmission risk identification. Journal of hospital medicine 2016;11:636-41.

14. Smith DM, Katz BP, Huster GA, Fitzgerald JF, Martin DK, Freedman JA. Risk factors for nonelective hospital readmissions. Journal of general internal medicine 1996;11:762-4.

15. Coleman EA, Min SJ, Chomiak A, Kramer AM. Posthospital care transitions: patterns, complications, and risk identification. Health services research 2004;39:1449-65.

16. Hoeymans N, Wouters ER, Feskens EJ, van den Bos GA, Kromhout D. Reproducibility of performance-based and self-reported measures of functional status. The journals of gerontology Series A, Biological sciences and medical sciences 1997;52:M363-8.

17. Podsiadlo D, Richardson S. The timed "Up & Go": a test of basic functional mobility for frail elderly persons. Journal of the American Geriatrics Society 1991;39:142-8.

18. Beauchet O, Fantino B, Allali G, Muir SW, Montero-Odasso M, Annweiler C. Timed Up and Go test and risk of falls in older adults: a systematic review. The journal of nutrition, health & aging 2011;15:933-8.

19. Barry E, Galvin R, Keogh C, Horgan F, Fahey T. Is the Timed Up and Go test a useful predictor of risk of falls in community dwelling older adults: a systematic review and meta-analysis. BMC geriatrics 2014;14:14.

20. Kojima G, Masud T, Kendrick D, et al. Does the timed up and go test predict future falls among British community-dwelling older people? Prospective cohort study nested within a randomised controlled trial. BMC geriatrics 2015;15:38.

21. Okumiya K, Matsubayashi K, Nakamura T, et al. The timed "up & go" test is a useful predictor of falls in community-dwelling older people. Journal of the American Geriatrics Society 1998;46:928-30.

22. Shumway-Cook A, Brauer S, Woollacott M. Predicting the probability for falls in community-dwelling older adults using the Timed Up & Go Test. Physical therapy 2000;80:896-903.

23. Summary of the Updated American Geriatrics Society/British Geriatrics Society clinical practice guideline for prevention of falls in older persons. Journal of the American Geriatrics Society 2011;59:148-57.

24. National Institute for Health and Care Excellence (UK). NICE clinical guidelines: assessment and prevention of falls in older people. 2013.

25. Guideline for the prevention of falls in older persons. American Geriatrics Society, British Geriatrics Society, and American Academy of Orthopaedic Surgeons Panel on Falls Prevention. Journal of the American Geriatrics Society 2001;49:664-72.

26. Nikolaus T, Bach M, Oster P, Schlierf G. Prospective value of self-report and performance-based tests of functional status for 18-month outcomes in elderly patients. Aging (Milan, Italy) 1996;8:271-6.

27. Castro-Rodriguez M, Carnicero JA, Garcia-Garcia FJ, et al. Frailty as a Major Factor in the Increased Risk of Death and Disability in Older People With Diabetes. Journal of the American Medical Directors Association 2016.

28. von Elm E, Altman DG, Egger M, Pocock SJ, Gotzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies. International journal of surgery (London, England) 2014;12:1495-9.

29. Zweig MH, Campbell G. Receiver-operating characteristic (ROC) plots: a fundamental evaluation tool in clinical medicine. Clinical chemistry 1993;39:561-77.

30. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. Journal of chronic diseases 1987;40:373-83.

31. Sebastiao E, Sandroff BM, Learmonth YC, Motl RW. Validity of the Timed Up and Go Test as a Measure of Functional Mobility in Persons With Multiple Sclerosis. Archives of physical medicine and rehabilitation 2016;97:1072-7.

32. Gautschi OP, Smoll NR, Corniola MV, et al. Validity and Reliability of a Measurement of Objective Functional Impairment in Lumbar Degenerative Disc Disease: The Timed Up and Go (TUG) Test. Neurosurgery 2016;79:270-8.

33. Berg KO, Maki BE, Williams JI, Holliday PJ, Wood-Dauphinee SL. Clinical and laboratory measures of postural balance in an elderly population. Archives of physical medicine and rehabilitation 1992;73:1073-80.

34. Isles RC, Choy NL, Steer M, Nitz JC. Normal values of balance tests in women aged 20-80. Journal of the American Geriatrics Society 2004;52:1367-72.

35. Steffen TM, Hacker TA, Mollinger L. Age- and gender-related test performance in community-dwelling elderly people: Six-Minute Walk Test, Berg Balance Scale, Timed Up & Go Test, and gait speeds. Physical therapy 2002;82:128-37.

36. Janssen WG, Bussmann HB, Stam HJ. Determinants of the sit-to-stand movement: a review. Physical therapy 2002;82:866-79.

37. Vereeck L, Wuyts F, Truijen S, Van de Heyning P. Clinical assessment of balance: normative data, and gender and age effects. International journal of audiology 2008;47:67-75.

38. Boulgarides LK, McGinty SM, Willett JA, Barnes CW. Use of clinical and impairment-based tests to predict falls by community-dwelling older adults. Physical therapy 2003;83:328-39.

39. Garland SJ, Stevenson TJ, Ivanova T. Postural responses to unilateral arm perturbation in young, elderly, and hemiplegic subjects. Archives of physical medicine and rehabilitation 1997;78:1072-7.

40. Herman T, Giladi N, Hausdorff JM. Properties of the 'timed up and go' test: more than meets the eye. Gerontology 2011;57:203-10.

41. Sletvold O, Tilvis R, Jonsson A, et al. Geriatric work-up in the Nordic countries. The Nordic approach to comprehensive geriatric assessment. Danish medical bulletin 1996;43:350-9.

Table 1. Baseline characteristics of the entire cohort, and according to the presence of functional impairment at discharge of index admission.

Variable	TUG test duration ≥15 seconds (n=129)	TUG test duration <15 seconds (n=209)
Age, years	80 (72-86)	70 (61-79)
Men	47 (36.4)	121 (57.9)
Charlson comorbidity index	8 (6-10)	6 (4-8)
Multimorbidity *	125 (96.9)	177 (84.7)
Previous admission †	49 (38.0)	46 (22.0)
Duration of TUG test, seconds	23 (18-34)	10 (8-12)
Hospitalization characteristics		
Elective	2 (1.6)	11 (5.3)
Lengths of stay, days	9 (6-15)	5 (4-9)
Diagnosis of index admission		
Cardiovascular disease ‡	39 (30.2)	52 (24.9)
Infection	26 (20.2)	41 (19.6)
Neuropsychiatric disease §, ‖	18 (14.0)	47 (22.5)
Oncological disease	12 (9.3)	14 (6.7)
Respiratory disease §	11 (8.5)	19 (9.1)
Other	11 (8.5)	5 (2.4)
Gastrointestinal disease §	4 (3.1)	14 (6.7)
Osteoarticular disease §	4 (3.1)	6 (2.9)
Endocrine or metabolic disease	4 (3.1)	7 (3.4)
Renal disease ‡	0 (0.0)	4 (1.9)

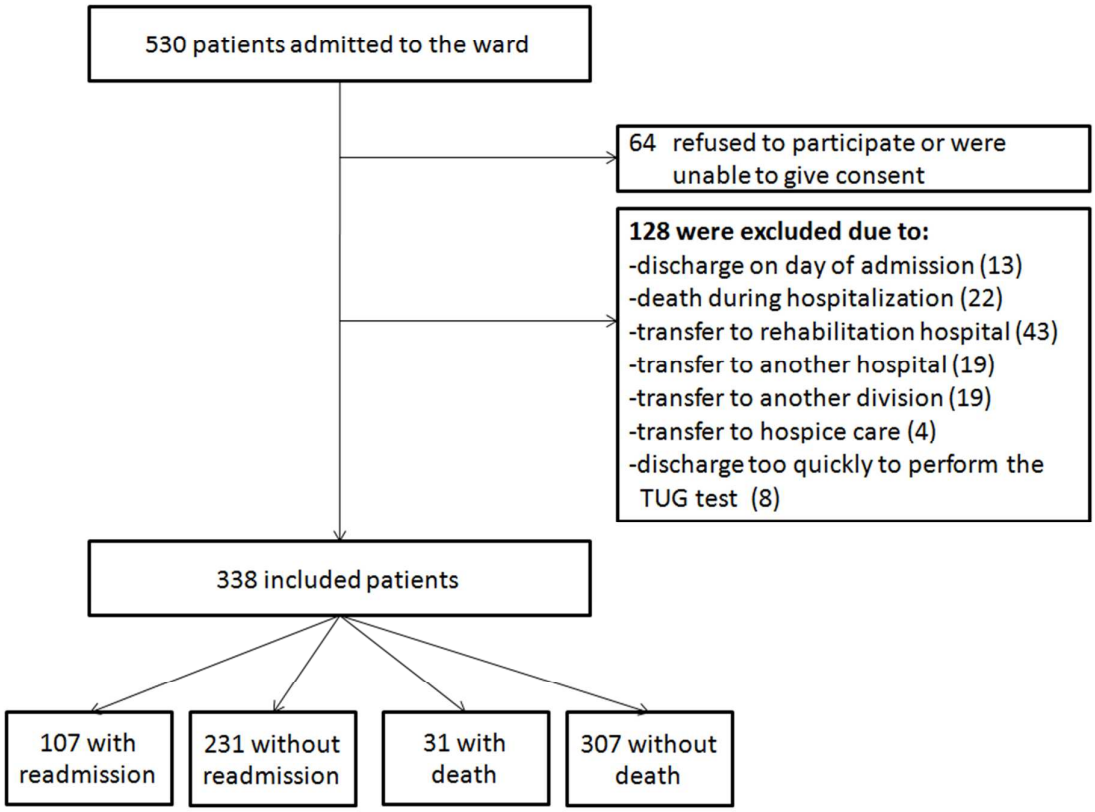
Data are n (% of column) or median (interquartile range).
Functional impairment was defined as a TUG test duration ≥ 15 seconds.
* Two or more comorbidities as recorded in the Charlson comorbidity index.
† Hospital admission(s) during the 6 months preceding index admission.
‡ Including ischemic/thrombotic disorder, congestive heart failure, arrhythmia.
§ Other than infection.
‖ Including dementia, alcohol disorder, intoxication.

Table 2. Causes of unplanned readmission within 6 months of discharge, according to the presence for functional impairment.

Diagnosis category	TUG test duration ≥ 15 seconds (n=46)	TUG test duration < 15 seconds (n=61)
Cardiovascular disease *, †	10 (21.7)	12 (19.7)
Infection	9 (19.6)	7 (11.5)
Oncological disease	7 (15.2)	11 (18.0)
Respiratory disease	6 (13.0)	7 (11.5)
Neuropsychiatric disease *, ‡	5 (10.9)	7 (11.5)
Gastro-intestinal disease *	3 (6.5)	6 (9.8)
Osteoarticular disease *	2 (4.4)	5 (8.2)
Endocrine or metabolic disease	2 (4.4)	3 (4.9)
Other / unknown	2 (4.4)	3 (4.9)
Renal disease *	1 (2.2)	2 (3.3)

Data are n (%).
Functional impairment was defined as a TUG test duration ≥ 15 seconds.
* Other than infection..
† Including ischemic/thrombotic disorder, congestive heart failure, arrhythmia.
‡ Including dementia, alcohol disorder, intoxication

Figure 1. Study flow diagram.



STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Page
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	5-6
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-7
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, explain how loss to follow-up was addressed	
		(*e*) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8 + Figure 1
		(b) Give reasons for non-participation at each stage	5+Fig 1
		(c) Consider use of a flow diagram	Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8+Table
		(b) Indicate number of participants with missing data for each variable of interest	7+Fig. 1
		(c) Summarise follow-up time (eg, average and total amount)	8
Outcome data	15*	Report numbers of outcome events or summary measures over time	8
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8-9
		(*b*) Report category boundaries when continuous variables were categorized	8-9
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9
Discussion			
Key results	18	Summarise key results with reference to study objectives	10
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	3+11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10-12
Generalisability	21	Discuss the generalisability (external validity) of the study results	11
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	1

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

BMJ Open

Performance-based functional impairment and readmission and death: a prospective study

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2017-016207.R1
Article Type:	Research
Date Submitted by the Author:	22-Mar-2017
Complete List of Authors:	Aubert, Carole; Inselspital, Bern University Hospital, University of Bern, General Internal Medicine Folly, Antoine; HFR Fribourg Hopital cantonal, General Internal Medicine Mancinetti, Marco; HFR Fribourg Hopital cantonal, General Internal Medicine Hayoz, Daniel; HFR Fribourg Hopital cantonal, General Internal Medicine Donzé, Jacques; Inselspital, Bern University Hospital, University of Bern, General Internal Medicine; Brigham and Women's Hospital Department of Medicine, General Medicine and Primary Care
Primary Subject Heading:	General practice / Family practice
Secondary Subject Heading:	Epidemiology, Geriatric medicine, Public health, Rehabilitation medicine
Keywords:	readmission, death, functional status, Timed Up and Go

Performance-based functional impairment and readmission and death: a prospective study

Running head: Functional status, readmission and death

Authors: Carole E Aubert, MD[1,2], Antoine Folly[2], Mancinetti Marco, MD[2], Daniel Hayoz, MD[2], Jacques D Donzé, MD, MSc[1,3,4].

Authors affiliations: [1] Department of General Internal Medicine, Inselspital, Bern University Hospital, University of Bern, Bern, Switzerland. [2] Department of General Internal Medicine, Fribourg Cantonal Hospital, Fribourg, Switzerland. [3] Division of General Medicine and Primary Care, Brigham and Women's Hospital, Boston, Massachusetts, USA. [4] Harvard Medical School, Boston, Massachusetts, USA.

Corresponding author:

Carole E Aubert, MD, Department of General Internal Medicine, Inselspital, Bern University Hospital, Freiburgstrasse, 3010 Bern, Switzerland.

Email: caroleelodie.aubert@insel.ch; phone: +41 31 632 21 11; fax: +41 31 632 88 85.

Authors contribution: All authors had access to the data during the study. Dr Aubert takes responsibility for the integrity of the data and the accuracy of the data analysis and is the guarantor. *Study concept and design:* Aubert, Donzé, Hayoz, Mancinetti. *Acquisition of data:* Aubert, Folly, Mancinetti. *Analysis and interpretation of data:* Aubert, Donzé. *Drafting of the manuscript:* Aubert, Donzé. *Critical revision of the manuscript for important intellectual content:* Hayoz, Folly, Mancinetti.

Funding source: This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Conflict of interest and acknowledgment: Nothing to declare.

Word count: 3077.

Abstract word count: 237.

Key words: readmission, death, functional status, Timed Up and Go.

Category: Original Article.

ABSTRACT

Objectives

Readmission and death are frequent after a hospitalization and difficult to predict. While many predictors have been identified, few studies have focused on functional status. We assessed whether performance-based functional impairment at discharge is associated with readmission and death after an acute medical hospitalization.

Design, setting and participants

We prospectively included patients aged ≥50 years admitted to the Department of General Internal Medicine of a large community hospital. Functional status was assessed shortly before discharge using the Timed Up and Go test performed twice in a standard way by trained physiotherapists, and defined as a test duration ≥15 seconds. Sensitivity analyses using a cut-off at >10 and >20 seconds were performed.

Primary and secondary outcome measures

The primary and secondary outcome measures were unplanned readmission and death, respectively, within 6 months after discharge.

Results

Within 6 months after discharge, 107/338 (31.7%) patients had an unplanned readmission and 31/338 (9.2%) died. Functional impairment was associated with higher risk of death (OR 2.44, 95% CI 1.15-5.18), but not with unplanned readmission (OR 1.34, 95% CI 0.84-2.15). No significant association was found between functional impairment and the total number of unplanned readmissions (adjusted OR 1.59, 95% CI 0.95-2.67).

Conclusions

Functional impairment at discharge of an acute medical hospitalization was associated with higher risk of death, but not of unplanned readmission within 6 months after discharge. Simple performance-based assessment may represent a better prognostic measure for mortality than for readmission.

ARTICLE SUMMARY

Strengths and limitations of this study

- ❖ Large prospective cohort study evaluating the association of performance-based assessment with readmissions and death in medical inpatients aged ≥50 years
- ❖ Long follow-up time of 6 months without loss to follow-up
- ❖ Assessment of both readmissions and deaths, separately
- ❖ Single center study including only medical patients

DATA SHARING STATEMENT: There are no unpublished data from the study.

INTRODUCTION

After an acute care hospitalization, readmissions are frequent, affecting 14-22% of the patients within 30 days after hospital discharge, and are associated with significant costs as well for the patients themselves as for the healthcare systems.[1-3] Factors that contribute to readmission are manifolds, including multimorbidity, complication of medical treatment, length of hospital stay, number of previous hospitalizations, socio-economic factors, care coordination, monitoring, follow-up care, and/or home support.[1,4,5] In this complex equation, patient's functional impairment could intuitively be considered as a potential predictor for readmission, as it may capture overall health status, including cardiorespiratory reserve and risk of falls altogether.[6,7]

Few studies assessed the association between performance-based functional impairment and readmission.[8-16] Although those studies reported mainly a significant association between functional impairment and readmission, they were often limited by a retrospective design, or by focusing on a specific setting such as surgical ward or rehabilitation care facilities, or on specific populations such as older adults or patients with chronic obstructive pulmonary disease or myocardial infarction. Functional impairment has also been associated with mortality in several studies in ambulatory care settings,[16-25] while the few studies assessing this outcome after a hospitalization found controversial results.[12,14,26]

Performance-based functional methods have been shown to perform better than self-reported assessment.[27] One of the former is the Timed Up and Go (TUG) test, a brief, objective and simple assessment of functional status that doesn't require any special competence or equipment, allowing a wide use in everyday practice.[28] Unlike many tools to assess functional status, the TUG test gives information both on balance and cardiorespiratory capacity, and was associated with overall health decline.[6] It has been also shown not to suffer from ceiling effect limitations, and to be related to executive function.[29] These characteristics make it a good potential tool to assess the risk of readmission. We therefore hypothesized that the TUG test may be a good predictor of adverse health outcomes, such as readmission.

In summary, although the TUG test has been associated with death and to a lesser extent with readmission, few studies looked at the predictability of the TUG test in a broader population such as general medical inpatients. Our aim was therefore to assess the association of performance-based functional impairment at discharge of an acute medical hospitalization with unplanned readmission and death in a prospective cohort study including medical patients aged 50 years or older.

MATERIALS AND METHODS

Reporting is in accordance with the *STrengthening the Reporting of OBservational studies in Epidemiology (STROBE)* statement.[30]

Study design and population

In a prospective cohort study, we included all consecutive patients aged ≥50 years admitted to the Department of General Internal Medicine of a large secondary care hospital in Switzerland (Fribourg Cantonal Hospital, 115 beds, 4400 admissions/year), between April and September 2013. Our exclusion criteria were: 1) discharge the day of admission; 2) discharge to another acute care clinic, a rehabilitation setting, a palliative care clinic or another division of the same hospital; 3) death during the index hospitalization; 4) refusal or inability to give informed consent. The study complies with the Declaration of Helsinki and local ethics committee (Commission d'éthique de recherche, Direction de la santé et des affaires sociales, Fribourg, Switzerland) approved the study. For this observational cohort without intervention, we didn't perform a sample size calculation, and limited the sample size due to the resources available.

Outcomes

We defined our primary outcome as the first unplanned readmission to any division of any acute care hospital, and our secondary outcome as death, both within 6 months after discharge of index hospitalization. We defined planned readmission as scheduled hospitalization for investigation (e.g. elective bronchoscopy) or for not emergent treatment (e.g. planned radiotherapy for oncological treatment). All patients were contacted by phone call 6 months after discharge in order to record our outcomes. If we failed to reach the patient directly, we phoned the general practitioner, a next of kin, or the nursing home, depending on each situation. To increase reliability, we additionally checked in the electronic health record for any readmission or death recorded within the network of Fribourg hospitals, which includes the 3 acute care hospitals of the

same region (Fribourg, Riaz, and Tavel), and 4 rehabilitation centers (Billens, Murten, Riaz, Tavel).

Functional status assessment

Patients performed the TUG test before discharge, according to its original description.[28] They were instructed to stand up from a chair without using their arms, walk 3 meters ahead (distance was marked on the floor), turn around, walk back to the chair and sit down. The duration to complete the test was timed by a stopwatch and recorded in seconds, beginning on the command "go" given to the patient, and ending after he/she had sit down and leaned against the back of the chair. The test was performed twice and the shortest time, indicating the best performance, was used for the analyses. Patients were allowed to use routine walking aids if needed (e.g. crutches or walker), but did not receive any physical assistance. Only 3 different trained physiotherapists performed the TUG test to all the cohort population. Patients who were too debilitated to perform the test were classified as having functional impairment.

We decided to dichotomize the results of the TUG test instead of using it as a continuous variable or in a higher number of categories, because we thought that classifying patients at high versus low risk of readmission or death would be more useful to interpret for clinicians. As we found no agreement in the literature for a specific duration to sort out patients with functional impairment,[7] we used the receiver operating characteristic (ROC) curve to define the optimal cutoff level associated with our outcomes. For this purpose, we used the point closest to the top left corner of the ROC curve, because it represents the best compromise between sensitivity and specificity.[31] Functional impairment was defined as a TUG test duration longer than the cutoff level that we identified. The areas under the ROC curves were 0.57 (95% confidence interval [CI] 0.51-0.64) for 6-month unplanned readmission and 0.63 (95% CI 0.54-0.73) for 6-month death. Both ROC curves identified the optimal cutoff level at 15 seconds. At this cutoff level, the sensitivity was 39.2% and 58.1% for unplanned readmission and death, respectively, and the specificity 66.1% and 64.1%.

Covariates

Socio-demographic data, number of hospitalizations during the 6 months before index admission and clinical information were recorded at baseline. Comorbidity was assessed by the Charlson comorbidity index, which attributes a number of points of 1,2,3 or 6 to different medical conditions, depending on their severity,[32] and multimorbidity was defined as the presence of at least 2 chronic diseases according to this index. The main diagnoses of index admission were retrieved from medical records and divided into 10 categories, according to the system affected: 1) osteoarticular disease; 2) gastrointestinal disease; 3) infection; 4) neuropsychiatric disease (including dementia, alcohol disorder and intoxication); 5) respiratory disease; 6) oncological disease; 7) endocrine or metabolic disease; 8) renal disease; 9) cardiovascular disease; 10) other.

Data analysis

We presented continuous variables as median with interquartile range (IQR) because of their non-normal distribution, and compared them using nonparametric K-sample test on the equality of medians. Categorical variables were presented as frequency and percentage and compared using Pearson's chi-squared test.

Univariate logistic regression analysis was used to assess the association between functional impairment and unplanned readmission and death, respectively, within 6 months after hospital discharge. Multivariate analysis was adjusted for age and gender. A collinearity diagnostic measurement was performed to detect collinearity between the variables included in the model.[33] A link test was used to confirm that the linear approach to model the outcome was correct.[34] We used age as a continuous variable because assessing the variable in categories or after cubic or quadratic transformation yielded similar results. Model fit was assessed using the Hosmer-Lemeshow goodness-of-fit test.[35]

We performed two sensitivity analyses including 8 patients with missing data for the TUG test. We defined the duration of their non-performed TUG test as ≥15 seconds in the first one (i.e.

functional impairment), and as <15 seconds in the second one (i.e. no functional impairment). As there was no agreement for a specific cutoff when dichotomizing the TUG test duration,[7] although we used a validated method to select it,[31] we also performed additional sensitivity analyses with the cutoff set at >10 and >20 seconds, respectively, as done in previous studies.[12,14,22] We finally performed a sensitivity analysis excluding the patients who were too debilitated to perform the test.A two sided $P < 0.05$ was considered to indicate statistical significance. All analyses were performed using STATA release 13.0 (StataCorp LP, College Station, Texas).

RESULTS

We included 338 patients (Figure 1) and had no lost to follow-up, as we managed to get the outcome information per phone call (to the patient or to the general practitioner, a next of kin, or the nursing home) for all patients. Median age was 73 (IQR 65-83) years with 168 (49.7%) men. Median Charlson comorbidity index was 5 (IQR 7-9) and 302 (89.4%) of the patients had multimorbidity. Median length of stay for index hospitalization was 7 (IQR 4-12) days. Within 6 months after discharge, 107 (31.7%) patients had an unplanned readmission and 31 (9.2%) died. Among the 31 patients who died, 23 (74.2%) had been previously readmitted. Patients with functional impairment were older and more likely to be women and to have been admitted to hospital within the 6 months before index admission ($P < 0.003$ for all). They had also a higher Charlson comorbidity index and a longer length of stay ($P < 0.001$ for all). Cardiovascular, infectious and neuropsychiatric diseases were the 3 most frequent main diagnoses of index hospitalization, with 91 (27%), 67 (20%), and 65 (19%) cases, respectively.

Association of functional impairment with unplanned readmission and death

Table 1 and Table 2 show the baseline characteristics according to the presence or absence of readmission or death, respectively. The median duration of the TUG test was 13 (IQR 10-19) seconds for patients with an unplanned readmission, and 12 (IQR 8-18) seconds for those without any unplanned readmission ($P = 0.34$). The TUG test duration was significantly longer among patients who died (median [IQR] duration: 17 [11-21] versus 12 [8-18] seconds, $P = 0.04$). The duration of the TUG test was ≥15 seconds in 46 (43.0%) of the 107 patients with an unplanned readmission and in 18 (58.1%) of the patients who died within 6 months after hospital discharge.

Functional impairment was associated with a higher risk of death within 6 months after discharge (odds ratio [OR] 2.44, 95% CI 1.15-5.18), while the risk of unplanned readmission was not significantly increased (OR 1.34, 95% CI 0.84-2.15). After adjusting for age and gender, the association was even stronger for death (OR 3.55, 95% CI 1.52-8.25), but remained unchanged for

unplanned readmission (OR 1.58, 95% CI 0.94-2.64). We found no significant association between functional impairment and the absolute total number of unplanned readmissions within 6 months (unadjusted OR 1.34, 95% CI 0.84-2.15, adjusted OR 1.59, 95% CI 0.95-2.67). *P* for the Hosmer-Lemeshow goodness-of-fit test was > 0.05 for both adjusted models, indicating good fit. The variance inflation factors and tolerance were near 1.00 for all variables, excluding significant collinearity. The link test confirmed that the linear approach to model the outcomes was correct.

In both sensitivity analyses including the 8 patients with missing data for the TUG test, results remained similar, with a significant increased risk of death, but not of readmission: sensitivity analysis defining patients with missing data as functional impaired (TUG test duration ≥15 seconds): adjusted OR 3.57, 95% 1.57-8.08 for death, adjusted OR 1.77, 95% CI 1.07-2.92 for readmission. Sensitivity analysis defining patients with missing data as non-functional impaired (TUG test duration <15 seconds): adjusted OR 2.93, 95% CI 1.31-6.56 for death, adjusted OR 1.43, 95% CI 0.86-2.37 for readmission. Results were similar in the sensitivity analyses setting the cutoff point at >10 or >20 seconds, respectively: OR 1.67 (95% CI 0.97-2.86) and 1.32 (95% CI 0.74-2.35) for readmission, and 2.69 (95% CI 1.09-6.67) and 2.64 (95% CI 1.11-6.30) for death, as well as in the sensitivity analysis excluding 12 patients who were too debilitated to perform the TUG test (OR 4.16, 95% CI 1.76-9.83 for death; OR 1.50, 95% CI 0.88-2.55).

CONCLUSIONS

In this prospective cohort study, we found that functional impairment, defined as ≥15 seconds to perform the validated performance-based "Timed Up and Go test" before acute care hospital discharge, was associated with an almost 150% increase in the risk of death within 6 months after hospital discharge. Conversely, functional impairment was not associated with an increased risk of unplanned readmission.

These findings contrast with previous studies in which functional impairment was mostly positively associated with a higher risk of readmission.[8-13] Several reasons may explain this difference.

First, we used the TUG test, which has been largely validated as a simple, quick, and reliable clinical method to assess functional status,[28,36-40] and presents several advantages in comparison with other tools to assess functional status. The TUG test is objective, and its very high inter-rater and test-retest reliability allows better comparability than other tools.[28,40,41] Although this measure is very simple, it is actually constituted of several complex sequences (e.g. moving from the sitting to the standing position), each of which evaluating multiple aspects needed for adequate functional status, including balance, mobility, cardiorespiratory function, and coordination.[42] It may therefore capture several factors such as disease severity, independently of the kind of disease, and may as such be a good proxy to predict overall health decline.[6,7] Moreover, as opposed to other tools used to assess functional status,[43-45] the TUG test does not suffer from ceiling or floor effects in healthy older adults.[29] Furthermore, a physiotherapist is not absolutely needed, as it can be performed by nursing personal as well.[46,47]

Second, we included only patients discharged directly home or to a nursing home, while others focused on patients discharged to a rehabilitation care facility.[8] Patients discharged to a rehabilitation clinic may be more functionally impaired and have a higher morbidity level than other patients at discharge from the acute care setting. Conversely, we can suppose that functional status will be improved by the rehabilitation stay, which may consequently lower the following

risk of readmission or death. Similarly, other authors evaluated functional status at admission before an elective operation, at the time of discharge from the emergency department, or one month after discharge.[11,15,16] We may suppose that all those patients have a better functional status than our population, as the acute care hospitalization may affect functional status, limiting comparability with our study.

Third, we focused on medical patients aged 50 years or older, while others studied older adults,[9-12,15] or patients with a specific disease, such as chronic obstructive pulmonary disease or myocardial infarction.[11,13] Fourth and finally, we included only unplanned readmissions, while many previous studies included elective readmissions in the primary outcome.[8,10-14,16] Two other findings in our study support the absence of association between functional impairment and readmission. First, the number of hospitalizations in the 6 months following discharge was not significantly higher in the group of patients with functional impairment. Second, sensitivity analyses using other cutoff points to define functional impairment yielded similar results.

Interestingly, we found a significant association between functional impairment and death within 6 months after hospital discharge. Only few studies looked at this relationship between functional impairment and mortality following discharge.[12,14,26] Two of them, which included 135 geriatric and 495 medical inpatients, respectively, were negative,[14,26] while another study using the TUG test in 147 geriatric inpatients found an association.[12] Our results are consistent with studies performed in ambulatory care settings.[16-24] All these findings together support that functional impairment may rather be a predictor for mortality than for readmission.

If confirmed by larger studies in general medical inpatients, our findings may have two main clinical implications. First, it may help to identify high-risk patients who would most likely benefit from interventions that have been shown to improve functional status.[10,48] However, further studies are needed to assess if these interventions can improve patients' outcome also. Second, it may help clinicians to assess the risk of short-term death of their patients, and to consequently tailor preventive and therapeutic care to each patient. Some drugs or preventive prescriptions, such as cancer screening, may indeed more harm than benefit to those high-risk patients unlikely to

survive long enough to benefit from the intervention. The TUG test may therefore represent an easy-to-use and reliable tool for clinicians to improve assessment of patients' life expectancy. As our results were similar when including or excluding patients who were too debilitated to perform the test, our findings may apply to those patients also, if classified as functionally impaired. Furthermore, our simple model adjusting only for age and gender lets suppose that other variables are not needed to predict the risk of death, which may be useful for clinical implementation.

Our findings should be considered in light of some limitations. First, our sample was relatively small. Second, the study was conducted in a single center and included only medical patients, limiting the generalizability of our results; however, except for age, our population was otherwise unselected. Third, we excluded patients who were discharged to a rehabilitation facility, because we hypothesized that their functional status at discharge of the acute care setting would not reflect their actual functional status at discharge of the rehabilitation clinic. Our findings may therefore not apply to these patients. Fourth, although we may not exclude residual confounding factors, the aim of our study was to evaluate the performance of the TUG test as a simple overall prediction measure and not as an independent risk factor. Therefore, we adjusted only for age and gender.

Our study has some strengths. First, we studied both readmissions and deaths, separately. Second, it was a prospective study with a long follow-up time of 6 months and no loss to follow-up during this whole period. Third, we included only unplanned readmissions. Fourth, we had no lost to follow-up, very few missing data, and in the sensitivity analyses including patients with missing data, excluding patients unable to perform the test, or using other cutoff points to define functional impairment, results remained unchanged.

In conclusion, in this prospective cohort study, functional impairment was associated with an increased risk of death within 6 months after hospital discharge, but not with a significant risk of readmission. Simple performance-based assessment may represent a better prognostic measure for mortality than for readmission.

.

REFERENCES

1. Donzé J, Aujesky D, Williams D, Schnipper JL. Potentially avoidable 30-day hospital readmissions in medical patients: derivation and validation of a prediction model. JAMA internal medicine 2013;173:632-8.

2. Donzé J, Lipsitz S, Bates DW, Schnipper JL. Causes and patterns of readmissions in patients with common comorbidities: retrospective cohort study. BMJ (Clinical research ed) 2013;347:f7171.

3. Jencks SF, Williams MV, Coleman EA. Rehospitalizations among patients in the Medicare fee-for-service program. The New England journal of medicine 2009;360:1418-28.

4. Librero J, Peiro S, Ordinana R. Chronic comorbidity and outcomes of hospital care: length of stay, mortality, and readmission at 30 and 365 days. Journal of clinical epidemiology 1999;52:171-9.

5. Kansagara D, Englander H, Salanitro A, et al. Risk Prediction Models for Hospital Readmission: A Systematic Review. JAMA 2011;306(15):1688-1698.

6. Roedl KJ, Wilson LS, Fine J. A systematic review and comparison of functional assessments of community-dwelling elderly patients. Journal of the American Association of Nurse Practitioners 2016;28:160-9.

7. Beauchet O, Fantino B, Allali G, Muir SW, Montero-Odasso M, Annweiler C. Timed Up and Go test and risk of falls in older adults: a systematic review. The journal of nutrition, health & aging 2011;15:933-8.

8. Burke RE, Whitfield EA, Hittle D, et al. Hospital Readmission From Post-Acute Care Facilities: Risk Factors, Timing, and Outcomes. Journal of the American Medical Directors Association 2016;17:249-55.

9. Tonkikh O, Shadmi E, Flaks-Manov N, Hoshen M, Balicer RD, Zisberg A. Functional status before and during acute hospitalization and readmission risk identification. Journal of hospital medicine 2016;11:636-41.

10. Peel NM, Navanathan S, Hubbard RE. Gait speed as a predictor of outcomes in post-acute transitional care for older people. Geriatrics & gerontology international 2014;14:906-10.

11. Robinson TN, Wu DS, Pointer L, Dunn CL, Cleveland JC, Jr., Moss M. Simple frailty score predicts postoperative complications across surgical specialties. American journal of surgery 2013;206:544-50.

12. Wong RY, Miller WC. Adverse outcomes following hospitalization in acutely ill older patients. BMC geriatrics 2008;8:10.

13. Kon SS, Jones SE, Schofield SJ, et al. Gait speed and readmission following hospitalisation for acute exacerbations of COPD: a prospective study. Thorax 2015;70:1131-7.

14. Belga S, Majumdar SR, Kahlon S, et al. Comparing three different measures of frailty in medical inpatients: Multicenter prospective cohort study examining 30-day risk of readmission or death. Journal of hospital medicine 2016;11:556-62.

15. Walker KJ, Bailey M, Bradshaw SJ, et al. Timed Up and Go test is not useful as a discharge risk screening tool. Emergency medicine Australasia : EMA 2006;18:31-6.

16. Dodson JA, Arnold SV, Gosch KL, et al. Slow Gait Speed and Risk of Mortality or Hospital Readmission After Myocardial Infarction in the Translational Research Investigating Underlying Disparities in Recovery from Acute Myocardial Infarction: Patients' Health Status Registry. Journal of the American Geriatrics Society 2016;64:596-601.

17. Roshanravan B, Robinson-Cohen C, Patel KV, et al. Association between physical performance and all-cause mortality in CKD. Journal of the American Society of Nephrology : JASN 2013;24:822-30.

18. Tice JA, Kanaya A, Hue T, et al. Risk factors for mortality in middle-aged women. Archives of internal medicine 2006;166:2469-77.

19. Bergland A, Jorgensen L, Emaus N, Strand BH. Mobility as a predictor of all-cause mortality in older men and women: 11.8 year follow-up in the Tromso study. BMC health services research 2017;17:22.

20. Antonini TC, de Paz JA, Ribeiro EE, et al. Impact of functional determinants on 5.5-year mortality in Amazon riparian elderly. Revista panamericana de salud publica = Pan American journal of public health 2016;40:9-15.

21. De Buyser SL, Petrovic M, Taes YE, Toye KR, Kaufman JM, Goemaere S. Physical function measurements predict mortality in ambulatory older men. European journal of clinical investigation 2013;43:379-86.

22. Idland G, Engedal K, Bergland A. Physical performance and 13.5-year mortality in elderly women. Scandinavian journal of public health 2013;41:102-8.

23. Studenski S, Perera S, Patel K, et al. Gait speed and survival in older adults. Jama 2011;305:50-8.

24. Castro-Rodriguez M, Carnicero JA, Garcia-Garcia FJ, et al. Frailty as a Major Factor in the Increased Risk of Death and Disability in Older People With Diabetes. Journal of the American Medical Directors Association 2016;17:949-55.

25. Castro-Rodriguez M, Carnicero JA, Garcia-Garcia FJ, et al. Frailty as a Major Factor in the Increased Risk of Death and Disability in Older People With Diabetes. Journal of the American Medical Directors Association 2016.

26. Nikolaus T, Bach M, Oster P, Schlierf G. Prospective value of self-report and performance-based tests of functional status for 18-month outcomes in elderly patients. Aging (Milan, Italy) 1996;8:271-6.

27. Hoeymans N, Wouters ER, Feskens EJ, van den Bos GA, Kromhout D. Reproducibility of performance-based and self-reported measures of functional status. The journals of gerontology Series A, Biological sciences and medical sciences 1997;52:M363-8.

28. Podsiadlo D, Richardson S. The timed "Up & Go": a test of basic functional mobility for frail elderly persons. Journal of the American Geriatrics Society 1991;39:142-8.

29. Herman T, Giladi N, Hausdorff JM. Properties of the 'timed up and go' test: more than meets the eye. Gerontology 2011;57:203-10.

30. von Elm E, Altman DG, Egger M, Pocock SJ, Gotzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies. International journal of surgery (London, England) 2014;12:1495-9.

31. Zweig MH, Campbell G. Receiver-operating characteristic (ROC) plots: a fundamental evaluation tool in clinical medicine. Clinical chemistry 1993;39:561-77.

32. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. Journal of chronic diseases 1987;40:373-83.

33. Belsley DA, E. Kuh, and R. E. Welsch. 1980. Regression Diagnostics: Identifying Influential Data and Sources of Collinearity. New York: Wiley.

34. Pregibon DDamfglmPd, University of Toronto. 1980. Goodness of link tests for generalized linear models. Applied Statistics 29: 15–24.

35. Steyerberg EW, Vickers AJ, Cook NR, et al. Assessing the performance of prediction models: a framework for traditional and novel measures. Epidemiology (Cambridge, Mass) 2010;21:128-38.

36. Sebastiao E, Sandroff BM, Learmonth YC, Motl RW. Validity of the Timed Up and Go Test as a Measure of Functional Mobility in Persons With Multiple Sclerosis. Archives of physical medicine and rehabilitation 2016;97:1072-7.

37. Gautschi OP, Smoll NR, Corniola MV, et al. Validity and Reliability of a Measurement of Objective Functional Impairment in Lumbar Degenerative Disc Disease: The Timed Up and Go (TUG) Test. Neurosurgery 2016;79:270-8.

38. Berg KO, Maki BE, Williams JI, Holliday PJ, Wood-Dauphinee SL. Clinical and laboratory measures of postural balance in an elderly population. Archives of physical medicine and rehabilitation 1992;73:1073-80.

39. Isles RC, Choy NL, Steer M, Nitz JC. Normal values of balance tests in women aged 20-80. Journal of the American Geriatrics Society 2004;52:1367-72.

40. Shumway-Cook A, Brauer S, Woollacott M. Predicting the probability for falls in community-dwelling older adults using the Timed Up & Go Test. Physical therapy 2000;80:896-903.

41. Steffen TM, Hacker TA, Mollinger L. Age- and gender-related test performance in community-dwelling elderly people: Six-Minute Walk Test, Berg Balance Scale, Timed Up & Go Test, and gait speeds. Physical therapy 2002;82:128-37.

42. Janssen WG, Bussmann HB, Stam HJ. Determinants of the sit-to-stand movement: a review. Physical therapy 2002;82:866-79.

43. Vereeck L, Wuyts F, Truijen S, Van de Heyning P. Clinical assessment of balance: normative data, and gender and age effects. International journal of audiology 2008;47:67-75.

44. Boulgarides LK, McGinty SM, Willett JA, Barnes CW. Use of clinical and impairment-based tests to predict falls by community-dwelling older adults. Physical therapy 2003;83:328-39.

45. Garland SJ, Stevenson TJ, Ivanova T. Postural responses to unilateral arm perturbation in young, elderly, and hemiplegic subjects. Archives of physical medicine and rehabilitation 1997;78:1072-7.

46. Mueller K, Hamilton G, Rodden B, DeHeer HD. Functional Assessment and Intervention by Nursing Assistants in Hospice and Palliative Care Inpatient Care Settings: A Quality Improvement Pilot Study. The American journal of hospice & palliative care 2016;33:136-43.

47. Murphy K, Lowe S. Improving fall risk assessment in home care: interdisciplinary use of the Timed Up and Go (TUG). Home healthcare nurse 2013;31:389-96; quiz 96-8.

48. Gu MO, Conn VS. Meta-analysis of the effects of exercise interventions on functional status in older adults. Research in nursing & health 2008;31:594-603.

Table 1. Baseline characteristics according to the presence of 6-month readmission.

Variable	6-month readmission (n=107)	No 6-month readmission (n=231)
Age, years	72 (64-83)	74 (64-83)
Men	57 (53.3)	111 (48.1)
Charlson comorbidity index	8 (6-10)	6 (4-8)
Multimorbidity *	100 (93.5)	202 (87.5)
Previous admission †	51 (47.7)	44 (19.1)
Duration of TUG test, seconds	13 (10-19)	12 (8-18)
TUG test duration ≥15 seconds	46 (43.0)	83 (35.9)
Hospitalization characteristics		
Elective	3 (2.8)	10 (4.3)
Length of stay, days	9 (5-15)	6 (4-11)
Diagnosis of index admission		
Cardiovascular disease ‡	25 (23.4)	66 (28.6)
Infection	20 (18.7)	47 (20.4)
Neuropsychiatric disease §, ‖	17 (15.9)	48 (20.8)
Oncological disease	16 (15.0)	10 (4.3)
Respiratory disease §	15 (14.0)	15 (6.5)
Other	4 (3.8)	12 (5.2)
Gastrointestinal disease §	2 (1.9)	16 (6.9)
Osteoarticular disease §	4 (3.8)	6 (2.6)
Endocrine or metabolic disease	3 (2.8)	8 (3.5)
Renal disease ‡	1 (0.9)	3 (1.3)

Data are n (% of column) or median (interquartile range).
* Two or more comorbidities as recorded in the Charlson comorbidity index.
† Hospital admission(s) during the 6 months preceding index admission.
‡ Including ischemic/thrombotic disorder, congestive heart failure, arrhythmia.
§ Other than infection.
‖ Including dementia, alcohol disorder, intoxication.

Table 2. Baseline characteristics according to the presence of 6-month death.

Variable	6-month death (n=31)	No 6-month death (n=331)
Age, years	69 (64-80)	74 (65-83)
Men	15 (48.4)	153 (49.8)
Charlson comorbidity index	10 (7-12)	7 (5-9)
Multimorbidity *	28 (90.3)	274 (89.3)
Previous admission †	17 (54.8)	78 (25.4)
Duration of TUG test, seconds	17 (11-21)	12 (8-18)
TUG test duration ≥15 seconds	18 (58.0)	111 (36.2)
Hospitalization characteristics		
Elective	0 (0.0)	13 (4.2)
Length of stay, days	13 (6-27)	6 (4-11)
Diagnosis of index admission		
Cardiovascular disease ‡	3 (9.7)	88 (28.7)
Infection	5 (16.1)	62 (20.2)
Neuropsychiatric disease §, ‖	2 (6.5)	63 (0.5)
Oncological disease	12 (38.7)	14 (4.6)
Respiratory disease §	1 (3.2)	29 (9.5)
Other	2 (6.5)	14 (4.6)
Gastrointestinal disease §	4 (12.9)	14 (4.6)
Osteoarticular disease §	0 (0.0)	10 (3.3)
Endocrine or metabolic disease	1 (3.2)	10 (3.3)
Renal disease ‡	1 (3.2)	3 (1.0)

Data are n (% of column) or median (interquartile range).
* Two or more comorbidities as recorded in the Charlson comorbidity index.
† Hospital admission(s) during the 6 months preceding index admission.
‡ Including ischemic/thrombotic disorder, congestive heart failure, arrhythmia.
§ Other than infection.
‖ Including dementia, alcohol disorder, intoxication.

FIGURE CAPTION

Figure 1. Study flow diagram.

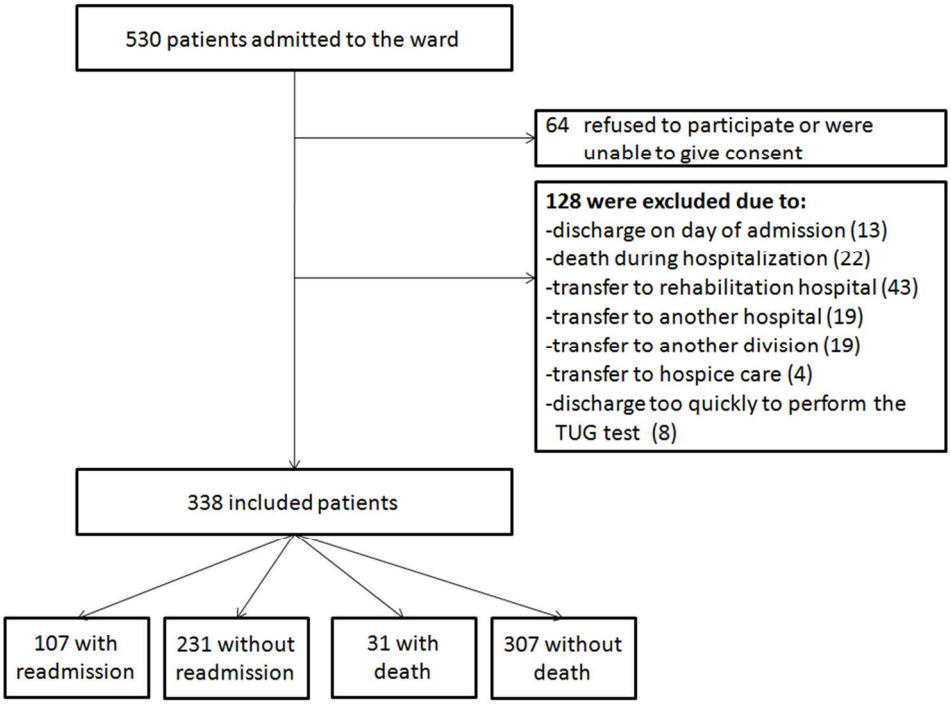


Figure 1. Study flow diagram.

85x65mm (300 x 300 DPI)

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4-5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-8
Bias	9	Describe any efforts to address potential sources of bias	8-9
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8-9
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, explain how loss to follow-up was addressed	
		(*e*) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	10+Fig. 1
		(b) Give reasons for non-participation at each stage	6+Fig. 1
		(c) Consider use of a flow diagram	Fig. 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10+ Tables 1&2
		(b) Indicate number of participants with missing data for each variable of interest	Fig. 1
		(c) Summarise follow-up time (eg, average and total amount)	10
Outcome data	15*	Report numbers of outcome events or summary measures over time	10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10-11
		(*b*) Report category boundaries when continuous variables were categorized	10-11
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11
Discussion			
Key results	18	Summarise key results with reference to study objectives	12 & 14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	3+14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	12-14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	1

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.