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Featured Article

# Factors associated with successful rehabilitation in older adults: *A systematic review and best evidence synthesis*

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ABSTRACT

*Purpose;* Returning to community living is an indicator for successful rehabilitation in older adults admitted to geriatric rehabilitation. Predicting successful rehabilitation could contribute to the deployment of early discharge planning, and leads to a more custom-made rehabilitation trajectory. This review aims to present an overview of factors associated with successful rehabilitation following inpatient geriatric rehabilitation.
*Method;* A systematic literature review was conducted in PubMed, CINAHL and Embase. Extracted factors were analysed via Bakker's five levels of evidence.
*Results*; Nine studies with methodological quality of good to moderate were included. For 13 of the 18 extracted factors, limited (n=3), moderate (n=5) and conflicting (n=5) evidence found a significant association.
*Conclusions*; Caregiver, comorbidities, motor-function, nutritional status, time from onset are significantly related to successful rehabilitation. These factors could support healthcare professionals to indicate successful rehabilitation at admission and contributes to deployment of early discharge planning and development of more custom-made rehabilitation trajectories.



## Introduction

Globally, the number of community-dwelling older adults is increasing rapidly. In 2050, the proportion of older adults is expected to contribute 21% of the global population.[1,2]

Due to functional decline and disability,[3] older adults have an increased risk of hospitalisation and admission to long-term care facilities.[4] An acute event or exacerbation of illness is a reason for hospitalisation. After hospitalisation, older adults can be admitted for inpatient geriatric rehabilitation (GR) to restore physical functions. The most common diagnoses in GR are stroke, trauma, joint replacement, chronic obstructive pulmonary disease, amputee, and heart failure.[5] Research has shown that GR is effective for restoring functional abilities, improves quality of life and reduces health-care costs by shortening length of hospital stay.[4,6,7]

GR is an inpatient programme that takes place in a skilled nursing facility, inpatient rehabilitation facility, nursing homes and long-term acute-care hospitals[8,9] and is delivered by a multidisciplinary team that consists of a geriatric physician, nursing staff, a physiotherapist and an occupational therapist, sometimes together with a psychologist, social worker, speech therapist and dietician.[5,8] The purpose of the multidisciplinary approach is to restore mobility, self-care abilities and cognitive functions.[4] The primary goal in GR for the patient, and thus for the multidisciplinary team, is returning to community living.[10,11] However, not all patients are able to return to their former living situation and are admitted to a nursing home or other residential care settings.[12] In literature, returning to community living is described as an indicator for successful rehabilitation.[6]

Making arrangements for older adults when leaving GR is called discharge planning. Early planning of discharge has been shown to reduce hospital readmissions and mortality and improve the patients' QoL.[7,13] Early discharge planning could lead to a more custom-made rehabilitation trajectory, rehabilitation goals and preparation for discharge.[6]

However, due to the frailty and multimorbidity of the patients admitted to GR, predicting discharge destination at admission is difficult.[14] In 2016, a systematic review described factors influencing home discharge in an older non-stroke population.[6,15] Everink et al. found younger age, non-white ethnicity, being married, better

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functional and cognitive function and the absence of depression were significantly associated with home discharge in older non stroke people. However, of the 23 revealed factors, only six factors demonstrated a clear significant association with home discharge. Moreover, the review included mainly studies including an orthopaedic population. Nevertheless, GR contains variated diagnoses often in combination with multi-comorbidities.[12] In addition, Lindenberg et al. reported that diagnosis was not associated with discharge destination.[16] Therefore, it should be possible to use factors which are not allied to specific diagnoses, to predict discharge destination for the entire sample of older adults admitted to GR.

More insight into people with higher odds for successful rehabilitation at admission could support healthcare professionals to make a prediction of discharge destination and tailor rehabilitation programs on increasing the changes of community discharge and deploy discharge planning early in the rehabilitation phase.[12,17]

Therefore, we aimed to provide an overview of factors associated with successful rehabilitation in older adults admitted to GR.

## Material and methods

A systematic review of the available evidence was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[18]

### *Search strategy*

A systematic search of publications was conducted in PubMed, CINAHL and Embase in February 2019 and updated in October 2019. As the latest review in associated factors in a non-stroke population[6] was carried out up to October 2015, articles published between October 2015 and October 2019 were included. Moreover, references of the included studies were analysed through Scopus.

A search string with a combination of MeSH terms and keywords was used to identify as many articles as possible. The complete search strings are presented in supplemental material.

### *Inclusion and exclusion criteria*

Studies were included for further analysis if the study met the following criteria: (1) included older adults admitted to an inpatient rehabilitation unit who lived in the community before the onset; (2) included older adults with a mean age of 65 years or older; (3) reported successful rehabilitation as an outcome measure; (4) associated factors were assessed at admission; (5) published in English or Dutch; and (6) full text was available.

Successful rehabilitation was defined as discharge to community living and discharge to home.[6,12] Studies that reported one of these definitions were included. Studies were excluded if the primary outcome was not statistically analysed. Moreover, because this review focused on associated factors and not on interventions, case reports, case series and (randomised) clinical trials were excluded.

### *Study selection*

All the studies found in the databases were uploaded in Rayyan.[19] Thereafter, duplicate articles were deleted. Potential studies were independently screened on title and abstract by two researchers (PL, SA) to identify whether studies met the inclusion criteria. The full text of the articles was obtained in the electronic databases or by contacting the first author when studies met the inclusion criteria. Furthermore, full-text publications were independently assessed by two researchers (PL, SA) if they met the inclusion and exclusion criteria. Studies that did not meet the criteria were excluded and the reason for exclusion was listed. In the case of disagreement between the two researchers, discussion took place until consensus was reached.

### *Data extraction*

A data extraction form was developed before the data extraction started. The following data was extracted from the studies: study design, sample characteristics (i.e. sample size, mean age, gender), diagnosis, setting, outcome of interest, predictive factor(s), and results ($p$-value; HR or OR; confidence interval). The influence of the factor on the outcome was considered significant by a $p$-value of $< 0.05$. When a study examined multiple factors, all the factors were individually analysed in this review. Factors allied specifically to one diagnoses (e.g. neglect) were not analysed. Finally, the results of the studies were categorised by associated factors.

### *Methodological quality*

The Quality Assessment Tool for Observational Cohort and Cross-Sectional studies of the National Heart, Lung and Blood Institute (NHLBI) was used[20] to assess the methodological quality of the individual studies. The NHLBI Quality Assessment Tool consists of 14 items and each item can be answered with 'yes', 'no' or 'other' (cannot determine, not reported or not applicable). The included studies were independently assessed by two researchers (PL, SA). Every item answered with 'yes' received one point. Items answered with 'no' or 'other' received no points. If the two researchers scored differently, discussion took place until consensus was reached. The two researchers (PL, SA) determined that if an item was not applicable in more than 90% of the studies, the item was eliminated for the overall conclusion. The sum of the scores was divided by the number of items included in the quality assessment. All items were weighted equally. A score of >75% was considered a good methodological quality score. A score of 50–75% was considered as moderate quality and a score of <50% as weak quality.

### *Data synthesis*

It was expected that there would be heterogeneity among the study populations in the included studies. Therefore, pooling the results in a meta-analysis was not possible. However, this review will provide a detailed narrative description of factors associated with successful rehabilitation. The results of the retrieved factors were analysed via best evidence synthesis.

Bakker et al.'s[21] five levels of evidence was used to evaluate the strength of the evidence for the extracted factors. Level (1) is strong evidence – consistent findings in two or more high-quality studies; level (2) is moderate evidence – consistent findings in one high-quality and at least one low-quality study; level (3) is limited evidence – only one study is available; level (4) is conflicting evidence – inconsistent findings in the available studies; and level (5) is no evidence – no studies found. Findings were predetermined as consistent if at least 75% of the included studies reported the same conclusion.[21]

## Results

### *Study selection*

In total, 1,094 studies were identified in PubMed, Embase and CINAHL. Another 14 studies were identified through reference check

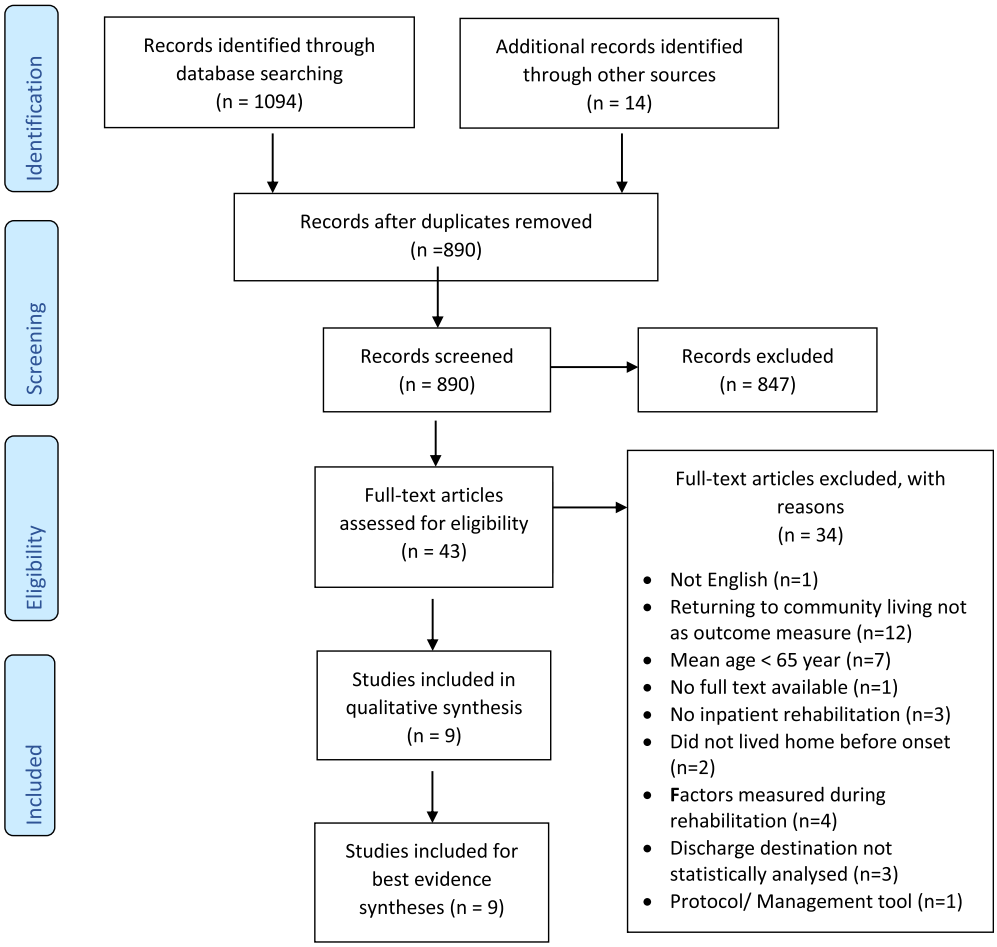


**Fig. 1.** Flowchart of the study identification and screening

in Scopus. After removing duplicates, 890 studies were screened on title and abstract (fig. 1). A total of 43 studies were eligible for further inclusion.

Two researchers (PL, SA) independently screened the 43 full-text articles to determine whether they met the inclusion and exclusion criteria. A total of 34 studies were excluded because they did not meet the inclusion criteria. Ultimately, nine studies were included in this review.

### *Study characteristics*

This review included four prospective cohorts, four retrospective cohorts and one cross-sectional study. Successful rehabilitation was the primary or secondary outcome in the studies. Most of the studies used other terms for successful rehabilitation, such as discharge disposition, home discharge, discharge to community living, and the ability to return home.

The included studies described multiple factors for successful rehabilitation. Six studies[4,22–26] examined the factors in a study population that included all diagnoses in inpatient rehabilitation. Two studies[27,28] included two diagnosis groups (stroke and amputation,) and one study[26] included three diagnosis groups (stroke, musculoskeletal and hospital-associated deconditioning).

Two studies[10,27] were conducted in the United States, one[25] in Spain, one[22] in the Netherlands, three[23,24,26] in Japan, one[4] in Switzerland, and one[28] in Singapore. The sample size of each of the studies ranged from 156 to 167,664. The total sample size of the studies was 242,667. A slightly larger number of females than males participated in the studies. All participants were admitted to the hospital and received inpatient rehabilitation treatment. The mean age of the participants provided in the included studies ranged from 66 to 88.55 years.

Table 1 presents the study characteristics, including the factors examined in the studies.

### *Methodological quality*

The score of the methodological quality assessment of the included studies ranged from seven to twelve points. Item 8, 'different levels of the exposure of interest', and item 10 'repeated measurement' were not applicable in more than 90% of the included studies, the total score of the assessment was determined as 12. Therefore, the sum of scores was divided by 12 in Table 2.

Two studies[24,26] were rated good and seven studies were rated as moderate. The most common weaknesses were seen in calculation of the sample size, repeated measurement of the exposure, blinding of the outcome assessors, and follow-up rate.

### *Factors extracted from included studies*

A total of 18 factors were extracted from the studies (Table 3). Seven studies reported multiple factors.[4,10,23,24,26–28] In two studies, a single factor was examined.[25,29]

**Table 1**
Study characteristics of the included studies

| Author, year/ Design/ Location | Sample characteristics*n, mean age (years) ±sd, gender* | Meth. Quality | Diagnosis | Setting data collection | Outcome | Factors |
|---|---|---|---|---|---|---|
| Hartog L, [22]<br>2016<br>Prospective cohort<br>Netherlands | N = 159<br>79.2 IQR<br>70% female | Moderate | All* | Nursing home | Successful rehabilitation; return home/ adapted home | Health Related Quality of Life (HRQOL) |
| Kool J, [4]<br>2017<br>Prospective cohort<br>Switzerland | N = 210<br>76.0<br>46.2% female | Moderate | All* | Inpatient rehabilitation | Living at home at 3 months follow up | Mobility at discharge, Fall risk (e/pA-AC), ADL before hospitalisation, Vulnerability (VES-13), Age, Multimorbidity (CIRS), Cognition (MMSE), Depression (geriatric depression scale), Living alone, Mobility barriers (stairs y/n) |
| Maeda K, [23]<br>2018<br>Prospective cohort<br>Japan | N = 207<br>84.7 ±6 .7<br>62% female | Moderate | All* | 150-bed hospital, which includes a 47-bed post-acute care ward | Ability to return home | Cognitive impairment (CPS), Malnutrition (ESPEN), Nutritional intake, Oral health (OHAT), ADL (BI) at admission, Rehabilitation by physiotherapist |
| Shiraishi A, [24]<br>2018<br>Prospective cohort<br>Japan | N = 1056<br>70 ± 17<br>52% female | Good | All* | Convalescent rehabilitation wards | Home discharge | Oral health problems (ROAG), Age<br>Sex, Nutritional status (MNA), FIM motor, FIM cognition, diagnose |
| Venkataraman K, [28]<br>2016<br>Retrospective cohort<br>Singapore | N = 256<br>66.0 ± 10.8<br>45.3% female | Moderate | Lower extremity amputation | Database; community hospital (after acute care hospital) | Discharge home vs other | Amputation level, Hospital bed, Race, Marital status, Primary caregiver, Sex, Comorbidity (CCI), Ischemic heart disease, Peripheral vascular disease, Renal disease, Age, LOS, AFG |
| Santaeugenia S, [25]<br>2017<br>Retrospective cohort<br>Spain | N = 668<br>82 ± 9.9<br>68%female | Moderate | All* | Database;<br>Inpatient rehabilitation | Discharge destination | Pressure ulcers at admission |
| Cary MP, [10]<br>2018<br>Retrospective cohort<br>United States | N = 167,664<br>78.9 ± 7.5<br>59.3%female | Moderate | All* | Database<br>Inpatient rehabilitation | Successful community discharge (30 days without readmission/ death) | Age, Sex, Race, disability benefits,<br>Social support, Impairment, FIM cognition at admission, FIM motor at admission, Comorbidity (CMS), Prior inpatient days, Hospital LOS, IRF LOS |
| Yoshimura Y, [26]<br>2019<br>Retrospective cohort<br>Japan | N = 795<br>74.9 ± 13.2<br>59% female | Good | All*<br>Categorised | 2 convalescent rehabilitation wards | Rate of home discharge | Sarcopenia, age, sex, premorbid ADL (mRs), LOS, comorbidity (CCI), Dysphagia (FILS), FIM discharge, nutrition status (MNA-sf), number of drugs<br>Time from onset<br>diagnose |
| O'Brien S, [27]<br>2016<br>Cross sectional<br>United States | N = 71,652<br>88.55 ± 2.73<br>65.5% female | Moderate | Stroke | Database; inpatient rehabilitation | Community discharge vs institutional discharge | LOS, Admission FIM, Discharge FIM<br>Age, Sex, Race, Stroke location, Number of comorbidities, Number of complications after admission |

*All; Central nervous system (CNS); Spinal cord injury (SCI); Neurological; Musculoskeletal; Endurance; Infection; Physical deconditioning; Nutrition support; Surgery; Digestive disease; Cardiovascular disease; Renal disease; Collagen diseases; decubitus; Respiratory diseases; Neurodegenerative diseases; Malignant diseases; Medical; orthopaedic.
LOS= Length of stay; FIM= Functional independence Measure; IRF= Inpatient Rehabilitation Facility; ADL = Activities of daily Living

**Table 2**
Appraisal methodological quality

| | Santaeugènia. S 2017 | Hartog L 2016 | Shiraishi A 2018 | O'Brien S 2016 | Maeda K 2018 | Kool J 2017 | Venkataraman K 2016 | Yoshimura Y 2019 | Cary M 2018 |
|---|---|---|---|---|---|---|---|---|---|
| 1. Research question | + | + | + | + | + | + | + | + | + |
| 2. Study population | + | + | + | + | + | + | - | + | + |
| 3. Participation rate | NR | + | + | NR | + | + | CD | + | + |
| 4. Selection subjects | + | + | + | + | + | + | + | + | + |
| 5. Sample size | - | - | + | - | + | + | NR | + | - |
| 6. Assessing exposure prior to outcome measurement | + | + | + | + | + | CD | + | + | + |
| 7. Timeframe | + | + | + | + | + | + | + | + | + |
| 8. Levels exposure | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 9. Exposure measures | - | + | + | + | + | + | + | + | + |
| 10. Repeated exposure assessment | - | NA | + | + | - | - | - | - | - |
| 11. Outcome measures | + | + | + | + | - | + | + | + | + |
| 12. Blinding outcome assessors | NA | - | - | NR | - | NR | NR | + | NR |
| 13. Loss to follow up | NR | NR | + | NR | + | - | CD | + | + |
| 14. Adjustment for confounding | CD | + | CD | - | - | CD | + | + | NR |
| Total score methodological quality | 7/12 58% | 9/12 75% | 11/12 92% | 8/12 67% | 9/12 75% | 8/12 67% | 7/12 58% | 12/12 100% | 9/12 75% |

NA = Not applicable; NR = Not reported; CD = Cannot Determine
Interpretation of the total score of methodological quality; <50% = weak quality, 50-75% = moderate quality, >75% = good methodological quality.

Twelve factors (i.e. age, Activities of Daily Living [ADL], caregiver, cognition, comorbidities, diagnosis, motor function, nutritional status, oral health problems, race, sex and time from onset) were examined in two or more studies. Six factors (i.e. disability benefits, living alone, number of drugs, pressure ulcers, QoL and sarcopenia) were examined in one study.

The strength of the significant associations between the factors and successful rehabilitation varied in each study from a high odds ratio (>2) to an odds ratio close to 1.

### *Synthesis of results*

This review found moderate (n = 5), limited (n = 6) and conflicting evidence (n = 5) for factors associated to successful rehabilitation in GR. In addition, diagnosis was not found to be significantly associated with successful rehabilitation in two high-quality studies. Moreover, one study of moderate quality[23] and one study of good quality did not find a significant association between good ADL and returning to the community. For eight factors (caregiver, comorbidities, motor function, nutritional status, time from onset, disability benefits, pressure ulcers, sarcopenia), a significant association with successful rehabilitation was found. A summary of the significantly related factors to successful rehabilitation is presented in Table 4.

### *Moderate evidence*

Consistent findings in one high-quality study and at least one low-quality study was found for the five factors listed below.

*Caregiver;* One study of moderate quality[28] examined the relationship between the availability of a caregiver and discharge destination. A significant relation for having a child, spouse or family was found. One study of moderate quality[10] showed a significant relationship between having social support (paid, family or friends) and successful community discharge.

*Comorbidities;* Five studies assessed the relationship between the number of comorbidities and successful home discharge. One study of moderate quality[4] reported a significant relationship between lower multimorbidity and living at home after three months. Another study of moderate quality[10] showed a significant relationship between no comorbidities and home discharge. One study of moderate quality[28] reported that older adults with one comorbidity have higher odds for successful discharge than older adults with four or more comorbidities. In addition, a significant relationship was not reported for two or three comorbidities.[28] Finally, two studies of moderate quality did not show a significant relationship between the number of comorbidities and community discharge.

*Motor function;* Having better motor function at admission was significantly related to successful community discharge in one study of good quality[24] and two studies of moderate quality.[10,27]

*Nutritional status;* Two studies, one of good quality[24] and one of moderate quality,[23] demonstrated a significant relationship between nutritional status and returning to community living. Two studies, one of good quality[30] and one of moderate quality,[23] did not show a significant relationship. However, one study[30] demonstrated a significant relationship for only the musculoskeletal disease group.

*Time from onset*; Time from onset was examined in two studies.[10,30] A significant relationship between time from onset was demonstrated in one study of moderate quality.[10] One study of good quality[30] reported a significant relationship for the hospital-associated deconditioning group and a non-significant result for the stroke and musculoskeletal disease groups.

### *Limited evidence*

Limited evidence (i.e. described in one study) was found for six factors. A significant association with sarcopenia and a lower rate of home discharge was demonstrated in a study of good quality.[26] A study of good quality[26] reported a relationship with the number of drugs and the rate of home discharge; however, the relationship was not significant.

**Table 3**
Extracted factors of identified studies

| Factors | Author | Measurement of the factor/ Category | Results OR/HR 95% CI *p*-value | Interpretation |
|---|---|---|---|---|
| Age | Shiraishi A 2018 | Continue | OR 0.818 (0.664–1.016) $p = 0.229$ | Age is not associated with the rate of home discharge |
| | O'Brien S 2016 | 85–89 vs >100 | OR 0.892 (0.672–1.185) $p = 0.43$ | Age is not associated with community discharge |
| | | 90–94 vs >100 | OR 0.951 (0.714-1.268) $p = 0.73$ | |
| | | 95–99 vs >100 | OR 1.071 (0.793–1.446) $p = 0.66$ | |
| | Venkataraman K 2016 | Continue | OR 0.96 (0.93–0.99) $p = 0.02$ | Younger age is associated with discharge home |
| | Cary MP 2018 | 76–85 vs >65 | OR 0.9 (0.87–0.93) $p < 0.001$ | Younger age is associated with successful community discharge |
| | | >85 vs >65 | OR 0.78 (0.75–0.81) $p < 0.001$ | |
| | Yoshimura Y 2019 | Stroke | OR 0.890 (0.822–1.049) $p = 0.381$ | Age is not associated with the rate of home discharge |
| | | Musculoskeletal disease | OR 0.910 (0.925–1.073) $p = 0.375$ | |
| | | Hospital associated deconditioning | OR 0.893 (0.822–1.095) $p = 0.116$ | |
| (Premorbid) ADL | Maeda K 2018 | BI | HR 1.006 (0.996–1.015) $p = 0.241$ | ADL at admission is not associated with returning home |
| | Yoshimura Y 2019 | mRS | | The premorbid activities of daily living are not associated with the rate of home discharge |
| | | Stroke | OR 0.777 (0.508–1.187) $p = 0.23$ | |
| | | Musculoskeletal diseases | OR 0.617 (0.284–1.333) $p = 0.224$ | |
| | | Hospital associated deconditioning | OR 0.364 (0.030–4.379) $p = 0.426$ | |
| Caregiver | Venkataraman K 2016 | Spouse vs none | OR 2.82 (1.07–7.46) $p = 0.037$ | Having a spouse child or family as caregiver is associated with discharge destination |
| | | Child vs none | OR 3.82 (1.31–11.12) $p = 0.014$ | |
| | | Family vs none | OR 16.39 (4.65–57.78) $p < 0.001$ | |
| | | Others vs none | OR 1.44 (0.49–4.23) $p = 0.507$ | |
| | Cary MP 2018 | Paid/other vs none | OR 1.19 (1.03–1.37) $p = 0.016$ | Patient with social support paid or family have a greater probability for successful community discharge |
| | | Family/friends vs none | OR 1.09 (1.06–1.13) $p < 0.001$ | |
| Cognition | Shiraishi A 2018 | FIM | OR 1.036 (0.997–1.077) $p = 0.098$ | A higher FIM cognition score is not associated with home discharge |
| | Maeda K 2018 | CPS | HR 1.013 (0.874–1.173) $p = 0.868$ | Cognitive impairment is not associated with returning home |
| | Kool J 2017 | MMSE < 27 | OR 0.26 (0.08–0.83) $p = 0.053$ | A better cognition is a predictor for living at home after 3 months |
| | Cary MP 2018 | FIM | | A higher cognition at admission is related to successful community discharge |
| | | 21–27 vs > 27 | OR 0.86 (0.83–0.90) $p < 0.001$ | |
| | | 5–20 vs > 27 | OR 0.73 (0.70–0.76) $p < 0.001$ | |
| Comorbidities | O'Brien S 2016 | Number of comorbidities | OR 1.005 (0.996–1.014) $p = 0.25$ | Number of comorbidities is not associated with community discharge |
| | Kool J 2017 | CIRS | OR 0.28 (0.12–0.66) $p = 0.004$ | A lower multimorbidity is a predictor for living at home after 3 months |
| | Venkataraman K 2016 | CCI 1 vs ≥4 | OR 4.32 (1.34–13.93) $p = 0.014$ | Patients with ≥4 comorbidities have less odds for a successful discharge than patients with 1 comorbidity |
| | | CCI 2 vs ≥4 | OR 2.19 (0.63–7.6) $p = 0.218$ | |
| | | CCI 3 vs ≥4 | OR 1.36 (0.65–2.84) $p = 0.417$ | |
| | Cary MP 2018 | CMS Tier 3 vs none | OR 0.75 (0.73–0.77) $p < 0.001$ | Patient with no comorbidities are likely to experience successful home discharge |
| | | CMS Tier 2 vs none | OR 0.74 (0.70–0.77) $p < 0.001$ | |
| | | CMS Tier 1 vs none | OR 0.57 (0.51–0.64) $p < 0.001$ | |
| | Yoshimura Y 2019 | CCI | | Number of comorbidities is not associated with the rate of home discharge |
| | | Stroke | OR 1.068 (0.710–1.608) $p = 0.331$ | |
| | | Musculoskeletal disease | OR 0.736 (0.463–1.170) $p = 0.195$ | |
| | | Hospital associated deconditioning | OR 2.406 (0.984–5.984) $p = 0.06$ | |
| Diagnosis | Cary MP 2018 | SCI vs CNS | OR 1.12 (1.04–1.21) $p = 0.002$ | Patients with central nervous system impairment have a lesser probability of successful community discharge |
| | | Neurological vs CNS | OR 0.92 (0.88–0.97) $p < 0.001$ | |
| | | Musculoskeletal vs CNS | OR 1.52 (1.46–1.58) $p < 0.001$ | |
| | | Endurance vs CNS | OR 0.8 (0.77–0.84) P<0.001 | |
| | | Other vs CNS | OR 0.96 (0.92-1.00) $p = 0.043$ | |
| | Shiraishi A 2018 | Stroke | OR 1.930 (0.316–11.788) $p = 0.476$ | Diagnosis is not associated with home discharge |
| | | Musculoskeletal | OR 2.017 (0.348–13.547) $p = 0.407$ | |
| | | Collagen | OR 2.182 (0.148–9.541) $p = 0.199$ | |
| | | Decubitus | OR 0.115 (0.008–1.933) $p = 0.137$ | |
| | | Cardiovascular | OR 0.476 (0.075–3.137) $p = 0.449$ | |
| | | Respiratory | OR 0.931 (0.143–6.156) $p = 0.948$ | |
| | | Neurodegenerative | OR 3.160 (0.406–26.144) $p = 0.266$ | |
| | Yoshimura Y 2019 | Vertebral compression fracture vs hip fracture | | Diagnosis is not associated with the rate of home discharge |
| | | TKA vs Hip fracture | | |

(*continued on next page*)

**Table 3** (*Continued*)

| Factors | Author | Measurement of the factor/ Category | Results OR/HR 95% CI *p*-value | Interpretation |
|---|---|---|---|---|
| | | Deconditioning due to pneumonia vs due t o others | OR 1.117 (0.585−4.091) $p = 0.246$<br>OR 0.529 (0.157−1.785) $p = 0.305$<br>OR 0.063 (0.001−3.047) $p = 0.125$ | |
| Disability benefits | Cary MP 2018 | Yes vs no | OR 1.21 (1.16−1.26) $p < 0.001$ | Patients not entitled to Medicare due to disability has a greater probability of successful community discharge |
| Living alone | Kool J 2017 | No vs yes | OR 0.46 (0.17−1.24) $p = 0.123$ | Living not alone is not associated with living at home after three months |
| Motor-function | Cary MP 2018 | FIM 33-43 vs > 43 | OR 0.82 (0.79−0.85) $p < 0.001$ | A higher motor function at admission is related to successful community discharge |
| | | FIM 13-32 vs > 43 | OR 0.62 (0.60−0.65) $p < 0.001$ | |
| | Shiraishi A 2018 | FIM motor | OR 1.021 (1.015−1.337) $p = 0.010$ | A higher motor function at admission is associated with the rate of home discharge |
| | O'Brien S 2016 | FIM motor | OR 0.985 (0.981−0.989) $p < 0.001$ | A higher motor function at admission associated with increased odds of achieving community discharge |
| Number of drugs | Yoshimura Y 2019 | Stroke | OR 0.823 (0.794−1.211) $p = 0.862$ | Number of drugs is not associated with the rate of home discharge |
| | | Musculoskeletal diseases | OR 0.893 (0.707−1.129) $p = 0.345$ | |
| | | Hospital associated deconditioning | OR 0.871 (0.112−1.122) $p = 0.142$ | |
| Nutritional status | Shiraishi A 2018 | MNA | OR 1.186 (1.049−1.339) $p = 0.016$ | Nutritional status is associated with the rate of home discharge |
| | Maeda K 2018 | According to ESPEN guideline | HR 0.517 (0.351−0.761) $p = 0.001$ | Malnutrition is associated with a lower chance of returning home |
| | Maeda K 2018 | Estimated nutritional intake | HR 1.001 (0.989−1.023) $p = 0.489$ | Nutritional intake is not associated with returning home |
| | Yoshimura Y 2019 | MNA-SF | | Nutritional status is not associated with the rate of home discharge |
| | | Stroke | OR 1.049 (0.818−1.344) $p = 0.307$ | |
| | | Musculoskeletal disease | OR 1.050 (0.765−1.182) $p = 0.126$ | |
| | | Hospital associated deconditioning | OR 1.072 (0.449−1.810) $p = 0.328$ | |
| | Yoshimura Y 2019 | FILS | | Nutritional intake is associated with the rate of home discharge in patients with musculoskeletal diseases. |
| | | Stroke | OR 1.044 (0.782−1.397) $p = 0.167$ | |
| | | Musculoskeletal disease | OR 1.650 (1.076−2.529) $p = 0.022$ | |
| | | Hospital associated deconditioning | OR 1.041 (0.624−1.998) $p = 0.444$ | |
| Oral health problems | Shiraishi A 2018 | ROAG | OR 0.844 (0.752−0.952) $p = 0.025$ | Oral health problems are associated with a lower rate of home discharge |
| | Maeda K 2018 | OHAT | HR 1.041 (0.940−1.151) $p = 0.441$ | Oral health problems are not associated with returning home |
| Pressure ulcers | Santaeugenia S 2017 | Presence yes/no | $p < 0.001$ | Presence of pressure ulcers is related to a lower percentage of home discharge |
| QoL | Hartog L 2016 | Physical component summary | HR 0.99 (0.84−1.15) | A high HRQOL at admission is not associated with successful rehabilitation |
| | | Mental component summary | HR 1.00 (0.87−1.15) | |
| Race | O'Brien S 2016 | White vs non-white | OR 2.140 (1.988−2.303) $p < 0.001$ | Being non-white is associated with an increased odds of community discharge |
| | Venkataraman K 2016 | Indian or others vs Chinese | OR 0.6 (0.2−1.81) $p = 0.365$ | Race is not associated with discharge home |
| | | Malay vs Chinese | OR 5.6 (0.67−46.49) $p = 0.111$ | |
| | Cary MP 2018 | Black vs white | OR 1.03 (0.98−1.09) $p = 0.207$ | Other race is associated with successful community discharge |
| | | Hispanic vs White | OR 1.05 (0.98−1.12) $p = 0.140$ | |
| | | Other vs white | OR 1.27 (1.15−1.39) $p < 0.001$ | |
| Sarcopenia | Yoshimura Y 2019 | Stroke | OR 0.201 (0.067−0.597) $p = 0.004$ | Having sarcopenia is associated with a lower rate of home discharge |
| | | Musculoskeletal diseases | OR 0.242 (0.076−0.772) $p = 0.016$ | |
| | | Hospital associated deconditioning | OR 0121 (0.110−0.347) $p = 0.009$ | |
| Sex | Shiraishi A 2018 | Male | OR 1.244 (0.695−2.227) $p = 0.462$ | Sex is not associated with the rate of home discharge |
| | O'Brien S 2016 | Female vs male | OR 0.885 (0.853−0.919) $p < 0.001$ | Being female is associated with reduced odds for discharge to the community |
| | Cary MP 2018 | Female vs male | OR 0.94 (0.92−0.97) $p < 0.001$ | Being male has a higher probability of successful community discharge |
| | Yoshimura Y 2019 | Stroke | OR 0.764 (0.307−1.901) $p = 0.562$ | Gender is not associated with the rate of home discharge |
| | | Musculoskeletal disease | OR 1.460 (0.501−4.268) $p = 0.487$ | |
| | | Hospital associated deconditioning | OR 0.548 (0.046−2.534) $p = 0.232$ | |
| Time from onset | Yoshimura Y 2019 | Stroke | OR 0.956 (0.896−1.019) $p = 0.169$ | The time from onset is associated with the rate of home discharge in patients with hospital-associated deconditioning |
| | | Musculoskeletal diseases | OR 1.051 (0.923−1.211) $p = 0.422$ | |
| | | Hospital associated deconditioning | OR 0.775 (0.606−0.990) $p = 0.042$ | |
| | Cary MP 2018 | Hospital length of stay | | A short length of hospital stay is associated with successful community discharge |
| | | 4-6 vs 1-3 | OR 0.93 (0.89−0.96) $p < 0.001$ | |
| | | >6 vs 1-3 | OR 0.81 (0.78−0.85) $p < 0.001$ | |

ROAG= Revised Oral Assessment Guide; HRQOL= Health Related Quality Of Life; OHAT= Oral Health Assessment Tool; ESPEN= European Society for Clinical Nutrition and Metabolism; MNA-SF= Mini Nutritional Assessment- Short Form; FILS= Food Intake Level Scale; SCI= Spinal Cord Injury; CNS = Central Nervous System; TKA= Total Knee Arthroplasty; CIRS= Cumulative Illness Rating Scale; CCI= Charlson Comorbidity Index; CMS= Centres for Medicare and Medicaid Services; FIM= Functional Independence Measure; CPS= Cognitive Performance Scale; MMSE= Mini Mental State Examination; BI= Barthel Index; mRS= modified Rankin Scale

**Table 4**
Factors significantly related to successful rehabilitation

| | Factors associated with successful rehabilitation | Author | Measurement of the factor/ Category | Results OR/HR | *p*-value |
|---|---|---|---|---|---|
| Moderate evidence | *Caregiver;* | Venkataraman K 2016 | Spouse vs none | OR 2.82 | $p = 0.037^{*}$ |
| | *Having a caregiver is associated with discharge destination* | | Child vs none | OR 3.82 | $p = 0.014^{*}$ |
| | | | Family vs none | OR 16.39 | $p < 0.001^{**}$ |
| | | | Others vs none | OR 1.44 | $p = 0.507$ |
| | | Cary MP 2018 | Paid/other vs none | OR 1.19 | $p = 0.016^{*}$ |
| | | | Family/friends vs none | OR 1.09 | $p < 0.001^{**}$ |
| | *Comorbidities;* | O'Brien S 2016 | Number of comorbidities | OR 1.005 | $p = 0.25$ |
| | *Less comorbidities is related to successful home discharge* | Kool J 2017 | CIRS | OR 0.28 | $p = 0.004^{*}$ |
| | | Venkataraman K 2016 | CCI 1 vs ≥4 | OR 4.32 | $p = 0.014^{*}$ |
| | | | CCI 2 vs ≥4 | OR 2.19 | $p = 0.218$ |
| | | | CCI 3 vs ≥4 | OR 1.36 | $p = 0.417$ |
| | | Cary MP 2018 | CMS Tier 3 vs none | OR 0.75 | $p < 0.001^{**}$ |
| | | | CMS Tier 2 vs none | OR 0.74 | $p < 0.001^{**}$ |
| | | | CMS Tier 1 vs none | OR 0.57 | $p < 0.001^{**}$ |
| | | Yoshimura Y 2019 | CCI | | |
| | | | Stroke | OR 1.068 | $p = 0.331$ |
| | | | Musculoskeletal disease | OR 0.736 | $p = 0.195$ |
| | | | Hospital associated deconditioning | OR 2.406 | $p = 0.06$ |
| | *Motor-function;* | Cary MP 2018 | FIM 33−43 vs > 43 | OR 0.82 | $p < 0.001^{**}$ |
| | *A better motor function is associated with home discharge* | | FIM 13−32 vs > 43 | OR 0.62 | $p < 0.001^{**}$ |
| | | Shiraishi A 2018 | FIM motor | OR 1.021 | $p = 0.010^{*}$ |
| | | O'Brien S 2016 | FIM motor | OR 0.985 | $p < 0.001^{**}$ |
| | *Nutritional status;* | Shiraishi A 2018 | MNA | OR 1.186 | $p = 0.016^{*}$ |
| | *Good nutritional status is associated with the rate of home discharge* | Maeda K 2018 | According to ESPEN guideline | HR 0.517 | $p = 0.001^{*}$ |
| | | Maeda K 2018 | Estimated nutritional intake | HR 1.001 | $p = 0.489$ |
| | | Yoshimura Y 2019 | MNA-SF | | |
| | | | Stroke | OR 1.049 | $p = 0.307$ |
| | | | Musculoskeletal disease | OR 1.050 | $p = 0.126$ |
| | | | Hospital associated deconditioning | OR 1.072 | $p = 0.328$ |
| | | Yoshimura Y 2019 | FILS | | |
| | | | Stroke | OR 1.044 | $p = 0.167$ |
| | | | Musculoskeletal disease | OR 1.650 | $p = .022^{*}$ |
| | | | Hospital associated deconditioning | OR 1.041 | $p = 0.444$ |
| | *Time from onset;* | Yoshimura Y 2019 | Stroke | OR 0.956 | $p = 0.169$ |
| | *A short time from onset is associated with successful home discharge* | | Musculoskeletal diseases | OR 1.051 | $p = 0.422$ |
| | | | Hospital associated deconditioning | OR 0.775 | $p = 0.042^{*}$ |
| | | Cary MP 2018 | Hospital length of stay | | |
| | | | 4−6 vs 1−3 | OR 0.93 | $p < 0.001^{**}$ |
| | | | >6 vs 1−3 | OR 0.81 | $p < 0.001^{**}$ |
| Limited evidence | *Disability benefits;* | Cary MP 2018 | Yes vs no | OR1.21 | $p < 0.001^{**}$ |
| | *Patients not entitled to Medicare has a greater probability of successful community discharge* | | | | |
| | *Pressure ulcers;* | Santaeugenia S 2017 | Presence yes/no | | $p < 0.001^{**}$ |
| | *Presence of pressure ulcers is related to a lower percentage of home discharge* | | | | |
| | *Sarcopenia;* | Yoshimura Y 2019 | Stroke | OR 0.201 | $p = 0.004^{*}$ |
| | *Having sarcopenia is associated with a lower rate of home discharge* | | Musculoskeletal diseases | OR 0.242 | $p = 0.016^{*}$ |
| | | | Hospital associated deconditioning | OR 0121 | $p = 0.009^{*}$ |

CIRS= Cumulative Illness Rating Scale; CCI= Charlson Comorbidity Index; CMS= Centres for Medicare and Medicaid Services; FIM= Functional Independence Measure; MNA= Mini Nutritional Assessment; FILS= Food Intake Level Scale
*p*-value* = significant with $p < 0.05$
*p*-value**= significant with $p < 0.001$

A study of moderate quality reported a significant relationship for not having disability benefits and home discharge.[10] Another study of moderate quality described the presence of pressure ulcers was related to a lower percentage of home discharge.[31] One study of moderate quality reported a non-significant relationship with not living alone [4]. Another study of moderate quality described high Health-related Quality of Life (HRQoL) at admission was not significantly related to successful rehabilitation.[22]

*Conflicting evidence*

Less than 75% of the studies reported the same results. Conflicting evidence was found regarding whether the factors listed below are associated with successful rehabilitation.

*Age;* Five studies examined the relationship between age and discharge to community living. Two studies of moderate quality[10,28] demonstrated that younger age was significantly related to community discharge. However, two studies of good quality[24,30] and one of moderate quality[27] did not show a significant relationship between age and community discharge.

*Cognition;* Four studies[4,10,23,24] investigated the relationship between cognition and community discharge. Two studies[4,10] of moderate quality demonstrated that better cognition was significantly related to home discharge. One study of good quality[24] and one study of moderate quality[23] showed a non-significant relationship.

*Oral health problems;* One study of good quality[24] showed a significant relationship between oral health problems and a lower rate of home discharge. One study of moderate quality[23] demonstrated a non-significant relationship between oral health problems and returning to community living.

*Race;* One study of moderate quality[27] reported a significant relationship between being non-white and community discharge. One study of moderate quality[10] demonstrated that a race other than black and Hispanic was related to successful community discharge. The same study did not report a significant relationship for black and Hispanic. A third study of moderate quality[28] showed a non-significant relationship between race and community discharge.

*Sex;* Being male was found to be significantly related to successful community discharge in two moderate-quality[10,27] studies. However, two other studies of good quality reported[24,30] a non-significant relationship.

## Discussion

This study extracted a total of 18 factors associated with successful rehabilitation in older adults admitted to GR. Moderate evidence was found that successful rehabilitation is significantly related to having a caregiver or social support, no or few comorbidities at admission, better motor function at admission, good nutrition status at admission, and a short time to onset. Furthermore, a significant relationship was found for not being entitled to disability benefits (Medicare), not having pressure ulcers, and not having sarcopenia. However, these factors were assessed in only one study. Therefore, this limited evidence has to be treated with caution.

Previous research on factors associated with successful rehabilitation in older adults was conducted in a non-stroke population.[6] The result of this review is partially in line with the review of Everink et al.[6] Similar results were found for higher functional status, sex, caregiver. However, contradictory results were found for younger age, race, comorbidities, not living alone, length of hospital stay and pressure sore. Research showed that older age is related to comorbidities[32] and pressure sore.[33] The contradictory results between the review of Everink[6] and this review could therefore be explained by the slightly older population in this review (66–88.55 years compared to 65–82.2 years).

Healthcare professionals can assess the revealed factors in all patients at time of admission to GR. Having insight into the possible discharge destination (discharge to community living yes/no) would give the professionals the ability to offer a more custom-made rehabilitation programme and deploy early discharge planning. Early discharge planning will provide the ability to make arrangements, if necessary, and to inform the patient and his caregiver well before discharge.[6,13] However, it is unknown what the patients' long-term functioning is after home discharge. Nevertheless, this is another area of interest.

To date, rehabilitation facilities target for short LOS, not only by goal achievement, but also by payment situation.[34] Therefore, healthcare professionals have the burdensome task to make an adequate prognosis of discharge destination and LOS early enough to promote best possible outcomes and allocate resources efficiently. Due to the frailty and multimorbidity of these patients, predicting rehabilitation outcomes is challenging.[6,12] Complex medical needs could influence the patient recovery trajectory.[17] This is in line with the significant association of comorbidity and home discharge found in this study. Early preparation of the necessary adjustments and/or arrangements could prevent that adjustments or arrangements not have been established when a patient completed the rehabilitation programme. With an effective coordination within and between organisations, treatment can be cost-effective.[35] If successful rehabilitation could be more adequate predicted, healthcare professionals could offer personalized rehabilitation trajectories to achieve the best possible rehabilitation outcomes according to future living situation, and discharge planning could be deployed early in the rehabilitation phase. This can be of considerable value to the management because a (too) long LOS could probably be avoided.[13]

This study has some limitations. First, the outcome 'successful rehabilitation' was determined as returning to community living 'yes'/'no'. The outcomes of the included studies differed between discharge to home and discharge to community living. However, this research aimed to support early discharge planning by predicting discharge destination at admission to GR. For both discharge to home and discharge to community living, it takes time for the healthcare professionals to make arrangements before discharge. Therefore, discharge to home and discharge to community living were defined as successful rehabilitation.

Second, many studies defined successful rehabilitation based on the FIM score (i.e. delta FIM $\geq$ 90).[36] The researchers hypothesised that motor function and cognitive function could be individually associated factors. This is supported by the findings of this review. FIM-motor is found to be significantly related to successful rehabilitation. For example, with the right amount of support (having a caregiver, disability benefits), a patient with a low FIM score can return home. However, a patient with negatively related factors (comorbidities, no system) could have a high FIM score but not be able to return home. Therefore, studies with FIM as the outcome were excluded in this review. Excluding studies with FIM as the outcome reduced the total number of included studies. Including these studies could have provided more evidence to strengthen the evidence for the 20 revealed factors. However, the results of the excluded studies could also affect the associations of the factors and provide inaccurate results.

## Conclusion

This review presents an overview of factors associated with successful rehabilitation following inpatient GR in older adults. Five factors were found significantly related to successful GR: having a caregiver or social support, no or few comorbidities at admission, better motor function at admission, good nutrition status, and a short time to onset. These factors can be assessed at admission to indicate discharge destination and could contribute to the deployment of early discharge planning.

Future research could further explore at least the factors that were examined in only one study (i.e. being entitled to Medicare, living alone, number of drugs, presence of pressure ulcers, HRQoL, and sarcopenia). With new insights into the uncertain factors, a complete list of factors associated with successful rehabilitation in older adults could be established.

## Declaration of Competing Interest

The authors declare no conflict of interest.

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PL, SA, AH were involved in the study design. PL, SA participated in the literature search, inclusion of the studies, assessment of methodological quality and data analysis. PL, SA, AH, MB were involved in writing and reviewing the manuscript. All authors read and approved the final manuscript. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

## Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.gerinurse.2020.11.010.

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