Brief Report

The Association of Changes in Physical Performance During Geriatric Inpatient Rehabilitation With Short-Term Hospital Readmission, Institutionalization, and Mortality: RESORT

Keenan A. Ramsey BSPH [a], Anna G.M. Rojer MD [a], Elma van Garderen MSc [a], Yvette Struik MSc [a], Jacqueline E. Kay MSc [b], Wen Kwang Lim MD, PhD [c], Carel G.M. Meskers PhD [a,d], Esmee M. Reijnierse PhD [c], Andrea B. Maier MD, PhD [a,c,e,f,*]

[a] Department of Human Movement Sciences, @AgeAmsterdam Amsterdam Movement Sciences Vrije Universiteit Amsterdam, Amsterdam, the Netherlands
[b] Department of Allied Health (Physiotherapy), The Royal Melbourne Hospital, Melbourne, Victoria, Australia
[c] Department of Medicine and Aged Care, @AgeMelbourne, The Royal Melbourne Hospital, The University of Melbourne, Melbourne, Victoria, Australia
[d] Department of Rehabilitation Medicine, Amsterdam UMC, VU University Medical Center, Amsterdam, the Netherlands
[e] Healthy Longevity Translational Research Program, Yong Loo Lin School of Medicine, National University of Singapore, Singapore
[f] Centre for Healthy Longevity, @AgeSingapore, National University Health System, Singapore

ABSTRACT

Keywords:
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Objectives: Geriatric inpatient rehabilitation aims to restore function, marked by physical performance, to enable patients to return and remain home after hospitalization. However, after discharge some patients are soon readmitted, institutionalized, or may die. Whether changes in physical performance during geriatric rehabilitation are associated with these short-term adverse outcomes is unknown. This study aimed to determine the association of changes in physical performance during geriatric inpatient rehabilitation with short-term adverse outcomes.
Design: Observational longitudinal study.
Setting and Participants: Geriatric rehabilitation inpatients of the REStORing health of acutely unwell adulTs (RESORT) cohort study of the Royal Melbourne Hospital (Melbourne, Australia) were included.
Methods: The change from admission to discharge in the Short Physical Performance Battery (SPPB) score, balance, gait speed (GS), chair stand test (CST), and hand grip strength (HGS) were calculated and analyzed using logistic regression analysis with readmission, incidence of institutionalization, and mortality, and ≥1 adverse outcome within 3 months postdischarge.
Results: Of 693 inpatients, 11 died during hospitalization and 572 patients (mean age 82.6 ± 7.6 years, 57.9% female) had available physical performance data. Within 3 months postdischarge, 47.3% of patients had ≥1 adverse outcome: readmission was 20.8%, institutionalization was 26.6%, and mortality was 7.9%. Improved SPPB score, balance, GS, CST, and HGS were associated with lower odds of institutionalization and mortality. Improved GS was additionally associated with lower odds of readmission [odds ratio (OR) 0.35, 95% CI 0.16-0.79]. CST score had the largest effect, with a 1-point increase associating with 40% lower odds of being institutionalized (OR 0.60, 95% CI 0.42-0.86), 52% lower odds of mortality (OR 0.48, 95% CI 0.29-0.81), and a 24% lower odds of ≥1 adverse outcome (OR 0.76, 95% CI 0.59-0.97).
Conclusions and Implications: Improvement in physical performance was associated with lower odds of short-term institutionalization and mortality indicating the prognostic value of physical performance improvement during geriatric inpatient rehabilitation.
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Geriatric inpatient rehabilitation aims to increase and restore function post-acute hospitalization to enable patients to return and remain home.[1] Despite physical performance being a primary target for improvement during geriatric inpatient rehabilitation, physical performance is vulnerable to deconditioning as hospitalization is associated with inactivity and subsequent muscle atrophy and reduced physical performance.[2−5] Inpatients who are healthy and well-functioning enough are discharged, which is an indicator of successful rehabilitation. After discharge, however, some patients are soon readmitted, institutionalized, or may die.[6−11] Improvements in physical performance during the inpatient stay may be associated with a lower risk of short-term adverse outcomes postdischarge.

In inpatients discharged home directly from acute hospitalization, physical deterioration has been associated with incident disability, morbidity, and mortality.[12−16] When acute patients are discharged to geriatric inpatient rehabilitation, there is a unique opportunity to improve physical performance and mitigate negative outcomes. Low physical performance at both admission and discharge of geriatric inpatient rehabilitation have been associated with readmission, institutionalization, and mortality.[13,17−19] However, whether the change in physical performance during geriatric inpatient rehabilitation is specifically associated with these short-term adverse outcomes is unclear. Identifying the role of these changes is imperative to shape rehabilitation goals, inform discharge criteria, and develop interventions to mitigate adverse outcomes.

This study aimed to determine the association of changes in physical performance measures during geriatric inpatient rehabilitation with readmission, institutionalization, and mortality within 3 months postdischarge.

Methods

Study Design and Setting

Patients included were a part of wave 1 of the REStORing health of acutely unwell adulTs (RESORT) cohort—a longitudinal, observational prospective cohort of geriatric rehabilitation inpatients at the Royal Melbourne Hospital (Melbourne, Victoria, Australia) assessed by a Comprehensive Geriatric Assessment. Details regarding study design, setting, and ascertainment of patient characteristics are described in the Supplementary Methods (Supplementary Material 1).

Measures of Physical Performance

The Short Physical Performance Battery (SPPB)[20] is a 12-point composite score of 3 subtests: progressive balance tests from a side by side to tandem stance (0-4 points), 4-meter walk test ascertaining gait speed (GS; expressed as 0-4 points and meters per second) and the 5 times chair stand test [CST; expressed as 0-4 points and no. of completed repetitions (reps) per 30 seconds (5 reps/(seconds to complete) × 30 seconds)]. Patients who were unable to complete the 4-m walk test or CST were awarded 0 m/s and 0 reps/30 s respectively.

Maximum hand grip strength (HGS) in kilograms was measured using a handheld dynamometer (JAMAR, Sammons Preston, Inc) by asking patients to squeeze as hard as possible 3 times per hand.[21] Patients unable to perform the HGS measurement were awarded 0 kg.

Short-Term Adverse Outcomes

Short-term adverse outcomes were assessed at 3 months postdischarge and were defined as readmission, institutionalization, and mortality after hospital discharge. Readmission was defined an unplanned acute readmission after discharge and was obtained from medical records and 3-month phone interviews. Incident institutionalization was defined as a new admission to a residential aged care facility within 3 months after discharge and was obtained from 3-month phone interviews. Patients who were already institutionalized at admission (n = 20) were excluded from analyses for institutionalization. Mortality within 3 months was defined as death of patient and was obtained from the Registry of Births, Deaths and Marriages Victoria and medical records. A composite outcome variable was created and defined as at least 1 of the aforementioned adverse outcomes.

Statistical Analysis

Patients were included in the current analysis if both admission and discharge data were available for at least 1 of 5 physical performance measures. Normally distributed variables were expressed as mean and SD, and skewed variables were expressed as median and interquartile range. Categorical measures were presented as the number of participants and percentage of the total sample falling within a category. Change (Δ) in physical performance was defined as discharge minus admission value. For all measures of physical performance, directions of change were characterized as improving when Δ > 0, declining when Δ < 0, not changing when Δ = 0. Associations between ΔSPPB score in points, Δ balance score in points, ΔGS in points and meters per second, ΔCST in points and repetitions per 30 seconds, and ΔHGS with readmission, institutionalization, and mortality 3 months after discharge were analyzed using logistic regression analyses. Adjustments included the following: crude (model 1), age and sex (model 2), model 2 plus Cumulative Illness Rating Scale score and length of stay (model 3), and model 3 plus physical performance at admission (model 4). Cumulative Illness Rating Scale was specifically included in adjustment models to highlight the critical role that acute conditions (ie, falls, fractures, heart attacks) may play in confounding the association between changes in physical performance and short-term adverse outcomes.

Results were presented as odds ratios (ORs) with 95% CIs and P values. Age and sex were additionally tested for being effect modifiers by introducing interaction terms. All analyses were performed using the Statistical Package for the Social Sciences (IBM SPSS Statistics for Windows 27.0; IBM Corp).

Results

Participant Characteristics

Of the 693 inpatients, 11 died during hospitalization and 110 were excluded because of missing data on all physical performance measures, leaving 572 patients included in the current analysis (Supplementary Figure 1). Patients were on average 82.6 (SD = 7.6) years old, 57.9% were female, and 96.5% were living at home before admission. Median length of stay in the geriatric rehabilitation ward was 19.8 (interquartile range = 13.6-28.9) days. Three months postdischarge, 47.3% of patients had at least 1 adverse outcome: incidence of readmission was 20.8%, institutionalization was 26.6%, and mortality was 7.4% (Table 1).

Changes in Physical Performance During Geriatric Inpatient Rehabilitation

From admission to discharge, physical performance was significantly higher (P ≤ .001) for all measures except for HGS in males (P = .198) (Supplementary Table 1). Distributions of Δs were visualized, stratified by ≥1 adverse outcome vs none, and showed a leptokurtotic

Table 1
Characteristics of Geriatric Rehabilitation Inpatients at Admission

Characteristic	n	Value
Age, y, mean ± SD	572	82.6 ± 7.56
Female	572	331 (57.9)
Married	572	222 (38.8)
Living in a nursing home before hospital admission	572	20 (3.5)
Reason for acute hospital admission:	572	
Musculoskeletal		280 (49.0)
Neurologic		102 (17.8)
Infection		65 (11.4)
Cardiovascular and respiratory		71 (12.4)
Other		54 (9.4)
LOS in geriatric rehabilitation, d, median (IQR)	572	19.8 (13.6-28.9)
Morbidities:		
CIRS score, mean ± SD	572	11.7 ± 4.65
CCI score, median (IQR)	572	2 (1-4)
Number of medications	572	10 (7-12)
Cognitively impaired	572	371 (64.9)
Risk of malnutrition	567	243 (42.5)
Presence of a fall	531	38 (7.2)
Height, cm, mean ± SD	559	160.6 ± 10.7
Weight, kg, mean ± SD	569	70.5 ± 17.4
BMI, mean ± SD	558	27.3 ± 6.34
Physical performance		
SPPB total score (0-12), median (IQR)	558	1 (0-4)
Balance, score (0-4), median (IQR)	561	0 (0-2)
Gait speed, score (0-4), median (IQR)	562	0 (0-1)
Gait speed, m/s, median (IQR)	562	0 (0-0.41)
5-CST, score (0-4), median (IQR)	566	0 (0-0)
5-CST, reps/30s, median (IQR)	562	0 (0-0)
Handgrip strength, kg, median (IQR)		
Male	222	19.6 (9.74)
Female	313	12.8 (6.53)
Adverse outcome within 3 mo		
Readmission	572	119 (20.8)
Incidence of institutionalization	474	126 (26.6)
Mortality	568	42 (7.4)
≥1 adverse outcome	530	256 (48.3)

5-CST, 5−Chair Stand Test; BMI, Body Mass Index; CCI, Charlson Comorbidity Index; CIRS, Cumulative Illness Rating Scale; IQR, interquartile range; LOS, length of stay; MST, Malnutrition Screening Tool; reps/30s, repetitions per 30 seconds.
Data are number (percentage), unless indicated otherwise.

positive skew across physical performance measures. Improvements in physical performance were more frequent in inpatients without adverse outcome compared to those with ≥1 adverse outcome except for HGS (Figure 1).

Associations of Changes in Physical Performance With Short-Term Readmission, Institutionalization, and Mortality

ΔGS was the only determinant associated with readmission: a 1-m/s improvement in GS was associated with 65% lower odds of readmission (OR 0.35, 95% CI 0.16-0.79). Improvements in SPPB score, balance score, GS in points and meters per second, and CST in points and repetitions per 30 seconds were, respectively, associated with lower odds of institutionalization, mortality, and ≥1 adverse outcome. HGS was not associated with ≥1 adverse outcome. Comparing effect sizes of the SPPB subtests in points, improvements in CST score had the largest effect against institutionalization, mortality, and ≥1 adverse outcome, respectively, with a 1-point increase in CST score from admission to discharge associated with 40% lower odds of being institutionalized (OR 0.60, 95% CI 0.42-0.86), a 52% lower odds of mortality (OR 0.48, 95% CI 0.29-0.81), and a 24% lower odds of ≥1 adverse outcome (OR 0.76, 95% CI 0.59-0.97). These aforementioned findings, adjusted for age, sex, length of stay, and Cumulative Illness Rating Scale, were independent of

additional adjustments for physical performance at admission (model 4; see Table 2). Age and sex were not effect modifiers. Effect sizes were consistent in magnitude except for the ΔHGS as an independent variable where spurious significant associations appeared for the first time for all outcomes (Table 2).

Discussion

Improvements in SPPB, balance, GS, and CST were determinants of a lower odds of short-term institutionalization, mortality, and ≥1 adverse outcome in geriatric rehabilitation inpatients. Only ΔGS was associated with readmission. Change in HGS was not a determinant of any adverse outcomes.

Our findings indicate that, on a population level, physical performance does not decline during geriatric inpatient rehabilitation, which is in line with previous studies.[1,22,23] Furthermore, this indicates the resilience of inpatients in light of acute illness and the high prevalence of hospital-associated functional decline.[24] HGS, in males specifically, was the only measure of physical performance that was not significantly different from admission to discharge. However, previous studies have shown that HGS is less susceptible to change in short periods of time than SPPB measures of physical performance, which may reflect the preservation of muscle strength in this context.[25] Although the majority of patients did not decline in physical performance during inpatient geriatric rehabilitation, it is important to acknowledge that physical performance at discharge was still very low when compared with that of community-dwelling older adults, which is a subsequent risk factor for poor health outcomes.[26−28] And geriatric inpatients on discharge, unless institutionalized, are community-dwelling older adults.

The prevalence of short-term adverse outcomes[1,6,7,9,19] was comparable to previous findings in geriatric rehabilitation inpatients. The absence of associations between the change in any measure of physical performance with readmission, except for GS (m/s), was unexpected and in contrast with similar studies investigating the change in physical performance and readmission.[12,13] However, readmission, compared with mortality and institutionalization, could be more influenced by health services accessibility, social and socioeconomic factors, and less by functional status,[29,30] which may explain our findings.

Independence is often measured by the ability to complete activities of daily living (ADL) such as toileting, transferring, and feeding, which require muscle strength, balance, and coordination. These capacities are addressed and measured by the physical performance measures in the current study and thus can explain the association between physical performance and institutionalization.[31] Specifically, improvement in the CST, a representation of muscle power, endurance, and coordination, was most associated with institutionalization of all SPPB subtests. This finding is supported by a strong relationship between the CST and ADL in community-dwelling older adults,[32] which suggests that improved ability to rise from a chair may be essential for independent ADL and thus remaining home and avoiding institutionalization.

The inverse association between changes in physical performance and mortality is consistent with previous studies in an acute hospital setting.[13] In a population of geriatric rehabilitation inpatients, declining physical performance within a short period of time may specifically indicate severe disease-related impairment to multiple systems that may eventually cause death. This may explain the consistent associations identified in the current study between changes in physical performance and mortality; however, changes in these potentially mediating disease-related factors require further investigation.

Table 2

Associations of Change in Physical Performance Measures During Geriatric Inpatient Rehabilitation With 3-Month Adverse Outcomes: Readmission, Institutionalization, Mortality, and Any (≥1) Adverse Outcome

	Readmission			Institutionalization			Mortality			Any (≥1) adverse outcome*		
	n	OR (95% CI)	P	n	OR (95% CI)	P	n	OR (95% CI)	P	n	OR (95% CI)	P
Δ SPPB total, score (−12 to 12)												
Model 1: Crude	547	0.96 (0.88-1.05)	.379	453	0.81 (0.74-0.90)	**<.001**	543	0.77 (0.66-0.90)	**.001**	516	0.84 (0.78-0.91)	**<.001**
Model 2: Age and sex	547	0.96 (0.88-1.05)	.396	453	0.82 (0.74-0.90)	**<.001**	543	0.78 (0.67-0.91)	**.001**	516	0.85 (0.78-0.92)	**<.001**
Model 3: + LOS and CIRS	547	0.97 (0.89-1.06)	.528	453	0.79 (0.71-0.88)	**<.001**	543	0.78 (0.66-0.91)	**.002**	516	0.85 (0.78-0.92)	**<.001**
Model 4: + admission	547	0.97 (0.89-1.07)	.567	453	0.76 (0.68-0.85)	**<.001**	543	0.76 (0.64-0.90)	**.002**	516	0.83 (0.76-0.90)	**<.001**
Δ Balance, score (−4 to 4)												
Model 1: Crude	553	0.95 (0.82-1.11)	.529	458	0.71 (0.60-0.85)	**<.001**	549	0.75 (0.58-0.96)	**.025**	522	0.78 (0.68-0.89)	**<.001**
Model 2: Age and sex	553	0.95 (0.82-1.11)	.524	458	0.72 (0.61-0.85)	**<.001**	549	0.76 (0.59-0.97)	**.030**	522	0.78 (0.68-0.89)	**<.001**
Model 3: + LOS and CIRS	553	0.97 (0.83-1.13)	.685	458	0.69 (0.58-0.82)	**<.001**	549	0.77 (0.59-1.01)	.059	522	0.78 (0.68-0.89)	**<.001**
Model 4: + admission	553	0.95 (0.80-1.13)	.547	458	0.62 (0.51-0.75)	**<.001**	549	0.71 (0.53-0.96)	**.024**	522	0.73 (0.63-0.84)	**<.001**
Δ Gait speed, score (−4 to 4)												
Model 1: Crude	556	0.84 (0.69-1.01)	.068	462	0.82 (0.67-0.99)	**.042**	552	0.67 (0.49-0.91)	**.011**	525	0.78 (0.66-0.92)	**.002**
Model 2: Age and sex	556	0.84 (0.69-1.02)	.073	462	0.82 (0.68-1.00)	**.046**	552	0.68 (0.50-0.92)	**.012**	525	0.78 (0.66-0.92)	**.003**
Model 3: + LOS and CIRS	556	0.85 (0.70-1.04)	.107	462	0.77 (0.63-0.95)	**.014**	552	0.67 (0.49-0.93)	**.015**	525	0.77 (0.65-0.92)	**.003**
Model 4: + admission	556	0.88 (0.71-1.08)	.221	462	0.69 (0.55-0.87)	**.001**	552	0.62 (0.43-0.89)	**.009**	525	0.74 (0.61-0.88)	**.001**
Δ Gait speed, m/s												
Model 1: Crude	556	0.33 (0.15-0.73)	**.006**	462	0.33 (0.15-0.74)	**.007**	552	0.18 (0.05-0.63)	**.007**	525	0.26 (0.13-0.50)	**<.001**
Model 2: Age and sex	556	0.33 (0.15-0.74)	**.007**	462	0.36 (0.16-0.80)	**.012**	552	0.19 (0.06-0.67)	**.010**	525	0.27 (0.14-0.52)	**<.001**
Model 3: + LOS and CIRS	556	0.35 (0.16-0.79)	**.011**	462	0.27 (0.11-0.63)	**.003**	552	0.20 (0.05-0.70)	**.013**	525	0.24 (0.12-0.49)	**<.001**
Model 4: + admission	556	0.40 (0.17-0.95)	**.039**	462	0.17 (0.07-0.43)	**<.001**	552	0.14 (0.04-0.58)	**.006**	525	0.19 (0.09-0.41)	**<.001**
Δ 5-CST, score (−4 to 4)												
Model 1: Crude	559	1.10 (0.84-1.44)	.482	463	0.60 (0.43-0.84)	**.003**	555	0.49 (0.30-0.79)	**.003**	528	0.72 (0.57-0.92)	**.007**
Model 2: Age and sex	559	1.10 (0.84-1.44)	.469	463	0.61 (0.44-0.85)	**.003**	555	0.49 (0.31-0.79)	**.003**	528	0.72 (0.57-0.92)	**.008**
Model 3: + LOS and CIRS	559	1.11 (0.85-1.46)	.442	463	0.60 (0.42-0.86)	**.005**	555	0.48 (0.29-0.81)	**.005**	528	0.76 (0.59-0.97)	**.028**
Model 4: + admission	559	1.12 (0.85-1.49)	.428	463	0.58 (0.40-0.84)	**.004**	555	0.52 (0.28-0.97)	**.040**	528	0.75 (0.58-0.98)	**.032**
Δ 5-CST, reps/30s												
Model 1: Crude	548	1.00 (0.94-1.06)	.968	452	0.91 (0.85-0.97)	**.002**	544	0.87 (0.78-0.96)	**.007**	517	0.93 (0.88-0.97)	**.003**
Model 2: Age and sex	548	1.00 (0.94-1.06)	1.000	452	0.91 (0.85-0.97)	**.003**	544	0.87 (0.78-0.96)	**.007**	517	0.93 (0.88-0.98)	**.003**
Model 3: + LOS and CIRS	548	1.00 (0.95-1.06)	.931	452	0.91 (0.85-0.97)	**.004**	544	0.87 (0.78-0.97)	**.014**	517	0.94 (0.89-0.99)	**.012**
Model 4: + admission	548	1.01 (0.95-1.07)	.775	452	0.89 (0.83-0.96)	**.002**	544	0.87 (0.78-0.99)	**.030**	517	0.93 (0.88-0.99)	**.013**
Δ HGS, kg												
Model 1: Crude	474	0.98 (0.95-1.02)	.276	400	1.01 (0.97-1.04)	.771	471	0.96 (0.91-1.02)	.186	456	0.99 (0.96-1.02)	.543
Model 2: Age and sex	474	0.98 (0.95-1.02)	.286	400	1.01 (0.97-1.04)	.746	471	0.97 (0.92-1.02)	.218	456	0.99 (0.96-1.02)	.564
Model 3: + LOS and CIRS	474	0.98 (0.95-1.02)	.353	400	1.00 (0.97-1.04)	.972	471	0.97 (0.92-1.01)	.165	456	0.99 (0.96-1.02)	.372
Model 4: + admission	474	0.97 (0.94-1.01)	.164	400	0.96 (0.92-1.00)	**.027**	471	0.94 (0.89-0.99)	**.019**	456	0.95 (0.92-0.98)	**.004**

5-CST, 5—Chair Stand Test; CIRS, Cumulative Illness Rating Scale; LOS, length of stay; reps/30s, repetitions per 30 seconds.
Bold values are considered statistically significant.
*≥1 adverse outcome refers to ≥1 adverse outcome (readmission, institutionalization, and/or mortality).

Methodologic Considerations

To be able to identify smaller changes in physical performance, units of GS and CST were analyzed as continuous outcomes. This revealed improvement in GS (m/s) as well as the association of a faster GS in meters per second with lower 3-month readmission, which was not found when using SPPB points as units; however, results were consistent for CST expressed in repetitions per 30 seconds and SPPB points. Despite the CST being a valid and reliable test for hospitalized older adults, it is subject to flooring effects[25] as having to stand up 5 times within 60 seconds to score at least 1 point may be too difficult for geriatric rehabilitation inpatients. This was reflected in our descriptive findings, where median CST was equal to 0 at both admission and discharge and in histograms where CST showed the highest proportion of no change of all measures. Nonetheless, change in CST was identified to be a strong determinant of all outcomes indicating that ability and faster performance is beneficial.

Final adjustment models adjusted for physical performance at admission, as a subanalysis, to account for differences in individuals baseline physical performance as this would likely affect the potential for change; results were consistent for all measures, except for spurious significant associations for the change in HGS with all outcomes. This is likely representative of the tendency of type 1 errors when analyzing change and adjusting for baseline.[33]

Strengths and Limitations

To our knowledge, this study was the first to study the association of continuous measures of change in physical performance during inpatient geriatric rehabilitation with readmission, institutionalization, and mortality. A strength of this study is the use of different measures of physical performance, as they represent different domains of function. Included data were assessed through a comprehensive geriatric assessment that incorporated validated and standardized measures allowing for comparability with other studies. The population-based design, limited exclusion criteria, and large sample size enhance the generalizability of findings. The use of continuous measures of change in physical performance represents a strength, rather than using cutoffs to categorize changes; however, measurement error may have introduced bias in calculating change values, which is a limitation.

Conclusions and Implications

Improvement of physical performance measures during geriatric inpatient rehabilitation is associated with lower odds of institutionalization and mortality within 3 months after discharge but not with readmission. These findings represent an opportunity to
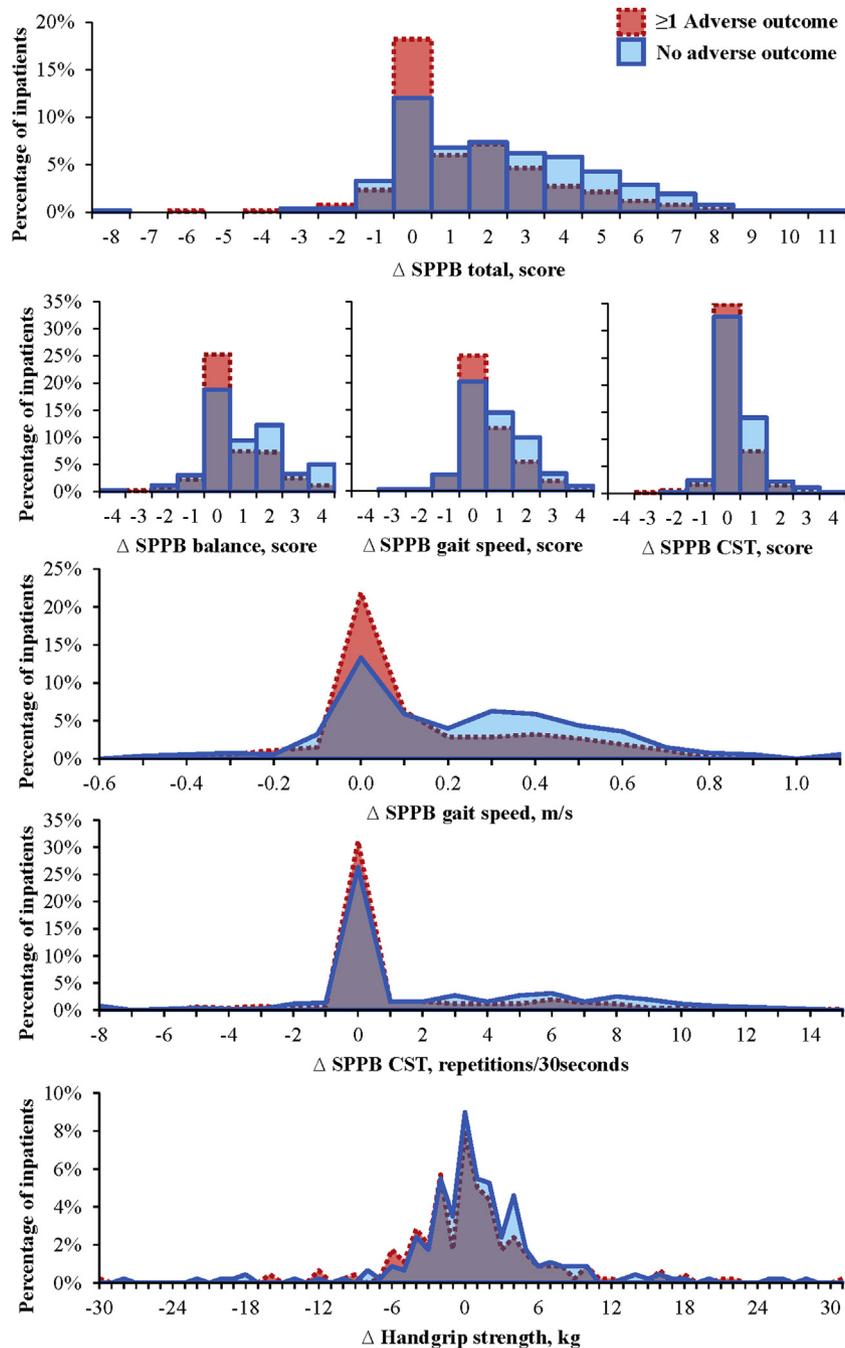
Fig. 1. Distributions of the changes in physical performance measures in geriatric rehabilitation inpatients with ≥1 adverse outcome (red) and with no adverse outcome (blue), respectively.

target changes in physical performance, focusing on GS and CST as they are more susceptible to change during geriatric inpatient rehabilitation and demonstrated a greater association with the adverse outcomes. Furthermore, our results reflect the need to acknowledge the different risk factors involved in short-term readmission, which may be less related to health status than institutionalization or mortality which may be reflected by the lack of association with changes in physical performance measures. Future research should aim to define thresholds for improvement of physical performance associated with lower rates of institutionalization and mortality to identify inpatients at risk and develop targeted interventions.

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Supplementary Material 1. Supplementary Methods

Study Design and Setting

The REStORing health of acutely unwell adulTs (RESORT) is a longitudinal, observational prospective cohort of geriatric rehabilitation inpatients at the Royal Melbourne Hospital (Melbourne, Victoria, Australia). Older and frailer adults, often presenting with multimorbidity and complex health problems, required multidisciplinary rehabilitation care for recovery after acute episodes of ill health and were thus transferred from acute to geriatric rehabilitation wards. Recruitment for wave 1 commenced October 16, 2017, and included patients discharged by August 31, 2018 (n = 693). Assessment of physical, cognitive, and physiological health status, and related factors, was assessed using a Comprehensive Geriatric Assessment within 48 hours of admission and discharge, respectively, by physicians, nurses, physiotherapist, occupational therapist, and dieticians. This was done to determine the ability of patients at admission as well as to determine their rehabilitation goals. Rehabilitation intensity was individualized based on the results of the assessment and the patient's goals. RESORT was approved by the Melbourne Health Human Research Ethics Committee (no. HREC/17/MH/103) and is performed in accordance with local, national, and international ethical guidelines laid out by the Helsinki Declaration,[1] the National Statement on Ethical Conduct in Human Research (2007),[2] and the Guidelines for Good Clinical Research Practice.[3] Written consent was obtained from all included patients or their designated proxy. All patients admitted to the geriatric rehabilitation wards were eligible for inclusion unless they met exclusion criteria (n = 152, 15.3%) because of their inability to provide consent and without a designated proxy, receiving palliative care at admission, or transfer to the acute ward before informed consent was obtained.

Patient Characteristics

Medical records of patients were used to extract age, sex, and the number of medications used at admission to geriatric rehabilitation. Marital status and living setting were self-reported or extracted through medical records. The primary reason for hospital admission was categorized into the following categories: musculoskeletal, neurologic, infection, cardiovascular and respiratory, and other (including metabolic, gastrointestinal, urology, cancer, hematology, ophthalmologic, and psychiatric). Length of stay (LOS) in geriatric rehabilitation in days was determined by the number of days between admission and discharge and extracted from medical records. Morbidity was assessed by the Cumulative Illness Rating Scale (CIRS)[4] and the Charlson Comorbidity Index (CCI).[5] Cognitive impairment was regarded as present if it was endorsed on either the CCI or CIRS; dementia or mild cognitive impairment/minor neurocognitive disorder was listed in the discharge, or if patients had a score <24 points on the standardized Mini-Mental State Examination (sMMSE),[6] <26 points on the Montreal Cognitive Assessment (MoCA),[7] or <23 on the Rowland Universal Dementia Assessment Scale (RUDAS).[8] The risk of malnutrition was assessed by the Malnutrition Screening Tool (MST), classifying patients at risk with a score of 2 or above.[9] The presence of a fall during geriatric rehabilitation was self-reported. Standing height was assessed to the nearest 0.1 cm using a stadiometer if the patient was able to stand and otherwise, knee height was assessed using a measuring rod and height was calculated from knee height using the LASA equation.[10] Weight was assessed to the nearest 0.1 kg either by use of a weighing scale, weighing chair, or a hoist, depending on the mobility status of the patient. Body mass index (BMI) was calculated from body weight (in kilogram) divided by height (in meters) squared.

Supplementary References

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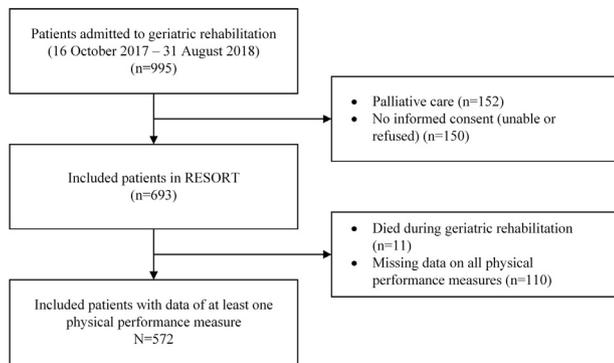
Supplementary Fig. 1. Flowchart of data availability of the RESORT cohort for the present analyses. Patients were included if both admission and discharge data were available for at least 1 of 5 physical performance measures.

Supplementary Table 1
Descriptive Statistics of Physical Performance Measures at Admission, Discharge, and the Change During Geriatric Rehabilitation

	N	Admission	Discharge	P^*	Change (Δ)[†]
SPPB score, points (0-12)	547	1 (0-4)	4 (1-6)	<.001	1 (0-3)
Balance score, points (0-4)	553	0 (0-2)	2 (0-3)	<.001	0 (0-2)
Gait speed score, points (0-4)	556	0 (0-1)	1 (0-2)	<.001	0 (0-1)
Gait speed, m/s	556	0.00 (0.00-0.42)	0.43 (0.00-0.62)	<.001	0.12 (0.00-0.39)
CST score, points (0-4)	559	0 (0-0)	0 (0-1)	<.001	0 (0-1)
CST, reps/30s	548	0 (0-0)	0 (0-7)	<.001	0 (0-3)
Hand grip strength, kg					
Male, mean ± SD	199	19.61 ± 9.59	20.36 ± 9.19	.198	0.75 ± 8.15
Female, mean ± SD	275	12.56 ± 6.13	13.56 ± 6.12	.001	0.99 ± 4.84

*Differences between admission and discharge physical performance measures were tested using paired samples t test for normally distributed variables, and related samples Wilcoxon signed rank tests for nonnormally distributed variables.
[†]Changes (Δ) in physical performance were calculated by subtracting admission values from discharge values. CST, chair stand test; SPPB, Short Physical Performance Battery; reps/30s, repetitions per 30 seconds.
Data are represented as median (interquartile range), unless indicated otherwise.