Effects, Barriers and Facilitators in Predischarge Home Assessments to Improve the Transition of Care from the Inpatient Care to Home in Adult Patients: An Integrative Review

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Abstract

Background: Predischarge home assessments (PDHA) aim to ensure safe discharge from hospital or rehabilitation. There is insufficient evidence on the effectiveness of PDHA. For adults with any diagnosis, we aimed to determine (1) the effects of PDHA on outcomes associated with the successful return to community living (e.g., Activities of Daily Living falls) and (2) the associated barriers and facilitators to derive recommendations for clinical practice.

Methods: We searched Medline, EMBASE, CINAHL, five additional databases and other sources. We included individual and cluster randomized (RCT/cRCT) and controlled clinical trials comparing PDHA versus usual care/other intervention, as well as qualitative/mixed methods studies dealing with PDHA. Critical appraisal was performed according to the Cochrane risk-of-bias tool in quantitative studies and the Critical Appraisal Skills Programme (CASP) for qualitative studies and data extraction. Meta-analysis, thematic synthesis and integrative synthesis were performed.

Results: Seven RCTs (n = 1072) and ten qualitative studies (n = 245) met the inclusion criteria. RCTs reported a variety of outcomes (n = 17). There is moderate to very low evidence for missing effects on (instrumental) Activities of Daily Living, quality of life, risk of falling and risk of readmission, mobility and fear of falling. The qualitative studies revealed the following topics related to patient education, patient information, patients' acceptance of modifications and aids, involvement of patient goals and meaningful activities in functional assessment, as well as relevant social- and diagnosis-related patient conditions in PDHA. Seven implications for interventions were derived from these topics. Six of the included RCTs each addressed at least one and at most three of the seven identified meaningful implications for implementation.

Conclusion: There is no evidence from the meta-analysis for the effectiveness of PDHA. Further robust studies are needed to adapt and evaluate PDHA interventions, taking the identified implications from stakeholders' views into account, and should follow the current recommendations for the development and evaluation of complex interventions.

Trial registration: The review was registered and methods were reported on PROSPERO on 18th July 2018 (https://www.crd.york.ac.uk/PROSPERO. CRD42018100636).

Background

Discharge planning aims to ensure patients' independence in activities of daily living (ADL) and participation in life and to ensure a safe home environment to prevent falls and injuries that could lead to hospital readmissions; in addition, predischarge home assessment is an important component of discharge planning.

Predischarge home assessments (PDHA) are conducted in hospitals and inpatient rehabilitation facilities to gain information for therapy and discharge management [1] and to provide individual technical aids and modification of the home environment. Practice widely varies [2–4], ranging from ward-based assessments of abilities and environment [6] to home assessment visits [2–4]. The latter are described as costly and time consuming [3, 5, 6]. Sometimes, "access visits" at the patient's home are performed by occupational therapists (OTs) on their own to assess any environmental demands for assistive equipment and access issues [4, 7].

There is limited evidence on the effects of PDHA. A recent systematic review analyzing the effects of predischarge home visits and their influencing factors [8] included five RCTs, one cohort study and three retrospective medical record/chart audits as well as four interview studies and one questionnaire survey. The studies were of low to moderate quality and reported a small decrease of the risk of falling, but no other effects.

In recent years, studies on new technologies for PDHA have been published, which were not included in the review by Lockwood et al. [8]. These studies focus on 3D visualization that offers computer-generated environments, scenarios and objects [3, 4, 9] that are used to avoid travelling to a patient's home and to improve the patient's involvement in home modification planning. Thus, an update of the evidence synthesis on PDHA is warranted.

There is some information of stakeholders' views on the PDHA process. In their review, Lockwood et al. also investigated the patients' and carers' perceptions of PDHA effectiveness and included five qualitative studies, reporting on three emerging themes: *satisfaction with the process*, *purpose of the visit*, *and incorporation of patient and carer opinions in the decision-making process* [8]. The authors concluded that it might have an impact on the effects of the intervention and *how* PDHA are conducted and recommended consultation and the participation of patients in the PDHA process [8]. A thematic synthesis included five qualitative studies and reported the experiences and perceptions of older adults concerning PDHA. It has been demanded that patients understand the purpose of PDHA and to be open-minded towards the coping strategies of older adults [10]. In recent years, a number of qualitative studies investigating the views of stakeholders of the PDHA process have been published.

Therefore, we conducted a mixed methods review aiming to determine the effects of PDHA on outcomes associated with a successful return to community living and to update the evidence on barriers and facilitators in the PDHA process to derive recommendations to improve PDHA.

Methods

Protocol and registration

The review was registered in the International Prospective Register of Systematic Reviews (PROSPERO) under the identification number CRD42018100636. The protocol and the review were reported according the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement (PRISMA) [11] and the framework to enhance transparency in reporting the synthesis of qualitative research (ENTREQ) [12].

Eligibility criteria

Quantitative clinical trials were included if the following:

(1)
an individual or cluster-randomized controlled or controlled trial design was used,
(2)
study participants were aged ≥ 18 years, admitted to hospitals or rehabilitation facilities for any diagnosis except for mental / cognitive disorders only and subsequently discharged home,
(3)
PDHA was reported as a primary intervention, though it could vary in purpose (e.g., discharge planning or functional assessment), delivery mode (e.g., with / without patient), intensity, length and frequency,
(4)
PDHA was compared to another intervention or to usual care,
(5)
outcomes were associated with a successful return to community living (e.g., functioning in the home environment, readmissions), quality of life, patient satisfaction, caregiver burden and / or the immediate output of the predischarge home assessment (e.g., home modifications),
(6)
the study was published in the English or German language.

Qualitative studies and mixed methods studies were included if they reported on views and opinions, perspectives, beliefs, feelings, understanding, experiences or behavior regarding PDHA of adult stakeholders (e.g., patients, healthcare providers) and were published in the English or German language.

Search strategy and selection criteria

In July 2018, Medline, EMBASE, CINAHL, the Cochrane Central Register of Controlled Trials (CENTRAL) PEDro and OTseeker databases and trial registries (PROSPERO and ICTRP) were searched. The overall search strategy used the following combined search terms for database searches: discharge, inpatient, subacute care, acute care, rehabilitation [MeSH], House Calls [Mesh], home visiting, home visit, environmental assessment, assessment visit, home safety, home modification, environmental modification, weekend passes, weekend pass (see Additional File 1 for search strategy). Relevant RCTs, CCTs and qualitative studies were included in the analysis. References of the identified publications were checked from July 2018 until December 2018. Forward citation search was conducted using Google Scholar and Web of Science.

Data collection and analysis

Study selection

Two independent reviewers (KK, UKH) applied the inclusion and exclusion criteria to titles and abstracts of the search results. Discrepancies were discussed and resolved by consensus with a third author (SuS) and by reading the full text, if needed. The remaining sample of studies was read in full text by two independent reviewers (KK, UKH). Discrepancies were discussed and resolved by consensus with a third author (SuS). Inclusion was unclear in one case (Gursen, 2003) due to insufficient reporting on the study design. After trying to contact the authors without any success, we excluded the study. Multiple publications reporting on the same study were clustered and handled as one unit. See Additional File 1 for excluded studies.

Data extraction and management

One reviewer extracted the descriptive information from the publications using a piloted data extraction sheet, and another reviewer double checked the extracted data. The following information was extracted for quantitative and qualitative studies: aim and focus of the studies, study design, details about the intervention according to the TiDier Checklist [13], number and characteristics of participants, outcomes, and outcome measures. For quantitative studies, raw scores were extracted using Excel sheets. If outcomes were measured at multiple time points, the latest follow-up was selected. If studies reported on outcomes using more than one measure, we used only one measure per outcome, according to a prespecified hierarchy, determined by the researcher group (see Additional File 2 for hierarchy of outcome measures for ADL). For qualitative studies, we extracted verbatim quotes from study participants and the authors' descriptions of findings from the results section [14].

Risk of bias assessment

Two reviewers (KK, UKH) independently assessed the risk of bias. Any disagreements were resolved by discussion and, if necessary, by consulting a third author (SuS). We used the methods and recommendations for the assessment of risk of bias and heterogeneity in individual quantitative studies as described in the Cochrane Handbook 5.1.0 [15].

For qualitative studies, a set of criteria from the CASP tool [16] as well as from the Guidelines for Critical Review Form: Qualitative Studies, Version 2 [17] was used to assess the internal validity (see Additional File 3 for quality appraisal of qualitative studies).

Data analysis and synthesis

In case only median, sample size and interquartile range (with first and third interquartile) were presented and imputing SDs was not possible, we estimated the sample mean and standard deviation according to Wan et al. [18]. Meta-analysis was conducted using a random-effects model (REM). For continuous outcome data, we used standardized mean differences (SMD) with 95% confidence intervals (CIs) for different scales or units and mean differences (MD) with standard deviations (SD) for same scales. For meta-analysis in dichotomous data, we calculated risk ratios (RR) with 95% CIs. We used the I^2 test for the assessment of statistical heterogeneity, a significance level of p less than 0.10, and the chi-squared test.

We assumed that effect sizes may differ due to different scales per outcome and conducted a corresponding sensitivity analysis. To judge the certainty of evidence, the GRADE approach [19] was used. See Additional File 5 for details on our GRADE ratings.

Qualitative data were entered verbatim using MAXQDA 2018.2 software for data analysis. Thematic analysis was applied [20]. Line-by-line coding was performed by two reviewers independently to reconcile comprehension. The descriptive themes were discussed iteratively with the whole team (KK, UKH, and SuSa) until a consensus regarding comprehensibility and distinction of themes was reached. We synthesized findings according to the emerging themes related to barriers and facilitators to the PDHA process. Implications for practice and intervention development were inferred [14].

An integrative synthesis of quantitative results and implications from qualitative studies was performed, whereby two reviewers (KK, UKH) examined the intervention descriptions of the included RCTs to identify whether implications were addressed or not. The detailed information supporting the decisions was discussed and documented. A matrix of the integrative synthesis mapped the studies' effect sizes with contextual details and information on corresponding implications and interventions (please see Additional File 8).

Results

Study selection

Our search revealed 3271 publications (Fig. 1), and n = 17 met our inclusion criteria (18 publications including two publications of the same study: seven randomized controlled trials and ten qualitative studies).

Study characteristics

Seven RCTs with 1072 participants were included [2, 4, 7, 21–25]. The size of the studies ranged from ten to 400 participants. The cohort study alongside one RCT was not considered in the analysis [7].

Ten qualitative studies [3, 9, 26–33] with a total of 245 participants (range: n = 4 [31] to n = 60 [26]) were included. All the studies used interview techniques, and one additionally used participant observation [32]. Three studies explored perceptions of patients, therapists and older adults in community dwellings with regard to the use of virtual reality (VR) applications in PDHA [9, 28, 29]. One study explored factors considered by the OTs when deciding about stroke patients' need for a predischarge home assessment visit [33]. One study focused on older adults' and carers' perception of and involvement in PDHA decision-making processes [27]. Another study also highlighted the patients' perspective on PDHA [31]. One study explored the aspects of home modifications, which might be important for patients and families [26], and another study focused on the OTs' perception of and clinical reasoning in the PDHA process [29]. A summary of characteristics of the included quantitative and qualitative studies is displayed in Table 1.

Table 1
Study characteristics of included studies

Reference	Study design, country, setting	Participants Number, age in years, percent female (%)	Intervention description	Outcomes/aim of qualitative research	Outcome measures	FU in months
Clemson et al., 2016 [2]	RCT Australia Acute care, unspecified	n = 400 **Intervention** 80.2 (± 6.4, range n.r.) 59.6% **Control** 80.7 (± 5.7, range n.r.) 63.9%	**Intervention** In-hospital rapport building, interview, ADL-assessment, predischarge home visit, post-discharge home-visit, telephone calls **Control** Usual care, in-hospital interview, ADL assessment, access visit if required	Functional independence, participation in ADL, unplanned readmissions, emergency department visits, recommendations	NEADL [34], Late Life Disability Index (LLDI) - sub scores: frequency and limitation [52], number of: recommendations, unplanned readmissions, emergency department visits, falls, process outcomes (e.g., number of prescribed and tried equipment; effects not estimated)	3
Drummond et al., 2013 [7]	RCT UK Stroke rehabilitation unit	n = 126 **Intervention** 70.64 (± 14.29, range 34–88) 54.7% **Control** 73.65 (± 16.06, range 41–99) 47.8%	**Intervention** One or two predischarge home visit(s) **Control** Structured home assessment interview	ADL/IADL, mobility, unplanned readmissions, falls, emotional distress in medical settings, depressed mood of clients with stroke and significant aphasia, caregiver strain	NEADL [34], Barthel Index [53], RMI [39], Number of unplanned readmissions, GHQ-28 [42], SADQ-10 [44], Caregiver Strain Index [54]	1
Hagsten et al., 2004 [21] Hagsten et al., 2006 [22]	RCT Sweden Acute care, hip fractures	n = 100 **Intervention** 81 (± 23, range 68–91) 84% **Control** 79 (± 30, range 65–95) 76%	**Intervention** Individual daily training, including use of technical aids, single predischarge home visit **Control** One walking instruction when in hospital	ADL/IADL, health-related quality of life	ADL [55], EQ5D [56], IADL single scales: moving around indoors; performance of light house work; getting in and out of a car, SWED-QUAL [36] subscales	2

Reference	Study design, country, setting	Participants Number, age in years, percent female (%)	Intervention description	Outcomes/aim of qualitative research	Outcome measures	FU in months
Lannin et al., 2007 [57]	RCT Australia Rehabilitation unit, mixed (cardiac, orthopedic trauma, neurological, orthopedic joint surgery, spinal or deconditioned)	n = 10 **Intervention** 80.0 (± 7, range n.r.) 100% **Control** 82.4 (± 7, range n.r.) 60%	**Intervention** Single predischarge home visit **Control** In-hospital consultation prior to discharge	ADL/IADL, mobility, unplanned readmissions, falls, fear of falling, community support, health-related quality of life	NEADL [34], FIM [58], RNLI - Reintegration to Normal Living Index [59], Tinnetti [38], number of unplanned readmissions, number of falls, FES-I [40], EQ5D [56], EQ-5D VAS [37]	7
Nikolaus et al., 2003 [24]	RCT Germany Geriatric acute care, unspecified	n = 360 **Intervention** 81.2 (± 6.2, range 84.9–87.5) 72.4% **Control** 81.9 (± 6.5, range 74.4–88.4) 74.3%	**Intervention** Predischarge home visit and post-discharge follow up visit(s), comprehensive in-hospital geriatric assessment **Control** Comprehensive geriatric assessment and usual care	Falls, recommendations	Number of falls, compliance with recommendations after 12 months	12
Pardessus et al., 2002 [25]	RCT France Geriatric acute care, unspecified	n = 60 **Intervention** 83.51 (± 9.08, range n.r.) 76% **Control** 82.9 (± 6.33, range n.r.) 80%	**Intervention** Predischarge home visit **Control** Usual care	ADL/IADL, Falls, rehospitalization, institutionalization	IADL [60], SMAF subscales [35] ADL subscales [61] number of recurring falls, mean number of fall recurrence in former fallers, number of rehospitalizations, number of institutionalizations	12

Reference	Study design, country, setting	Participants Number, age in years, percent female (%)	Intervention description	Outcomes/aim of qualitative research	Outcome measures	FU in months
Threapleton et al., 2018 [4]	RCT UK Stroke ward, acute care	n = 16 **Intervention** 72 (± 21.08, range 38–90) 75% **Control** 70 (± 12.6, range 46–86) 37%	**Intervention** Single predischarge virtual home assessment **Control** Usual care	ADL/IADL, overall independence, mobility, fear of falling, health-related quality of life	NEADL [34], Barthel- Index [53], MRS [62], Rivermead Mobility Index [39], FES-I [40], EQ5D [56]	6
Aplin et al., 2013 [26]	In-depth interview, semi-structured Australia Clients of home modification service	**Patients** n = 55, 25–87 years **Parents of children receiving services**, n = 5 **Spouses of clients**, n = 13 **Carer, friend** n = 1 (2%) 25–87 years 45% across all participants	**Intervention** Major home modifications	- To explore if the dimensions of home (physical / social / personal / temporal / occupational) are important to clients in the home modification process and whether there were other aspects of the home environment previously not considered; - To understand the aspects of the home environment which affect home modification decision-making	n.a.	n.a.
Atwal et al., 2008 [27]	Semi-structured interview UK Geriatric acute care	**Patients, main carers** n = 15 86,46 years (range 73–97) 60%	**Intervention** Single predischarge home visit	- To explore older adults' and carers' involvement in decisions that were made during the home visit; - To explore older adults' and carers' perceptions of the home visit process	n.a.	n.a.

Reference	Study design, country, setting	Participants Number, age in years, percent female (%)	Intervention description	Outcomes/aim of qualitative research	Outcome measures	FU in mo nths
Atwal et al., 2014a [28]	Semi-structured interview; think aloud technique UK Acute care and community care	**OTs** n = 7 71% social services, older persons, mental health, acute care, pediatrics	**Intervention** Virtual reality predischarge home assessment with interior design application	- To explore occupational therapists' perceptions of a virtual reality interior design application (VRIDA); - to gain insights into the feasibility of using VRIDA as a tool to aid the predischarge home visit (perceived usefulness, perceived ease of use, actual use)	n.a.	n.a.
Atwal et al., 2014b [29]	Semi-structured interview UK Acute care, intermediate care, rehabilitation, older patients, mental health (older people)	**OTs** n = 21	**Intervention** Predischarge home visit / access visit	- To explore occupational therapists' perceptions of home visits; - To ascertain occupational therapists' clinical reasoning with respect to conducting home visits	n.a.	n.a.

Reference	Study design, country, setting	Participants Number, age in years, percent female (%)	Intervention description	Outcomes/aim of qualitative research	Outcome measures	FU in months
Cameron et al., 2014 [30]	In-depth interview, semi-structured, focus groups Canada Rehabilitation facility, stroke	**Patients** n = 16 62 years (range 25–87) 75% **Family caregivers** n = 15 41 years (range 23–75) 86,7% **Multiple health professionals** n = 20	**Intervention** Single predischarge home visit or preparation in hospital and single/multiple predischarge weekend passes	- To explore stroke survivors', caregivers', and health care professionals' perceptions of weekend passes offered during inpatient rehabilitation and its role in facilitating the transition home	n.a.	n.a.
Hibberd, 2008 [31]	Semi-structured interview UK Intermediate care unit	**Patients** n = 4 65 years and older 50%	**Intervention** Predischarge home visit / access visit	Part of an evaluation study; - To gain patient perspectives on home visiting process -to ensure service meets needs	n.a.	n.a.
Money et al., 2015 [9]	Semi-structured interviews, thinking aloud UK Community dwelling	**Community dwelling older people** n = 10 56-80 years 50%	**Intervention** Virtual reality predischarge home assessment with interior design application	- To explore community dwelling older adults' perceptions of using a computerized 3D interior design application (perceived usefulness, ease of use, and actual use) - To consider the potential barriers and opportunities of using CIDA as an assistive tool within the predischarge home visits process	n.a.	n.a.

Reference	Study design, country, setting	Participants Number, age in years, percent female (%)	Intervention description	Outcomes/aim of qualitative research	Outcome measures	FU in months
Nygard et al., 2004 [32]	Interviews, focus groups, participant observation Sweden Geriatric acute care, mixed diagnoses	**Patients** n = 23 78 years (range 68–86) 50% **Living alone** n = 12 **OTs** n = 9	**Intervention** Single predischarge home visit	- To describe and illuminate, from both clients' and therapists' perspectives, the occupational therapy interventions and recommendations that were undertaken and followed-up in common practice during predischarge home visits; - To gain insight in the accuracy of expectations of therapists and in perceived usefulness of predischarge home visits to clients	n.a.	n.a.
Threapleton et al., 2017 [3]	Semi-structured interview UK Acute care, rehabilitation, community, stroke	**Patients** n = 8 68 years (range 44–92) 75% **Stroke survivors n** = 4 70 years (range 61–79) 75% **OTs** n = 13	**Intervention** Virtual predischarge home visit	- To explore perceptions concerning the acceptability, potential utility and limitations of the use of a virtual reality interior design application from the perspectives of therapists and patients	n.a.	n.a.

Reference	Study design, country, setting	Participants Number, age in years, percent female (%)	Intervention description	Outcomes/aim of qualitative research	Outcome measures	FU in months
Whitehead et al., 2014 [33]	Semi-structured interview UK Acute, rehabilitation, mixed, hyper acute, stroke	**OTs** n = 20	**Intervention** Predischarge home assessment visits	- To explore what factors occupational therapists consider when deciding which patients with a stroke need a predischarge home assessment visit	n.a.	n.a.
FU: latest time point of follow-up; n.r.: not reported; n.a.: not applicable						

Setting and participants

Studies were published between 2002 and 2018, and the majority were conducted in the UK [3, 4, 7, 9, 27–29, 31, 33] and Australia [2, 23, 26]. One study each was carried out in Germany [24], France [25] and Canada [30], and two studies were conducted in Sweden [21, 22, 32].

Participants in RCTs were recruited in acute care settings [2, 4, 21, 22, 24, 25] and rehabilitation units [7, 23], and for qualitative studies in the community [9, 26], in rehabilitation [30], in acute care [3, 27] and in intermediate care [31].

In one quantitative study, the diagnoses were mixed [32], and diagnoses were not specified or not sufficiently reported in three studies [24, 25, 32]. In two studies, participants suffered from stroke [4, 7] and from hip fracture in another study [21, 22].

Qualitative studies reported on participants' views [3, 26, 30–32] and on views of OTs [3, 27, 28, 30, 32, 33], families [26, 30], and older community-dwelling people [9].

Participants' diagnoses were either stroke [3, 30], mixed [32] or not reported [27, 30].

Types of interventions

Interventions comprised a single predischarge home visit only [4, 7, 23] as well as additional supportive interventions through in-hospital activities [21, 22, 24, 25], including extended assessment [2, 23, 24] and / or extended training [22, 24]. Further intervention components were patient education [4, 7, 23, 25] and post discharge follow-ups [2, 24]. All the PDHAs were conducted by OTs alone, or with additional professionals allied to health (physiotherapists, nurses, social workers) [24, 25]. The patients were present during the home assessment in six out of seven RCTs [2, 4, 7, 21–23, 25]. All but one of the interventions were conducted in the patient's home, including functional assessment [2, 7, 22–24, 26]. Virtual home visits, conducted at the hospital, were investigated in one study [4]. Intervention details are available from the corresponding author.

Types of comparators

Usual care in Australia was described as an in-hospital structured interview with the OT, including two structured assessments and an access visit, if more information was required, such as measurements for rails [2] or additional patient education and information about equipment use and community services [23]. Usual care in the UK was described as structured interviews and general discussions about potential problems and referring to agencies [7]. One study [4] reported additional home / access visits for controls, if required. Usual care in Sweden [21, 22] comprised nursing care and instruction from a physiotherapist for walking aids. Usual care in Germany [24] comprised comprehensive geriatric assessment and recommendations. Usual care in France was not described [25].

Risk of bias within studies

The results of the risk of bias assessment are summarized in Fig. 2 and are presented in more detail in Additional File 3. Risk of selection bias was low in all but one study, where it was unclear [25]. Risk of performance bias was unclear in four of five studies [2, 4, 7, 25], and there was a high risk of performance bias in two of the five studies addressing the outcome IADL/ADL. Risk of performance bias was high in two studies [21–23] and unclear in two of four studies [4, 7]. Risk of readmission and risk of falling were not biased in all five studies addressing this outcome [2, 7, 21–25]. Mobility was detected in two studies with low or unclear performance bias, respectively. The same two studies assessed fear of falling with high or unclear risk of bias, respectively [4, 23, 25]. Risk of detection bias was unclear in two studies [21, 22, 25]. Risk of attrition bias was high in one study and unclear in another study [21, 22]. Risk of other bias was unclear in one study [2].

The quality appraisal of the qualitative studies is shown in Additional File 4. The quality of the studies did not influence the analysis since all the studies were considered as being valuable for our research question.

Effectiveness of PDHA versus usual care

Seven RCTs including 1072 participants compared PDHA with usual care [2, 4, 7, 21–25]. Forest plots for comparisons are displayed in Additional File 6. Meta-analysis was performed for Instrumental Activities of Daily Living (IADL) and Activities of Daily Living (ADL), quality of life (Qol), mobility, fear of falling, risk of falling and risk of readmission. Details on the GRADE judgment are reported in Additional File 5.

The summary of findings for the main outcomes is presented in Table 2.

Table 2
Summary of findings

PDHA compared with usual care for adults with any diagnosis at all				
Patients or population: *adults with any diagnosis at all (except mental disorders only)* Setting: *acute / subacute hospital care or rehabilitation unit* Intervention: *predischarge home assessment* Comparison: *usual care*				
Outcomes	**SMD* or MD* or RR, [95% CI], I^2, p**	**Number of participants (number of studies)**	**GRADE**	**Comments**
IADL/ADL. **Various scales.** Including studies with NEADL, NEADL (60), SMAF, SWED-QUAL Subscale Physical function. Higher score indicates better function. Mean duration of follow-up: 14.6 weeks (range 4–48 weeks)	SMD −0.17 [-0.87, 0.53], I^2 = 91% p = 0.64	656 (6)	⨁OOO very low[a]	No statistically significant effects. *(favors control not significantly, FE and RE applied)*
IADL/ADL. **NEADL** Score 0–22 points. Higher score indicates better results. Mean duration of follow-up: 6.7 weeks (range 4–12 weeks)	MD -0.32 [-1.26, 0.61], I^2 = 7% p = 0.50	501 (3)	⨁⨁OO low[c]	No statistically significant effects. *(favors control not significantly, FEM and RE applied)*
Quality of life. **Various scales**: EQ-5D overall score, EQ-5D subscale VAS, SWED-QUAL subscale general health perception. Higher score indicates better health status. Mean duration of follow-up: 7 weeks (range 4–12)	SMD 0.14 [-036, 0.65, I^2 = 57% p = 0.57	204 (4)	⨁OOO very low[c]	No statistically significant effects. *(favors experimental not significantly, FE and RE applied)*
Quality of life. **EQ-5D** overall score 0–1. Higher score indicates better health status. Mean duration of follow-up: 4 weeks	MD 0.19 [-0.08, 0.46], I^2 = 0% p = 0.18	109 (2)	⨁⨁OO low[b]	No statistically significant effects. *(favors experimental not significantly, FE and RE applied)*

PDHA compared with usual care for adults with any diagnosis at all				
Mobility. **Various scales**: Tinetti (scale 4–24) and RMI (0–15). Higher scores indicate better mobility. Mean duration of follow-up: 8 weeks (range 4–12)	SMD 1.24 ['-0.69, 3.17], I^2 = 78% p = 0.21	26 (2)	⨁OOO very low[b]	No statistically significant effects. *(favors experimental not significantly, FE and RE applied)*
Fear of falling. **FES-I** Score 10–100. Higher scores indicate more confidence. Mean duration of follow-up: 8 weeks (range 4–12).	MD -5.42 [-16.07, 5.23], I^2 = 27% p = 0.32	26 (2)	⨁OOO very low[c]	Significant harm if FE applied (MD -7.26 [-11.91, -2.61], p = 0.002)
Risk of falling Mean duration of follow-up: 19 weeks (range 4–48).	RR 0.88 [0.69, 1.13], I^2 = 0% p = 0.32	523 (4)	⨁⨁⨁O[d] moderate	No statistically significant effects. *(favors experimental not significantly, FE and RE applied)*
Risk of readmission: Mean duration of follow-up: 19 weeks (range 4–48).	RR 1.14 [0.81, 1.62], I^2 = 36% p = 0.70	563 (4)	⨁⨁⨁O[d] moderate	No statistically significant effects. *(favors control not significantly, FE and RE applied)*
Adverse effects of intervention				No adverse events reported in studies.

[a] downgraded due to unblinded personnel and participants, inconsistency and imprecision of results

[b] downgraded due to inconsistency and high imprecision of results

[c] downgraded due to downgraded due to unblinded participants and personnel and imprecision of results

[d] downgraded due to imprecision of results; FE: fixed effect model, RE: random effects model

File name	File format	Title of data	Description of data
Additional File 1	.docx	Search strategy and excluded references	Search terms and search strategy exemplary for MEDLINE via PubMed
Additional File 2	.docx	Outcome hierarchy for ADL IADL measures	Authors' prespecified hierarchy of ADL and IADL measures for meta-analysis
Additional File 3	.docx	Detailed ROB single studies	Risk of bias assessment on single study level, detailed explanation per outcome, additional graphics
Additional File 4	.docx	Quality appraisal qualitative studies	Quality appraisal on single study level in qualitative studies
Additional File 5	.docx	GRADE pooled effects	Detailed explanation of GRADE judgment per outcome
Additional File 6	.pdf	Forest plots	Graphical display of meta-analysis with effects in all pooled outcomes
Additional File 7	.docx	Descriptive themes	Summary of findings in qualitative studies on level of descriptive themes
Additional File 8	.xlsx	Analytical themes	Summary of analytical themes from qualitative synthesis with related barriers and facilitators and derived implications
Additional File 9	.xlsx	Integrative synthesis	Detailed overview on integrated results of meta-analysis and qualitative synthesis

Additional Files

Assessment of reporting bias through funnel plot analysis was not appropriate due to the small number of studies.

IADL/ADL (Instrumental) Activities of Daily Living (IADL/ADL) were measured in six of seven studies [2, 4, 7, 21–23, 25]. Four studies used the Extended Activities of Daily Living scale (NEADL) [34], another used the Functional Autonomy Measurement System (SMAF) [35], each as a full questionnaire. One study used single items addressing Activities of Daily Living from The Swedish Health-Related Quality of Life Survey (SWED-QUAL) [36]. There was no overall effect in functions of daily living for participants at the latest follow-up after receiving PDHA when measured with various scales (656 participants, SMD − 0.17, 95% CI [-0.87 to 0.53], p = 0.64, I^2 = 91%). The quality of evidence was judged to be very low due to concerns about risk of bias (blinding of outcome assessment), inconsistency and imprecision with considerable heterogeneity. A sensitivity analysis of three studies using the same scale (NEADL) confirmed the results (MD -0.32 [-1.26 to 0.61], p = 0.50, I^2 = 0%) with very low heterogeneity [2, 4, 7]. GRADE assessment indicated low quality due to high risk of bias (blinding of outcome assessment) and imprecision.

Quality of life (QoL) Two studies used the EQ-5D overall score [37] and another two the subscales of the EQ-5D measure of health status from the EuroQol Group (EQ-5D) or SWED-QUAL [36], respectively. Pooling all studies with any Qol measure [4, 21–23] showed no statistical significant group differences of PDHA compared to usual care with moderate heterogeneity (204 participants, SMD 0.14, 95% CI [-0.36 to 0.65], p = 0.57, I^2 = 57%). Applying the GRADE approach, we assessed the quality of the evidence to be low due to risk of bias (unblinded participants and personnel) and imprecision of results. A sensitivity analysis of two studies using the same scale (EQ-5D overall score) did not significantly affect the Qol outcome (109 participants MD 0.19, 95% CI [-9.40 to 9.46], p = 0.18, I^2 = 0%). The quality of the evidence for these results is low only due to inconsistency and high imprecision.

Mobility Two studies assessed mobility through Performance-Oriented Assessment of Mobility Problems (Tinetti) or The Rivermead Mobility Index (RMI) rating scale, respectively [38, 39]. Pooling these studies showed no improvement at the latest time points of follow-up at one and three months (26 participants, SMD 1.24, 95% CI [-0.69 to 3.17], p = 0.21, I2 =

78%). However, the quality of the evidence was rated very low due to inconsistency and high imprecision based on a very small number of participants with high heterogeneity.

Two studies measured **fear of falling** with the Falls Efficacy Scale - International (FES-I) [40]. There might be a slight trend towards an increase of fear of falling in participants who received the PDHA intervention. Applying the fixed effect Model (FEM) resulted in a statistically significant effect in favor of the control group (26 participants, MD -7.26, 95% CI [-11.91 to -2.61], p = 0.002) with moderate heterogeneity (I^2 = 27%). When a prespecified random effects model (REM) was used, there was no difference between groups in pooled effects for fear of falling (26 participants, MD -7.26, 95% CI [-11.91 to -2.61], p = 0.32). Using the GRADE approach, we assessed the quality of the evidence for this outcome to be very low due to risk of performance bias (unblinded participants and personnel) and imprecision of results resulting from the very small number of participants.

Risk of falling The overall effect of PDHA on reducing risk of falling was not statistically significant (523 participants, RR 0.88, 95% CI [0.69 to 1.13], p = 0.32), I^2 = 0%). Using the GRADE, the quality of evidence was assessed as moderate because considerable harm and benefit were included in confidence intervals of all the studies. Therefore, we had concerns regarding imprecision.

Risk of readmission Pooling four studies showed no statistically significant effect on the reduction of readmissions throughout an average of 16 weeks after receiving PDHA (523 participants, RR 1.13, 95% CI [0.61 to 2.10], p = 0.70, I^2 = 36%). Applying the GRADE approach, the quality of evidence was assessed as moderate because significant harm and benefit were included in the confidence intervals of all the studies. For this reason, we had concerns regarding imprecision.

Outcomes from single studies:

Overall independence was assessed with the Modified Ranking Scale [41] in one study with a missing significant difference between the groups at one month after discharge (16 participants, MD -0.20 95% CI [-0.65 to 0.25], p = 0.38) [4].

Psycho-social outcomes

One study reported on three different psycho-social outcomes, although all with missing significant differences at one month after discharge: **Emotional distress** in medical settings was measured through the GHQ-28 [42, 43] in 85 participants (in the intervention group with median 19; IQR 12.25–23.75 vs. median 23; IQR 15.5–31.5 in the control group; p = 0.10). **Depression** was measured through The Stroke Aphasic Questionnaire [44] in 85 participants (in the intervention group with median 6; IQR 3.25–9.75 vs. median 7; IQR 4–11 in the control group; p = 0.37). **Caregiver strain** was measured though the Caregiver Strain Index [7] in 85 participants (in the intervention group with median 5.5; IQR 1.75–7 vs. median 6; IQR 5–8 in the control group; p = 0.11).

Process outcomes

The number of recommendations was reported in one study with a significant increase in the number of modifications in the intervention group compared to the control group at 90 days after discharge (range 0–13 in intervention vs. 0–7 in controls, p = 0.001) [2].

Admissions to hospitals and care facilities

The **number of emergency department visits** was reported in one study with missing significant differences between the groups at 90 days after discharge (337 participants; RR = 1.06, 95% CI [0.73 to 1.55], p = 0.73 [2].

One study (86 participants) reported missing significant differences in the **number of institutionalizations** after 12 months (60 participants, RR = 0.58; 95% CI 0.26 to 1.27; p = 0.17) [25].

The number of patients receiving community support was reported by one study. Three months after discharge three patients in total across groups received community support (seven patients across groups received support at baseline) [23].

Qualitative synthesis

Based on four comprehensive descriptive themes, five analytical themes were identified regarding the barriers and facilitators of the PDHA process. Details are reported in Additional File 7 (Summary of the descriptive themes) and Additional File 8 (Overview on analytical themes).

Barriers and facilitators in PDHA process, analytical themes

Safety at home For decisions on home modifications, safety was the most important factor for OTs [26] and patients [26, 30]. OTs are appreciated as experts for safety by the participants. In patient education on safety, virtual reality (VR) applications have proved helpful for understanding the possible hazards [3, 9].

Patients and family carers' acceptance of home modification and aids Patients had specific demands on modifications and aids. They refused 'disabled' or 'like a hospital' looks as well as recommendations that might possibly mean that ADL and other meaningful activities could not be performed in the way the patients were used to or that they preferred [26, 27]. Patients wanted to have control over the number and kinds of changes [26]. Patients had their own ideas and solutions for aids and modifications [32]. The needs of family members and visitors in joining in with social activities and performing activities of daily living together with patients were equally important to patients and family carers when planning modifications [26]. For patients and family carers, it was difficult to imagine modifications, adaptations and the logistic requirements [3, 28]. OTs reported on the challenges encountered when trying to propose and communicate potential adaptations to the patient adequately [9]. OTs and older people found the use of visualization with a 3D interior design software application to be helpful for imagining and understanding the assistive technologies and adaptations planned [3, 9, 28] and for involving patients in decision-making on proposed changes [3, 9, 28]. OTs rated the VR applications as being better than drawings and photographs [28] and more helpful for communicating decisions regarding discharge destination, choice of aids and modifications [3].

Appropriateness of information to include patients in the PDHA process Predischarge home assessments were, when conducted as home visits with the OT and the patient, often frightening for the patients [27, 29], particularly when older people initially lacked information regarding the goal and consequences of the PDHA [27, 29, 31]. Therefore, having general and written information beforehand was appreciated [31]. During the home assessment, patients felt excluded from the assessment and planning modifications if the conversation took place only between therapists and carers. Patients appreciated getting feedback about the quality of their performance during the assessment and appreciated the social skills of the OTs in providing support [27]. After the home assessment, patients often did not feel sufficiently informed about the outcome of the assessment, were uncertain about next steps and felt excluded [27, 29].

Involvement in patient goals and meaningful activities in functional assessment. PDHAs were seen as a chance for both the patients and the therapists to gain a realistic view about the patient's function and limitations in the home environment [27, 29, 32, 33]. The patients felt restrained by the time limitation during the self-assessment at home [27, 31]. Whereas some therapists expressed to take sufficient time for a functional assessment [29], others emphasized that *"The clients need to spend some time at home and feel what it really is like before they can recognize what they need"* [32], just as the patients emphasized the need to try out their functional abilities in individual meaningful activities at home [30].

Relevant patient conditions in PDHA The levels of impairment and functioning were important factors in decision-making about a home assessment [30, 33]. Moderately impaired patients were seen as most likely to benefit from a PDHA [32, 33],

while PDHA was not considered as suitable for severely physically impaired, immobile and medically instable patients for PDHA [30, 33]. PDHA was also not considered as suitable for patients with severe cognitive impairment in contrast to patients with mild cognitive impairments [9, 29]. Further indications were visual and perceptual impairments, new complex needs and diagnoses of hip and knee replacements [29]. A virtual predischarge home assessment app does not seem indicated for patients with bad eyesight, visual impairments, severe cognitive impairments [9], low fine motor function, [3] and or who lack familiarity with the occupational therapy objects shown in the app's catalogue and have low computer literacy [3, 9]. OTs reported that access visits are sometimes difficult to conduct with patients with mental disorders, when patients were unwilling to let therapists enter the home in the patient's absence. However, hip and knee replacements were seen as appropriate indications for access visits [29]. Social conditions in terms of a supportive network of family members and outpatient services were considered to be crucial for gaining reliable information about the home environment and for realizing home modifications and aids provision and could possibly avoid the necessity of a PDHA [32, 33].

From these analytical themes, seven implications for PDHA interventions were derived for planning and conducting PDHAs, providing aids and implementing home modifications.

Integrative synthesis

Implications for practice are displayed in Table 3. Further details on the description of the interventions and on the extent to which implications were considered in intervention components of the included RCTs are displayed in additional files (see Additional File 9 for a detailed overview on study interventions, outcomes, effect sizes and implications addressed by study interventions).

Table 3
Synthesis of practice implications and RCT interventions

Implication		Studies addressing implications
1	Provide education about environmental hazards in an appropriate manner.	**Nikolaus et al., 2003,** **Drummond et al., 2013,** **Threapleton et al., 2018,** **Pardessus et al., 2002**
2	Provide tailored adaptations based on shared decision-making and explicitly involve patients' ideas, solutions and expectations in planning home modifications and adaptations of aids and provide the patient with advice on alternative solutions.	**Threapleton et al., 2018,** **Hagsten et al, 2004/Hagsten et al., 2006,**
3	Consider needs of family members and friends in home modifications.	Not identified
4	Use 3D applications to visualize and discuss modifications (if this method is appropriate for patients).	**Threapleton et al., 2018**
5	Provide adequate (verbal and written) patient information about the aim, process, assessment, the results and consequences.	Not identified
6	Involve patient goals in the PDHA	**Clemson et al., 2016**
7	Include patients' levels and kinds of impairments, diagnoses and availability of a supportive network in deciding about if and what kind of predischarge home assessment should be performed.	Not identified

Discussion

This review investigated the impact of PDHA on functional outcomes associated with a successful return to community living for patients with various diagnoses. It also identified barriers and facilitators of the PDHA process to derive recommendations for clinical practice.

Improving patient outcomes with PDHA

Overall, there is a very low to moderate quality of evidence on missing effects in favor of PDHA compared to usual care. There were only a few studies, and each of them investigated a variety of outcomes.

Our findings on the missing effects of PDHA on the **quality of life** are in line with the systematic review by Lockwood et al. [8]. Although we included two additional RCTs and excluded one cohort study, the quality of evidence was "low". This was caused by a high imprecision due to small sample sizes and large confidence intervals, which included possible harms as well as possible benefits. Future studies with a robust sample size are required that are powered to assess effects in quality of life as a primary outcome.

Mobility To our knowledge, the evidence on the effect of PDHA on mobility was assessed for the first time in our review. Since there were only two studies with different outcome measures and very small sample sizes, the quality of the evidence on missing effects of PDHA on mobility is very low.

Risk of falling Since we only included randomized trials and excluded cohorts, our results differ from the findings of Lockwood [8]. Our review revealed a moderate quality of evidence on missing overall effects concerning the risk of falling. PDHA might have a clinically important impact for reducing risk of falls, as Lockwood et al. reported; however, the few studies included reported heterogeneous results. Due to conflicting results and large confidence intervals, these pooled results are rather imprecise. Further RCTs are needed to confirm the effects on risk of falling.

Fear of falling To our knowledge, the evidence on the effect of PDHA on the fear of falling was assessed for the first time in our review. There is a low quality of evidence from two small studies showing a slight but significant increase of fear of falling in the intervention group when compared to usual care. This is in contrast to existing literature, which assumes that an increased fear of falling contributes to an increased risk of falling [45]. Our findings might be explained by the fact that an element of PDHA is to increase patients' awareness of potential risk of falling at home, which might also result in an increased fear of falling. This needs further investigation and should be considered when conducting the PDHA and the measures of discharge planning that result from the PDHA.

IADL/ADL When pooling various IADL measures, the quality of evidence for missing effects on IADL/ADL was very low. Pooling only studies that used the NEADL measure still resulted in low quality of evidence with missing effects. Whereas the earlier review by Lockwood et al. [8] suggested a benefit in ADL with low quality of the evidence, our update taking three additional RCTs into account could not confirm this result. Since improving independence in everyday living is a core objective of PDHA, these results seem surprising. One reason might be the appropriateness of the chosen outcome measures used in RCTs [46]. The outcome measures included a range of items that are unlikely to be affected by PDHA interventions (e.g., items related to various activities outside the living environment or items for the assessment of communication functions or mental functions). A definition of desirable activity and participation items that are operationalized for each individual patient could make a measurement more sensitive and thus make changes more visible [46]. Standardized measures for patient goal attainment (e.g., The Canadian Occupational Performance Measure, COPM [47]) or single items from validated ADL scales would be conceivable here. At the same time, such measures would enhance patient involvement, which is supposed to be fundamental to occupational therapy practice and the discharge planning process [48, 49].

Our findings on missing effects of PDHA on **risk of readmission** are in line with the existing literature [8]. Since we included an additional RCT with a large sample size, while excluding the cohort study, the quality of the evidence increased from "low" according to Lockwood et al. to "moderate" [8]. A PDHA might reduce risk of readmission to the hospital by preventing falls and their consequences. However, there are a number of other events causing readmission to hospital, which cannot be affected by PDHAs (e.g., relapse or aggravation of a previously known condition, complications and drug-related adverse events[50]). However, risk of falling and fall-related consequences might be more appropriate outcome measures for assessing the effects of PDHA than readmission to hospital.

In this review, we identified potential factors for effectiveness from the views of stakeholders involved in the PDHA process; this method allowed some clear recommendations for practice to be systematically derived.

We included five additional qualitative studies in the analysis of the barriers and facilitators of the PDHA process compared to earlier syntheses [8, 10]. Various implications were derived from the analysis of the qualitative studies as meaningful aspects for PDHA implementation and, in particular, for the patient-centeredness of the intervention; however, only very few of the included RCTs addressed the identified meaningful aspects of implementation.

This illustrates that a modification of PDHA to improve patient-centeredness is indicated and might explain the missing effects on the investigated outcomes.

PDHAs themselves fulfill all characteristics of complex interventions, especially when a PDHA is part of the discharge management (e.g., involving a variety of stakeholders, organizational levels and outcomes) [6, 51]. Nevertheless, none of

the included studies reported to have taken into account the current recommendations for the development of complex interventions [51]. The consequent inclusion of the user perspective in the development of future PDHA interventions (which are requested according to the current recommendations) would contribute to a more patient-centered approach of PDHA processes and outcomes.

A pilot study of a carefully modified intervention accompanied by an appropriate implementation strategy would avoid common problems, such as delays or lack of transfer of accurate information from hospital to secondary actors (like outpatient service providers), or problems in coordinating complex interactions between those involved, which were described as barriers in qualitative studies [9, 28, 32]. A pilot study would also contribute to the question of which outcome measure might be appropriate for investigating PDHAs.

Limitations

Our review has limitations owing to the shortcomings of the underlying studies. Due to the small number of studies in this field, research subgroup analysis was not possible. To overcome this limitation, a random effects model was used for the analysis. The experiences and beliefs of the participants in the included qualitative studies were shaped by the context of specific healthcare and insurance systems and may not be valid in other regions. The findings of the integrative synthesis must be interpreted with caution. First, the implications derived from the individual studies by the thematic analysis has to be considered on the background of their particular study samples in their respective context and therefore lack of generalizability. We tried to overcome this limitation by including views from different stakeholder groups and different contexts of PDHA in a thematic analysis and distinguished between the perspectives of the different stakeholder groups. Second, in some studies, it might not be possible to distinguish whether the implications were ultimately not taken into account during the implementation, or they were only insufficiently reported. Our comprehensive search strategy minimized the risk of missing studies, as we searched through the reference lists of systematic reviews, conducted a forward citation search and searched trial registers. A language bias due to the English and German language restriction cannot be ruled out. Further valuable strengths of our review include an unlimited search period and the screening and critical appraisal by two independent scientists.

Conclusions

This systematic review revealed very low to moderate quality of evidence that PDHAs might have no impact on patient outcomes associated with successful return to community living. Only a few implications for PDHA interventions derived from views of patients, carers, and healthcare professionals were reported in a few RCTs. Future studies on the effectiveness of PDHAs should consider implications from the users' point-of-view when modifying the PDHA and should follow the current recommendations for the development and evaluation of complex interventions. Furthermore, studies should adequately describe the PDHA intervention, including how it is embedded in the discharge management to improve the dependability and to contribute to a better understanding of how the intervention might work. Sufficiently robust RCTs using valid effect size estimates are needed to assess the effects of PDHAs. The use of appropriate outcome measures to assess ADL systematically according to information from individual patients might improve the evaluation of the interventions' effectiveness.

Abbreviations

3D: three-dimensional; **ADL/IADL:** Activities of Daily Living/Instrumental Activities of Daily Living; **COPM:** Canadian Occupational Performance Measure; **EQ-5D:** measure of health status from the EuroQol Group (EQ-5D); FE: Fixed Effect Model; **FES-I:** Falls Efficacy Scale-International; **FU:** follow-up; **GRADE:** The Grading of Recommendations Assessment, Development and Evaluation working group; **MRS:** Modified Ranking Scale; **n.a.:** not applicable; **n.r.:** not reported; **NEADL:**

Extended Activities of Daily Living scale; **OT:** Occupational Therapy; **PDHA:** Predischarge home assessment; **RCT:** Randomized Controlled Trial; **RE:** Random Effects Model; **RMI:** The Rivermead Mobility Index; **SMAF:** The Functional Autonomy Measurement System; **SWED-QUAL:** The Swedish Health-Related Quality of Life Survey; **VR:** Virtual Reality, **vs**: versus

Declarations

Ethics approval and consent to participate

Not applicable. This research article was a systematic review summarizing previously published literature.

Consent for publication

Not applicable.

Availability of data and materials

The data published may be found in the original manuscripts cited in the references list. The data extraction sheets of the RCTs and qualitative studies are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

SuS initially planned the review and wrote the protocol. KK conducted the initial search supervised by SS. UKH and KK conducted the critical appraisal and data extraction. The qualitative synthesis was conducted by UKH, assisted by KK. The meta-analysis and mixed method analysis were performed by UKH. All the authors took part in interpreting the study data. UKH wrote the drafts of the manuscript with support from SS. All the authors approved the final version of the manuscript and are accountable for all aspects of the work.

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Figures

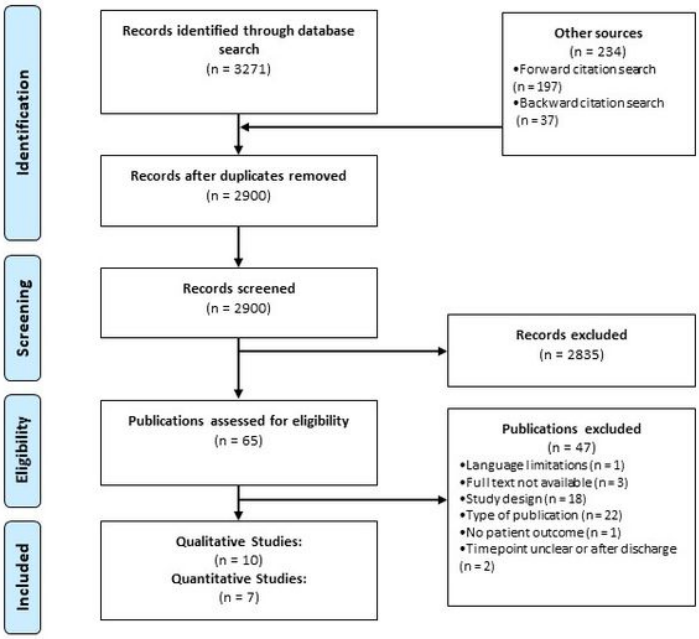

Figure 1

Flow diagram of study selection

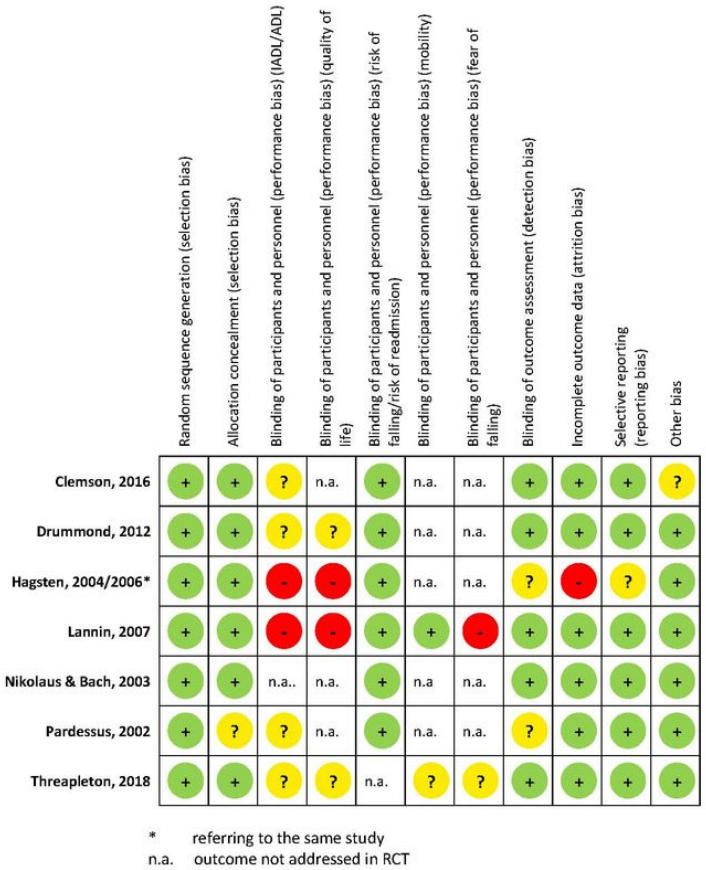

Figure 2

Risk of bias in single studies

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