

Does admission grip strength predict length of stay in hospitalised older patients?

SIR—Epidemiological studies have shown that grip strength measured in middle-aged and older people is a powerful predictor of functional decline, disability and mortality [1–3]. Findings from cross-sectional data also suggest that grip strength may be a useful single marker of frailty [4]. However, grip strength is rarely measured in a clinical setting either for objective assessment of muscle function in relation to physical function or to predict outcome. The few clinical studies involving measurement of grip strength have been confined to a surgical setting and showed that lower grip strength was associated with increased post-operative complications [5–10]. Two studies also showed a relationship between pre-operative grip strength and post-operative length of stay [11, 12].

It is suggested that the link between grip strength and surgical outcome in these studies is nutritional status, but there may be broader underlying mechanisms. There is growing interest in the loss of muscle mass and strength with age, a phenomenon known as sarcopenia. Furthermore, there is emerging evidence for a causal link between sarcopenia and co-morbidity such as osteoporosis [13], obesity [14] and type 2 diabetes [15] as well as functional limitation [16] and falls [17]. This suggests that grip strength might be a useful predictor of prognosis for older inpatients in medical as well as surgical settings.

Predicting length of stay is of increasing importance with the pressure to maximise use of secondary care resources. It has relevance to both the individual patient in terms of planning care but also to the health care organisation in terms of providing, resourcing and developing an effective service [18]. However, there is evidence that the ability of medical staff to predict length of stay is poor [19]. No studies to date have investigated the link between grip strength and outcome in non-surgical settings. This study was designed to determine whether admission grip strength could be used to predict length of stay in older medical inpatients.

Methods

We undertook a prospective cohort study of older patients admitted to a Medical Admissions Unit (MAU) at Southampton University Hospitals NHS Trust (SUHT) and followed up their admission either until discharge home, transfer to intermediate care or death. Recruitment was carried out weekly and potential participants included all patients admitted within the preceding 48 hours. Exclusions included patients with an Abbreviated Mental Test (AMT) score of less than 7/10 because of difficulty obtaining informed consent and those admitted from residential care. Written informed consent was obtained from all participants and the study received ethical approval from the Southampton and South West Hampshire Joint Local Research Ethics Committee.

Information collected from the case notes included date of admission and discharge from SUHT, number of active medical problems and number of medications. The clinical assessment included measurement of forearm length as a proxy for height [20] and hand grip strength using a Jamar dynamometer (Promedics, UK) [21]. Grip strength was

measured three times on each side using a standard protocol. The highest grip strength measurement was used for statistical analyses. Additional information was collected on falls history, nutritional status (Malnutrition Universal Screening Tool, MUST) [20], functional status (three-item Barthel score) [22] and case-mix (Modified Admission Case-Mix for Elderly Score, MACME) [23].

Statistical analyses

Characteristics of study participants on admission to SUHT were summarised using medians and inter-quartile ranges (IQR) or frequency and percentage distributions. Characteristics of subgroups were compared using the Mann–Whitney or chi-squared tests. The principal outcome variable was length of stay from SUHT admission to discharge to usual residence. Simple regression analyses for grip versus length of stay in days were not possible because length of stay had a positively skewed distribution and only a minimum value for the length of stay was known for some patients owing to death, or to discharge to intermediate care or a nursing home rather than the usual residence (i.e. these values were censored).

Cox's proportional hazards model therefore had to be used to analyse these data [24]; this approach accounts for censoring of observations and yields relative risks for discharge home in relation to admission characteristics. A relationship between a change in an admission characteristic and greater likelihood of being discharged home is equivalent to a relationship between the change in that characteristic and a shorter length of stay. *P* values <0.05 were declared as statistically significant. Men and women were combined but all analyses adjusted for gender. Analyses were carried out using the statistical software package Stata 8 (Stata Statistical Software Release 8.0, Stata Corporation, College Station, TX).

Results

Fifty-two men and 68 women participated in the study (age range 75–101 years, median 83.7 years). Summary characteristics of the participants are presented in Appendix 1 in the supplementary data available on the journal website (www.ageing.oxfordjournals.org). Grip strength was greater among men (median 29 kg) than women (16 kg, $P < 0.0001$). The median length of stay was 9 days but this was somewhat longer for men (10) than women (8). All subsequent analyses were adjusted for the potential confounding influence of gender. Forty men (76.9%) and 53 women (77.9%) were discharged to their usual place of residence (18 direct from MAU); seven men and 12 women were discharged to intermediate care; one woman was discharged to a nursing home; four men and two women died; and one man remained in SUHT at the end of the study. Therefore, only a minimum length of stay was known for participants not discharged to their usual place of residence during the study (censored observations). Fifteen patients were approached but did not take part (10 did not meet the inclusion criteria and five did not give consent).

Higher grip strength on admission was associated with increased likelihood of discharge to usual residence. A 1 kg increase in grip strength was associated with a 3% increase in

likelihood of discharge to usual residence (gender-adjusted hazard ratio, HR (95% CI) per kilogram increase in grip strength: 1.03 (1.00, 1.07), $P = 0.05$). Adjustment for chronological age did not alter this relationship. Figure 1 shows the relationship between grip strength and likelihood of discharge to usual residence using sex-specific thirds of the grip strength distribution. A grip strength of greater than 18 kg for women and 31 kg for men was associated with a 25% increase in the likelihood of return home.

Table 1 presents the relationships between each of the patients' admission characteristics and grip strength, and length of stay. Higher MUST and MACME scores, lower Barthel index score and increased frequency of falls in the past year were all significantly associated with decreased grip strength. Higher MUST and MACME scores, and lower Barthel score were each associated with decreased likelihood of discharge to usual residence.

Discussion

Our study showed that higher admission grip strength in older medical inpatients was associated with increased like-

lihood of discharge home independent of age and gender. Other significant predictors were decreased functional impairment, lower dependency case-mix and higher nutritional status. In contrast, age, number of admission medical problems or medications, falls history and cognitive function (within the range 7–10/10) were not related to discharge. There were significant associations between grip strength and the Barthel, MACME and MUST scores.

These findings suggest that grip strength is a significant predictor of length of stay because it is a good marker of functional and nutritional status. This is consistent with the existing literature [1–12] and it is perhaps surprising that such knowledge has not already translated into routine use of grip strength measurement in the clinical setting, for both assessment of frailty and prognostic purposes. This study suggests that the Barthel, MACME and MUST questionnaires would be suitable alternatives for predicting discharge but time constraints limit their use in the acute setting. In contrast, quick assessment of grip strength has the potential to become part of the admission clerking alongside the measurement of blood pressure.

There are a number of limitations to our study. This was a small clinical study and the generalisability of the findings may be limited by the study population chosen and the study group included. Furthermore, the study was carried out within a complex health care system, limiting investigation of all the potential explanations linking grip strength and length of stay. However, we were able to collect information on major confounding factors including gender, age, functional status, nutritional status and co-morbidity. In addition the study was designed to minimise bias. All patients admitted within 48 hours of the weekly recruitment visit were screened for inclusion and data collection by a single investigator minimised observer variation.

There were a number of unmeasured extrinsic influences on length of stay, such as the availability of home care. However, there is no evidence to suggest that these extrinsic influences were also related to grip strength, so the effect of these unmeasured variables would have been to weaken our ability to detect a relationship between admission grip strength and outcome. The fact that grip strength was still associated with likelihood of discharge despite these multiple factors suggests that it could become a useful tool in clinical practice and the

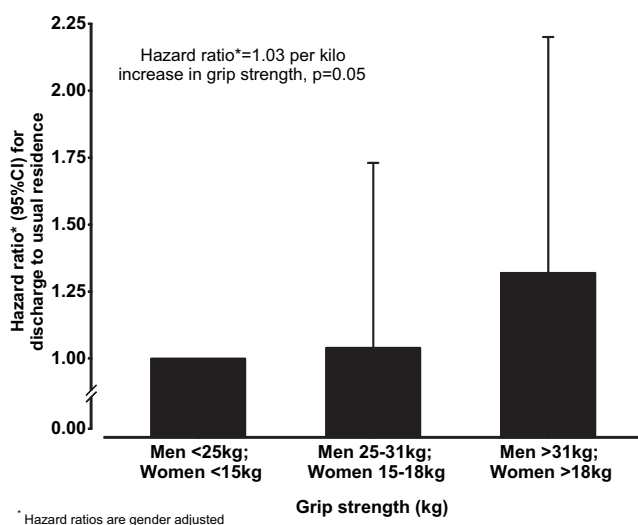


Figure 1. Relationship between grip strength and discharge to usual residence.

Table 1. Relationships between admission characteristics and grip strength and discharge to usual residence

Characteristic	Effect of a unit increase in each admission characteristic:	
	Change ^a (95% CI) in grip strength (kg)	HR ^b (95% CI) for discharge to usual residence
Age (years)	-0.20 (-0.43, 0.02) $P = 0.08$	1.00 (0.96, 1.04) $P = 0.89$
Medications on admission (number)	-0.00 (-0.37, 0.36) $P = 0.98$	1.03 (0.96, 1.10) $P = 0.40$
Medical problems on admission (number)	-0.30 (-0.93, 0.32) $P = 0.34$	1.03 (0.92, 1.15) $P = 0.64$
Barthel score	0.45 (0.20, 0.70) $P < 0.001$	1.14 (1.08, 1.21) $P < 0.001$
AMT score	0.92 (-0.23, 2.07) $P = 0.12$	1.17 (0.95, 1.45) $P = 0.15$
MUST score	-2.22 (-3.43, -1.00) $P < 0.001$	0.78 (0.61, 0.98) $P = 0.03$
MACME score	-2.79 (-4.11, -1.46) $P < 0.001$	0.55 (0.43, 0.72) $P < 0.001$
Falls in past year (number)	-1.52 (-2.48, -0.57) $P = 0.002$	0.99 (0.83, 1.19) $P = 0.94$

^aGender-adjusted regression coefficient from linear regression model.

^bGender-adjusted hazard ratio from Cox's proportional hazards model.

AMT, Abbreviated Mental Test; MUST, Malnutritional Universal Screening Tool; MACME, Modified Admission Case Mix for Elderly Score.

study warrants replication in diverse health care settings to determine the generalisability of these findings.

Key points

- Grip strength is an important determinant of future health but it is rarely used in the clinical setting.
- In this small clinical study, admission grip strength was related to length of stay in hospitalised older patients in an acute medical setting.
- Grip strength was significantly associated with both functional and nutritional status, explaining its relationship with length of stay.
- Measurement of grip strength could become a useful tool in clinical practice and the study warrants replication to determine the generalisability of these findings to diverse healthcare settings.

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Conflicts of interest

None.

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