Transitional Care Interventions to Prevent Readmissions for Persons With Heart Failure
A Systematic Review and Meta-analysis

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Background: Nearly 25% of patients hospitalized with heart failure (HF) are readmitted within 30 days.

Purpose: To assess the efficacy, comparative effectiveness, and harms of transitional care interventions to reduce readmission and mortality rates for adults hospitalized with HF.

Data Sources: MEDLINE, Cochrane Library, CINAHL, ClinicalTrials.gov, and World Health Organization International Clinical Trials Registry Platform (1 January 1990 to late October 2013).

Study Selection: Two reviewers independently selected randomized, controlled trials published in English reporting a readmission or mortality rate within 6 months of an index hospitalization.

Data Extraction: One reviewer extracted data, and another checked accuracy. Two reviewers assessed risk of bias and graded strength of evidence (SOE).

Data Synthesis: Forty-seven trials were included. Most enrolled adults with moderate to severe HF and a mean age of 70 years. Few trials reported 30-day readmission rates. At 30 days, a high-intensity home-visiting program reduced all-cause readmission and the composite end point (all-cause readmission or death; low SOE). Over 3 to 6 months, home-visiting programs and multidisciplinary care, such as preventable readmissions (9). Although no clear set of components defines transitional care interventions, they focus on patient or caregiver education, medication reconciliation, and coordination among health professionals involved in the transition.

We conducted a systematic review of transitional care interventions for persons with HF for the Effective Health Care Program of the Agency for Healthcare Research and Quality (AHRQ) (10). We included a broad range of intervention types (Table 1) applicable to adults transitioning from hospital to home that aimed to prevent readmissions. Although 30-day readmissions are the focus of quality measures, we also included readmissions measured over 3 to 6 months because these are common, costly, and potentially preventable (5). The full technical report addressed 5 questions (Appendix Table 1, available at www.annals.org). For this article, we focused on readmission and mortality outcomes.

Methods
We developed and followed a standard protocol. A technical report that details methods and includes complete search strategies and additional evidence tables is available at www.annals.org.

Heart failure (HF) is a leading cause of hospitalization and health care costs in the United States (1). Up to 25% of patients hospitalized with HF are readmitted within 30 days (2–5). Readmissions after an index hospitalization for HF are related to various conditions. An analysis of Medicare claims data from 2007 to 2009 found that 35% of readmissions within 30 days were for HF; the remainder were for diverse indications (for example, renal disorders, pneumonia, and arrhythmias) (2).

To reduce rehospitalization of Medicare patients, in October 2012, the Centers for Medicare & Medicaid Services began decreasing reimbursements to hospitals with excessive risk-standardized readmission (6). This policy incentivizes hospitals to develop programs to reduce readmission rates for persons with HF. Despite advances in the quality of acute and chronic HF disease management, knowledge gaps remain about effective interventions to support the transition of care for persons with HF.

Interventions designed to prevent readmissions among populations transitioning from one care setting to another are often called “transitional care interventions” (7, 8). They aim to avoid poor outcomes caused by uncoordinated care, such as preventable readmissions (9). Although.

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Data Sources and Searches
We searched MEDLINE, the Cochrane Library, and CINAHL for English-language and human-only studies published from 1 July 2007 to late October 2013, and we used a previous technology assessment on a similar topic to identify randomized, controlled trials (RCTs) published before 1 July 2007 (11). An experienced Evidence-based Practice Center librarian conducted the searches, and a second librarian reviewed them. We manually searched reference lists of pertinent reviews, included trials, and background articles on this topic to look for relevant citations our searches might have missed. We searched for relevant unpublished studies using ClinicalTrials.gov and the World Health Organization International Clinical Trials Registry Platform.

Study Selection
We developed inclusion and exclusion criteria with respect to populations, interventions, comparators, outcomes, timing, settings, and study designs (Appendix Table 2, available at www.annals.org). We included studies of adults recruited during or within 1 week of an index hospitalization for HF that compared a transitional care intervention with another eligible intervention or with usual care (that is, routine or standard care, as defined by the primary studies). We required that interventions include 1 or more of the following components: education of patient or caregiver delivered before or after discharge, planned or scheduled outpatient clinic visits (primary care or multidisciplinary heart failure [MDS-HF] clinic), home visits, telemonitoring, structured telephone support (STS), transition coach or case management, or interventions to increase provider continuity. We required studies to report a readmission rate, mortality rate, or the composite outcome (all-cause readmission or mortality). In the full report, we also assessed emergency department visits, acute care visits, hospital days of subsequent readmissions, quality of life, functional status, and caregiver or self-care burden (10).

Data Extraction and Risk-of-Bias Assessment
One team member extracted relevant data from each article, and a second team member reviewed all data extractions for completeness and accuracy.

We used predefined criteria based on the AHRQ Methods Guide for Comparative Effectiveness Reviews (12) to rate studies as having low, medium, high, or unclear risk of bias. Two reviewers independently assessed risk of bias for each study, and disagreements were resolved by consensus.

Data Synthesis and Analysis
We categorized intervention types primarily on the basis of the method and environment of delivery, as defined in Table 1. One investigator categorized the intervention, and a second team member reviewed the categorization. Disagreements were resolved by consensus. Given heterogeneity of the clinic-based interventions, we subcategorized these by clinic setting: MDS-HF, nurse-led HF, or primary care.

We used DerSimonian–Laird random-effects models (13) for meta-analyses of outcomes reported by multiple studies that were sufficiently similar to justify combining results. We ran meta-analyses of trials that reported the number of deaths or number of persons readmitted in each group (and not total readmissions per group). When only the total number of readmissions per group was available, we contacted authors for additional data. When we could not obtain the number of persons readmitted, we did not include the results in meta-analyses; instead, we included the results in qualitative synthesizes and considered them when grading the strength of evidence (SOE).

For readmission and mortality rates, we calculated risk ratios (RRs). We stratified analyses for each intervention category by outcome timing and separated rates reported at 30 days from those after 30 days (that is, rates reported over 3 to 6 months were combined). We did not include

| Table 1. Transitional Care Interventions |
|-------------------------------|--------------------------------------------------|
| **Category**                  | **Definition**                                    |
| Home-visiting programs        | Home visits by clinicians, such as a nurse or pharmacist, who educate, reinforce self-care instructions, perform physical examination, or provide other care (e.g., physical therapy or medication reconciliation). These interventions are often referred to as nurse case management interventions, but they also can include home visits by a pharmacist or multidisciplinary team. |
| STS                           | Monitoring, education, or self-care management (or various combinations) using simple telephone technology after discharge in a structured format (e.g., series of scheduled calls with a specific goal, structured questioning, or use of decision-support software). |
| Telemonitoring                | Remote monitoring of physiologic data (e.g., electrocardiogram, blood pressure, weight, pulse oximetry, or respiratory rate) with digital, broadband, satellite, wireless, or Bluetooth transmission to a monitoring center, with or without remote clinical visits (e.g., video monitoring). |
| Outpatient clinic–based       | Services provided in one of several types of outpatient clinics: multidisciplinary HF, nurse-led HF, or primary care. The clinic-based intervention can be managed by a nurse or other provider and may also offer unstructured telephone support (e.g., patient hotline) outside clinic hours. |
| Primarily educational         | Patient education (and self-care training) delivered before or at discharge by various personnel or methods: in person, interactive CD-ROM, or video education. Interventions in this category do not feature telemonitoring, home visits, or STS and are not delivered primarily through a clinic-based intervention. Follow-up telephone calls may occur to ascertain outcomes (e.g., readmission rates) but not to monitor patients’ physiologic data. |
| Other                         | Unique interventions or interventions that do not fit into any of the other categories (e.g., individual peer support for patients with HF). |

HF = heart failure; STS = structured telephone support.
studies rated as high or unclear risk of bias in our main analyses but included them in sensitivity analyses, which are available in the technical report (10); we describe them here only when they differed from primary analyses. We assessed statistical heterogeneity using the chi-square and $I^2$ statistics (14, 15). We calculated the number needed to treat (NNT) for readmission and mortality outcomes when we had statistically significant findings based on our primary analyses of trials rated as low or medium risk of bias, and we found at least low SOE for benefit. The NNT was derived from the RR and median usual care event rate using methods described in the Cochrane Handbook (16). We conducted meta-analyses using Stata, version 11.1 (StataCorp, College Station, Texas).

We did meta-analysis stratified by intensity in each intervention category when variation existed. The results of these subgroup analyses are available in the main report (10); we describe them here only when we found a difference in efficacy based on level of intensity. Given the heterogeneity of included interventions, we could not develop a single measure of intensity that could be applied to all intervention categories. For most interventions, we defined intensity as the duration, frequency, or periodicity of patient contact and categorized each intervention as low-, medium-, or high-intensity. We reserved the low-intensity category for interventions that included 1 episode of patient contact or few resources.

We graded SOE as high, moderate, low, or insufficient based on guidance established for the Evidence-based Practice Center program (17). The approach incorporates 4 key domains: risk of bias, consistency, directness, and precision. When only 1 study reported an outcome of interest, we usually graded the SOE as insufficient (primarily due to unknown consistency and imprecision); however, when similar interventions had consistent results at other time points, we graded the SOE as low. Two reviewers assessed each domain for each outcome, and differences were resolved by consensus.

Role of the Funding Source

The AHRQ funded this review, and AHRQ staff participated in the development of the scope of the work and reviewed draft manuscripts. Approval from AHRQ was required before the manuscript could be submitted for publication, but the authors are solely responsible for the content and the decision to submit it for publication.

RESULTS

Searches of all sources identified 2419 potentially relevant citations. We included 47 RCTs (Appendix Figure 1, available at www.annals.org). Trial characteristics are shown in Appendix Table 3 (available at www.annals.org). Most trials compared a transitional care intervention with usual care; 2 directly compared more than 1 intervention (both rated high risk of bias) (18, 19). In general, trials included adults with a mean age of 70 years who were hospitalized with a primary diagnosis of HF. Most reported HF disease severity based on the New York Heart Association classification and included persons with moderate to severe HF. Twenty-nine trials reported mean ejection fraction. Of these, 27 enrolled persons with a mean ejection fraction less than 0.50 and 7 trials specified a reduced ejection fraction as an inclusion criterion. Across most trials, the majority of patients were prescribed an angiotensin-converting enzyme inhibitor or angiotensin-receptor blocker. The percentages of patients who were prescribed $\beta$-blockers at discharge varied widely across trials. Trials were conducted in a range of settings: academic medical centers, Department of Veterans Affairs hospitals, and community hospitals. Twenty-three were multicenter trials, and 23 were conducted in a single center. Twenty-six trials were conducted in the United States, and 21 were done in other developed countries.

In general, trials report usual care as “standard discharge instructions” or “follow-up with outpatient provider as usual.” Most trials did not describe specific details, such as the type of clinic follow-up (for example, primary care vs. follow-up in a specialty clinic) or the timing of outpatient follow-up in the usual care group. We assessed most interventions as medium- or high-intensity (Appendix Table 3).

Fourteen RCTs compared a home-visiting program with usual care (20–33), and 1 trial compared a home-visiting program with telemonitoring (19). Five trials involved only 1 comprehensive home visit (20, 23, 24, 26, 33) after an index hospitalization; the remainder included several planned visits. In most trials, nurses conducted the home visits, most of which began within 7 days of discharge. Three trials included visits within 24 to 48 hours of discharge (28, 30, 31), and 3 trials specified that visits were done within 14 days of discharge (21, 25, 32).

Thirteen RCTs described in 15 publications compared STS with usual care (18, 34–45). Most trials averaged 1 or 2 calls during the intervention period, with the first contact occurring within 7 days of discharge. Interventions varied in whether predischarge education was delivered with STS. Most trials included a patient-initiated hotline for questions or additional support (34, 37, 38, 40–42, 44).

Eight trials evaluated telemonitoring. Five evaluated remote clinical data monitoring using equipment installed in a patient’s home (generally delivered within 2 to 7 days of discharge) that transmitted data to a central site (19, 46–49). Three trials used specialized equipment to allow for video assessments and interactions with patients (18, 50–52); the equipment could also check clinical data, such as blood pressure, or included stethoscopes to allow remote auscultation.

Seven trials evaluated outpatient clinic–based interventions (53–60). Four were in MDS-HF specialty clinics (54–57, 59, 60), 2 were in nurse-led HF specialty clinics (53, 58), and 1 assessed enhanced access to primary care (61). All involved a series of scheduled outpatient clinic
transitional care for persons with heart failure

Review

Table 2. Summary of Key Findings and SOE, by Outcome and Intervention Category*

<table>
<thead>
<tr>
<th>Intervention Category</th>
<th>All-Cause Readmissions</th>
<th>HF-Specific Readmissions</th>
<th>Composite End Point</th>
<th>Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30 d 3–6 mo</td>
<td>30 d 3–6 mo</td>
<td>30 d 3–6 mo</td>
<td>30 d 3–6 mo</td>
</tr>
<tr>
<td>Home-visiting program</td>
<td>Low†‡</td>
<td>–§</td>
<td>Low†</td>
<td>Moderate†</td>
</tr>
<tr>
<td>STS</td>
<td>Insufficient</td>
<td>Moderate†</td>
<td>Low†</td>
<td>Moderate†</td>
</tr>
<tr>
<td>Telemonitoring</td>
<td>–§</td>
<td>Moderate†</td>
<td>–§</td>
<td>Moderate†</td>
</tr>
<tr>
<td>MDS-HF clinic</td>
<td>–§</td>
<td>Insufficient</td>
<td>–§</td>
<td>Moderate†</td>
</tr>
<tr>
<td>Nurse-led clinic</td>
<td>Low†</td>
<td>–§</td>
<td>Insufficient</td>
<td>Low†</td>
</tr>
<tr>
<td>Primary care clinic</td>
<td>–§</td>
<td>Insufficient</td>
<td>–§</td>
<td>Insufficient</td>
</tr>
<tr>
<td>Primarily educational</td>
<td>–§</td>
<td>Insufficient</td>
<td>–§</td>
<td>Low†</td>
</tr>
<tr>
<td>Other</td>
<td>Insufficient</td>
<td>–§</td>
<td>–§</td>
<td>Insufficient</td>
</tr>
</tbody>
</table>

HF = heart failure; MDS = multidisciplinary; SOE = strength of evidence; STS = structured telephone support.

* SOE graded as low, moderate, high, or insufficient.
† Benefit was found (i.e., statistically significant reduction in readmission rate or mortality compared with usual care).
‡ Two home-visiting programs reported all-cause readmission at 30 d. The intervention studied by Naylor and colleagues (28) was of higher intensity and showed efficacy.
§ No trials in this category reported on an eligible outcome at this time point.
| No benefit was found (i.e., no statistically significant reduction in the outcome).

visits beginning within 7 days of discharge or enrollment, as well as individualized care planning. The 2 interventions described as “nurse-led” focused on patient education delivered by nurses during scheduled appointments (53, 58). Trials that described MDS-HF clinic interventions emphasized more physician contact and access to a multidisciplinary care team (cardiologists, diabeticians, and pharmacists) than nurse-led clinics.

Four trials evaluated a primarily educational intervention. One compared the effects of a 1-hour, in-person patient education program with usual discharge care; no other components were delivered after discharge (62). Two trials investigated the effects of HF education delivered by technology through predischarge viewing of an educational CD-ROM (63) or a 60-minute video that was intended to be viewed at home (64). One trial featured predischarge nurse-led intensive education about HF symptoms and treatment followed by 1 telephone call 3 to 5 days after discharge to reinforce education (65).

We also included 2 interventions in an “other” category. One featured individual peer support (66), and 1 emphasized cognitive training for persons with HF and coexisting mild cognitive impairment (67).

Overall Summary of Key Findings

Table 2 summarizes our key findings by intervention category, outcome, and timing and notes when we had the following: sufficient evidence to grade the SOE and whether evidence supports benefit, insufficient evidence to make a determination, or no included trials that reported an outcome. Table 3 presents more detailed results, including the RR (and its 95% CI) and the NNT (when applicable) for comparisons that included at least 1 trial reporting an outcome of interest.

Readmission and Mortality Rates at 30 Days

Figures 1 and 2 present our meta-analyses and RR calculations of trials reporting all-cause readmission and mortality, respectively. Results in both figures are stratified by intervention category and outcome timing. Meta-analysis and RR calculations for HF-specific readmission rates and the composite outcome are presented in Appendix Figures 2 and 3 (available at www.annals.org).

Two home-visiting trials reported 30-day all-cause readmission rates. One trial evaluating a high-intensity home-visiting program found a lower risk for readmission among persons receiving home visits compared with the usual care group (RR, 0.34 [95% CI, 0.19 to 0.62]) (28). This intervention included a series of 8 planned home visits, the first within 24 hours of discharge. The other trial (20) assessed a medium-intensity intervention that included 1 telephone call within 7 days of discharge and 1 planned home visit within 10 days of discharge; this trial found no statistically significant reduction in all-cause readmissions (RR, 0.89 [CI, 0.43 to 1.85]). We concluded that high-intensity home-visiting programs (frequent home visits starting within 24 hours after discharge) reduce all-cause readmissions (low SOE), with an NNT of 6. Our SOE grade accounted for the consistency of similar interventions in reducing readmissions over 3 to 6 months (Figure 1). We also found low SOE for home-visiting programs in reducing the composite outcome at 30 days (Table 3) (28).

Four other trials across different intervention categories reported 30-day all-cause readmission: 1 STS trial (36), 2 telemonitoring trials (50, 52), and 1 trial of cognitive training (in persons with HF and coexisting cognitive dysfunction) (67). None of these interventions reduced 30-day all-cause readmission rates. One STS trial found no difference in the risk for 30-day HF-specific readmissions between persons receiving STS and those receiving usual care (36).

Readmission and Mortality Rates at 3 to 6 Months

All-Cause Readmissions

Both home-visiting programs and MDS-HF clinic interventions reduced all-cause readmissions over 3 to 6
Table 3. Summary of Key Findings and SOE for Transitional Care Interventions: Readmission Rates and Mortality

<table>
<thead>
<tr>
<th>Intervention Category</th>
<th>Outcome</th>
<th>Outcome Timing</th>
<th>Trials (Participants, n)</th>
<th>RR (95% CI)*</th>
<th>NNT</th>
<th>SOE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home-visiting programs</td>
<td>All-cause readmission</td>
<td>30 d</td>
<td>2 (418)</td>
<td>0.89 (0.43–1.85)</td>
<td>6</td>
<td>for high-intensity programs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.34 (0.19–0.62)</td>
<td></td>
<td>NA for lower-intensity programs</td>
</tr>
<tr>
<td></td>
<td>HF-specific readmission</td>
<td>3–6 mo</td>
<td>9 (1563)</td>
<td>0.75 (0.68–0.86)</td>
<td>9</td>
<td>High for benefit</td>
</tr>
<tr>
<td></td>
<td>Composite end point</td>
<td>30 d</td>
<td>1 (239)</td>
<td>0.91 (0.23–1.65)</td>
<td>8</td>
<td>Moderate for benefit</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.51 (0.31–0.82)</td>
<td></td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Composite end point</td>
<td>3–6 mo</td>
<td>4 (824)</td>
<td>0.71 (0.55–0.89)</td>
<td>10</td>
<td>Moderate for benefit</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.54 (0.36–0.80)</td>
<td></td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Mortality</td>
<td>30 d</td>
<td>1 (239)</td>
<td>1.03 (0.5–7.16)</td>
<td>33</td>
<td>Moderate for benefit</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.77 (0.60–0.997)</td>
<td></td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Mortality</td>
<td>3–6 mo</td>
<td>8 (1693)</td>
<td>1.10 (0.60–1.90)</td>
<td>5</td>
<td>Moderate for benefit</td>
</tr>
<tr>
<td></td>
<td>All-cause readmission</td>
<td>30 d</td>
<td>1 (134)</td>
<td>0.80 (0.38–1.65)</td>
<td>NA</td>
<td>Insufficient</td>
</tr>
<tr>
<td></td>
<td>All-cause readmission</td>
<td>3–6 mo</td>
<td>8 (2166)</td>
<td>0.92 (0.77–1.10)</td>
<td>NA</td>
<td>Moderate for no benefit</td>
</tr>
<tr>
<td></td>
<td>HF-specific readmission</td>
<td>30 d</td>
<td>1 (134)</td>
<td>0.61 (0.28–1.37)</td>
<td>NA</td>
<td>Insufficient</td>
</tr>
<tr>
<td></td>
<td>HF-specific readmission</td>
<td>3–6 mo</td>
<td>7 (1790)</td>
<td>0.74 (0.61–0.90)</td>
<td>14</td>
<td>High for benefit</td>
</tr>
<tr>
<td></td>
<td>Composite end point</td>
<td>3–6 mo</td>
<td>3 (977)</td>
<td>0.81 (0.58–1.12)</td>
<td>NA</td>
<td>Low for no benefit</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.74 (0.60–0.97)</td>
<td>27</td>
<td>Moderate for benefit</td>
</tr>
<tr>
<td></td>
<td>Mortality</td>
<td>3–6 mo</td>
<td>7 (2011)</td>
<td>1.02 (0.64–1.63)</td>
<td>NA</td>
<td>Insufficient</td>
</tr>
<tr>
<td></td>
<td>All-cause readmission</td>
<td>30 d</td>
<td>1 (168)</td>
<td>1.11 (0.87–1.42)</td>
<td>NA</td>
<td>Moderate** for no benefit</td>
</tr>
<tr>
<td></td>
<td>All-cause readmission</td>
<td>3–6 mo</td>
<td>3 (434)</td>
<td>0.93 (0.36–2.48)</td>
<td>NA</td>
<td>Low for no benefit</td>
</tr>
<tr>
<td></td>
<td>HF-specific readmission</td>
<td>3–6 mo</td>
<td>1 (182)</td>
<td>1.70 (0.82–3.51)</td>
<td>NA</td>
<td>Moderate** for no benefit</td>
</tr>
<tr>
<td></td>
<td>Composite end point</td>
<td>3–6 mo</td>
<td>3 (564)</td>
<td>0.93 (0.25–3.48)</td>
<td>18</td>
<td>Moderate for benefit</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.56 (0.34–0.92)</td>
<td></td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Mortality</td>
<td>3–6 mo</td>
<td>3 (536)</td>
<td>0.88 (0.57–1.37)</td>
<td>NA</td>
<td>Low for no benefit</td>
</tr>
<tr>
<td></td>
<td>All-cause readmission</td>
<td>3–6 mo</td>
<td>2 (264)</td>
<td>0.95 (0.68–1.32)</td>
<td>NA</td>
<td>Insufficient</td>
</tr>
<tr>
<td></td>
<td>HF-specific readmission</td>
<td>3–6 mo</td>
<td>1 (158)</td>
<td>0.66 (0.43–1.01)</td>
<td>NA</td>
<td>Insufficient</td>
</tr>
<tr>
<td></td>
<td>Composite end point</td>
<td>3–6 mo</td>
<td>1 (106)</td>
<td>0.70 (0.29–1.70)</td>
<td>NA</td>
<td>Insufficient</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.80 (0.43–1.01)</td>
<td></td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Mortality</td>
<td>3–6 mo</td>
<td>2 (306)</td>
<td>0.93 (0.25–3.48)</td>
<td>18</td>
<td>Moderate for benefit</td>
</tr>
<tr>
<td></td>
<td>All-cause readmission</td>
<td>3–6 mo</td>
<td>1 (443)</td>
<td>1.27 (0.57–2.95)</td>
<td>NA</td>
<td>Insufficient</td>
</tr>
<tr>
<td></td>
<td>HF-specific readmission</td>
<td>3–6 mo</td>
<td>1 (443)</td>
<td>1.52 (0.88–2.63)</td>
<td>NA</td>
<td>Insufficient</td>
</tr>
<tr>
<td></td>
<td>Composite end point</td>
<td>3–6 mo</td>
<td>1 (106)</td>
<td>0.66 (0.43–1.01)</td>
<td>NA</td>
<td>Insufficient</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.59 (0.25–1.40)</td>
<td></td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Mortality</td>
<td>3–6 mo</td>
<td>2 (264)</td>
<td>1.70 (0.82–3.51)</td>
<td>NA</td>
<td>Low for no benefit</td>
</tr>
<tr>
<td></td>
<td>All-cause readmission</td>
<td>3–6 mo</td>
<td>1 (125)</td>
<td>1.5 (0.71–2.82)</td>
<td>NA</td>
<td>Insufficient</td>
</tr>
<tr>
<td></td>
<td>Mortality</td>
<td>3–6 mo</td>
<td>2 (423)</td>
<td>1.02 (0.52–2.76)</td>
<td>NA</td>
<td>Low for no benefit</td>
</tr>
<tr>
<td></td>
<td>Other (cognitive training)</td>
<td>All-cause readmission</td>
<td>30 d</td>
<td>1 (125)</td>
<td>0.07 (0.00–1.12)</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.15 (0.07–0.33)</td>
<td></td>
<td>NA</td>
</tr>
</tbody>
</table>

HF = heart failure; MDS = multidisciplinary; NA = not applicable; NNT = number needed to treat; RR = risk ratio; SOE = strength of evidence; STS = structured telephone support.

* RR from our meta-analyses or RR calculations unless otherwise specified. RR < 1 favors interventions over controls.
† Although only 1 trial reported total number of persons readmitted per group, we considered the findings consistent because 1 other trial reported on the number of readmissions per group and found a similar effect: Persons receiving home visits had fewer total HF readmissions than did those receiving usual care (measured as readmissions per patient-year alive; RR, 0.54; P < 0.001; n = 200) (24).
‡ Two home-visiting programs reported all-cause readmission at 30 d. The intervention studied by Naylor and colleagues (28) was of higher intensity and showed efficacy. The lower-intensity intervention studied by Jaarsma and colleagues (20) did not show efficacy at 30 d (low SOE; NNT, NA).
§ All-cause readmission or death.
¶ We did not calculate NNT because the RR was not statistically significant. We calculated NNT only for binary outcomes and not when outcomes were given as time to an event (i.e., hazard ratios).
∥ Although only 1 trial reported the number of persons alive and not readmitted at 30 d and 3 mo, we considered the consistency of similar programs reducing 3-mo readmissions rates when grading the SOE for this intervention at 30 d.
** Although only 1 trial reported on the number of persons readmitted, we considered this finding consistent given that 4 other telemonitoring trials reported the total number of readmissions per group (rather than the number of persons readmitted); all-cause readmissions did not differ between persons receiving telemonitoring and those receiving usual care at 30 d (44), 3 mo (43), or 6 mo (38, 40, 44).
### Figure 1. All-cause readmissions for transitional care interventions compared with usual care, by intervention category and outcome timing.

<table>
<thead>
<tr>
<th>Study, Year (Reference)</th>
<th>Treatment, n</th>
<th>Usual Care, n</th>
<th>RR (95% CI)</th>
<th>Weight, %</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Home-visiting program, 30 d</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Naylor et al, 2004 (28)</td>
<td>118 12</td>
<td>121 36</td>
<td>0.34 (0.19–0.62)</td>
<td>52.49</td>
</tr>
<tr>
<td>Jaarsma et al, 1999 (20)</td>
<td>84 11</td>
<td>95 14</td>
<td>0.89 (0.43–1.85)</td>
<td>47.51</td>
</tr>
<tr>
<td><strong>Home-visiting program, 3–6 mo</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rich et al, 1993 (31)</td>
<td>63 21</td>
<td>35 16</td>
<td>0.73 (0.44–1.20)</td>
<td>6.53</td>
</tr>
<tr>
<td>Rich et al, 1995 (30)</td>
<td>142 41</td>
<td>140 59</td>
<td>0.69 (0.50–0.95)</td>
<td>15.80</td>
</tr>
<tr>
<td>Stewart et al, 1998 (24)</td>
<td>49 24</td>
<td>48 31</td>
<td>0.76 (0.53–1.08)</td>
<td>13.13</td>
</tr>
<tr>
<td>Jaarsma et al, 1999 (20)</td>
<td>84 22</td>
<td>95 29</td>
<td>0.86 (0.54–1.37)</td>
<td>7.46</td>
</tr>
<tr>
<td>Naylor et al, 2004 (28)</td>
<td>118 34</td>
<td>121 52</td>
<td>0.67 (0.47–0.95)</td>
<td>13.45</td>
</tr>
<tr>
<td>Thompson et al, 2005 (33)</td>
<td>58 13</td>
<td>48 21</td>
<td>0.51 (0.29–0.91)</td>
<td>4.96</td>
</tr>
<tr>
<td>Holland et al, 2007 (32)</td>
<td>148 42</td>
<td>143 49</td>
<td>0.83 (0.59–1.17)</td>
<td>14.09</td>
</tr>
<tr>
<td>Aldaziz-Echevaria Iraigüi et al, 2007 (29)</td>
<td>137 44</td>
<td>142 54</td>
<td>0.84 (0.61–1.16)</td>
<td>15.95</td>
</tr>
<tr>
<td>Kwok et al, 2008 (27)</td>
<td>44 19</td>
<td>46 24</td>
<td>0.83 (0.53–1.28)</td>
<td>8.61</td>
</tr>
<tr>
<td><strong>Subtotal (I² = 0.0%; P = 0.09)</strong></td>
<td></td>
<td></td>
<td></td>
<td>0.75 (0.66–0.86)</td>
</tr>
<tr>
<td><strong>Structured telephone support, 30 d</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riegel et al, 2006 (36)</td>
<td>69 11</td>
<td>65 13</td>
<td>0.80 (0.38–1.65)</td>
<td>100.00</td>
</tr>
<tr>
<td><strong>Structured telephone support, 3–6 mo</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laramée et al, 2003 (37)</td>
<td>141 49</td>
<td>146 46</td>
<td>1.10 (0.79–1.53)</td>
<td>12.34</td>
</tr>
<tr>
<td>Riegel et al, 2002 (35)</td>
<td>130 56</td>
<td>228 114</td>
<td>0.86 (0.68–1.09)</td>
<td>15.51</td>
</tr>
<tr>
<td>Tsuyuki et al, 2004 (43)</td>
<td>140 59</td>
<td>136 51</td>
<td>1.12 (0.84–1.50)</td>
<td>13.59</td>
</tr>
<tr>
<td>Dunagan et al, 2005 (40)</td>
<td>76 28</td>
<td>75 49</td>
<td>0.56 (0.40–0.79)</td>
<td>12.08</td>
</tr>
<tr>
<td>López Cabezas et al, 2006 (44)</td>
<td>70 17</td>
<td>64 27</td>
<td>0.58 (0.35–0.95)</td>
<td>7.89</td>
</tr>
<tr>
<td>Riegel et al, 2006 (36)</td>
<td>69 40</td>
<td>65 37</td>
<td>1.02 (0.76–1.36)</td>
<td>13.57</td>
</tr>
<tr>
<td>Domingues et al, 2011 (39)</td>
<td>48 20</td>
<td>63 23</td>
<td>1.14 (0.72–1.82)</td>
<td>8.65</td>
</tr>
<tr>
<td>Angermann et al, 2012 (38)</td>
<td>352 119</td>
<td>363 112</td>
<td>1.10 (0.89–1.35)</td>
<td>16.37</td>
</tr>
<tr>
<td><strong>Subtotal (I² = 61.7%; P = 0.011)</strong></td>
<td></td>
<td></td>
<td></td>
<td>0.92 (0.77–1.10)</td>
</tr>
<tr>
<td><strong>Telemonitoring, 30 d</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pekmezaris et al, 2012 (50)</td>
<td>83 25</td>
<td>85 25</td>
<td>1.02 (0.64–1.63)</td>
<td>100.00</td>
</tr>
<tr>
<td><strong>Telemonitoring, 3–6 mo</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schwarz et al, 2008 (47)</td>
<td>44 12</td>
<td>40 13</td>
<td>0.84 (0.43–1.62)</td>
<td>13.61</td>
</tr>
<tr>
<td>Dar et al, 2009 (49)</td>
<td>91 33</td>
<td>91 23</td>
<td>1.43 (0.92–2.24)</td>
<td>28.73</td>
</tr>
<tr>
<td>Pekmezaris et al, 2012 (50)</td>
<td>83 42</td>
<td>85 41</td>
<td>1.05 (0.77–1.42)</td>
<td>57.66</td>
</tr>
<tr>
<td><strong>Subtotal (I² = 5.2%; P = 0.35)</strong></td>
<td></td>
<td></td>
<td></td>
<td>1.11 (0.87–1.42)</td>
</tr>
<tr>
<td><strong>Clinic-based (nurse-led), 3–6 mo</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ekman et al, 1998 (53)</td>
<td>79 48</td>
<td>79 45</td>
<td>1.07 (0.82–1.38)</td>
<td>57.62</td>
</tr>
<tr>
<td>Strömborg et al, 2003 (58)</td>
<td>52 19</td>
<td>54 29</td>
<td>0.68 (0.44–1.05)</td>
<td>42.38</td>
</tr>
<tr>
<td><strong>Clinic-based (MDS-HF), 6 mo</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ducharme et al, 2005 (59)</td>
<td>115 45</td>
<td>115 66</td>
<td>0.68 (0.52–0.90)</td>
<td>78.37</td>
</tr>
<tr>
<td>Liu et al, 2012 (60)</td>
<td>53 16</td>
<td>53 21</td>
<td>0.76 (0.45–1.29)</td>
<td>21.63</td>
</tr>
<tr>
<td><strong>Subtotal (I² = 0.0%; P = 0.71)</strong></td>
<td></td>
<td></td>
<td></td>
<td>0.70 (0.55–0.89)</td>
</tr>
<tr>
<td><strong>Clinic-based (primary care), 6 mo</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oddone et al, 1999 (61)</td>
<td>222 124</td>
<td>221 97</td>
<td>1.27 (1.05–1.54)</td>
<td>100.00</td>
</tr>
<tr>
<td><strong>Cognitive training (other), 30 d</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Davis et al, 2012 (67)</td>
<td>63 14</td>
<td>62 12</td>
<td>1.15 (0.58–2.28)</td>
<td>100.00</td>
</tr>
<tr>
<td><strong>Primarily educational, 6 mo</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nucifora et al, 2006 (65)</td>
<td>99 48</td>
<td>101 43</td>
<td>1.14 (0.84–1.54)</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Weights are from random-effects analysis. MDS-HF = multidisciplinary heart failure; RR = risk ratio.

* Number of people readmitted per group (not total readmissions per group).

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months (high SOE; NNT, 7 to 9). The STS and telemonitoring interventions were not effective in reducing the risk for all-cause readmission (moderate SOE and outcome timing.

Figure 2. Mortality rate among persons receiving transitional care interventions compared with usual care, by intervention category and outcome timing.

<table>
<thead>
<tr>
<th>Study, Year (Reference)</th>
<th>Treatment, n</th>
<th>Usual Care, n</th>
<th>RR (95% CI)</th>
<th>Weight, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home-visiting program, 30 d</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Naylor et al, 2004 (28)</td>
<td>118 2</td>
<td>121 2</td>
<td>1.03 (0.15–7.16)</td>
<td>100.00</td>
</tr>
<tr>
<td>Home-visiting program, 3–6 mo</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rich et al, 1995 (30)</td>
<td>142 13</td>
<td>140 17</td>
<td>0.75 (0.38–1.49)</td>
<td>14.04</td>
</tr>
<tr>
<td>Kimmelstiel et al, 2004 (26)</td>
<td>97 4</td>
<td>103 5</td>
<td>0.85 (0.23–3.07)</td>
<td>3.97</td>
</tr>
<tr>
<td>Stewart et al, 1998 (24)</td>
<td>49 6</td>
<td>48 12</td>
<td>0.49 (0.20–1.20)</td>
<td>8.18</td>
</tr>
<tr>
<td>Jaarsma et al, 1999 (20)</td>
<td>100 18</td>
<td>100 28</td>
<td>0.64 (0.38–1.08)</td>
<td>23.95</td>
</tr>
<tr>
<td>Naylor et al, 2004 (28)</td>
<td>118 7</td>
<td>121 10</td>
<td>0.72 (0.28–1.82)</td>
<td>7.55</td>
</tr>
<tr>
<td>Holland et al, 2007 (32)</td>
<td>148 30</td>
<td>143 24</td>
<td>1.21 (0.74–1.96)</td>
<td>27.87</td>
</tr>
<tr>
<td>Aldamiz-Echevarria Iraürgui et al, 2007 (29)</td>
<td>137 8</td>
<td>142 14</td>
<td>0.59 (0.26–1.37)</td>
<td>9.37</td>
</tr>
<tr>
<td>Kwok et al, 2008 (27)</td>
<td>49 4</td>
<td>56 8</td>
<td>0.57 (0.18–1.78)</td>
<td>5.07</td>
</tr>
<tr>
<td>Subtotal (P² = 0.0%; P = 0.61)</td>
<td></td>
<td></td>
<td>0.77 (0.60–0.996)</td>
<td>100.00</td>
</tr>
<tr>
<td>Structured telephone support, 3–6 mo</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laramée et al, 2003 (37)</td>
<td>141 13</td>
<td>146 15</td>
<td>0.90 (0.44–1.82)</td>
<td>17.19</td>
</tr>
<tr>
<td>Dunagan et al, 2005 (40)</td>
<td>76 6</td>
<td>75 5</td>
<td>1.18 (0.38–3.71)</td>
<td>6.55</td>
</tr>
<tr>
<td>López Cabezás et al, 2006 (44)</td>
<td>70 6</td>
<td>64 12</td>
<td>0.46 (0.18–1.15)</td>
<td>10.13</td>
</tr>
<tr>
<td>Riegel et al, 2006 (36)</td>
<td>70 5</td>
<td>65 8</td>
<td>0.58 (0.20–1.68)</td>
<td>7.55</td>
</tr>
<tr>
<td>Wakefield et al, 2008 (41)</td>
<td>47 6</td>
<td>49 8</td>
<td>0.78 (0.29–2.08)</td>
<td>8.92</td>
</tr>
<tr>
<td>Angermann et al, 2012 (38)</td>
<td>352 32</td>
<td>363 52</td>
<td>0.63 (0.42–0.96)</td>
<td>49.66</td>
</tr>
<tr>
<td>Subtotal (P² = 0.0%; P = 0.78)</td>
<td></td>
<td></td>
<td>0.69 (0.51–0.92)</td>
<td>100.00</td>
</tr>
<tr>
<td>Telemonitoring, 3–6 mo</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schwarz et al, 2008 (47)</td>
<td>51 4</td>
<td>51 7</td>
<td>0.57 (0.18–1.83)</td>
<td>30.50</td>
</tr>
<tr>
<td>Goldberg et al, 2003 (48)</td>
<td>138 11</td>
<td>142 26</td>
<td>0.44 (0.22–0.85)</td>
<td>36.37</td>
</tr>
<tr>
<td>Dar et al, 2009 (49)</td>
<td>91 17</td>
<td>91 5</td>
<td>3.40 (1.31–8.83)</td>
<td>33.12</td>
</tr>
<tr>
<td>Clinic-based (MDS-HF), 6 mo</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kasper et al, 2002 (57)</td>
<td>102 7</td>
<td>98 13</td>
<td>0.52 (0.22–1.24)</td>
<td>31.84</td>
</tr>
<tr>
<td>Ducharme et al, 2005 (59)</td>
<td>115 12</td>
<td>115 19</td>
<td>0.63 (0.32–1.24)</td>
<td>53.65</td>
</tr>
<tr>
<td>Liu et al, 2012 (60)</td>
<td>53 3</td>
<td>53 7</td>
<td>0.43 (0.12–1.57)</td>
<td>14.51</td>
</tr>
<tr>
<td>Subtotal (P² = 0.0%; P = 0.85)</td>
<td></td>
<td></td>
<td>0.56 (0.34–0.92)</td>
<td>100.00</td>
</tr>
<tr>
<td>Clinic-based (nurse-led), 3–6 mo</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strömberg et al, 2003 (58)</td>
<td>52 3</td>
<td>54 13</td>
<td>0.24 (0.07–0.79)</td>
<td>44.81</td>
</tr>
<tr>
<td>Ekman et al, 1998 (53)</td>
<td>79 21</td>
<td>79 17</td>
<td>1.24 (0.71–2.16)</td>
<td>55.19</td>
</tr>
<tr>
<td>0.59 (0.12–3.03)</td>
<td>100.00</td>
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<tr>
<td>Clinic-based (primary care), 6 mo</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oddone et al, 1999 (61)</td>
<td>222 29</td>
<td>221 19</td>
<td>1.52 (0.88–2.63)</td>
<td>100.00</td>
</tr>
<tr>
<td>Primarily educational, 6 mo</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Koelling et al, 2005 (62)</td>
<td>107 7</td>
<td>116 10</td>
<td>0.76 (0.30–1.92)</td>
<td>46.69</td>
</tr>
<tr>
<td>Nuñez et al, 2006 (65)</td>
<td>99 14</td>
<td>101 8</td>
<td>1.79 (0.78–4.07)</td>
<td>53.31</td>
</tr>
<tr>
<td>Cognitive training, 30 d</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Davis et al, 2012 (67)</td>
<td>63 0</td>
<td>62 7</td>
<td>0.07 (0.00–1.12)</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Weights are from random-effects analysis. MDS-HF = multidisciplinary heart failure; RR = risk ratio.

One trial found that patients with HF who had enhanced access to primary care after discharge (through a Veterans Affairs health care setting) had a higher risk for all-cause readmission than those in the control group (61). However, because we had limited evidence from a single
trial and unknown consistency, we graded the evidence on increasing access to primary care as insufficient. Evidence was insufficient to determine whether primarily educational interventions were effective in reducing all-cause readmission.

HF-Specific Readmissions

Home-visiting programs and STS interventions both reduced the risk for HF-specific readmissions (moderate and high SOE, respectively; NNT, 7 to 14). Telemonitoring did not reduce the risk for HF-specific readmissions (moderate SOE). Evidence was insufficient about whether MDS-HF clinic interventions, nurse-led HF clinic interventions, or primarily educational interventions reduced HF-specific readmissions (1 trial with unknown consistency for each).

Composite Outcome

Few trials reported the composite outcome (all-cause readmission or death). Home-visiting programs reduced the composite outcome over 3 to 6 months (moderate SOE; NNT, 10). Structured telephone support, MDS-HF clinic interventions, and primarily educational interventions were not effective in reducing the risk for the composite outcome. We had insufficient evidence for nurse-led clinic interventions (58) and no evidence for other intervention categories.

Mortality

Figure 2 presents our meta-analysis of trials reporting mortality rates stratified by intervention category and outcome timing. The following interventions reduced mortality compared with usual care (moderate SOE): home-visiting programs (NNT, 33), MDS-HF clinic interventions (NNT, 18), and STS (NNT, 27). Telemonitoring, nurse-led clinics, and primarily educational interventions did not reduce mortality (low SOE). Evidence for a reduction in mortality was insufficient for primary care interventions and cognitive training programs.

Sensitivity Analysis

For most sensitivity analyses, results were similar to those of our primary analyses. Details and complete forest plots are available in the full report (10). We found 1 exception. When we added 3 trials rated as high or unclear risk of bias, the effect of home-visiting programs on mortality over 3 to 6 months was no longer statistically significant, although the estimates of effects were similar (RR, 0.85 vs. 0.77); however, the CI was less precise and crossed 1 (RR, 0.85 [CI, 0.68 to 1.05]). In no other cases did adding trials rated as high or unclear risk of bias significantly change the overall conclusions.

DISCUSSION

Current clinical practice for the care of adults with HF after hospitalization varies greatly (68). Our findings provide guidance to quality improvement efforts aimed at reducing readmission and mortality rates for persons with HF. Home-visiting programs and MDS-HF clinic interventions currently have the best evidence for reducing all-cause readmissions and mortality up to 6 months after an index hospitalization for persons with HF. We found little evidence on whether interventions reduced 30-day readmissions.

Trials included adults with similarities in age and New York Heart Association scores. Included trials commonly excluded persons with end-stage renal or severe cardiovascular disease; thus, results may not be applicable to persons with high levels of coexisting illness. The trials we examined were conducted in various inpatient settings, and more than half of included trials were done in the United States. Our findings are, therefore, generally applicable to many hospital settings in the United States.

Most trials compared an intervention with “usual care.” Whether usual care in trials published during the early 1990s is comparable to current practice is not clear. In general, trials did not report on specific details of usual care. However, median rates of readmission in the usual care groups of included trials are similar to readmission rates among Medicare beneficiaries (5). It is not clear whether variation in usual care across trials is a major factor in the applicability of findings because current clinical practice in the care of adults with HF after hospitalization is diverse and readmission rates vary by geographic location and insurance coverage (68, 69).

We identified systematic reviews during our searches that were relevant to our key questions. Prior reviews differed in scope in that they either excluded readmission outcomes measured before 6 months or included trials that enrolled stable samples of patients with HF recruited from outpatient settings (70–72). In addition, other reviews used different categorization strategies, which may have led to different conclusions. For example, 1 recent systematic review and network meta-analysis found no statistically significant effect of remote monitoring interventions on mortality or all-cause readmission up to 1 year; this review also combined STS and telemonitoring (70). A 2009 Cochrane review found that “case-management” interventions (home-visiting programs and telephone support) reduced all-cause mortality at 12 months (but not at 6 months) and reduced HF-specific readmissions at 6 months and 1 year (71). The interventions included in our review were heterogeneous and could probably be categorized using various approaches. We classified them in a manner that we believe is descriptive and informative for physicians interested in interventions that could be implemented during the transition from hospital to home.

Potential limitations of our review include publication bias and selective reporting. We searched for unpublished trials and outcomes but did not find direct evidence of either type of bias. Many of the included trials were published before trial registries (for example, ClinicalTrials...
requests for single reprints: Cynthia Feltner, MD, MPH, Department of Medicine, University of North Carolina at Chapel Hill, 5034 Old Clinic Building, CB 7110, Chapel Hill, NC 27599; e-mail, cindy_feltner@med.unc.edu.

Current author addresses and author contributions are available at www.annals.org.

References


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Mr. Coker-Schwimmer and Dr. Middleton: RTI-UNC Evidence-based Practice Center, Cecil G. Sheps Center for Health Services Research, University of North Carolina at Chapel Hill, CB 7590, Chapel Hill, NC 27599.

Dr. Lohr: RTI International, 3040 Cornwallis Road, PO Box 12194, Research Triangle Park, NC 27709.

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Provision of study materials or patients: Z.J. Zheng.


Obtaining of funding: D.E. Jonas.


**Web-Only Reference**


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**Appendix Table 1. Scope and Key Questions**

<table>
<thead>
<tr>
<th>Key Question</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Among adults who have been admitted for heart failure, do transitional care interventions increase or decrease the following health care utilization rates? a. Readmission rates b. Emergency department visits c. Acute care visits d. Hospital days (of subsequent readmissions)</td>
</tr>
<tr>
<td>2</td>
<td>Among adults who have been admitted for heart failure, do transitional care interventions increase or decrease the following health and social outcomes? a. Mortality rate b. Functional status c. Quality of life d. Caregiver burden e. Self-care burden</td>
</tr>
<tr>
<td>3</td>
<td>a. What are the components of effective interventions? b. Among effective interventions, are particular components necessary? c. Among multicomponent interventions, do particular components add benefit?</td>
</tr>
<tr>
<td>4</td>
<td>a. Does the effectiveness of interventions differ on the basis of intensity (e.g., duration, frequency, or periodicity) of the interventions? b. Does the effectiveness of interventions differ on the basis of delivery personnel (e.g., nurse or pharmacist)? c. Does the effectiveness of interventions differ on the basis of method of communication (e.g., face-to-face, telephone, or Internet)?</td>
</tr>
<tr>
<td>5</td>
<td>Do transitional care interventions differ in effectiveness or harms for subgroups of patients based on age, sex, race, ethnicity, disease severity (left ventricular ejection fraction or New York Heart Association classification), coexisting conditions, or socioeconomic status?</td>
</tr>
</tbody>
</table>

* In the article, we present our findings from only key questions 1a and 2a. We also describe our findings from key question 4a only when we found evidence that efficacy of interventions differed on the basis of intensity.
### Appendix Table 2. Inclusion and Exclusion Criteria for Studies of Transitional Care Interventions for Patients Hospitalized for HF

<table>
<thead>
<tr>
<th>Category</th>
<th>Inclusion Criteria</th>
<th>Exclusion Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Population</strong></td>
<td>Adults (aged ≥18 y) with HF requiring inpatient admission Recruited during or immediately after an index hospitalization for HF*</td>
<td>Children and adolescents aged &lt;18 y</td>
</tr>
<tr>
<td><strong>Interventions</strong></td>
<td>Any transitional care interventions aimed at reducing readmissions, including ≥1 of the following components: Education to patient or caregiver (or both), delivered before or after discharge (or both) Discharge planning Appointment scheduling before discharge Increased planned or scheduled outpatient clinic visits (primary care, multidisciplinary HF) Home visits Telemonitoring (including remote clinical visits) Telephone support Transition coach or case management Interventions to increase provider continuity (same provider between inpatient and outpatient care)</td>
<td>NT-proBNP–guided therapy Pharmacotherapy (e.g., randomized trials of medication compared with placebo) Physician training (e.g., continuing medical education on evidence-based treatment for management of patients with HF) Surgical interventions or invasive procedures (e.g., left ventricular assist device, ultrafiltration, or dialysis) Technology aimed at guiding evaluation of patient volume status (e.g., pulmonary artery pressure sensor or segmental multifrequency bioelectrical impedance analysis) Hospital-at-home interventions</td>
</tr>
<tr>
<td><strong>Comparators</strong></td>
<td>Usual care, routine care, or standard care (as defined by the primary studies) Comparison of 1 intervention with another eligible one</td>
<td>Comparison of one intervention with an excluded one</td>
</tr>
<tr>
<td><strong>Outcomes</strong></td>
<td>KQ1: Readmission rates or the composite outcome (all-cause readmission or death), emergency department visits, acute care visits, or all-cause hospital days (of subsequent readmissions) KQ2: Mortality, quality of life, functional status, caregiver or self-care burden KQ3: All-cause readmissions, mortality, and the composite outcome (all-cause readmission or death) KQ4: All-cause readmission and mortality KQ5: Subgroups: any outcome eligible for KQ1 or KQ2</td>
<td>Trials that reported only an eligible quality-of-life or functional status outcome (and no readmission or mortality rate) were excluded from the analysis unless they accompanied a trial that measured readmission rates. Other composite end points (e.g., all-cause readmission or emergency department visits) were excluded.</td>
</tr>
<tr>
<td><strong>Timing of outcome measurement</strong></td>
<td>Outcomes (readmissions, deaths, or other outcomes) occurring ≤6 mo from the index hospitalization</td>
<td>Outcomes measured any time after 6 mo</td>
</tr>
<tr>
<td><strong>Length of follow-up</strong></td>
<td>≥30 d</td>
<td>&lt;30 d</td>
</tr>
<tr>
<td><strong>Settings</strong></td>
<td>Studies published from 1990 to 29 October 2013</td>
<td>Studies published before 1990</td>
</tr>
<tr>
<td><strong>Publication language</strong></td>
<td>English</td>
<td>Other</td>
</tr>
<tr>
<td><strong>Admissible evidence</strong></td>
<td>Original research Eligible study designs included the following: For all KQs: randomized, controlled trials For caregiver burden and self-care burden: nonrandomized, controlled trials or prospective cohort studies with an eligible comparison group</td>
<td>Case series Case reports Nonsystematic reviews Systematic reviews Editorials Letters to the editor Case-control studies Retrospective cohort studies Studies with historical, rather than concurrent, control groups</td>
</tr>
</tbody>
</table>

HF = heart failure; KQ = key question; NT-proBNP = N-terminal pro-B-type natriuretic peptide; PICOTS = populations, interventions, comparators, outcomes, timing, and setting.

* During data abstraction, we required samples to have been recruited during or within 1 wk of an index hospitalization. If the study authors did not report this clearly, we contacted them to obtain additional information. When we could not verify whether the majority of the sample had been recruited during this period, we excluded the study.

† We did not consider results presented only in figures (e.g., Kaplan–Meier curves) to be eligible for inclusion when the investigators did not clearly report results for an eligible outcome timing (readmission rate ≥6 mo from the index hospitalization).

‡ Eligible quality-of-life and functional status measures included the Minnesota Living With Heart Failure Questionnaire, the Quality of Life Index–Cardiac Version, the Kansas City Cardiomyopathy Questionnaire, the 6-min walk test, change in the New York Heart Association classification from baseline, the Short Form-36, the Short Form-12, and EQ-5D.
Appendix Figure 1. Summary of evidence search and selection.

Records found in database after duplicates removed (n = 2280)
  MEDLINE: 1670
  CINAHL: 135
  Cochrane Library: 475

Additional records identified through other sources (n = 139)
  Hand-searches of references: 139
  Gray literature: 0

Records after duplicates removed (n = 2419)

Records screened (n = 2419)

Records excluded (n = 2017)

Full-text articles assessed for eligibility (n = 402)

Full-text articles excluded (n = 349)
  Publication type: 41
  Design: 62
  Population: 145
  No intervention: 30
  Comparator: 4
  Outcomes: 33
  Timing: 34

Studies included in qualitative synthesis of systematic review (n = 47 [53 articles])

Studies included in quantitative synthesis of systematic review (n = 45)
### Appendix Table 3. Characteristics of Included Trials

<table>
<thead>
<tr>
<th>Study, Year (Reference)</th>
<th>Country</th>
<th>Setting</th>
<th>Intervention Group: Participants, n</th>
<th>Comparator Group: Participants, n</th>
<th>Intensity</th>
<th>Timing, mo*</th>
<th>Baseline NYHA Class</th>
<th>Mean EF</th>
<th>Age, y</th>
<th>Female, %</th>
<th>Nonwhite, %</th>
<th>Medication at Discharge, %</th>
<th>Coexisting Conditions, %</th>
<th>Risk of Bias</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albert et al, 2007 (64)</td>
<td>United States</td>
<td>Single-center</td>
<td>PE; 37 UC; 39</td>
<td>Low 3</td>
<td>–</td>
<td>EF &lt;0.40; 100%</td>
<td>60</td>
<td>23</td>
<td>17</td>
<td>ACEI or ARB: 88 BB: 56</td>
<td>DM: 33 CAD: 66 AF: 45 MI: 37</td>
<td>High</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aldamiz-Echevarría Iraúrgui et al, 2007 (29)</td>
<td>Spain</td>
<td>Single-center</td>
<td>HVP; 137 UC; 142</td>
<td>High 6</td>
<td>–</td>
<td>0.50</td>
<td>76</td>
<td>61</td>
<td>NR</td>
<td>ACEI or ARB: 84 BB: 12</td>
<td>DM: 36 IHD: 30.9 AF: 49.6</td>
<td>Medium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angermann et al, 2012 (38)</td>
<td>Germany</td>
<td>Multicenter</td>
<td>STS; 352 UC; 363</td>
<td>High 6</td>
<td>III or IV: 40%</td>
<td>0.30</td>
<td>69</td>
<td>29</td>
<td>NR</td>
<td>ACEI or ARB: 88 BB: 80</td>
<td>DM: 36 CAD: 58 AF: 29 COPD: 19</td>
<td>Medium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barth, 2001 (34)</td>
<td>United States</td>
<td>Single-center</td>
<td>STS; 17 UC; 17</td>
<td>Low 2</td>
<td>NR</td>
<td>NR</td>
<td>75</td>
<td>53</td>
<td>NR</td>
<td>NR</td>
<td>DM: 33 Other CD: 68</td>
<td>Medium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benatar et al, 2003 (19)</td>
<td>United States</td>
<td>Multicenter</td>
<td>HVP; 108 TM; 108</td>
<td>Medium 6</td>
<td>Mean: 3.1</td>
<td>0.38</td>
<td>63</td>
<td>63</td>
<td>93</td>
<td>ACEI or ARB: 76 BB: 53</td>
<td>DM: 23 CAD or other CD: 61</td>
<td>Undear</td>
<td></td>
<td></td>
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<tr>
<td>López Cabezas et al, 2006 (44)</td>
<td>Spain</td>
<td>Multicenter</td>
<td>STS; 70 UC; 64</td>
<td>Medium 2.6</td>
<td>III or IV: 10%</td>
<td>0.51</td>
<td>75</td>
<td>56</td>
<td>NR</td>
<td>ACEI or ARB: 88 BB: 56</td>
<td>DM: 34 MI: 20</td>
<td>Medium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dar et al, 2009 (49)</td>
<td>United Kingdom</td>
<td>Multicenter</td>
<td>TM; 91 UC; 91</td>
<td>High 6</td>
<td>–</td>
<td>EF ≥0.40; 39%</td>
<td>72</td>
<td>34</td>
<td>20 (South Asian)</td>
<td>ACEI or ARB: 88 BB: 56</td>
<td>DM: 36 CAD: 55 Prior MI: 48 COPD: 91</td>
<td>Medium</td>
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<tr>
<td>Davis et al, 2012 (67)</td>
<td>United States</td>
<td>Single-center</td>
<td>CT; 63 UC; 62</td>
<td>Medium 1</td>
<td>III or IV: 53%</td>
<td>0.34</td>
<td>59</td>
<td>53</td>
<td>69</td>
<td>NR</td>
<td>DM: 28 AF: 26 COPD: 22 MCI: 100</td>
<td>Medium</td>
<td></td>
<td></td>
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<tr>
<td>Dendale et al, 2011 (39)</td>
<td>Brazil</td>
<td>Single-center</td>
<td>STS; 48 UC; 63</td>
<td>Low 3</td>
<td>–</td>
<td>LVEF: 0.29</td>
<td>63</td>
<td>32</td>
<td>19</td>
<td>NR</td>
<td>NR</td>
<td>Medium</td>
<td></td>
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</tr>
<tr>
<td>Duzgunes et al, 2011 (31)</td>
<td>Canada</td>
<td>Single-center</td>
<td>CB (MDS-HF); 115 UC; 115</td>
<td>High 6</td>
<td>III or IV: 91%</td>
<td>0.35</td>
<td>69</td>
<td>28</td>
<td>NR</td>
<td>ACEI or ARB: 80 BB: 43</td>
<td>DM: 30 CAD: 66 Prior MI: 50</td>
<td>Low</td>
<td></td>
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<tr>
<td>Duffy et al, 2010 (45)</td>
<td>United States</td>
<td>Multicenter</td>
<td>STS; 15 UC; 174</td>
<td>Medium 6</td>
<td>NR</td>
<td>NR</td>
<td>81</td>
<td>59</td>
<td>355</td>
<td>NR</td>
<td>NR</td>
<td>High</td>
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<tr>
<td>Duran et al, 2006 (40)</td>
<td>United States</td>
<td>Single-center</td>
<td>STS; 76 UC; 75</td>
<td>High 6</td>
<td>III or IV: 80%</td>
<td>EF &lt;0.40; 58%</td>
<td>70</td>
<td>56</td>
<td>56</td>
<td>ACEI or ARB: 71 BB: NR</td>
<td>NR</td>
<td>Medium</td>
<td></td>
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<tr>
<td>Ekman et al, 1998 (53)</td>
<td>Sweden</td>
<td>Single-center</td>
<td>CB (nurse-led); 29 UC; 79</td>
<td>Medium 6</td>
<td>Mean: 3.2</td>
<td>0.41</td>
<td>80</td>
<td>42</td>
<td>NR</td>
<td>ACEI or ARB: 37 BB: 30</td>
<td>DM: 28 AF: 41 Prior MI: 45</td>
<td>Medium</td>
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<tr>
<td>Holland et al, 2007 (12)</td>
<td>United Kingdom</td>
<td>Multicenter</td>
<td>HVP; 148 UC; 143</td>
<td>Medium 6</td>
<td>III or IV: 67%</td>
<td>–</td>
<td>77</td>
<td>36</td>
<td>NR</td>
<td>ACEI or ARB: 77 BB: 39</td>
<td>DM: 30</td>
<td>Medium</td>
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<tr>
<td>Jaarsma et al, 1999 (20)</td>
<td>The Netherlands</td>
<td>Single-center</td>
<td>HVP; 84 UC; 95</td>
<td>Medium 1.3</td>
<td>III or IV: 100%</td>
<td>LVEF: 0.34</td>
<td>73</td>
<td>42</td>
<td>NR</td>
<td>ACEI or ARB: 70 BB: NR</td>
<td>DM: 27</td>
<td>Medium</td>
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<tr>
<td>Jerant et al, 2001 (18); Jerant et al, 2003 (51)</td>
<td>United States</td>
<td>Multicenter</td>
<td>STS; 12 UC; 12 TM; 13</td>
<td>Medium 6</td>
<td>III or IV: 35%</td>
<td>–</td>
<td>70</td>
<td>54</td>
<td>51</td>
<td>ACEI or ARB: 68 BB: 38</td>
<td>DM: 20</td>
<td>High</td>
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<tr>
<td>Kasper et al, 2002 (57)</td>
<td>United States</td>
<td>Multicenter</td>
<td>CB (MDS-HF); 102 UC; 98</td>
<td>High 6</td>
<td>III: 99% (no patients with class IV)</td>
<td>EF &lt;0.45; 88%</td>
<td>64</td>
<td>40</td>
<td>35</td>
<td>ACEI or ARB: 86 BB: 39</td>
<td>DM: 40</td>
<td>Low</td>
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<tr>
<td>Kimmeistel et al, 2004 (26)</td>
<td>United States</td>
<td>Multicenter</td>
<td>HVP; 97 UC; 103</td>
<td>Medium 3</td>
<td>II or III: 97%</td>
<td>–</td>
<td>72</td>
<td>42</td>
<td>NR</td>
<td>ACEI or ARB: 92 BB: 57</td>
<td>DM: 48</td>
<td>Medium</td>
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</tr>
</tbody>
</table>

Continued on following page.
# Appendix Table 3—Continued

<table>
<thead>
<tr>
<th>Study, Year (Reference)</th>
<th>Country</th>
<th>Setting</th>
<th>Intervention Group: Participants, n</th>
<th>Comparator Group: Participants, n</th>
<th>Intensity</th>
<th>Timing, mo*</th>
<th>Baseline NYHA Class</th>
<th>Mean EF</th>
<th>Age, y</th>
<th>Female, %</th>
<th>Nonwhite, %</th>
<th>Medication at Discharge, %</th>
<th>Consisting Conditions, %</th>
<th>Risk of Bias</th>
</tr>
</thead>
<tbody>
<tr>
<td>Koelling et al, 2005 (62)</td>
<td>United States</td>
<td>Single-center</td>
<td>PE: 107 UC: 116 Low 6 – 0.27</td>
<td>65 42 22</td>
<td>ACEI or alternative: 61</td>
<td>BB: 55</td>
<td>CAD: 64</td>
<td>Low</td>
<td></td>
<td></td>
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<tr>
<td>Lasamee et al, 2003 (37)</td>
<td>United States</td>
<td>Single-center</td>
<td>STS: 141 UC: 146 High 2 III or IV: 35% –</td>
<td>70 46</td>
<td>NR</td>
<td>ACEI or ARB: 82</td>
<td>BB: 63</td>
<td>DM: 43</td>
<td>Prior MI: 42</td>
<td>IHD: 71</td>
<td>Medium</td>
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<tr>
<td>Linnée and Lidhölm, 2006 (63)</td>
<td>Sweden</td>
<td>Multicenter</td>
<td>PE: 122 UC: 108 Low 6 –</td>
<td>70 29</td>
<td>NR</td>
<td>ACEI or ARB: 80</td>
<td>BB: 49</td>
<td>NR</td>
<td>Undear</td>
<td></td>
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<tr>
<td>Liu et al, 2012 (60)</td>
<td>Taiwan</td>
<td>Single-center</td>
<td>CB (MDS-HF): 53 UC: 53 High 6 III or IV: 62%</td>
<td>61 35 100</td>
<td>ACEI or ARB: 40</td>
<td>BB: 69</td>
<td>DM: 46</td>
<td>Low</td>
<td></td>
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<tr>
<td>McDonald et al, 2001 (54); McDonald et al, 2002 (55); Ledwidge et al, 2003 (56)</td>
<td>Ireland</td>
<td>Single-center</td>
<td>CB (MDS-HF): 51 at 3 mo; 35 at 30 d¶</td>
<td>63%¶</td>
<td>71¶ 34¶ NR</td>
<td>ACEI or ARB: 61</td>
<td>BB: NR</td>
<td>NR</td>
<td>Undear</td>
<td></td>
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<tr>
<td>Oddone et al, 1999 (61)</td>
<td>United States</td>
<td>Multicenter</td>
<td>CB (primary care): 222 UC: 221 Medium 6 III or IV: 53% –</td>
<td>65 1</td>
<td>34</td>
<td>ACEI or ARB: 74</td>
<td>BB: 12</td>
<td>NR</td>
<td>Medium</td>
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<tr>
<td>Pekmezaris et al, 2012 (50)</td>
<td>United States</td>
<td>Multicenter</td>
<td>TM; 83 UC: 85** Medium 1, 3 NR</td>
<td>82 62</td>
<td>9</td>
<td>NR</td>
<td>Medium</td>
<td></td>
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<tr>
<td>Pugh et al, 2001 (25)</td>
<td>United States</td>
<td>Multicenter</td>
<td>HVP: 27 UC: 31 Medium 6 III or IV: 51% –</td>
<td>74 57</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>High</td>
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</tr>
<tr>
<td>Rainville, 1999 (42)</td>
<td>United States</td>
<td>Single-center</td>
<td>STS: 17 UC: 17 Medium 6 III or IV: 85% –</td>
<td>70 50</td>
<td>NR</td>
<td>ACEI or ARB: 88</td>
<td>BB: 44</td>
<td>NR</td>
<td>Medium</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riegel et al, 2002 (35)</td>
<td>United States</td>
<td>Multicenter</td>
<td>STS: 130 UC: 228 Medium 3, 6 III or IV: 97% 0.43</td>
<td>72 51</td>
<td>NR</td>
<td>ACEI or ARB: 54</td>
<td>BB: 17</td>
<td>DM: 42</td>
<td>CAD: 65</td>
<td>AF: 24</td>
<td>COPD: 36</td>
<td>Medium</td>
<td></td>
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</tr>
<tr>
<td>Riegel and Carlson, 2004 (66)</td>
<td>United States</td>
<td>Multicenter</td>
<td>PS: 45 UC: 43 Medium 1, 3 III or IV: 64% 0.46</td>
<td>73 58</td>
<td>NR</td>
<td>NR</td>
<td>DM: 46</td>
<td>Prior MI: 35</td>
<td>COPD: 25</td>
<td>High</td>
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<tr>
<td>Riegel et al, 2006 (36)</td>
<td>United States</td>
<td>Multicenter</td>
<td>STS: 69 UC: 65 Medium 1, 3, 6 III or IV: 81% EF</td>
<td>72 54</td>
<td>100</td>
<td>ACEI or ARB: 75</td>
<td>BB: 54</td>
<td>DM: 59</td>
<td>IHD: 44</td>
<td>M1: 28</td>
<td>AF: 17</td>
<td>Medium</td>
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<tr>
<td>Schwarz et al, 2008 (47)</td>
<td>United States</td>
<td>Single-center</td>
<td>HVP: 142 UC: 51 Medium 3 III or IV: 79% –</td>
<td>78 52</td>
<td>19</td>
<td>NR</td>
<td>Medium</td>
<td>Continued on following page</td>
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<tr>
<td>Study, Year (Reference)</td>
<td>Country</td>
<td>Setting</td>
<td>Intervention Group Participants, n</td>
<td>Comparator Group Participants, n</td>
<td>Intensity</td>
<td>Timing, mo*</td>
<td>Baseline NYHA Class</td>
<td>Mean EF</td>
<td>Age, y</td>
<td>Female, %</td>
<td>Race, %</td>
<td>Medication at Discharge, %</td>
<td>Coexisting Conditions, %</td>
<td>Risk of Bias</td>
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<tr>
<td>Sethares and Elliott,</td>
<td>United States</td>
<td>Single-center</td>
<td>HVP; 142 UC; 37</td>
<td>Medium</td>
<td>3</td>
<td>Mean: 3</td>
<td>–</td>
<td>0.40</td>
<td>76</td>
<td>53</td>
<td>8.5</td>
<td>ACEI or ARB: 61 BB: 49</td>
<td>NR</td>
<td>High</td>
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<td>2004 (21)</td>
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<tr>
<td>Stewart et al,</td>
<td>Australia</td>
<td>Single-center</td>
<td>HVP; 142 UC; 100</td>
<td>Medium</td>
<td>6</td>
<td>III or IV: 56%</td>
<td>0.37</td>
<td>76</td>
<td>38</td>
<td>NR</td>
<td>ACEI or ARB: 82 BB: 59</td>
<td>DM: 34 IHD: 78 AF: 35</td>
<td>Medium</td>
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<tr>
<td>1999 (23)</td>
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<tr>
<td>Strömberg et al, 2003 (58)</td>
<td>Sweden</td>
<td>Multi center</td>
<td>CB (nurse-led); 52 UC; 54</td>
<td>Medium</td>
<td>3</td>
<td>III or IV: 82%</td>
<td>–</td>
<td>78</td>
<td>39</td>
<td>NR</td>
<td>ACEI or ARB: 82 BB: 59</td>
<td>DM: 24 IHD: 68</td>
<td>Low</td>
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<tr>
<td>Thompson et al, 2005 (33)</td>
<td>United Kingdom</td>
<td>Multi center</td>
<td>HVP; 58 UC; 48</td>
<td>High</td>
<td>6</td>
<td>III or IV: 40%</td>
<td>0.30</td>
<td>73</td>
<td>28</td>
<td>NR</td>
<td>ACEI or ARB: 69 BB: 18</td>
<td>DM: 21 MI: 52 AF: 30 CA: 24</td>
<td>High</td>
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<tr>
<td>Triller and Hamilton,</td>
<td>United States</td>
<td>Multi center</td>
<td>HVP; 77 UC††; 77</td>
<td>Medium</td>
<td>6</td>
<td>NR</td>
<td>NR</td>
<td>80</td>
<td>72</td>
<td>7</td>
<td>NR</td>
<td>ACEI or ARB: 47 BB: 62</td>
<td>NR</td>
<td>Undear</td>
</tr>
<tr>
<td>2007 (22)</td>
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<tr>
<td>Tsuyuki et al, 2004 (28)</td>
<td>Canada</td>
<td>Multi center</td>
<td>STS: 140 UC; 136</td>
<td>High</td>
<td>6</td>
<td>III or IV: 37%</td>
<td>0.315</td>
<td>72</td>
<td>20</td>
<td>NR</td>
<td>ACEI or ARB: 85 BB: 43</td>
<td>NR</td>
<td>Medium</td>
<td></td>
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<tr>
<td>Wakefield et al, 2008 (41); Wakefield et al, 2009 (73)</td>
<td>United States</td>
<td>Multi center (VAMC)</td>
<td>STS: 47 UC; 52 VP: 52</td>
<td>Medium</td>
<td>6</td>
<td>III or IV: 72%</td>
<td>0.41</td>
<td>69</td>
<td>1</td>
<td>6</td>
<td>NR</td>
<td>NR</td>
<td>High</td>
<td></td>
</tr>
</tbody>
</table>

ACEI = angiotensin-converting enzyme inhibitor; AF = atrial fibrillation; ARB = angiotensin II–receptor blocker; BB = β-blocker; CAD = coronary artery disease; CB = clinic-based; CD = cardiac disorder; COPD = chronic obstructive pulmonary disease; CT = cognitive training; DM = diabetes mellitus; EF = ejection fraction; HF = heart failure; HVP = home-visiting program; IHD = ischemic heart disease; LVEF = left ventricular ejection fraction; MCI = mild cognitive impairment; MDS = multidisciplinary; MI = myocardial infarction; NR = not reported; NYHA = New York Heart Association; PD = pulmonary disease; PE = primarily educational; PS = peer support; STS = structured telephone support; TM = telemonitoring; UC = usual care; VAMC = Veterans Affairs medical center; VP = videophone.

* Timing of readmission outcome.
† From 168 patients (92% of total sample).
‡ Both groups also received home health care co-intervention that included home nursing visits.
§ Authors reported that >35% of participants were members of minority groups but did not provide exact numbers.
¶ From 99 patients (63% of total sample).
‖ Data are from reference 67; percentages vary slightly from those presented in companion studies (66, 68).
** Both groups received home health care, including home nursing visits (42).
†† Study compared pharmacist home visits among a sample of patients receiving home nursing visits.
Appendix Figure 2. HF readmissions for transitional care interventions compared with usual care, by intervention category and outcome timing.

<table>
<thead>
<tr>
<th>Study, Year (Reference)</th>
<th>Treatment, n</th>
<th>Usual Care, n</th>
<th>RR (95% CI)</th>
<th>Weight, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home-visiting program, 3 mo</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rich et al, 1995 (30)</td>
<td>142 (20)</td>
<td>140 (39)</td>
<td>0.51 (0.31–0.82)</td>
<td>100.00</td>
</tr>
<tr>
<td>Structured telephone support, 30 d</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riegel et al, 2008 (36)</td>
<td>69 (6)</td>
<td>65 (9)</td>
<td>0.63 (0.24–1.67)</td>
<td>100.00</td>
</tr>
<tr>
<td>Structured telephone support, 3–6 mo</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rainville, 1999 (42)</td>
<td>17 (4)</td>
<td>17 (7)</td>
<td>0.57 (0.20–1.60)</td>
<td>3.56</td>
</tr>
<tr>
<td>Riegel et al, 2002 (35)</td>
<td>130 (23)</td>
<td>228 (63)</td>
<td>0.64 (0.42–0.98)</td>
<td>20.75</td>
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<tr>
<td>Laramee et al, 2003 (37)</td>
<td>141 (18)</td>
<td>146 (21)</td>
<td>0.89 (0.49–1.59)</td>
<td>10.99</td>
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<tr>
<td>Dunagan et al, 2005 (40)</td>
<td>76 (23)</td>
<td>75 (35)</td>
<td>0.65 (0.43–0.99)</td>
<td>21.53</td>
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<tr>
<td>Riegel et al, 2006 (36)</td>
<td>69 (22)</td>
<td>65 (22)</td>
<td>0.94 (0.58–1.53)</td>
<td>16.07</td>
</tr>
<tr>
<td>Domingues et al, 2011 (39)</td>
<td>48 (6)</td>
<td>63 (13)</td>
<td>0.61 (0.25–1.48)</td>
<td>4.74</td>
</tr>
<tr>
<td>Angermann et al, 2012 (38)</td>
<td>352 (36)</td>
<td>363 (46)</td>
<td>0.81 (0.54–1.22)</td>
<td>22.34</td>
</tr>
<tr>
<td>Subtotal (I² = 0.0%; P = 0.84)</td>
<td></td>
<td></td>
<td>0.74 (0.61–0.90)</td>
<td>100.00</td>
</tr>
<tr>
<td>Telemonitoring, 6 mo</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Dar et al, 2009 (49)</td>
<td>91 (17)</td>
<td>91 (10)</td>
<td>1.70 (0.82–3.51)</td>
<td>100.00</td>
</tr>
<tr>
<td>Clinic-based (MDS-HF), 6 mo</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liu et al, 2012 (60)</td>
<td>53 (7)</td>
<td>53 (10)</td>
<td>0.70 (0.29–1.70)</td>
<td>100.00</td>
</tr>
<tr>
<td>Clinic-based (nurse-led), 6 mo</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ekman et al, 1998 (33)</td>
<td>79 (36)</td>
<td>79 (38)</td>
<td>0.95 (0.68–1.32)</td>
<td>100.00</td>
</tr>
<tr>
<td>Primarily educational, 3 mo</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Koelling et al, 2005 (62)</td>
<td>107 (16)</td>
<td>116 (33)</td>
<td>0.53 (0.31–0.90)</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Weights are from random-effects analysis. HF = heart failure; MDS = multidisciplinary; RR = risk ratio.
### Appendix Figure 3. Composite all-cause readmission or mortality for transitional care interventions compared with usual care, by intervention category and outcome timing.

<table>
<thead>
<tr>
<th>Study, Year (Reference)</th>
<th>Treatment, n</th>
<th>Usual Care, n</th>
<th>RR (95% CI)</th>
<th>Weight, %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Events</td>
<td>Total</td>
<td>Events</td>
</tr>
<tr>
<td><strong>Home-visiting program, 6 mo</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jaarsma et al, 1999 (20)</td>
<td>100</td>
<td>49</td>
<td>100</td>
<td>62</td>
</tr>
<tr>
<td>Thompson et al, 2005 (33)</td>
<td>58</td>
<td>15</td>
<td>48</td>
<td>21</td>
</tr>
<tr>
<td>Aldamiz-Echevarría Iraúrregui et al, 2007 (29)</td>
<td>137</td>
<td>42</td>
<td>142</td>
<td>51</td>
</tr>
<tr>
<td><strong>Subtotal (I² = 0.0%; P = 0.52)</strong></td>
<td>365</td>
<td>106</td>
<td>394</td>
<td>164</td>
</tr>
<tr>
<td><strong>Structured telephone support, 3–6 mo</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dunagan et al, 2005 (40)</td>
<td>76</td>
<td>30</td>
<td>75</td>
<td>51</td>
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<tr>
<td>Domingues et al, 2011 (39)</td>
<td>48</td>
<td>22</td>
<td>63</td>
<td>32</td>
</tr>
<tr>
<td>Angermann et al, 2012 (38)</td>
<td>352</td>
<td>130</td>
<td>363</td>
<td>138</td>
</tr>
<tr>
<td><strong>Clinic-based (MDS-HF), 6 mo</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Kasper et al, 2002 (57)</td>
<td>102</td>
<td>47</td>
<td>98</td>
<td>55</td>
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<tr>
<td>Liu et al, 2012 (60)</td>
<td>53</td>
<td>16</td>
<td>53</td>
<td>22</td>
</tr>
<tr>
<td><strong>Subtotal (P = 0.0%; P = 0.68)</strong></td>
<td>255</td>
<td>89</td>
<td>251</td>
<td>77</td>
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<tr>
<td><strong>Clinic-based (nurse-led), 3 mo</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strömberg et al, 2003 (58)</td>
<td>52</td>
<td>19</td>
<td>54</td>
<td>30</td>
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<td><strong>Primarily educational, 6 mo</strong></td>
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<tr>
<td>Koelling et al, 2005 (62)</td>
<td>107</td>
<td>50</td>
<td>116</td>
<td>74</td>
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<tr>
<td>Nucifora et al, 2006 (65)</td>
<td>99</td>
<td>53</td>
<td>101</td>
<td>46</td>
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</tbody>
</table>

Weights are from random-effects analysis. MDS-HF = multidisciplinary heart failure; RR = risk ratio.