Interventions to Reduce 30-Day Rehospitalization: A Systematic Review

Luke O. Hansen, MD, MHS; Robert S. Young, MD, MS; Keiki Hinami, MD, MS; Alicia Leung, MD; and Mark V. Williams, MD

Background: About 1 in 5 Medicare fee-for-service patients discharged from the hospital is rehospitalized within 30 days. Beginning in 2013, hospitals with high risk-standardized readmission rates will be subject to a Medicare reimbursement penalty.

Purpose: To describe interventions evaluated in studies aimed at reducing rehospitalization within 30 days of discharge.

Data Sources: MEDLINE, EMBASE, Web of Science, and the Cochrane Library were searched for reports published between January 1975 and January 2011.

Study Selection: English-language randomized, controlled trials; cohort studies; or noncontrolled before–after studies of interventions to reduce rehospitalization that reported rehospitalization rates within 30 days.

Data Extraction: 2 reviewers independently identified candidate articles from the results of the initial search on the basis of title and abstract. Two 2-physician reviewer teams reviewed the full text of candidate articles to identify interventions and assess study quality.

Data Synthesis: 43 articles were identified, and a taxonomy was developed to categorize interventions into 3 domains that encompassed 12 distinct activities. Predischarge interventions included patient education, medication reconciliation, discharge planning, and scheduling of a follow-up appointment before discharge. Postdischarge interventions included follow-up telephone calls, patient-activated hotlines, timely communication with ambulatory providers, timely ambulatory provider follow-up, and postdischarge home visits. Bridging interventions included transition coaches, physician continuity across the inpatient and outpatient setting, and patient-centered discharge instruction.

Limitations: Inadequate description of individual studies' interventions precluded meta-analysis of effects. Many studies identified in the review were single-institution assessments of quality improvement activities rather than those with experimental designs. Several common interventions have not been studied outside of multicomponent "discharge bundles."

Conclusion: No single intervention implemented alone was regularly associated with reduced risk for 30-day rehospitalization.

Primary Funding Source: None.

Ann Intern Med. 2011;155:520-528. www.annals.org
For author affiliations, see end of text.

Among Medicare fee-for-service patients discharged from the hospital, 19.6% are rehospitalized within 30 days (1). The Medicare Payment Advisory Commission has estimated that three quarters of such rehospitalizations may be avoidable and annually account for $12 billion in excess health care costs (2). Others have estimated total hospital costs at $44 billion per year for rehospitalizations within 30 days of hospital discharge (3). The Patient Protection and Affordable Care Act designates reduction of avoidable rehospitalization as a target for health care cost savings and authorizes lower payments to hospitals with high risk-standardized rates of readmission. Reducing readmission rates may be facilitated by a provision of the legislation (section 3026 of HR 3590) that provides $500 million for the Centers for Medicare & Medicaid Services to fund the Community-based Care Transitions Program (4). This initiative aims to help organizations implement evidence-based interventions that reduce hospital readmission among high-risk Medicare beneficiaries.

See also:

Web-Only
Appendix Table
Conversion of graphics into slides

Parker and colleagues (5) have classified interventions to reduce readmission into 4 categories: discharge planning protocols, comprehensive geriatric assessments, discharge support arrangements, and educational interventions. Although each of these general categories may have unique benefits, efforts to enhance care delivery processes would benefit from a comprehensive inventory of evidence-based components to reduce readmissions within the 30-day window that has become the standard for evaluation of hospital quality. A previous review of hospital utilization did not focus on 30-day readmission and did not provide a taxonomy of interventions to reduce rehospitalization (6).

We identified studies that 1) tested peridischarge process interventions applicable to a general medical adult population by using experimental or observational designs and 2) reported relative readmission outcomes for an intervention and a nonintervention cohort. We developed a taxonomy of interventions used to reduce rehospitalization within 30 days. This review provides an inventory of interventions studied to reduce rehospitalization within 30 days and describes the best published evidence for effectiveness of these interventions.

METHODS

Data Sources

In collaboration with a research librarian, we conducted a systematic search of MEDLINE, EMBASE,

Web of Science, and the Cochrane Library for English-language reports published between January 1975 and 11 January 2011. The MEDLINE search was conducted by using combinations of Medical Subject Heading (MeSH) search terms and keywords according to the following algorithm: ("Hospitalization"[Mesh] OR "Patient Discharge"[Mesh] OR "Patient Readmission"[Mesh] OR readmission[All Fields] OR post discharge[All Fields] OR postdischarge[All Fields]) AND ("Continuity of Patient Care"[Mesh] OR transition*[All Fields] OR co-ordination[All Fields] OR coordination[All Fields])) OR ("patient readmission" [mesh] AND "patient discharge"[mesh]) OR (rehospitali*[title] OR readmi*[title]). Other databases were queried by using identical terms for keyword searching. We also reviewed reference lists from included studies and reviews to identify additional studies, and we consulted experts on transitions of care and hospital readmission to identify further studies.

Study Selection

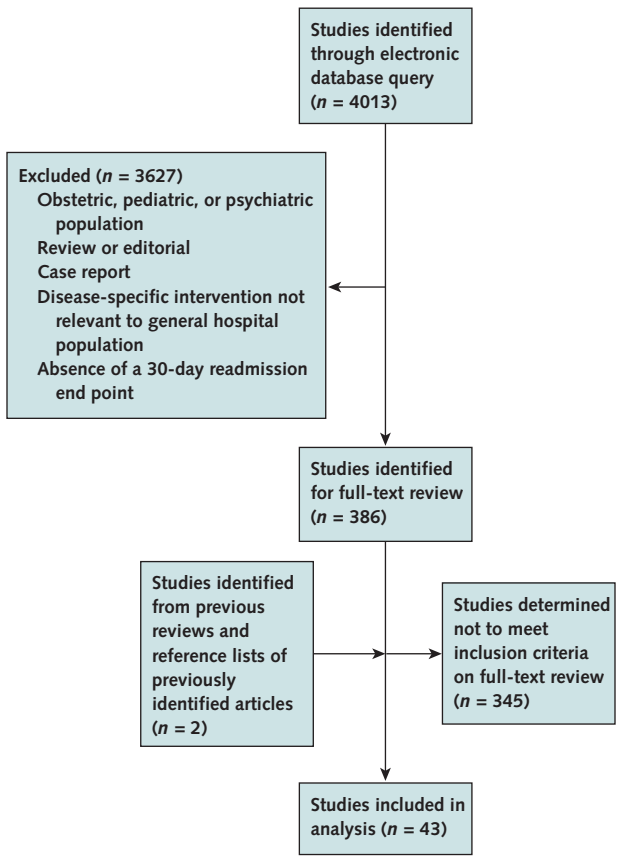
Two reviewers screened studies for eligibility through abstract review. Criteria for full-text review were the following: 1) The objective of the study was to evaluate the effectiveness of specified interventions in reducing rehospitalization; 2) interventions could not require disease-specific approaches (for example, measurement of brain natriuretic peptide before heart failure discharge); and 3) readmission outcomes in an intervention cohort compared with a nonintervention cohort were reported. Both prospective and retrospective designs were included. We limited our search to studies reporting readmission within 30 days because this has become the standard for assessment in national measures (7). Both reviewers screened all abstracts, and all relevant articles identified by them were retained for full-text review. If abstract review did not clearly indicate whether inclusion criteria were met, the article was retained for full-text review. Review articles describing interventions that tested models of care transitions were also included to allow identification of relevant additional articles. We excluded studies of pediatric, obstetric, and psychiatric populations.

The full text of each of these selected articles was independently reviewed by 2 members of a 4-physician team. The previously described inclusion criteria were again applied, and a final set of articles was identified for data extraction. Agreement between members of the 2-person review teams regarding exclusion was good ($\kappa = 0.81$ and 0.71 for respective reviewer pairs). Disagreements regarding inclusion in the final review were resolved through discussion among the entire 4-physician review team.

Data Abstraction and Quality Assessment

We categorized study designs as randomized, controlled; cohort; or noncontrolled before–after designs. The review team used a standardized form adapted from the Cochrane Effective Practice and Organisation of Care (EPOC) Group's Risk of Bias criteria to systematically identify study quality (8). The instrument recorded 9 criteria, including whether studies used random and concealed allocation, documented similar baseline characteristics and outcomes between the intervention and control groups, and described a plan for missing data (including rehospitalization to nonstudy sites), as well as the likelihood of contamination between study groups. Two members of the review team separately assessed each study. Disagreements were resolved by consensus after discussion among the reviewers, and the total criteria met for each study were calculated. For each study included in the final review, an absolute risk reduction between the intervention and nonintervention groups was identified or was calculated if not provided in the original manuscript.

Figure 1. **Summary of evidence search and selection.**



Data Synthesis and Analysis

Because of the overlapping nature of intervention components and the heterogeneity of interventions in the included studies, meta-analysis of interventions was not feasible; a narrative synthesis of components follows. The team assigned categorical descriptions of intervention component types, and these categories were refined in

an iterative manner until a stable inventory of intervention types was reached. Intervention types were then sorted to form a taxonomy of interventions to reduce 30-day rehospitalization.

Role of the Funding Source

This study received no external funding.

RESULTS

Our initial search yielded 4013 reports (**Figure 1**). On the basis of abstract review, 386 of these were identified for full-text review. The 4-physician review group classified 41 articles as meeting the predefined criteria for analysis. Two additional papers were identified from review of the citations in the original 386 manuscripts and previous reviews on the topic found in the electronic database search. Thus, the final set consisted of 43 articles.

Application of the EPOC quality criteria to studies meeting our selection criteria demonstrated several limitations in the available literature. Most studies using random allocation designs (9 of 16) studied an intervention sample of fewer than 100 patients. Studies were more frequently conducted in the setting of natural experiments as institutions piloted quality improvement programs to reduce avoidable hospitalization. Fourteen of the 27 studies using nonrandomized designs reported differences in baseline characteristics potentially relevant to rehospitalization between groups. Most studies in our review (60.5%; $n = 26$) inadequately accounted for missing data or incomplete outcome measurement, such as rehospitalization at sites other than the discharging institution. Failure to account for such rehospitalization has been estimated to miss approximately 20% of events (9). Randomized, controlled trials on average satisfied 5 of 9 possible EPOC quality criteria, and cohort or quasi-experimental studies satisfied 4 criteria on average (**Appendix Table**, available at www.annals.org).

We identified 12 intervention categories (**Figure 2**). Drawing on work by Ashton and Wray (10) and Coleman and colleagues (11), we developed a taxonomy for categorizing individual components of interventions into those that are applied in 1 of 3 temporal categories: predischarge interventions, postdischarge interventions, and interventions active both before and after discharge as a "bridge" across care settings. These bridge interventions provided a longitudinal service, with activity spanning the pre- and postdischarge periods.

Most of the 43 studies (55.8%; $n = 24$) tested a single-component intervention (**Table 1** [12–54]), and of these, only 7 studies were randomized. Twelve studies tested 3 or more interventions as a bundle. Whether in isolation or within a "discharge bundle," the components constituting each study's intervention varied considerably among the studies included in our review. The possibility that interactions among various components in bundles may modify the effectiveness of individual pieces limits isolation of a single component's effect in studies of bundled interventions. In addition, definition of the optimal design of individual interventions is hindered in the current literature by limited descriptions of program detail, likely context heterogeneity, and a small number of studies testing these strategies outside of bundled interventions. Only 4 interventions we identified have been tested in isolation by using randomized designs.

Given these characteristics of the literature, we first present each type of intervention identified, with emphasis on effectiveness as measured in single-intervention randomized trials. We then describe the available randomized trials that have tested bundled in-

Figure 2. **Taxonomy of interventions to reduce 30-day rehospitalization.**

Predischarge Intervention	Postdischarge Intervention
Patient education	Timely follow-up
Discharge planning	Timely PCP communication
Medication reconciliation	Follow-up telephone call
Appointment scheduled before discharge	Patient hotline
	Home visit
Intervention Bridging the Transition	
Transition coach	
Patient-centered discharge instructions	
Provider continuity	

PCP = primary care provider.

Table 1. **Study Characteristics and Absolute Risk Reduction**

Study, Year (Reference)	Population	Setting	Control Group, *n*	Intervention Group, *n*	EPOC Quality Criteria Satisfied (9 Possible), *n*	Absolute Risk Reduction, *percentage points*
Randomized, controlled trials						
Balaban et al, 2008 (12)	Patients with a medical home	USA	49	47	5	−0.3
Braun et al, 2009 (13)	General medicine ward	Israel	156	153	5	0.5
Coleman et al, 2006 (14)	Geriatric	USA	371	379	5	3.6*
Dudas et al, 2001 (15)	General medicine ward	USA	111	110	4	10
Dunn et al, 1994 (16)	Geriatric	United Kingdom	43	16	4	−2
Evans and Hendricks, 1993 (17)	Veterans Affairs; high risk based on admission risk assessment	USA	418	417	4	11.0*
Forster et al, 2005 (18)	General medicine ward	Canada	313	307	5	−7.8 (readmission or death)
Jaarsma et al, 1999 (19)	Heart failure, age >50 y	Netherlands	95	84	5	2
Jack et al, 2009 (20)	Medical/surgical ward	USA	368	370	6	6.0*
Koehler et al, 2009 (21)	Geriatric, high risk	USA	21	20	6	28.1* (readmission or ED visit)
Kwok et al, 2004 (22)	Chronic lung disease, geriatric population	Hong Kong	79	70	6	−10
McDonald et al, 2001 (23)	Heart failure, geriatric	Ireland	35	35	4	0
Naylor et al, 1994 (24)	Cardiac (medical and surgical), geriatric	USA	70 (medical subgroup)	72 (medical subgroup)	5	12.0* (2 weeks, medical DRGs); 4 (surgical DRGs)
Parry et al, 2009 (25)	Geriatric	USA	49	49	7	9.9
Rainville, 1999 (26)	Heart failure	USA	17	17	7	7.1
Wong et al, 2008 (27)	General medicine ward	Hong Kong	166	166	5	2.4
Quasi-experimental and cohort studies						
Ahmed et al, 2004 (28)	General medicine ward	USA	1266	8972	1	23.1*
Anderson et al, 2005 (29)	Heart failure	USA	77	44	3	16*
Azevedo et al, 2002 (30)	Heart failure	Portugal	182	157	3	17.5*
Bostrom et al, 1996 (31)	Medical/surgical ward	USA	474	Patient-initiated: 494; nurse-initiated: 445	3	0.9 (hotline), 1.3 (nurse call)
Coleman et al, 2004 (32)	Geriatric	USA	1235	158	3	4.9*
Creason, 2001 (33)	Heart failure	USA	231	62	4	10.0*
Einstadter et al, 1996 (34)	General medicine ward	USA	229	243	3	−5.4
Gow et al, 1999 (35)	General medicine ward	New Zealand	59	18	3	−1.4
Grafft et al, 2010 (36)	General medicine ward	USA	1952	3037	6	Hazard ratio: 1.03
Harrison et al, 2011 (37)	Medicare Advantage enrollees	USA	19 041	6920	6	0.9*
Hernandez et al, 2010 (38)	Heart failure, geriatric	USA	7081	6581	6	2.4*
Lucas, 1998 (39)	Cardiology population	USA	142	143	3	−2.7
McPhee et al, 1983 (40)	General medicine ward	USA	248	53	4	1
Misky et al, 2010 (41)	General medicine ward	USA	32	33	4	11.7
O'Dell and Kucukarslan, 2005 (42)	Cardiac patients	USA	81	156	4	2.3
Schneider et al, 1993 (43)	Heart failure	USA	28	26	3	20.9
Sharma et al, 2010 (44)	COPD	USA	20 744	42 002	4	2.5*
Sorknaes et al, 2011 (45)	COPD	Denmark	50	50	4	10
Steeman et al, 2006 (46)	Geriatric	Belgium	469	355	6	2.3 (15 d)
van Walraven et al, 2004 (47)	Medical/surgical ward	Canada	276 804	474 971	6	0.7* (30-d readmission or death)
Noncontrolled before–after studies						
Brown and Caplan, 1997 (48)	Chronic lung disease	Australia	395	331	3	8.6
Dai et al, 2003 (49)	Craniotomy and stroke	Taiwan	128	155	2	7.6*
Dedhia et al, 2009 (50)	Geriatric	USA	49	26	4	6.8
Hess et al, 2010 (51)	Post–respiratory failure	USA	151	211	2	2.6
Houghton et al, 1996 (52)	Medical/surgical ward	United Kingdom	215	207	3	0.9
Kramer et al, 2007 (53)	General medicine ward	USA	147	136	4	6.3
Smith, 1995 (54)	Veterans Affairs	USA	Unable to determine	Unable to determine	3	4.4* (10-d readmission rate)

COPD = chronic obstructive pulmonary disease; DRG = diagnosis-related group; ED = emergency department; EPOC = Effective Practice and Organisation of Care; USA = United States.
* Statistically significant results.

Table 2. **Interventions Tested Among Studies Selected**

Study, Year (Reference)	Predischarge Interventions				Postdischarge Interventions		
	Patient Education	Discharge Planning	Medication Reconciliation	Appointment Scheduled Before Discharge	Timely PCP Communication	Timely Clinic Follow-up	Follow-up Telephone Call
Randomized, controlled trials							
Balaban et al, 2008 (12)					√		√
Braun et al, 2009 (13)							√
Coleman et al, 2006 (14)							√
Dudas et al, 2001 (15)							√
Dunn et al, 1994 (16)							
Evans and Hendricks, 1993 (17)		√					
Forster et al, 2005 (18)		√					
Jaarsma et al, 1999 (19)	√						√
Jack et al, 2009 (20)	√	√	√		√		√
Koehler et al, 2009 (21)	√	√	√		√		√
Kwok et al, 2004 (22)							
McDonald et al, 2001 (23)	√						√
Naylor et al, 1994 (24)	√	√					√
Parry et al, 2009 (25)	√		√			√	√
Rainville, 1999 (26)	√						
Wong et al, 2008 (27)							
Quasi-experimental and cohort studies							
Ahmed et al, 2004 (28)	√	√					√
Anderson et al, 2005 (29)	√						√
Azevedo et al, 2002 (30)						√	
Bostrom et al, 1996 (31)							√
Coleman et al, 2004 (32)							√
Creason, 2001 (33)	√						√
Einstadter et al, 1996 (34)		√					
Gow et al, 1999 (35)		√					
Grafft et al, 2010 (36)				√			
Harrison et al, 2011 (37)							√
Hernandez et al, 2010 (38)						√	
Lucas, 1998 (39)			√				
McPhee et al, 1983 (40)	√						
Misky et al, 2010 (41)						√	
O'Dell and Kucukarslan, 2005 (42)	√						
Schneider et al, 1993 (43)	√						
Sharma et al, 2010 (44)						√	
Sorknaes et al, 2011 (45)							√
Steeman et al, 2006 (46)		√					
van Walraven et al, 2004 (47)							
Noncontrolled before–after studies							
Brown and Caplan, 1997 (48)		√					
Dai et al, 2003 (49)	√	√					
Dedhia et al, 2009 (50)		√	√		√		
Hess et al, 2010 (51)					√		
Houghton et al, 1996 (52)		√					
Kramer et al, 2007 (53)			√				
Smith, 1995 (54)							

PCP = primary care provider.

terventions. **Tables 1** and **2** list both experimental and observational studies.

Predischarge Interventions

Predischarge patient education and discharge planning were the most commonly evaluated interventions identified in our review, appearing in 22 of 43 studies. However, as described earlier, heterogeneity of design limited robust characterization of these interventions.

Three papers examined a predischarge intervention in isolation in a randomized fashion. An isolated patient education intervention was tested in a single trial that randomly assigned 34 patients with heart failure and demonstrated a nonsignificant decrease in rehospitalization (26). One randomized trial of discharge planning as a single intervention demonstrated significant benefit (17). A second did not demonstrate significant benefit (18). Medica-

Table 2—Continued

Postdischarge Interventions (continued)		Interventions Bridging the Transition		
Post-discharge Hotline	Home Visit	Transition Coach	Patient-Centered Discharge instructions	Provider Continuity
			✓	
	✓	✓	✓	
	✓			
✓	✓	✓		
			✓	
		✓	✓	
✓	✓			
✓		✓	✓	
	✓	✓	✓	
	✓			
	✓			
✓				
	✓	✓	✓	
✓				
				✓
	✓	✓		
			✓	
				✓

tion reconciliation and the establishment of scheduled follow-up appointments before discharge were not studied as isolated interventions in experimental designs (12, 20, 21, 25, 36, 39, 50, 51, 53). **Table 2** summarizes results of individual observational studies of predischarge interventions, including absolute risk reduction.

Postdischarge Interventions

Postdischarge interventions identified were follow-up telephone calls, patient-activated "hotlines," home visits, timely outpatient follow-up, and timely communication of patient information to an outpatient provider. Follow-up telephone calls to patients after discharge were the most frequently studied type of intervention in the postdischarge setting ($n = 17$). Ten studies described specific call scripts that inquired about new symptoms since discharge, plans for ambulatory follow-up, and access and use of prescription medication. We additionally categorized patient-activated telephone "hotlines" observed in 5 studies (19, 22, 24, 31, 45). Home visits were evaluated in 9 studies (14, 16, 19, 22, 25, 27, 29, 32, 48). Nursing staff conducted home visits in 8 of the 9 studies identified. Postdischarge visits focused on medication adherence, appropriate ambulatory follow-up, and symptom monitoring.

As with predischarge interventions, we identified few isolated randomized trials of postdischarge interventions. Dudas and colleagues randomly assigned 221 patients after discharge to usual care or a telephone call within 48 hours as a single intervention (15). Braun and coworkers randomly assigned 400 patients to a call at 1 week (13). A third randomized trial examined the effect of home visits (16). None of these 3 studies identified a significant benefit.

Timely clinical follow-up and information transfer were examined in several studies. The definition of "timely" clinic follow-up ranged from 1 to 4 weeks (25, 30, 38, 41, 44); 2 studies were restricted to patients with heart failure (30, 38) and 1 to those with chronic lung disease (44). An association between 30-day follow-up in a heart failure specialty clinic and 30-day rehospitalization was described in 1 observational study; however, this trial did not satisfy most of the EPOC criteria, and generalizability to other specialty care sites is unknown (30). Five studies analyzed the effect of timely communication between hospital and ambulatory providers (12, 20, 21, 50, 51). Three of these described electronic transmittal of a clinical summary at the time of discharge, 1 described electronic communication at the time of admission, and 1 described verbal signout between clinicians at the time of discharge. None of the studies testing timely clinical follow-up, timely ambulatory specialty care follow-up, or timely communication of hospital summary were tested as a single intervention in a randomized design, limiting our ability to isolate any unique intervention effects.

Interventions Bridging the Transition From Hospital to Home

Twelve trials described processes that we considered "bridging" interventions. These interventions were patient-centered discharge instructions (PCDI), a transition coach, and same-provider continuity between inpatient and outpatient care. Bridge components were derived from transition interventions described previously, such as patient education and discharge planning, home visits or follow-up calls, and primary care provider communication; but the bridge interventions recast these more conventional interventions to emphasize longitudinal relationships active in

both the pre- and the postdischarge periods, as well as the role of the patient or caregiver in maintaining safe transitions.

The PCDI, used in 8 studies included in the review, facilitated patient engagement in the transition of care (that is, patient responsibility for the use and transmittal of health care information) (12, 14, 20, 21, 24, 25, 32, 52). The PCDI form of the discharge instruction was repeatedly described by study authors as an individualized document tailored to patients' health literacy and social circumstances. Information was limited to high-value categories, such as medications and follow-up plans, and the document was frequently used as an inpatient teaching tool as well as a discharge instruction. Coleman and colleagues summarized this function as a "patient-centered record owned and maintained by the patient to facilitate cross-site information transfer" (14). Jack and associates subsequently published the structure of their PCDI, which is characterized by a highly readable format (55). No study examined the isolated effect of a PCDI.

Six studies used a nurse or an advanced practice nurse who interacted with the patient before and after hospital discharge (14, 19, 24, 25, 32, 48). This individual engaged the patient throughout the hospitalization rather than only as discharge approached and then continued to contact the patient after discharge by telephone, home visit, or both. Coleman and colleagues described this role in improving patient self-care behavior as a "transition coach." Generally, predischarge visits in these interventions focused on disease-specific education and the completion of a social needs assessment. Postdischarge contacts focused on medication adherence, appropriate ambulatory follow-up, and symptom monitoring. Although other trials used a dedicated discharge advocate before discharge or a home visit afterward (20), the transition coach represented a longitudinal relationship that bridged the inpatient and outpatient settings. The transition coach has not been tested as a single intervention in a randomized design.

Two studies tested the hypothesis that having the inpatient physician continue to manage the patient in the ambulatory setting protected against readmission (47, 54). The first described implementation of an ambulatory firm system with residents that increased inpatient–outpatient provider continuity (54). The second study documented an association between postdischarge follow-up with the hospital treating physician (compared with the patient's community physician) and reduced incidence of readmission (47). Although both studies reported a significant benefit, neither used a randomized design.

Randomized Trials

We identified 5 randomized trials that documented statistically significant improvements in rehospitalization outcomes within 30 days (14, 17, 20, 21, 24) among 16 randomized, controlled trials overall. One of these 5 trials documenting effectiveness consisted of a single intervention in which high-risk patients received early discharge planning or usual care (17). Among these patients selected for high risk for rehospitalization, those randomly assigned to the treatment group experienced an absolute 11–percentage point reduction in 30-day rehospitalization.

The remainder of the randomized trials that demonstrated statistically significant beneficial effect tested multicomponent discharge bundles. Coleman and Jack and their colleagues used discharge bundles and demonstrated absolute reductions in 30-day readmission of 3.6 and 6.0 percentage points, respectively (14, 20); Naylor and colleagues found a 12–percentage point absolute improvement in readmission outcomes at 2 weeks in a cohort defined by medical diagnosis-related groups (24); and Koehler and coworkers found a 28–percentage point reduction in the combined end point of rehospitalization and emergency department revisit at 30 days (21). Interventions common to these 4 studies were the postdischarge telephone call and PCDI. However, 2 separate randomized trials that included these 2 interventions among others in a bundle did not demonstrate significant reductions in rehospitalization within 30 days (12, 25), and the 2 randomized trials of follow-up calls as an isolated intervention did not find a significant effect (13, 15).

Ten randomized, controlled trials identified in our review did not show a significant effect of isolated or bundled interventions. These included negative experimental studies of isolated application of discharge planning (18), patient education (26), home visits (16, 27), and postdischarge telephone calls (13, 15).

Discussion

In this systematic review of studies evaluating interventions to reduce readmission within 30 days of hospital discharge, we did not identify a discrete intervention or bundle of interventions that appears to reliably reduce rehospitalization. We identified 12 categories of interventions that have been repeatedly evaluated in isolation or as components of discharge bundles. Overall, observational designs predominated, and studies were characterized by significant heterogeneity of intervention content and context. This has been acknowledged to be a common limitation in the patient safety literature (56).

The current literature on how to reduce 30-day rehospitalization is probably limited by marginal internal and external validity. Interventions tested were diverse in character or underdescribed, making analysis of the relative efficacy of individual interventions difficult. Particularly for patient education and discharge planning, staffing and scope of intervention components or the population targeted for intervention varied among studies. In addition, most studies we identified used nonexperimental designs and probably did not adequately adjust for contextual factors at both the hospital and the community level, thus limiting the generalizability of findings.

Although recommendations for practice must be tempered by limitations in the literature, we believe promising approaches exist and merit additional investigation. For example, the PCDI and the postdischarge telephone call were included in all randomized trials showing significantly effective discharge bundles. In the current discharge pathway, patients may experience a critical "voltage drop" in the availability of both care and knowledge between hospital discharge and ambulatory follow-up. By supporting availability of patient-friendly information after discharge, the PCDI and follow-up calls may facilitate knowledge transfer as well as patient activation in the postdischarge period. Bridging interventions, such as the PCDI and the transition coach, engage the patient in the discharge process and transform the process into an activity done *with* a patient rather than *to* a patient.

However, although postdischarge calls were common components of successful bundled interventions, 2 randomized trials testing them in isolation found no effect. This difference, along with the higher frequency of bundled interventions in randomized trials showing effect, may suggest limited efficacy of isolated interventions. In our review, the only randomized trial of an isolated intervention demonstrating effectiveness was applied to a high-risk subgroup. It may be the case that isolated interventions have small effects. Bundled interventions may realize an additive effect or additional value through change in cultural or organizational factors. Understanding these effects will require deeper consideration of the institutional culture in which implementation is attempted (56, 57).

Avoiding rehospitalization has captivated policymakers as a goal that both improves quality and reduces health care costs. With powerful incentives in the Patient Protection and Affordable Care Act that penalize hospitals with higher-than-expected readmission rates and new funding for efforts to reduce rehospitalization, health care providers will be attempting to implement evidence-based interventions that reduce 30-day readmission rates. This systematic review describes options intended to be broadly applicable to acute inpatient populations. Given the paucity of high-quality trials evaluating various interventions to reduce 30-day readmissions (for example, we found only 4 randomized, controlled trials enrolling >400 participants) and the impending hospital reimbursement penalty for excess rehospitalization, additional patient-centered outcomes research on remedies for avoidable rehospitalization and characteristics of successful implementation is clearly needed. Although rehospitalization represents a large burden to patients and the health care system, the current evidence base may not be adequate to facilitate change even for highly incentivized hospitals, and reconsideration of planned penalties may be reasonable.

From Northwestern University Feinberg School of Medicine, Chicago, Illinois.

Acknowledgment: The authors thank Linda O'Dwyer, MA, MSLIS, for assistance in the development of the initial database query for this review.

Grant Support: By the Northwestern University Feinberg School of Medicine (all authors). Drs. Williams and Hansen have received financial support from the John A. Hartford Foundation and the Society of Hospital Medicine for Project BOOST (Better Outcomes for Older Adults Through Safe Transitions). Dr. Young is supported by a National Research Service Award postdoctoral fellowship grant through the Institute for Healthcare Studies at Northwestern University under institutional awards from the Agency for Healthcare Research and Quality (T-32 HS 000078).

Potential Conflicts of Interest: Disclosures can be viewed at www.acponline.org/authors/icmje/ConflictOfInterestForms.do?msNum=M11-1422.

Requests for Single Reprints: Luke O. Hansen, MD, MHS, Division of Hospital Medicine, Northwestern University Feinberg School of Medicine, 211 East Ontario Street, 07-733, Chicago, IL 60611; e-mail, l-hansen@northwestern.edu.

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

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Current Author Addresses: Dr. Hansen: Division of Hospital Medicine, Northwestern University Feinberg School of Medicine, 211 East Ontario Street, 07-733, Chicago, IL 60611.
Dr. Young: Northwestern University Feinberg School of Medicine, 211 East Ontario Street, 7th Floor, Chicago, IL 60611.
Dr. Hinami: Division of Hospital Medicine, Northwestern University Feinberg School of Medicine, 211 East Ontario Street, 07-727, Chicago, IL 60611.
Dr. Leung: Northwestern University Feinberg School of Medicine, 251 East Huron Street, Feinberg 16-738, Chicago, IL 60610.
Dr. Williams: Division of Hospital Medicine, Northwestern University Feinberg School of Medicine, 211 East Ontario Street, 7th Floor, Chicago, IL 60611.

Author Contributions: Conception and design: L.O. Hansen, R.S. Young, M.V. Williams.
Analysis and interpretation of the data: L.O. Hansen, R.S. Young, K. Hinami, M.V. Williams.
Drafting of the article: L.O. Hansen, R.S. Young, K. Hinami, M.V. Williams.
Critical revision of the article for important intellectual content: L.O. Hansen, R.S. Young, K. Hinami, A. Leung, M.V. Williams.
Final approval of the article: L.O. Hansen, R.S. Young, K. Hinami, M.V. Williams.
Statistical expertise: L.O. Hansen, R.S. Young.
Administrative, technical, or logistic support: M.V. Williams.
Collection and assembly of data: L.O. Hansen, K. Hinami, A. Leung, M.V. Williams.

Appendix Table. **Results of Effective Practice and Organization of Care Risk-of-Bias Analysis**

Study, Year (Reference)	Study Design*	Allocation Sequence Random?	Allocation Concealed?	Baseline Outcomes Similar?	Baseline Characteristics Similar?	Plan for Missing Data/Incomplete Measurement of Primary Outcome (Outreach to Find Other Site Readmissions)?	Outcomes Assessed Blind to Intervention?	No Contamination?	Free of Selective Outcome Reporting Risk?	No Other Bias? (Including Whether Study Was From Single Institution)	EPOC Group Risk-of-Bias Criteria Total (9 Maximum)
Ahmed et al, 2004 (28)	NCBA	0	0	Unclear	0	0	1	0	0	0	1
Anderson et al, 2005 (29)	NCBA	0	0	Unclear	1	Unclear	1	0	1	0	3
Azevedo et al, 2002 (30)	CCT	0	0	Unclear	0	1	1	0	1	0	3
Balaban et al, 2008 (12)	RCT	1	Unclear	Unclear	1	1	1	0	1	0	5
Bostrom et al, 1996 (31)	CCT	0	0	Unclear	0	0	1	1	1	0	3
Braun et al, 2009 (13)	RCT	0	1	Unclear	0	1	1	1	1	0	5
Brown and Caplan, 1997 (48)	NCBA	0	0	Unclear	0	0	1	1	1	0	3
Coleman et al, 2006 (14)	RCT	1	1	Unclear	0	1	1	0	1	0	5
Coleman et al, 2004 (32)	CCT	0	0	Unclear	0	1	1	0	1	0	3
Creason, 2001 (33)	NCBA	0	0	Unclear	1	1	1	0	1	0	4
Dai et al, 2003 (49)	CCT	0	Unclear	Unclear	0	Unclear	1	0	1	0	2
Dedhia et al, 2009 (50)	NCBA	0	0	Unclear	0	1	1	1	1	0	4
Dudas et al, 2001 (15)	RCT	1	Unclear	Unclear	1	Unclear	1	0	1	0	4
Dunn et al, 1994 (16)	RCT	1	Unclear	Unclear	0	0	1	1	1	0	4
Einstadter et al, 1996 (34)	NCBA	0	0	Unclear	1	Unclear	1	0	1	0	3
Evans and Hendricks, 1993 (17)	RCT	1	Unclear	Unclear	1	Unclear	1	0	1	0	4
Forster et al, 2005 (18)	RCT	1	1	Unclear	1	Unclear	1	0	1	0	5
Gow et al, 1999 (35)	CCT	0	1	Unclear	0	0	1	1	0	0	3
Grafft et al, 2010 (36)	CCT	0	1	Unclear	1	0	1	1	1	1	6
Harrison et al, 2011 (37)	CCT	0	1	Unclear	0	1	1	1	1	1	6
Hernandez et al, 2010 (38)	CCT	0	0	Unclear	1	1	1	1	1	1	6
Hess et al, 2010 (51)	NCBA	0	0	Unclear	0	Unclear	1	0	1	0	2
Houghton et al, 1996 (52)	NCBA	0	0	Unclear	Unclear	Unclear	1	1	1	0	3
Jaarsma et al, 1999 (19)	RCT	1	1	Unclear	1	Unclear	1	0	1	0	5
Jack et al, 2009 (20)	RCT	1	1	Unclear	1	Unclear	1	1	1	0	6
Koehler et al, 2009 (21)	RCT	1	1	Unclear	1	Unclear	1	1	1	0	6
Kramer et al, 2007 (53)	NCBA	0	0	Unclear	0	1	1	1	1	0	4
Kwok et al, 2004 (22)	RCT	1	1	Unclear	1	Unclear	1	1	1	0	6
Lucas, 1998 (39)	NCBA	0	0	Unclear	0	0	1	1	1	0	3
McDonald et al, 2001 (23)	RCT	1	Unclear	Unclear	1	Unclear	1	1	Unclear	0	4
McPhee et al, 1983 (40)	CCT	0	1	Unclear	1	Unclear	1	0	1	0	4
Misky et al, 2010 (41)	CCT	0	0	Unclear	0	1	1	1	1	0	4
Naylor et al, 1994 (24)	RCT	1	0	Unclear	1	Unclear	1	1	1	0	5
O'Dell and Kucukarslan, 2005 (42)	NCBA	0	0	Unclear	1	0	1	1	1	0	4
Parry et al, 2009 (25)	RCT	1	1	Unclear	1	1	1	1	1	0	7
Rainville, 1999 (26)	RCT	1	1	Unclear	1	1	1	1	1	0	7
Sharma et al, 2010 (44)	CCT	0	0	Unclear	0	1	1	1	1	0	4
Smith, 1995 (54)	NCBA	0	0	Unclear	0	1	1	0	1	0	3
Sorknaes et al, 2011 (45)	CCT	0	Unclear	Unclear	1	Unclear	1	1	1	0	4
Steeman et al, 2006 (46)	CCT	0	1	Unclear	1	1	1	1	1	0	6
Schneider et al, 1993 (43)	CCT	0	0	Unclear	1	0	1	0	1	0	3
van Walraven et al, 2004 (47)	NCBA	0	0	Unclear	1	1	1	1	1	1	6
Wong et al, 2008 (27)	RCT	1	Unclear	Unclear	0	0	1	1	1	1	5

CCT = controlled clinical trial; EPOC = Effective Practice and Organisation of Care; NCBA = noncontrolled before–after trial; RCT = randomized, controlled trial.
* The EPOC group does not consider noncontrolled before–after trials in evidence reviews (http://epoc.cochrane.org/epoc-resources-review-authors).