Risk Factors of Readmissions in Geriatric Rehabilitation Patients: RESORT

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Abstract

Objective: To evaluate the risk factors associated with 30- and 90-day hospital readmissions in geriatric rehabilitation inpatients.

Design: Observational, prospective longitudinal inception cohort.

Setting: Tertiary hospital in Victoria, Australia.

Participants: Geriatric rehabilitation inpatients of the RESiORing Health of Acutely Unwell AdultTs (RESORT) cohort evaluated by a comprehensive geriatric assessment including potential readmission risk factors (ie, demographic, social support, lifestyle, functional performance, quality of life, morbidity, length of stay in an acute ward). Of 693 inpatients, 11 died during geriatric rehabilitation. The mean age of the remaining 682 inpatients was 82.2±7.8 years, and 56.7% were women.

Interventions: Not applicable.

Main Outcome Measures: Thirty- and 90-day readmissions after discharge from geriatric inpatient rehabilitation.

Results: The 30- and 90-day unplanned all-cause readmission rates were 11.6% and 25.2%, respectively. Risk factors for 30- and 90-day readmissions were as follows: did not receive tertiary education, lower quality of life, higher Charlson Comorbidity Index and Cumulative Illness Rating Scale (CIRS) scores, and a higher number of medications used in the univariable models. Formal care was associated with increased risk for 90-day readmissions. In multivariable models, CIRS score was a significant risk factor for 30-day readmissions, whereas high fear of falling and CIRS score were significant risk factors for 90-day readmissions.

Conclusions: High fear of falling and CIRS score were independent risk factors for readmission in geriatric rehabilitation inpatients. These variables should be included in hospital readmission risk prediction model developments for geriatric rehabilitation inpatients.

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higher health care needs. Limited evidence on evaluating and improving geriatric rehabilitation interventions to avoid readmissions is available. Investigating risk factors of readmissions and identifying high-risk geriatric rehabilitation inpatients upon admission who need tailored case management and transitional care after discharge improve patient-centered care and reduce potentially preventable readmissions. Among geriatric rehabilitation inpatients, malnutrition, functional status, polypharmacy, and multimorbidity are associated with hospital readmission. However, the association between other patient characteristics, such as social factors, lifestyle, quality of life, and readmissions, is unknown. The identification of aforementioned risk factors for readmissions may provide insights into developing risk prediction models in this population. This study aimed to identify risk factors associated with the risk of 30- and 90-day hospital readmissions in geriatric rehabilitation inpatients.

Methods

Study design

RESORTing Health of Acutely Unwell AdultTs (RESORT) is an ongoing observational, longitudinal inception cohort from October 16, 2017 onwards using a comprehensive geriatric assessment (CGA) to investigate the characteristics and health outcomes of inpatients recruited from geriatric rehabilitation wards at the Royal Melbourne Hospital. Older and frailer adults tending to have multimorbidity who require multidisciplinary rehabilitation care for recovery after acute episodes of ill-health are transferred to geriatric rehabilitation wards. CGA is a multidimensional, interdisciplinary diagnostic process to determine health characteristics and develop relevant coordinated intervention or follow-up. The study was approved by the Melbourne Health Human Research Ethics Committee (reference no: HREC/17/MH/103) and followed national and international ethical guidelines according to the Declaration of Helsinki. Written informed consent was obtained by either the patient or a nominated proxy. Patients were excluded if they were receiving palliative care at admission, incapable of providing informed consent without a nominated proxy, or transferring to acute care prior to consenting to the study.

This study used data of 693 geriatric rehabilitation inpatients of the first wave from October 16, 2017 until August 31, 2018 after excluding patients (n=152, 15.3%) who met the exclusion criteria. Patients who died during their hospital stay in geriatric rehabilitation wards (n=11) were excluded from the data analysis, leaving 682 patients for the present study. Patients were assessed using the CGA within 48 hours of admission to the geriatric rehabilitation wards by physicians, nurses, physiotherapists, occupational therapists, and dietitians on social characteristics, nutrition status, physical and functional capacity, morbidity, and cognition using standardized assessment tools. The CGA also included patient surveys consisting of brief, primarily closed-ended questions to collect demographics, social support, quality of life, and lifestyle information completed by patients, caregivers, or health professionals. Potential risk factors for readmissions were grouped into 7 domains: demographics, social support, lifestyle, functional performance, quality of life, morbidity (including cognition), and index admission.

Demographics

Age and sex were collected from medical records. Country of birth, ethnicity, and highest level of education data were collected from surveys. Patients with tertiary education were defined as those having pursued beyond the secondary school level, including college education.

Social support

Whether patients were institutionalized before admission and received services from the council or other organizations (formal care) were collected from surveys. The question on whether patients had caregivers (informal care) in the Brief Abuse Screen for the Elderly questionnaire was completed by physicians. Caregivers were defined as unremunerated individuals providing needed care regularly.

Lifestyle

Current smoking status and alcohol consumption over the past year were collected from surveys. Trained nurses completed the Malnutrition Screening Tool. Patients who scored more than 2 were at risk of malnutrition. Body mass index was calculated by anthropometric measurements completed by trained nurses.

Functional performance

Patients’ walking ability, history of having at least 1 fall over the past year before hospital admission, and fear of falling 1 month before hospital admission were collected from surveys. Frailty was assessed by physicians using the Clinical Frailty Scale ranging from 1-9, with greater scores indicating a higher level of frailty. Trained occupational therapists assessed functional independence status using activities of daily living (ADL) and instrumental activities of daily living (IADL). ADL and IADL scores ranged from 0-6 and 0-8, respectively, with higher scores indicating higher levels of independence for both scales. A physical functioning assessment was performed by trained physiotherapists using the Short Physical Performance Battery. It included assessments on balance maintenance with eyes open, a timed 4-meter walk, and a timed sit-to-stand test. It ranged from 0-12, with higher scores demonstrating higher levels of lower extremity functioning.

Quality of life

Patients were asked to rate their health status from 0 (worst imaginable health) to 100 (best imaginable health) using the

List of abbreviations:

- ADL: activities of daily living
- AUC: area under the receiver operating characteristic curve
- CCI: Charlson Comorbidity Index
- CFS: Clinical Frailty Scale
- CGA: comprehensive geriatric assessment
- CI: confidence interval
- CIRS: Cumulative Illness Rating Scale
- IADL: instrumental activities of daily living
- IQR: interquartile range
- OR: odds ratio
- RESORT: RESORTing Health of Acutely Unwell AdultTs

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Table 1 Characteristics of geriatric rehabilitation inpatients at admission

| Characteristics                          | No. of Patients (n) | Value       |
|------------------------------------------|---------------------|-------------|
| Demographics                             |                     |             |
| Age (y), mean ± SD                       | 682                 | 82.2±7.8    |
| Women                                    | 682                 | 387 (56.7)  |
| White                                    | 677                 | 603 (89.1)  |
| Australian-born                          | 679                 | 297 (43.7)  |
| Tertiary education                       | 510                 | 59 (11.6)   |
| Social support                           |                     |             |
| Institutionalized                        | 682                 | 24 (3.5)    |
| Informal care*                           | 569                 | 348 (61.2)  |
| Formal care†                             | 649                 | 360 (55.5)  |
| Lifestyle                                |                     |             |
| Current smoking                          | 601                 | 39 (6.5)    |
| Alcohol use over the past year           | 546                 | 282 (51.6)  |
| Risk of malnutrition (MST)               | 672                 | 83 (12.4)   |
| BMI (kg/m²), mean ± SD                   | 654                 | 27.3±6.5    |
| Functional performance                   |                     |             |
| Ability to walk with or without a walking aid | 679     | 494 (72.8)  |
| Fall history over the past year          | 669                 | 443 (66.2)  |
| High fear of falling 1 mo before admission, n (%) | 476     | 86 (18.1)   |
| Clinical Frailty Scale score, median (IQR) | 605     | 6 (5-6)     |
| ADL score, median (IQR)                  | 663                 | 2 (1-3)     |
| IADL score, median (IQR)                 | 664                 | 1 (0-1)     |
| SPPB score, median (IQR)                 | 647                 | 1 (0-4)     |
| Quality of life                          |                     |             |
| EuroQoL-VAS score, median (IQR)          | 419                 | 50 (35-70)  |
| Morbidity                                |                     |             |
| CCI score, median (IQR)                  | 682                 | 2 (1-4)     |
| CIRS score, median (IQR)                 | 682                 | 11 (8-15)   |
| CIRS no. of systems affected, median (IQR)| 682     | 6 (5-8)     |
| **CIRS severity index, median (IQR)**    | 682                 | 1.9 (1.6-2.2)|
| Cognitive impairment                     | 682                 | 435 (63.8)  |
| Anxiety, HADS                            | 431                 | 82 (19.0)   |
| Depression, HADS                         | 444                 | 100 (22.5)  |
| No. of medications, median (IQR)         | 682                 | 10 (7-13)   |
| Index admission                          |                     |             |
| LOS in acute ward, d, median (IQR)       | 682                 | 7.0 (4.0-11.0)|
| LOS in rehabilitation ward, d, median (IQR)| 682   | 20.0 (14.0-30.0) |
| Readmission                              |                     |             |
| 30-d readmission                         | 682                 | 79 (11.6)   |
| 90-d readmission                         | 682                 | 172 (25.2)  |

NOTE. Data in are presented in numbers of patients and percentages unless stated otherwise.

Abbreviations: BMI, body mass index; EuroQoL-VAS, EuroQol visual analog scale; HADS, Hospital Anxiety and Depression Scale; LOS, length of stay; MST, Malnutrition Screening Tool; SPPB, Short Physical Performance Battery.

* Informal care indicates that patients had caregivers.
† Formal care indicates that patients received services from the council or other organizations.

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90-d readmission 682 172 (25.2)
30-d readmission 682 79 (11.6)

Morbidity

Physicians assessed morbidity using the Charlson Comorbidity Index (CCI) and the Cumulative Illness Rating Scale (CIRS). CCI and CIRS scores ranged from 0-37 and 0-56, respectively. CIRS scores at admission were presented as total scores, the total number of organ systems endorsed, and severity index (total score/total number of systems endorsed). The number of medications at admission to geriatric rehabilitation wards was extracted from the medical records.

Cognitive impairment was defined as a dementia diagnosis captured by the CCI, CIRS, or medical records, a score on the Standardized Mini-Mental State Examination of less than 24 points, Montreal Cognitive Assessment less than 26 points, or Rowland Universal Dementia Scale less than 23 points. Cognitive testing was completed by physicians. Hospital Anxiety and Depression Scale in surveys was used to assess anxiety (≥11 points indicating anxiety symptoms) and depressive symptoms (≥11 points indicating depression symptoms).

Index admission

The length of stay during the acute admission before being admitted to geriatric rehabilitation and the length of stay during geriatric rehabilitation were collected from medical records.

Readmission

Information on whether patients had all-cause unplanned 30- and 90-day hospital readmissions to the Royal Melbourne Hospital were obtained from the hospital administrative system. Questions on whether they had hospital readmissions to other hospitals within 90 days after discharged were asked during a follow-up phone call with the patient or caregiver. Planned admissions after discharge were excluded, which included elective admissions for follow-up surgical or medical treatments, such as scheduled dialysis or chemotherapy.

Statistical analysis

Descriptive variables were presented as numbers and percentages, means and SDs or as medians and interquartile ranges (IQR). We compared categorical variables using Pearson or Fisher exact tests and continuous variables using Student t tests or Mann-Whitney U tests as appropriate. We performed Levene’s test of homogeneity of variances as part of the continuous variable comparison statistical tests.

The linearity between continuous variables and readmissions were checked, and univariable logistic regression analyses were performed to identify associations, odds ratios (ORs), and 95% confidence intervals (CIs) between potential risk factors and readmissions. Multivariable logistic regression analyses were performed using the variables with P<.10 from the univariable logistic regression analysis to identify risk factors for readmissions. We checked multicollinearity within each domain using variance inflation factors and chi-square test for significant continuous and categorical variables, respectively. Variance inflation factors higher than 3 or a P value below 0.05 in chi-square tests were considered as having multicollinearity. For variables that were found to have multicollinearity, the variable

EuroQoL visual analog scale in surveys. Patients with visual impairment were asked verbally to rate their health status.
| Patient Characteristics | 30-Day Readmission | 90-Day Readmission |
|-------------------------|--------------------|--------------------|
|                         | No. of Patients (n) | No. of Patients (n) | OR (95% CI) | No. of Patients (n) | No. of Patients (n) | OR (95% CI) |
| Demographics            |                    |                    |             |                    |                    |             |
| Age at admission (y), mean ± SD | 603 | 82.1±7.9 | 79 | 83.0±7.0 | 1.02 (0.99- 1.05) | 510 | 82.2±8.0 | 172 | 82.2±7.4 | 1.00 (0.98- 1.02) |
| Women                   | 603 | 341 (56.6) | 46 (58.2) | 1.07 (0.67- 1.72) | 509 | 290 (57.0) | 171 | 96 (56.1) | 0.95 (0.67- 1.35) |
| White                   | 598 | 535 (89.5) | 68 (86.1) | 0.76 (0.22- 2.66) | 506 | 453 (89.5) | 171 | 150 (87.7) | 0.66 (0.26- 1.67) |
| Australian-born         | 600 | 272 (45.3) | 25 (31.6) | 0.56 (0.34- 0.92) | 507 | 232 (45.8) | 172 | 65 (37.8) | 0.72 (0.51- 1.03) |
| Tertiary education      | 453 | 58 (12.8) | 1 (1.8) | 0.12 (0.02- 0.90) | 385 | 51 (13.2) | 125 | 8 (6.4) | 0.45 (0.21- 0.97) |
| Social support          |                    |                    |             |                    |                    |             |
| Institutionalized       | 603 | 23 (3.8) | 1 (1.3) | 0.32 (0.04- 2.43) | 510 | 17 (3.3) | 172 | 7 (4.1) | 1.23 (0.50- 3.02) |
| Informal care           | 504 | 307 (60.9) | 41 (63.1) | 1.10 (0.64- 1.87) | 431 | 257 (59.6) | 138 | 91 (65.9) | 1.31 (0.88- 1.96) |
| Formal care             | 573 | 314 (54.8) | 46 (60.5) | 1.32 (0.80- 2.18) | 486 | 260 (53.5) | 163 | 100 (61.3) | 1.39 (1.00-2.06) |
| Lifestyle               |                    |                    |             |                    |                    |             |
| Smoking                 | 529 | 35 (6.6) | 4 (5.6) | 0.94 (0.32- 2.80) | 449 | 28 (6.2) | 152 | 11 (7.2) | 1.16 (0.55-2.42) |
| Alcohol use over the past year | 482 | 254 (52.7) | 28 (43.8) | 0.70 (0.41- 1.18) | 413 | 226 (54.7) | 133 | 56 (42.1) | 0.60 (0.41-0.89) |
| Risk of malnutrition (MST) | 593 | 68 (11.5) | 15 (19.0) | 1.86 (0.97-3.54) | 503 | 61 (12.1) | 169 | 22 (13.0) | 1.17 (0.68-2.01) |
| BMI (kg/m²), mean ± SD  | 576 | 27.2±6.5 | 28.0±6.7 | 1.02 (0.98-1.05) | 487 | 27.2±6.6 | 167 | 26.6±6.3 | 1.01 (0.98-1.04) |
| Functional performance   |                    |                    |             |                    |                    |             |
| Ability to walk         | 601 | 439 (73.0) | 55 (70.5) | 0.88 (0.53-1.48) | 508 | 366 (72.0) | 171 | 128 (74.9) | 1.16 (0.78-1.72) |
| Fall history over the past year | 591 | 393 (66.5) | 78 (64.1) | 0.90 (0.55-1.47) | 500 | 329 (65.8) | 169 | 114 (67.5) | 1.08 (0.74-1.56) |
| High fear of falling 1 mo before admission | 428 | 71 (16.6) | 45 (10.9) | 2.03 (0.97-4.25) | 366 | 55 (15.0) | 110 | 31 (28.2) | 2.51 (1.42-4.46) |
| Clinical Frailty Scale score, median (IQR) | 537 | 6 (5-6) | 6 (5-7) | 1.21 (0.98-1.50) | 458 | 6 (5-6) | 147 | 6 (5-7) | 1.18 (1.01-1.38) |
| ADL score, median (IQR) | 586 | 1 (0-1) | 1 (0-1) | 0.93 (0.76-1.15) | 500 | 1 (0-1) | 164 | 1 (0-1) | 0.93 (0.80-1.08) |
| IADL score, median (IQR) | 587 | 1 (0-1) | 1 (0-1) | 0.93 (0.76-1.15) | 500 | 1 (0-1) | 164 | 1 (0-1) | 0.93 (0.80-1.08) |
| SPPB score, median (IQR) | 569 | 1 (0-4) | 2 (0-3) | 0.99 (0.90-1.08) | 485 | 1 (0-4) | 162 | 1 (0-3) | 0.97 (0.91-1.04) |
| Quality of life         |                    |                    |             |                    |                    |             |
| EuroQoL-VAS score, median (IQR) | 372 | 55 (40-72) | 50 (30-70) | 0.99 (0.98-1.00) | 319 | 60 (40-75) | 100 | 50 (30-70) | 0.99 (0.98-1.00) |
| Morbidity               |                    |                    |             |                    |                    |             |
| CCI score, median (IQR) | 603 | 2 (1-4) | 3 (2-5) | 1.18 (1.08-1.28) | 510 | 2 (1-4) | 172 | 3 (1-5) | 1.14 (1.07-1.22) |
| CIRS score, median (IQR) | 603 | 11 (8-14) | 13 (10-17) | 1.08 (1.03-1.13) | 510 | 11 (8-14) | 172 | 12 (9-15) | 1.05 (1.02-1.09) |
| CIRS no. of systems affected, median (IQR) | 603 | 6 (5-8) | 7 (6-8) | 1.26 (1.12-1.41) | 510 | 6 (5-7) | 172 | 7 (5-8) | 1.16 (1.06-1.26) |
| CIRS severity index, median (IQR) | 603 | 1.9 (1.6-2.2) | 1.9 (1.7-2.2) | 0.83 (0.47-1.44) | 510 | 1.9 (1.6-2.2) | 172 | 1.9 (1.7-2.2) | 0.95 (0.63-1.43) |
| Cognitive impairment    | 603 | 385 (63.8) | 50 (63.3) | 0.98 (0.60-1.59) | 510 | 326 (63.9) | 172 | 109 (63.4) | 0.98 (0.68-1.40) |
| Anxiety, HADS           | 385 | 76 (19.7) | 6 (13.0) | 0.64 (0.26-1.60) | 331 | 61 (18.4) | 100 | 21 (21.0) | 1.21 (0.68-2.13) |
| Depression, HADS        | 396 | 90 (22.7) | 10 (20.8) | 0.98 (0.46-2.11) | 341 | 73 (21.4) | 103 | 27 (26.2) | 1.45 (0.85-2.46) |
| No. of medications, median (IQR) | 603 | 9 (7-12) | 10 (8-14) | 1.07 (1.02-1.13) | 510 | 9 (7-12) | 172 | 10 (8-14) | 1.08 (1.04-1.12) |

(continued on next page)
with the lowest $P$ value in univariable analysis was chosen. Given that different sections of the CGA were completed by specific health care professionals at different times, certain sections could have been missed at admission. Multiple imputation was performed in handling missing data before multivariable analysis if data were missing at random.\(^3\) Missing value analysis using the Little’s missing completely at random test and missing value patterns graph were used to determine whether the data were missing at random or not. A 2-tailed $P$ value $>0.05$ was considered a statistically significant independent risk factor for readmission in multivariable analysis. Sensitivity analysis was performed comparing independent risk factors of patients with complete data sets and patients with imputed missing data. The performance of the model including significant risk factors in multivariable analysis was assessed using analysis of area under the receiver operating characteristic curve (AUC) statistics. We conducted statistical analysis using the Statistical Package for Social Sciences (SPSS Statistics for Windows, version 25.0).

**Results**

**Patient characteristics**

Table 1 shows the characteristics of 682 geriatric rehabilitation inpatients at admission. The mean age at admission was 82.2±7.8 years, and 56.7% ($n=387$) were women. Four percent of the patients were institutionalized and 61% had caregivers. Seventy-three percent of the patients were able to walk and 66.2% had experienced at least 1 fall within the year before admission. A median CCI score of 2 (IQR, 1-4) and a median of 6 (IQR, 5-8) systems were affected in CIRS. The median length of stay in acute wards before geriatric rehabilitation ward admission was 7.0 days (IQR, 4.0-11.0). The 30- and 90-day all-cause readmissions rates were 11.6% and 25.2% respectively. Among patients who had 90-day readmissions, 26 (15.1%) were identified outside the Royal Melbourne Hospital.

**Risk factors for 30-day all-cause hospital readmissions**

Table 2 shows the comparison of characteristics between patients with and without readmissions. Patients readmitted within 30 days after discharge were more likely to be non-Australian born, not have received tertiary education, have a lower self-rated quality of life, have higher CCI and CIRS scores, and have a higher number of medications used and longer length of acute hospital stay. Owing to the multicollinearity between CFS, CCI, CIRS, and number of medications (shown in appendix 1), CIRS score was only included in the multivariable analysis. Little’s missing completely at random test and missing value pattern graph showed random arrangement of missing values across variables ($P=.541$), with more missing data from patient surveys. Multiple imputation was used to handle missing values. Multivariable analysis (table 3) found CIRS to be a significant risk factor for 30-day readmissions (OR, 1.06; 95% CI, 1.01-1.12), achieving an AUC of 0.61 (95% CI, 0.54-0.68). It was also significant in the multivariable analysis using only patients with complete data (appendix 2).

**Risk factors for 90-day all-cause readmissions**

Not receiving tertiary education; receiving formal care from councils or organizations; nonalcohol consumer; self-reported
high fear of falling; lower self-rated quality of life; higher scores in CFS, CCI, and CIRS; and higher number of medications used were risk factors for 90-day readmissions. Significant risk factors for 90-day readmissions were self-reported high fear of falling (OR, 1.86; 95% CI, 1.11-3.10) and CIRS (OR, 1.05; 95% CI, 1.01-1.09) score using multivariable analysis after multiple imputation, achieving an AUC of 0.62 (95% CI, 0.56-0.68). It was similar to multivariable analysis using only patients with complete data (see appendix 2).

Discussion

Lower self-rated quality of life and higher CCI, CIRS, and number of medications used were associated with increased risk for 30- and 90-day readmissions. Significant risk factors for 90-day readmissions were self-reported high fear of falling (OR, 1.86; 95% CI, 1.11-3.10) and CIRS (OR, 1.05; 95% CI, 1.01-1.09) score using multivariable analysis after multiple imputation, achieving an AUC of 0.62 (95% CI, 0.56-0.68). It was similar to multivariable analysis using only patients with complete data (see appendix 2).

Our finding that receiving formal care was a risk factor for 90-day readmissions is consistent with a recently published study among geriatric inpatients demonstrating a positive relationship between receipt of help or home health services postdischarge and 30-day readmissions.43 Requiring a strong social support network can be an indicator for complex health needs and consequent risk of readmission.43 Interventions aiming to reduce fear of falling, which include strategies such as medication reviews, home safety assessment, osteoporosis prevention, regular eye examination, weight-bearing exercise programs, and caregiver-targeted fall prevention education,42,44 might enhance self-confidence and self-efficacy in falls prevention.

Low quality of life was a risk factor for 30- and 90-day readmission, which is in line with previous literature, including geriatric inpatients45 and older community-dwelling individuals.46,47 Lower quality of life may indicate living with compromised health due to existing morbidities48 and is therefore associated with readmissions.

The finding that comorbidities and polypharmacy were risk factors for readmissions concurs with existing literature showing an association between the number of comorbidities with medications prescribed and hospital readmissions in geriatric patients after discharge from the hospital.49,50,55 The effect of comorbidities on readmission is linked to polypharmacy.56 Polypharmacy is associated with the increased use of potentially inappropriate medications, increased likelihood of adverse drug reactions, lower adherence to therapeutics, and increased likelihood of making mistakes on complex medication regimens.50,53,56,57 This medication-related harm is potentially preventable.58

Study limitations

This was a single-site study, which might limit generalizability to other hospitals. The prevalence of 30-day readmissions could have been underestimated because it only included readmissions to the Royal Melbourne Hospital. Reasons for subacute ward admission were not available for readmission rate stratification. Furthermore, the sample size of this study was relatively small to detect moderate risk factors. A small proportion of data were randomly missing, which enabled imputation. The data are based on a highly standardized collected comprehensive assessments performed by a trained multidisciplinary team in a highly relevant cohort of patients.
geriatric rehabilitation inpatients. Exclusion criteria were limited. Ongoing recruitment within the RESORT cohort will enable validating readmission risk prediction models for geriatric rehabilitation inpatients.

Conclusions
In geriatric rehabilitation patients, the risk factors for both 30- and 90-day readmissions included non-Australian born; not receiving a tertiary education; self-reported high fear of falling; self-rated quality of life; CFS, CCI, and CIRS score; and the number of medications used. In multivariable analysis, CIRS score was the significant risk factor for both 30- and 90-day readmissions; self-reported high fear of falling was a risk factor for 90-day readmissions. The inclusion of these risk factors in future readmission risk prediction models among geriatric rehabilitation inpatients is recommended.

Supplier
a. SPSS Statistics for Windows, version 25.0; IBM Corp.

Appendix 1 Multicollinearity analysis for multivariable logistic regression

| Patient Characteristics          | Multicollinearity | \(P\) Value (Univariate Logistic Regression) |
|----------------------------------|-------------------|--------------------------------------------|
|                                  | Variance Inflation Factor | \(P\) Value (\(\chi^2\)) | 30-Day Readmission | 90-Day Readmission |
| Demographics                     |                   |                                         |                  |                  |
| Australian-born                  | -                 | .176                                     | .021*            | .069             |
| Tertiary education               | -                 | .176                                     | .014*            | .038*            |
| Morbidity/Functional performance |                   |                                         |                  |                  |
| Clinical Frailty Scale score     | CCI: 1.368        |                                         |                   |                  |
|                                  | CIRS: 4.209       |                                         |                   |                  |
|                                  | CIRS no. of system affected: 3.876 |                                         |                   |                  |
|                                  | No. of medications: 1.116 |                                         |                   |                  |
| CCI score                        | Clinical frailty scale: 1.086 | -                                      | .001*            | .009*            |
|                                  | CIRS:4.115        |                                         |                   |                  |
|                                  | CIRS no. of systems affected: 3.889 | -                                      | <.0001*          | <.0001*          |
|                                  | No. of medications: 1.105 |                                         |                   |                  |
| CIRS score                       | Clinical frailty scale: 1.057 | -                                      | <.0001*          | <.0001*          |
|                                  | CCI: 1.301        |                                         |                   |                  |
|                                  | CIRS no. of systems affected: 1.328 | -                                      | .003*            | .001*            |
|                                  | No. of medications: 1.104 |                                         |                   |                  |
| CIRS no. of systems affected     | Clinical Frailty Scale: 1.087 | -                                      | .001*            | .001*            |
|                                  | CCI: 1.373        |                                         |                   |                  |
|                                  | CIRS: 1.482       |                                         |                   |                  |
|                                  | No. of medications: 1.118 |                                         |                   |                  |
| No. of medications               | Clinical Frailty Scale: 1.089 | -                                      | .001*            | .001*            |
|                                  | CCI: 1.357        |                                         |                   |                  |
|                                  | CIRS: 4.288       |                                         |                   |                  |
|                                  | CIRS no. of systems affected: 3.893 |                                         |                   |                  |

* \(p<0.05\).

Keywords
Aged; Geriatrics; Patient readmission; Rehabilitation; Risk factors

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Appendix 2 Risk factors for 30- and 90-day readmissions in geriatric rehabilitation inpatients with complete data

| Patient Characteristics | 30-Day Readmission (n=380) | 90-Day Readmission (n=377) |
|-------------------------|---------------------------|---------------------------|
|                         | OR (95% CI) | P Value | OR (95% CI) | P Value |
| **Demographics**        |             |         |             |         |
| Australian-born          | 0.54 (0.25-1.17) | .119 | 0.66 (0.38-1.15) | .143 |
| Tertiary education       | 0.73 (0.32-3.36) | .946 | 0.47 (0.17-1.26) | .132 |
| **Social support**       |             |         |             |         |
| Formal care              | -           | -       | 1.06 (0.63-1.78) | .832 |
| **Lifestyle**            |             |         |             |         |
| Alcohol use over the past year | -       | -       | 0.68 (0.41-1.16) | .155 |
| Risk of malnutrition (MST) | 2.24 (0.83-6.03) | .209 | -           | -       |
| **Functional performance** |             |         |             |         |
| High fear of falling 1 mo prior to admission | 2.32 (0.94-5.71) | .067 | 2.24 (1.13-4.44) | .020* |
| **Morbidity**            |             |         |             |         |
| EuroQol-VAS score        | 0.99 (0.98-1.01) | .235 | 0.99 (0.98-1.01) | .300 |
| CIRS score               | 1.07 (0.99-1.15) | .068 | 1.07 (1.01-1.13) | .015* |
| **Quality of life**      |             |         |             |         |
| Length of stay in acute ward, d | 1.04 (1.01-1.08) | .020* | -           | -       |

Abbreviation: EuroQol-VAS, EuroQol visual analog scale.
* P<.05.

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