## **Transitional care interventions from hospital to community to reduce healthcare use and improve patient outcomes: a systematic review and network meta-analysis.**

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**Key Points**

**Question**

What is the comparative effectiveness of transitional care interventions with different complexity levels at improving health care utilisation and patient outcomes after hospital discharge?

**Findings**

Low and medium complexity interventions were associated with a 22% and 19% statistically significant decrease in the odds of readmission at 30 days compared to usual care respectively, whereas high complexity interventions were associated with a 4% non-significant decrease. All intervention complexities were associated with significant reductions in the odds of readmissions at 180 days including low complexity interventions with 57% decrease, medium intensity interventions with 42% decrease and high intensity interventions with 34% decrease, respectively.

**Meanings**

Low and medium complexity transitional care interventions seem to be more effective for reducing readmission for patients transitioning from hospitals to the community.

**Abstract**

**Importance**

# Discharge from hospital to the community has been associated with serious patient risks and excess service costs**.**

# **Objective**

# **This study** **aimed to** evaluate the comparative effectiveness of transitional care interventions with different complexity levels at improving health care utilisation and patient outcomes in the transition from hospitals to the community.

**Data Sources**

We searched CENTRAL, Embase, MEDLINE, and PsycINFO from inception until August 2022.

**Study Selection**

We identified randomised controlled trialsevaluating transitional care interventions from hospitals to community.

**Data Extraction and Synthesis**

PRISMA guidelines were followed, at least two reviewers were involved in data screening and extraction.  Random-effects, network meta-analyses and meta-regressions were applied.

**Main Outcomes and Measures**

The primary outcome was readmission at 30, 90, and 180 days after discharge. Secondary outcomes include emergency department visits, mortality, quality-of-life, satisfaction, medication adherence, length of stay, primary care/outpatient visits and intervention uptake.

**Results**

Overall, 128 trials with 98,274 participants were included, 87 (68%) of which were of low risk of bias using the Cochrane Risk of Bias Tool for randomised controlled trials. Low complexity interventions were most effective for reducing hospital readmissions at 30-day (OR=0.78, 95%CI=0.66 to 0.92), 180-day (OR=0.43, 0.29 to 0.65) and emergency department visits (OR=0.68, 0.48 to 0.95). Medium complexity interventions were most effective at reducing hospital readmissions at 90-day (OR=0.60, 0.42 to 0.87), reducing adverse events (OR=0.43, 0.26 to 0.69), and improving medication adherence (SMD=0.49, 0.30 to 0.67) but were less effective than low complexity interventions for reducing readmissions at 30 and 180-days. High complexity interventions were most effective for reducing length of hospital stay (SMD=-0.20, -0.38 to -0.03) and increasing patient satisfaction (SMD=0.52, 0.22 to 0.82) but were least effective for reducing readmissions at all time periods. None of the interventions were associated with improved uptake, quality of life (general, mental, or physical), and primary care/outpatient visits.

**Conclusions and Relevance**

Low and medium complexity transitional care interventions seem to be better for reducing health care utilisation for patients transitioning from hospitals to the community. Comprehensive and consistent outcome measures are needed to capture the patient benefits of transitional care interventions.

**Background**

An increased demand for urgent hospital care has created pressure to discharge patients to the community (1) with some patients having been discharged too early or without necessary support to recover in the community especially during the Covid-19 pandemic (2) (3). There is evidence that one in five patients may experience suboptimal or unsafe care around the time of discharge from hospital mainly because of the prompt reduction in continuity of care and co-ordination challenges of multiple independent professionals and agencies(1,4,5).

To date, several trials have evaluated transitional care interventions to improve health care utilisation and patient outcomes in the transition from hospitals to the community. Some interventions include multiple components (6) implemented mainly at pre-discharge but some also at post-discharge (7,8) and/or involve a care co-ordinator/case manager (9,10). Other less intensive interventions target one key challenge of the discharge process (e.g. medication safety) (11,12) at one stage of the discharge process (13,14). A number of systematic reviews suggest that various transitional care interventions are promising for improving health care utilisation and possibly patient outcomes (15–18). However, most of these systematic reviews have focused on certain health care settings or populations or have included data from varying study designs which cannot be pooled together (19–21). Hence, despite the large number of trials conducted to improve discharge from hospitals to the community, there is no definitive evidence on how intensive (in terms of the number of components and number of discharge stages) transitional care interventions must be to work best, and whether different intervention complexity levels are best for improving certain outcomes.

This systematic review and network meta-analysis (22) examined the comparative effectiveness and uptake of different intensities of transitional care interventions in improving health care utilisation and patient outcomes in transition from hospitals to the community.

**Methods**

Reporting is consistent with the PRISMA extension for NMAs statement (guideline for reporting systematic reviews comparing multiple treatments using direct and indirect evidence in network meta-analyses; see also Appendix 1) (23). The review protocol is registered on PROSPERO CRD42020166169.

**Search Methods**

Searches were performed in the Cochrane Central Register of Controlled Trials, CINAHL, Embase, MEDLINE, and PsycINFO) from inception until August 2022 with no language restriction. We used combinations of Medical Subject Headings terms and text words in “discharge”, “intervention”, “readmission”, “continuity of patient care”. The full search strategy for each database is available in Appendix 2. The search strategy was adapted from a Cochrane ‘discharge planning from hospital’ review (19) and the reference lists of two relevant reviews were screened (19, 21).

**Eligibility Criteria**

**Population**

All patients in hospital (acute, rehabilitation or community) irrespective of age, gender, or condition.

**Intervention**

Randomised clinical trials (RCTs) or cluster RCTs evaluating a transitional care intervention from hospitals to the community implemented at pre-discharge (discharge planning), and post-discharge, or across the discharge period (pre, bridging and post). We excluded studies whereby the transitional/discharge element was a minor component of a multi-faceted intervention. We also excluded studies that were solely about follow-up in the community without a discharge component.

**Comparator**

Any comparator (e.g., usual care, another intervention, minimal intervention, or no intervention) were included.

**Outcome**

The primary outcome was readmission at 30, 90, and 180 days after discharge. Secondary outcomes included emergency department visits, mortality, quality of life, satisfaction, medication adherence, length of stay, primary care/outpatient visits and intervention uptake.

**Data Collection and Extraction**

A three-stage screening was conducted. Title screening was conducted by 2 authors independently (NT, MP). One author screened 100% of abstracts (NT) and four authors double-screened 25% of abstracts each, independently (Aha, Aho, GDK, CK). One author screened 100% of full texts (NT) and two authors double-screened 50% each, independently (CK, Aha).

Quantitative data were extracted by one author (NT) and checked for consistency by two authors (MP, Aho). Descriptive data were extracted by two authors (PPJ, OW) and checked for consistency by two authors (CK, Aha). A novel data extraction excel spreadsheet was used which was based on the Cochrane data extraction spreadsheet but refined for the needs of this study; it was piloted on five studies and adapted after discussion between three authors (NT, MP, Aho).

**Classification of Intervention Complexity**

For determining the complexity of the interventions, we focused on the number of key transitional care components included, as well as the number of discharge stages (pre-discharge, post-discharge, or bridging) at which the components were implemented. These components were themed after reviewing previous systematic reviews of transitional care interventions (24–29), consultations within our research team and professionals/patients with lived experience of transitioning from hospitals to the community. The transitional care components per discharge phase are presented in Figure 1. Interventions that included 8 or more of these components were classified as high complexity, those with 4-7 components were classified as medium complexity and those with 1-3 components were classified as low complexity.

**Assessment of Risk of Bias**

We used four risk of bias criteria from the Cochrane Risk of Bias Tool for randomised controlled trials: Allocation concealment (3=adequate, 2=less adequate, 1=unclear), intention-to-treat (3=yes; 2=no; 1=unclear), attrition (2=low (<5%); 1=medium (5-20%); 0=high/unclear (>20%)) and selection reporting bias (2=low; 1=medium; 0=unclear); we excluded blinding as it was really used in service-level interventions. A total risk of bias score was calculated for each study of which ranged from 2 to 10. Scores above 6 were classified as low risk of bias overall and scores ≤ 6 were classified as high risk of bias overall.

**Missing Data**

Study authors were contacted (three attempts were made) where there was missing or unclear data (e.g., relating to the primary outcomes). Studies for which sufficient primary data were not obtained, were excluded.

**Data Synthesis and Analysis**

*Network meta-analyses of primary outcomes*

We conducted network meta-analyses on the complexity of interventions (low, medium, high) including minimal control interventions to reduce readmission at 30, 90, and 180 days after discharge, ED visits, mortality, and intervention uptake compared to usual care (UC) at the level of significance of 0.05. We conducted pairwise meta-analyses using Dersimonian Laird random effects on the complexity of interventions to reduce adverse events, patient safety incidents, medication adherence, length of hospital stay in hospital, general quality of life (QoL), patient satisfaction at the level of significance of 0.05. We converted the dichotomous outcome data to log OR and then back to OR. Continuous data were converted to the standardised mean difference (SMD) and pooled effect sizes were interpreted according to Cohen’s criteria.16 The Comprehensive Meta-Analysis (CMA version 3)17 was used to perform the transformations.

Random-effects, network meta-analysis models based on the frequentist package *netmeta* in R (R Foundation for Statistical Computing, version 4.0.5). Network graphs scaled by the number of studies and forest plots presented by each intervention complexity compared with no intervention or UC, were presented. League tables of all head-to-head comparisons of interventions were also inspected (Appendix 6). The *I2*statistic and the (heterogeneity) variance in the random effect’s distribution (τ2) were used to measure the extent of the influence of variability across and within studies on intervention effects. Traditionally, values of 25, 50, and 75% indicate low, moderate, and high heterogeneity, respectively. We considered the P score, a frequentist analogue to SUCRA,18 to rank the interventions’ performance. We separated direct from indirect evidence by use of node splitting to evaluate consistency.19 Cochrane’s Q statistic was used to calculate consistency throughout the entire network.20 We produced network funnel plots to examine the presence of bias due to small-study effect which allowed us to visually scrutinize the criterion of symmetry. A sensitivity network meta-analysis for 30 and 90-day readmissions was done based on the number of discharge stages (1 to 3) and their seven combinations (pre; post; bridging; pre-post; pre-bridging; post-bridging; pre-post-bridging).

*Meta-regressions*

A series of univariate network meta-regressions were conducted for readmissions at 30- and 90-days, intervention uptake and mortality with a level of significance of 0.05. All models were fitted in OpenBUGS (version 3.2.3) using uninformative prior distributions for the intervention effects and a minimally informative prior distribution for common heterogeneity standard deviation. We assumed uninformative priors for all meta-regression coefficients. Model convergence was ensured by visual inspection of the three Markov Chain Monte Carlo chains after considering the Brooks Gelman Rubin diagnostic. Overall, 8 moderators were examined including age (<45, 45 to 59, 60 to 79, ≥80 years), gender (studies involving 54% or more females, studies involving 54% or more males, mixed or not reported), Organisation for Economic Co-operation and Development (OECD) (no, yes, nr), World Health Organisation (WHO) region (Africa, America, South-east Asia, Europe, Eastern Mediterranean, Western Pacific, unclear), delivery professional (nurse, pharmacist, medic, care co-ordinator, multi-disciplinary team, two professionals, allied health professionals, non-clinical staff, social worker, not reported), medication reconciliation (no, yes, not reported), patient population (medical, mental health), and risk of bias (low > 6; high ≤ 6) and patient complexity (low, high -based on studies that explicitly reported the population as high-risk, high complexity or described multi-morbidity, poly-pharmacy, vulnerability, terminal illness).

*Patient and Public Involvement*

We regularly consulted a group of four patient and carer partners who were members of an established patient and public involvement group about the appropriateness of our research questions, development of the review protocol, classification of the complexity levels of transitional care interventions, and selection of the outcome measures of this study. Patient and carer partners also advised on the interpretation of our findings, and their dissemination including drafting lay summaries.

**Role of the funding source**

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

**Results**

After removing duplicates, the search retrieved 10,685 references. Following title and abstract screening, 274 full texts were retrieved. 128 RCTs (involving 98,274 participants) met our inclusion criteria (see PRISMA flow diagram in Figure 2). The list of included studies and their characteristics are presented in Appendices 3 and 4.

**Descriptive Characteristics of the Included Studies**

Most studies were conducted in OECD countries (74%, k=89 studies); 51 (40%) in the Americas, 36 (28%) in Europe, 29 (23%) in the Western Pacific, 8 (6%) in Eastern Mediterranean, 3 (2%) in Africa and 1 (1%) in South-East Asia. Forty-three studies (34%) included mostly female participants,43 (34%) included mostly male participants, and 37 (29%) included an equal percentage of genders. The average age of the participants ranged between 2 and 87 (median 66, IQR 59-75). Nine (7%) studies were conducted in mental health hospitals and the remainder 119 (93%) in general hospitals. Fifty-six (44%) studies did not use a condition reporting index, 22 (17%) used the Charlson Comorbidity Index, 11 (9%) used the New York Heart Association (NYHA) functional classification (n=11), and 39 (33%) used another reporting index (see Appendix 4).

Thirty-seven (29%) studies applied low complexity interventions, 42 (33%) medium complexity and 49 (38%) high complexity. In terms of discharge stage, 49 (38%) studies applied intervention elements across all three stages (pre-discharge, post-discharge, and bridging), 51 (40%) in two stages and 28 (22%) in one stage only. Forty-five (35%) studies included a medication reconciliation component.

In 47 (37%) studies, interventions were conducted by a nurse, 34 (27%) by another health professional, 29 (23%) used a multi-disciplinary team, 8 (6%) by social care professionals and 10 (8%) by others.

*Assessment of risk of bias*

Eighty-seven studies (68%) were of low risk of bias, whereas 41 studies (32%) showed high risk of bias. Ratings for each of the risk of bias domains are provided in Appendix 5.

*Network meta-analysis*

**30-day hospital readmissions**

Pooling data from the 74 studies (85 direct comparisons) involving 80,255 participants, low (OR= 0.78, 95% CI 0.66 to 0.92) and medium complexity (OR= 0.81, 95% CI 0.68 to 0.97) interventions were associated with a 22% and 19% decrease in the odds of readmission at 30 days respectively (figure 3), compared to usual care (Appendix 6). High intensity interventions (OR=0.96, 95% CI 0.80 to 1.15) were associated with 4% non-significant reductions in readmissions. The P-score also showed that low complexity interventions (P-Score, 89%) were the most effective in reducing the 30-day readmission odds. Global heterogeneity of the network was seen to be moderate, *I2*=64 (54 to 72) %. There was evidence of inconsistency through node-splitting analysis in the comparison of high complexity interventions against minimal interventions Ratio OR= 2.96, 95% CI 1.20 to 7.29) and the comparison of minimal interventions against usual care Ratio OR=4.29, 95%CI=1.80 to 10.18) (Appendix 7). There was evidence of publication bias (Egger’s *p* value < 0.0001) (Appendix 8) and the league table of head-to-head comparisons also showed that low (OR=0.50, 95% CI 0.32 to 0.77), medium (OR=0.52, 95% CI 0.33 to 0.81), and high complexity (OR=0.61, 95% CI 0.40 to 0.92) interventions were significantly effective at reducing 30-day readmissions when compared to minimal interventions.

Meta-regressions (Appendix 11) showed that low complexity interventions were more effective for reducing 30-day readmissions when delivered by a health professional other than a nurse, or social carer (*b* =-1.51, *p* = 0.002) and in studies with high risk of bias ((*b*=-0.88, p=0.042). Medium complexity interventions were more effective for reducing 30-day readmissions in studies based in Western Pacific (log OR (*b)* =-0.84, *p* = 0.010) compared with the Americas.

Sensitivity analysis focused on discharge stages revealed that interventions applied at one discharge stage (OR=0.68, 0.55 to 0.84, P-score = 0.99, I2 = 66%) and especially at post-discharge (OR=0.56, 0.40 to 0.78, P-score = 0.90, I2 = 64%) were only effective at reducing 30-day readmissions (see full results in Appendix 10).

**90-day hospital readmissions**

Using data from 35 studies (35 direct comparisons) involving 16,873 participants, medium (OR=0.60, 95% CI 0.42 to 0.87), and high complexity (OR=0.71, 95% CI 0.56 to 0.91) interventions were associated with an 40%, and 29% decrease in the odds of readmission at 90 days respectively when compared to usual care (Appendix 6). Low intensity interventions (OR=0.64, 95% 0.40 to 1.02) were associated with 36% non-significant reductions in readmissions. The P-score ranked medium complexity interventions (P-Score, 78%) as being the most effective in reducing 90-day readmissions. Global heterogeneity of the network was seen to be moderate (*I2*=67 (53 to 77) %), and since there was no indirect evidence, inconsistency assessment was not applicable (Appendix 7). However, there was evidence for publication bias (Egger’s *p* value = 0.0002) (Appendix 8).

Meta-regressions showed that low complexity interventions were less effective for reducing 90-day readmissions in non-OECD countries (*b* =1.39, *p* = 0.009) and when delivered by a professional who was not nurse, other HCP or social carer (*b* =2.30, *p* = 0.008) or an MDT (*b=1.79, p=0.006*). High complexity interventions were less effective for reducing 90-day readmissions in studies involving mixed genders (*b* =0.89, *p* = 0.003) compared with studies with more than 54% female participants.

Sensitivity analysis focused on discharge stage showed that interventions applied at one discharge stage were most effective for reducing 90-day readmissions (0.31, 0.16 to 0.59, P-score = 0.99, I2 = 65%) although interventions with any number of discharge stages were effective too. Specifically, interventions at post-discharge stage (0.31, 0.16 to 0.59, P-score = 0.95, I2 = 63%) were most effective at reducing 90-day readmissions.

**180-day hospital readmissions**

Pooling data from 28 studies (34 direct comparisons) involving 13,806 participants, low (OR=0.43, 95% CI 0.29 to 0.65), medium (OR=0.58, 95% CI 0.40 to 0.86), minimal interventions (OR=0.66, 95% CI 0.45 to 0.96) and high (OR=0.76, 95% CI 0.60 to 0.97) were associated with an 57%, 42%, 34% and 24% decrease in the odds of readmission at 180 days respectively when compared to usual care (figure 4). The P-score showed that low complexity interventions (P-Score, 95%) were most effective in reducing the 180-day readmission odds. Global heterogeneity of the network was seen to be moderate, *I2*=66 (50 to 77) %. No evidence of inconsistency in the model was found (Appendix 7), and publication bias assessment revealed no concerns (Egger’s *p* value = 0.058) (Appendix 8). The only significant head-to-head finding from the league table of comparisons was that low complexity interventions were significantly better than the high complexity interventions at reducing 180-day readmissions (OR=0.57, 95% CI 0.36 to 0.90).

**ED visits**

Across 42 studies (46 direct comparisons) involving 31,088 participants, only low complexity (OR=0.68, 95% CI 0.48 to 0.95) interventions were associated with a 32% decrease in the odds of ED visits when compared to usual care (figure 5). The P-score showed that low complexity interventions (P-Score, 88%) were the most effective in reducing the odds of the ED visits. Global heterogeneity of the network was seen to be moderate, *I2*=71 (60 to 79) %, and there was no evidence of inconsistency in the model (Appendix 7). There was evidence of publication bias (Egger’s *p* value = 0.028) (Appendix 8).

**Mortality**

Across 43 studies (54 direct comparisons) involving 32,755 participants, none of the three intervention intensities were significantly effective at reducing mortality compared to usual care (figure 5). Global heterogeneity of the network was seen to be very low, *I2*=0 (0 to 35) %, and there was no evidence of inconsistency in the model (Appendix 7). There was evidence of publication bias (Egger’s *p* value = 0.001) (Appendix 8).

Meta-regressions did not reveal significant moderators for the effect of intervention intensities on mortality.

**Intervention Uptake**

Pooling uptake data from 111 studies (125 direction comparisons) involving 83,489 participants none of the intervention intensities were effective at increasing the odds of intervention uptake compared to usual care (figure 5). Global heterogeneity of the network was seen to be moderate, *I2*=60 (51 to 67) %, and there was no evidence of inconsistency in the model (Appendix 7) or publication bias (Egger’s *p* value = 0.407) (Appendix 8).

Meta-regressions showed that medium complexity interventions were associated with lower uptake in studies involving mixed genders (*b* =-0.78, *p* = 0.046) and when delivered in Africa (*b* =-3.86, *p* < 0.0001).

*Pairwise meta-analyses*

**Adverse Events**

Medium complexity interventions were associated with a 57% decrease in the odds for adverse events after discharge (OR=0.43, 95% CI 0.26 to 0.69; k=6) without heterogeneity (I2=0 (0 to 75) %). Low (k=3) and high complexity (k=3) interventions were non-significant in reducing adverse events.

**Patient Safety Incidents**

Low complexity interventions were associated with a 29% decrease in the odds for patient safety incidents (fixed-effects OR=0.71, 95% CI 0.53 to 0.94; k=2). High (k=4) and medium (k=5) complexity interventions were non-significant.

**Medication Adherence**

High (SMD=0.19, 95% CI 0.03 to 0.36, k=5) and medium complexity (SMD= 0.49, 95% CI 0.30 to 0.67, k=7) interventions were associated with small and medium increases in medication adherence, respectively. Heterogeneity was low. Low complexity (k=3) interventions were non-significant.

**Length of Hospital Stay**

High complexity interventions (SMD=-0.20, 95% CI -0.38 to -0.03, k=12) were associated with small reductions in the length of hospital stay. Heterogeneity was high (I2=75 (56 to 86) %). Low (k=6) and medium (k=5) complexity interventions were non-significant.

**Patient satisfaction**

High complexity interventions (SMD=0.52, 95% CI 0.22 to 0.82, k=7) showed a medium increase in patient satisfaction. Heterogeneity was moderate (I2=58 (3 to 82) %). Low (k=5) and medium (k=5) complexity interventions were non-significant.

**General Quality of Life (QoL)**

None of the intervention intensities significantly improved the general (k=27), mental (k=8) and physical quality of life (k=5) of patients after discharge.

**Discussion**

*Summary of main findings*

This study found that low complexity interventions followed by medium complexity interventions, especially those with a post-discharge component (e.g., patient follow-up visit or phone call) were the most effective in reducing health care utilisation and mortality; they were associated with between 19% to 57% reduction in hospital readmissions compared to usual care. High complexity interventions were effective in reducing some (but not all) health care utilisation outcomes, but their effects were less pronounced. Moreover, we obtained preliminary evidence from pairwise meta-analysis that medium-complexity interventions might be best for reducing patient/medication harms (adverse events and medication adherence) whereas high complexity interventions might be best for improving patient satisfaction. In general, the intervention complexity did not affect the intervention uptake; the only exception was the uptake of medium complexity interventions might be lower in low resource settings such as African countries compared to developed countries. Moreover, an important but unintended finding of this review is that the range of outcomes reported by interventions is very narrow. The vast majority of the trials reported hospital readmissions and at best, some additional health care utilisation outcomes (e.g., ED visits, length of hospital stay), and adverse outcomes (mortality). Very few trials have measured patient reported outcomes (such as quality of life and patient satisfaction with the transitional care) and broader risks for patient harm/safety, and none of the studies have reported staff outcomes despite that transitional care interventions were mostly service delivery interventions relying on staff engagement for their success.

*Comparison with similar research*

The evidence from previous reviews about the effectiveness of transitional care interventions from hospitals to the community is inconclusive. Direct comparisons with our findings are not possible because this is the first network meta-analysis which examined the comparative effectiveness of intervention complexities. For example, some reviews have found little or no evidence that discharge planning interventions reduce readmissions (27, 28, (21), whereas other reviews concluded that intensive interventions promoting integrated systems between inpatient and community care and multidisciplinary working might be most effective (30). However, most of these systematic reviews have focused on hospital sub-settings, were underpowered to detect significant reductions in re-admissions or their conclusions reflected the mixed findings of RCTs and observational studies. Our findings are partly consistent with the findings of a previous narrative systematic review which found that examined interventions to improve mental health care transitions (15). Less complex interventions targeting one specific outcome such as homelessness were more likely to be successful compared to more complex interventions that aimed to reduce readmissions (15).

*Strengths and limitations*

This systematic review has numerous methodological strengths but has also important limitations. First, the classification of the interventions into complexity levels was based on extensive review of the literature and expert/stakeholder engagement to discuss what intervention components are important to improve patient discharge from hospitals into the community. The later was confirmed by our sensitivity analyses based on discharge stages. Nevertheless, our classification approach is not flawless; for example, some of the components might be more important than others in improving all or some of the health care utilisation or patient outcomes. Our classification system of the interventions is an integrated version of similar classification systems that previous reviews have used (24–29). We also included expert and PPI (Patient and Public Involvement) input when deciding on the intervention components of the classification system. However, we recommend that future trials adopt a more standardized approach to reporting the intervention components they have used. This practice will facilitate comparisons between different transitional care interventions and support similar meta-analyses in the future. Second, only a small proportion of the included studies secondary outcomes including patient-reported outcomes which precluded the use of network meta-analyses; nevertheless, these outcomes were quantified using pairwise meta-analyses. Moreover, although we did a series of network meta-regressions to identify moderators of the intervention effects, we were not able to examine whether clinical or social characteristics of patients (frailty or multimorbidity, having carers) were confounders in our analyses due to low reporting quality of individual patient level data (31,32). We used patient complexity as a moderator by comparing studies that explicitly described the patient group as ‘high-risk’ or ‘high complexity’ or described multi-morbidity, polypharmacy, vulnerability, terminal illness across the whole patient population of the study. However, we recommend individual patient data meta-analysis to reliably examine whether patient level factors such as patient complexity or index disease moderate the effectiveness of different interventions needed. Finally, realist reviews could shed further light into the mechanisms of action and implementation of transitional care interventions (33).

*Implications for clinicians and policy makers*

Our findings convey three key messages for clinicians and policy makers. First, low and medium complexity interventions are the most effective options to reduce health care utilisation and prevent emergency department visits patients transitioning from hospital to the community. Second, the targets and benefits of high complexity interventions must be reviewed. The achieved reductions in readmission rates may not show good value for the cost of high complexity interventions (24,34) but improvements in patient and staff experience of discharge could better justify their costs and need for scalable implementation. Third, a core outcome set needs to be developed and used as standard practice by future trials of transitional care interventions. This core outcome set should complement health care utilisation outcomes with patient-reported outcomes (35,36), and staff-reported outcomes, whose experiences are important for the success (delivery as planned) and sustainability of service delivery interventions.

Key prerequisites to inform actionable clinical practice/guidelines are better understanding of how patient factors and intervention mechanisms impact on the effectiveness of transitional care interventions for patients transitioning from hospitals to the community, more comprehensive data on cost-effectiveness and establishing core outcome sets to capture the full range of benefits and impacts of such interventions.

*Conclusion*

In this meta-analysis, our findings mostly supported the use of low and medium complexity transitional care interventions for reducing health care utilisation for patients transitioning from hospitals to the community. We strongly recommend the development of a core outcome set which will include patient reported and staff-reported outcomes to better capture the full range of benefits and impacts of transitional care interventions especially those of high complexity.

Contributors: MP, NT and AHo had the initial research idea. MP, AHo and NT formulated the research questions and designed the study. NT, MP and AHo searched for published work, extracted data, and selected articles. MP, AHo, NT, extracted and checked data extraction. AHo analysed the data. MP, NT, AHo and IA drafted the protocol and manuscript. OW, CK, AHa, TB, CP, PPJ helped with searching for articles and data selection and extraction. MP, NT and AHo substantially contributed to designing the searches and the statistical analysis plan, writing the manuscript, and interpreting the findings. RK contributed to the manuscript by providing review comments and edits. All authors have read and approved the final manuscript. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted. MP is the guarantor.

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Ethical approval: Not required.

Data sharing: All summary level data and statistical code will become available upon request.

The lead author (the manuscript’s guarantor) affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

Dissemination to participants and related patient and public communities: Dissemination of this research will be done though a press release from the University of Manchester and social media.

**References**

1. Coleman EA, Berenson RA. Lost in transition: challenges and opportunities for improving the quality of transitional care. Ann Intern Med [Internet]. 2004 Oct 5 [cited 2019 Sep 11];141(7):533–6. Available from: http://www.ncbi.nlm.nih.gov/pubmed/15466770

2. Healthwatch England. Safely home: What happens when people leave hospital and care settings? [Internet]. 2015 [cited 2018 Sep 26]. Available from: www.healthwatch.co.uk

3. Braithwaite J, Churruca K, Long JC, Ellis LA, Herkes J. When complexity science meets implementation science: a theoretical and empirical analysis of systems change. BMC Med [Internet]. 2018 Dec 30 [cited 2019 Dec 12];16(1):63. Available from: https://bmcmedicine.biomedcentral.com/articles/10.1186/s12916-018-1057-z

4. Aase K, Schibevaag L, Waring J. Crossing Boundaries: Quality in Care Transitions. In: Researching Quality in Care Transitions [Internet]. Cham: Springer International Publishing; 2017 [cited 2019 Sep 11]. p. 3–29. Available from: http://link.springer.com/10.1007/978-3-319-62346-7\_1

5. Wright N, Rowley E, Chopra A, Gregoriou K, Waring J. From admission to discharge in mental health services: a qualitative analysis of service user involvement. Heal Expect [Internet]. 2016 Apr 1 [cited 2018 Mar 3];19(2):367–76. Available from: http://doi.wiley.com/10.1111/hex.12361

6. Waring J, Bishop S, Marshall F, Tyler N, Vickers R. An ethnographic study comparing approaches to inter-professional knowledge sharing and learning in discharge planning and care transitions. J Health Organ Manag. 2019 Oct 18;33(6):677–94.

7. Adamuz J, Viasus D, Simonetti A, Jiménez-Martínez E, Molero L, González-Samartino M, et al. Impact of an Educational Program to Reduce Healthcare Resources in Community-Acquired Pneumonia: The EDUCAP Randomized Controlled Trial. PLoS One [Internet]. 2015 Oct 13 [cited 2022 Jul 28];10(10). Available from: https://pubmed.ncbi.nlm.nih.gov/26460907/

8. Danielsen SO, Moons P, Sandvik L, Leegaard M, Solheim S, Tønnessen T, et al. Impact of telephone follow-up and 24/7 hotline on 30-day readmission rates following aortic valve replacement -A randomized controlled trial. Int J Cardiol [Internet]. 2020 Feb 1 [cited 2022 Jul 28];300:66–72. Available from: https://pubmed.ncbi.nlm.nih.gov/31387822/

9. Lainscak M, Kadivec S, Kosnik M, Benedik B, Bratkovic M, Jakhel T, et al. Discharge coordinator intervention prevents hospitalizations in patients with COPD: a randomized controlled trial. J Am Med Dir Assoc [Internet]. 2013 [cited 2022 Jul 28];14(6):450.e1-450.e6. Available from: https://pubmed.ncbi.nlm.nih.gov/23623520/

10. Meisinger C, Stollenwerk B, Kirchberger I, Seidl H, Wende R, Kuch B, et al. Effects of a nurse-based case management compared to usual care among aged patients with myocardial infarction: results from the randomized controlled KORINNA study. BMC Geriatr [Internet]. 2013 [cited 2022 Jul 28];13(1). Available from: https://pubmed.ncbi.nlm.nih.gov/24168465/

11. Bouchand F, Leplay C, Guimaraes R, Fontenay S, Fellous L, Dinh A, et al. Impact of a medication reconciliation care bundle at hospital discharge on continuity of care: A randomised controlled trial. Int J Clin Pract [Internet]. 2021 Aug 1 [cited 2022 Jul 28];75(8). Available from: https://pubmed.ncbi.nlm.nih.gov/33915011/

12. Graabæk T, Hedegaard U, Christensen MB, Clemmensen MH, Knudsen T, Aagaard L. Effect of a medicines management model on medication-related readmissions in older patients admitted to a medical acute admission unit-A randomized controlled trial. J Eval Clin Pract [Internet]. 2019 Feb 1 [cited 2022 Jul 28];25(1):88–96. Available from: https://pubmed.ncbi.nlm.nih.gov/30088321/

13. Dawes HA, Docherty T, Traynor I, Gilmore DH, Jardine AG, Knill-Jones R. Specialist nurse supported discharge in gynaecology: A randomised comparison and economic evaluation. Eur J Obstet Gynecol Reprod Biol [Internet]. 2007 Feb 1 [cited 2022 Aug 8];130(2):262–70. Available from: http://www.ejog.org/article/S030121150600100X/fulltext

14. Finn S, D’arcy E, Donovan P, Kanagarajah S, Barras M. A randomised trial of pharmacist-led discharge prescribing in an Australian geriatric evaluation and management service. Int J Clin Pharm [Internet]. 2021 Aug 1 [cited 2022 Aug 8];43(4):847–57. Available from: https://pubmed.ncbi.nlm.nih.gov/33136253/

15. Tyler N, Wright N, Waring J. Interventions to improve discharge from acute adult mental health inpatient care to the community: systematic review and narrative synthesis. BMC Health Serv Res [Internet]. 2019 Dec 25 [cited 2019 Dec 12];19(1):883. Available from: https://bmchealthservres.biomedcentral.com/articles/10.1186/s12913-019-4658-0

16. Lambrinou E, Kalogirou F, Lamnisos D, Sourtzi P. Effectiveness of heart failure management programmes with nurse-led discharge planning in reducing re-admissions: A systematic review and meta-analysis. Int J Nurs Stud. 2012 May 1;49(5):610–24.

17. Steffen S, Kösters M, Becker T, Puschner B. Discharge planning in mental health care: A systematic review of the recent literature. Acta Psychiatr Scand [Internet]. 2009;120(1):1–9. Available from: http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=emed12&NEWS=N&AN=354702668

18. Ospina MB, Mrklas K, Deuchar L, Rowe BH, Leigh R, Bhutani M, et al. A systematic review of the effectiveness of discharge care bundles for patients with COPD. Thorax [Internet]. 2017 Jan 1 [cited 2022 Jul 28];72(1):31–9. Available from: https://thorax.bmj.com/content/72/1/31

19. Gonçalves-Bradley DC, Lannin NA, Clemson LM, Cameron ID, Shepperd S. Discharge planning from hospital. Cochrane Database of Systematic Reviews. 2016.

20. Gonçalves-Bradley DC, Lannin NA, Clemson L, Cameron ID, Shepperd S. Discharge planning from hospital. Cochrane Database Syst Rev [Internet]. 2022 Feb 24 [cited 2022 Jul 19];2022(2). Available from: https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD000313.pub6/full

21. Coffey A, Leahy-Warren P, Savage E, Hegarty J, Cornally N, Day MR, et al. Interventions to Promote Early Discharge and Avoid Inappropriate Hospital (Re)Admission: A Systematic Review. Int J Environ Res Public Health [Internet]. 2019 Jul 2 [cited 2022 Mar 29];16(14). Available from: https://pubmed.ncbi.nlm.nih.gov/31295933/

22. Li T, Puhan MA, Vedula SS, Singh S, Dickersin K. Network meta-analysis-highly attractive but more methodological research is needed. BMC Medicine. 2011.

23. Hutton B, Salanti G, Caldwell DM, Chaimani A, Schmid CH, Cameron C, et al. The PRISMA extension statement for reporting of systematic reviews incorporating network meta-analyses of health care interventions: Checklist and explanations. Ann Intern Med. 2015 Jun 2;162(11):777–84.

24. Vigod SN, Kurdyak PA, Dennis C-L, Leszcz T, Taylor VH, Blumberger DM, et al. Transitional interventions to reduce early psychiatric readmissions in adults: systematic review. Br J Psychiatry [Internet]. 2013 Mar 2 [cited 2019 Mar 7];202(03):187–94. Available from: https://www.cambridge.org/core/product/identifier/S0007125000273819/type/journal\_article

25. Feltner C, Jones CD, Cené CW, Zheng ZJ, Sueta CA, Coker-Schwimmer EJL, et al. Transitional care interventions to prevent readmissions for persons with heart failure: A systematic review and meta-analysis. Ann Intern Med. 2014 Jun 3;160(11):774–84.

26. Rennke S, Nguyen OK, Shoeb MH, Magan Y, Wachter RM, Ranji SR. Hospital-initiated transitional care interventions as a patient safety strategy: A systematic review. Ann Intern Med. 2013 Mar 5;158(5 PART 2):433–40.

27. Laugaland K, Aase K, Barach P. Interventions to improve patient safety in transitional care – a review of the evidence. Work. 2012 Jan 1;41(Supplement 1):2915–24.

28. Rennke S, Ranji SR. Transitional Care Strategies From Hospital to Home. undefined. 2015;5(1):35–42.

29. Liebzeit D, Rutkowski R, Arbaje AI, Fields B, Werner NE. A scoping review of interventions for older adults transitioning from hospital to home. J Am Geriatr Soc [Internet]. 2021 Oct 1 [cited 2022 Nov 7];69(10):2950–62. Available from: https://onlinelibrary.wiley.com/doi/full/10.1111/jgs.17323

30. Leppin AL, Gionfriddo MR, Kessler M, Brito JP, Mair FS, Gallacher K, et al. Preventing 30-Day Hospital Readmissions: A Systematic Review and Meta-analysis of Randomized Trials. JAMA Intern Med [Internet]. 2014 Jul 1 [cited 2022 Jul 19];174(7):1095–107. Available from: https://jamanetwork.com/journals/jamainternalmedicine/fullarticle/1868538

31. Linkens AEMJH, Milosevic V, van der Kuy PHM, Damen-Hendriks VH, Mestres Gonzalvo C, Hurkens KPGM. Medication-related hospital admissions and readmissions in older patients: an overview of literature. Int J Clin Pharm [Internet]. 2020 Oct 1 [cited 2022 Aug 8];42(5):1243–51. Available from: https://link.springer.com/article/10.1007/s11096-020-01040-1

32. Pereira F, Verloo H, Zhivko T, Giovanni S Di, Meyer-Massetti C, Von Gunten A, et al. Risk of 30-day hospital readmission associated with medical conditions and drug regimens of polymedicated, older inpatients discharged home: a registry-based cohort study. BMJ Open [Internet]. 2021 [cited 2022 Aug 8];11:52755. Available from: http://bmjopen.bmj.com/

33. Alharbi K, Blakeman T, Van Marwijk H, Reeves D, Tsang JY. Understanding the implementation of interventions to improve the management of frailty in primary care: a rapid realist review. BMJ Open [Internet]. 2022 Jun 1 [cited 2022 Nov 7];12(6):e054780. Available from: https://bmjopen.bmj.com/content/12/6/e054780

34. Joynt KE, Jha AK. Thirty-Day Readmissions — Truth and Consequences. N Engl J Med. 2012;366(15):1366-1369.

35. Bee P, Gibbons C, Callaghan P, Fraser C, Lovell K. Evaluating and Quantifying User and Carer Involvement in Mental Health Care Planning (EQUIP): Co-Development of a New Patient-Reported Outcome Measure. PLoS One [Internet]. 2016 Mar 1 [cited 2022 Jul 21];11(3):e0149973. Available from: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0149973

36. Tyler N, Wright N, Grundy A, Waring J. Developing a core outcome set for interventions to improve discharge from mental health inpatient services: A survey, Delphi and consensus meeting with key stakeholder groups. BMJ Open. 2020.

37. Tyler N, Wright N, Grundy A, Waring J. Developing a core outcome set for interventions to improve discharge from mental health inpatient services: A survey, Delphi and consensus meeting with key stakeholder groups. BMJ Open. 2020.