



# HHS Public Access

Author manuscript

*JAMA Intern Med.* Author manuscript; available in PMC 2019 December 09.

Published in final edited form as:

*JAMA Intern Med.* 2016 April ; 176(4): 484–493. doi:10.1001/jamainternmed.2015.7863.

## Preventability and Causes of Readmissions in a National Cohort of General Medicine Patients

**Andrew D. Auerbach, MD, MPH,**

Division of Hospital Medicine, Department of Medicine, University of California, San Francisco

**Sunil Kripalani, MD, MSc,**

Section of Hospital Medicine at Vanderbilt, Department of Medicine, Vanderbilt University, Nashville, Tennessee

Center for Clinical Quality and Implementation Research, Vanderbilt University, Nashville, Tennessee

**Eduard E. Vasilevskis, MD, MPH,**

Section of Hospital Medicine at Vanderbilt, Department of Medicine, Vanderbilt University, Nashville, Tennessee

Center for Clinical Quality and Implementation Research, Vanderbilt University, Nashville, Tennessee

**Neil Sehgal, PhD, MPH,**

Division of Hospital Medicine, Department of Medicine, University of California, San Francisco

**Peter K. Lindenauer, MD, MSc,**

Center for Quality of Care Research, Baystate Medical Center, Department of Medicine, Tufts University School of Medicine, Boston, Massachusetts

**Joshua P. Metlay, MD, PhD,**

Division of General Internal Medicine, Massachusetts General Hospital, Boston

**Grant Fletcher, MD,**

---

**Corresponding Author:** Andrew D. Auerbach, MD, MPH, Division of Hospital Medicine, Department of Medicine, University of California, San Francisco, 505 Parnassus Ave, PO Box 0131, San Francisco, CA 94143 (andrew.auerbach@ucsf.edu).

**Author Contributions:** Dr Auerbach had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

**Study concept and design:** Auerbach, Kripalani, Sehgal, Lindenauer, Metlay, Fletcher, Ruhnke, Flanders, Williams, Giang, Herzig, Robinson, Schnipper.

**Acquisition, analysis, or interpretation of data:** Auerbach, Kripalani, Vasilevskis, Sehgal, Lindenauer, Fletcher, Ruhnke, Kim, Williams, Thomas, Herzig, Patel, Boscardin, Robinson, Schnipper.

**Drafting of the manuscript:** Auerbach, Fletcher, Giang, Patel.

**Critical revision of the manuscript for important intellectual content:** Auerbach, Kripalani, Vasilevskis, Sehgal, Lindenauer, Metlay, Fletcher, Ruhnke, Flanders, Kim, Williams, Thomas, Herzig, Boscardin, Robinson, Schnipper.

**Statistical analysis:** Auerbach, Sehgal, Patel, Boscardin.

**Obtained funding:** Auerbach, Vasilevskis, Lindenauer, Metlay, Ruhnke, Kim, Robinson, Schnipper.

**Administrative, technical, or material support:** Auerbach, Vasilevskis, Lindenauer, Fletcher, Ruhnke, Flanders, Kim, Williams, Thomas, Giang, Robinson.

**Study supervision:** Kripalani, Vasilevskis, Sehgal, Fletcher, Ruhnke, Kim, Thomas, Herzig, Schnipper.

**Additional Contributions:** Association of American Medical Colleges employees Anne Bonham, MD, PhD, Mildred Solomon, PhD, and Ellen Sakeld, PhD, supported this program. We also acknowledge the Hospital Medicine Reengineering Network and the Association of American Medical Colleges. We would also like to acknowledge the support and assistance of the dozens of physicians, unit teams, and patients who helped carry out this project.

Division of General Internal Medicine, Harborview Medical Center, Seattle, Washington

**Gregory W. Ruhnke, MD, MS, MPH,**

Section of Hospital Medicine, Department of Medicine, The University of Chicago, Chicago, Illinois

**Scott A. Flanders, MD,**

Department of Internal Medicine, University of Michigan, Ann Arbor

**Christopher Kim, MD,**

Department of Internal Medicine, University of Michigan, Ann Arbor

**Mark V. Williams, MD,**

Center for Health Services Research, University of Kentucky College of Medicine, Louisville

**Larissa Thomas, MD,**

Division of General Internal Medicine, San Francisco General Hospital, San Francisco, California

**Vernon Giang, MD,**

Department of Medicine, California Pacific Medical Center, San Francisco

**Shoshana J. Herzig, MD, MPH,**

Division of General Medicine and Primary Care, Beth Israel Deaconess Medical Center, Boston, Massachusetts

**Kanan Patel, MBBS, MPH,**

Division of Geriatrics, Department of Medicine, University of California, San Francisco

**W. John Boscardin, PhD,**

Department of Medicine, University of California, San Francisco

Department of Epidemiology and Biostatistics, University of California, San Francisco

**Edmondo J. Robinson, MD, MBA, MS,**

Value Institute and Department of Medicine, Christiana Care Health System, Wilmington, Delaware

**Jeffrey L. Schnipper, MD, MPH**

Hospital Medicine Service, Division of General Medicine, Brigham and Women's Hospital, Harvard Medical School, Boston, Massachusetts

## Abstract

**IMPORTANCE**—Readmission penalties have catalyzed efforts to improve care transitions, but few programs have incorporated viewpoints of patients and health care professionals to determine readmission preventability or to prioritize opportunities for care improvement.

**OBJECTIVES**—To determine preventability of readmissions and to use these estimates to prioritize areas for improvement.

**DESIGN, SETTING, AND PARTICIPANTS**—An observational study was conducted of 1000 general medicine patients readmitted within 30 days of discharge to 12 US academic medical centers between April 1, 2012, and March 31, 2013. We surveyed patients and physicians,

reviewed documentation, and performed 2-physician case review to determine preventability of and factors contributing to readmission. We used bivariable statistics to compare preventable and nonpreventable readmissions, multivariable models to identify factors associated with potential preventability, and baseline risk factor prevalence and adjusted odds ratios (aORs) to determine the proportion of readmissions affected by individual risk factors.

**MAIN OUTCOME AND MEASURE**—Likelihood that a readmission could have been prevented.

**RESULTS**—The study cohort comprised 1000 patients (median age was 55 years). Of these, 269 (26.9%) were considered potentially preventable. In multivariable models, factors most strongly associated with potential preventability included emergency department decision making regarding the readmission (aOR, 9.13; 95% CI, 5.23–15.95), failure to relay important information to outpatient health care professionals (aOR, 4.19; 95% CI, 2.17–8.09), discharge of patients too soon (aOR, 3.88; 95% CI, 2.44–6.17), and lack of discussions about care goals among patients with serious illnesses (aOR, 3.84; 95% CI, 1.39–10.64). The most common factors associated with potentially preventable readmissions included emergency department decision making (affecting 9.0%; 95% CI, 7.1%–10.3%), inability to keep appointments after discharge (affecting 8.3%; 95% CI, 4.1%–12.0%), premature discharge from the hospital (affecting 8.7%; 95% CI, 5.8%–11.3%), and patient lack of awareness of whom to contact after discharge (affecting 6.2%; 95% CI, 3.5%–8.7%).

**CONCLUSIONS AND RELEVANCE**—Approximately one-quarter of readmissions are potentially preventable when assessed using multiple perspectives. High-priority areas for improvement efforts include improved communication among health care teams and between health care professionals and patients, greater attention to patients' readiness for discharge, enhanced disease monitoring, and better support for patient self-management.

Despite continuous and robust efforts, the ability of health systems to reduce hospital readmissions has been disappointing.<sup>1</sup> The discouraging progress in reducing readmissions across broad populations points to potential gaps in health systems and communities,<sup>2–6</sup> as well as to shortcomings of broad-based readmission reduction programs, few of which have fulfilled their initial promise.<sup>7–9</sup>

Underlying readmission reduction programs are the concepts that some proportion of readmissions is preventable<sup>2,3,10</sup> and that identifying and addressing the drivers of “preventable” readmissions can improve the effectiveness of care transitions programs.<sup>11</sup> However, few nationally representative data exist to define the frequency of readmission preventability.<sup>3,12</sup> Moreover, national data are lacking on whether specific care processes, patients' needs, or comorbidities are more associated or less associated with preventability. Finally, although small studies<sup>7,8,13</sup> have included viewpoints of patients in understanding readmission preventability, few large-scale studies have explicitly included their viewpoints and that of their physicians in determining preventability.<sup>14</sup>

To explore these questions, we performed an observational study of general medicine patients readmitted within 30 days of discharge to 12 academic medical centers in the United States. We collected data from

patient and physician surveys and medical record review to identify factors contributing to readmissions. After aggregating information from these sources, we used a structured case review process to determine if a readmission was potentially preventable, whether clinical or health care delivery processes could have contributed to the readmission, and which of these processes were most commonly associated with preventable readmissions.

## Methods

### Sites and Participants

Our study took place in the Hospital Medicine Reengineering Network (HOMERuN), a national network of hospital medicine investigators at 12 academic medical centers.<sup>15</sup> Patients in our study were discharged by general medicine services at HOMERuN sites and readmitted (also to a general medicine service) within 30 days of discharge between April 1, 2012, and March 31, 2013.

Eligible patients were 18 years or older and spoke English as their primary language. Patients who had a scheduled readmission (eg, for chemotherapy or a procedure) were excluded. Within the eligible sample, we used a random-digit generation schema to select up to 5 patients per week at each site for interview and study participation. If a patient declined an interview, was too sick to participate, was unavailable, or otherwise declined participation, the next randomly selected patient was approached for enrollment. Institutional review boards at the University of California, San Francisco (the data coordinating center) and all participating HOMERuN sites approved the study.

### Data Collection

Data were collected from interviews with patients, from reviews of available inpatient and outpatient medical records, and from surveys of patients' physicians (primary care physician when available, discharging inpatient physician from the index admission, and inpatient physician from the readmission). After obtaining written informed consent, trained research assistants administered patient interviews that included fixed-choice and open-ended questions to learn about patients' perceptions of their care during their previous admission and their experience since discharge. Fixed-choice items included the following domains: social support, quality of communication with hospital physicians, whether a follow-up appointment was made and attended, and perceived ability to manage medications, symptoms, and appointments after discharge. Open-ended questions asked patients about any problems in recovery that they experienced after the index discharge, as well as what patients thought could have helped avoid a readmission to the hospital.

We then emailed or faxed up to 5 surveys to each patient's primary care physician, physician from the index admission, and current attending physician. Physician surveys asked questions regarding their impression of factors contributing to the readmission and aspects of care that could have been improved, such as timely communication about discharge plans. Physicians were encouraged to read the medical record to better inform their answers to survey questions. Using this approach, we received 359 responses from primary care physicians, 683 responses from physicians from the index admission, and 743 responses

from current attending physicians. All cases had at least 1 physician survey available at the time of case review.

Next, research assistants performed a structured medical record review, collecting information regarding patients' comorbidities and medications. They also recorded medical record-based measures of care transitions processes (eg, receipt of a reconciled list of medications at the time of the index hospital discharge).

### Measure Development

Our medical record-based measures were determined based on those criteria proposed by the National Quality Forum's Care Coordination Measures<sup>16</sup> and other published standards for discharge documentation completeness.<sup>17</sup> Patient survey questions included modified items from the 3-item Care Transition Measure<sup>18</sup> and the interpersonal processes of care measure.<sup>19,20</sup> Physician surveys were developed to include questions that paralleled those questions asked in our case review process (see the next subsection below), as well as impressions of key transitions processes (eg, the completeness of the discharge summary). Before use, all surveys were pretested among the investigator group and with physicians not associated with the study.

### Process for Case Review of Preventability and Identification of Underlying Causes

Our case review process was based in part on the approach used in other studies,<sup>21,22</sup> as well as approaches considered standard in defining preventability in adverse drug events and care transitions gaps.<sup>22-29</sup> We further refined past approaches to permit implementation across multiple sites, while adding processes to retain intersite and longitudinal intrareviewer consistency.

Our case review process had the following 2 key objectives: (1) to determine whether readmission was potentially preventable and (2) to identify factors that contributed to readmission, regardless of preventability. Case reviewers chose from a large set of potential factors that were identified and categorized using the framework of the Ideal Transitions in Care.<sup>30</sup> In assessing preventability, we trained case reviewers to consider patient illness but to primarily focus on system flaws and gaps in care that could have been avoided with reasonable patient or physician activities. As a framing example, we trained physician adjudicators to consider an "ideal health system" as a model for system and care assessment, even if all aspects of an ideal system did not exist at their site. For example, if a patient's readmission appeared to be related to the inability to obtain a post discharge appointment, we instructed case reviewers to consider it a preventable readmission because an ideal system would be able to accommodate these patients' needs without requiring readmission.

We assigned preventability with a scale used in previous research regarding care transitions.<sup>22,28</sup> Within this scale, we further defined a threshold of "greater than 50-50, but close call" as a standard cutoff, also based on previous studies.<sup>22,28</sup> This approach is useful in that it links an approach that encourages reviewers to explicitly avoid a "neutral" response in assessing preventability and provides a valid cut point that can help direct intervention strategies.

Physician reviewers had access to completed patient interviews, physician surveys, data derived from abstracted medical records, and the complete medical record. At a minimum, each case review packet included the patient interview, a complete medical record review, and at least 1 physician survey. All physician adjudicators reviewed several reference cases during a series of weekly webinars and conference calls. As the case review work proceeded, each site presented at least 2 anonymized cases for group discussion during biweekly conference calls to foster consistency among physician adjudicators.

The Hospital Medicine Reengineering Network did not calculate interrater reliability as part of its methods and instead used a 2-physician case review process to assign preventability. We provided substantial structure and support for the dual-physician reviews. All reviews were performed by physicians who were initially trained via our physician review guides, and then by having all reviewers perform “test” reviews and by regularly discussing reviews at biweekly conference calls. In addition, we maintained an “FAQ” document for how to adjudicate various situations, with an email of all updates as they became available, and maintained a resource for teaching points and clarifications using a HOMERuN wiki webpage.

Each site had a pool of 3 to 10 physician adjudicators coordinated by a physician lead, who oversaw the process and resolved difficult cases. A pair of physician adjudicators reviewed all available information for each case and developed the initial assessments, after which the pair made a final assessment of the case jointly. Site physician leads were responsible for resolving any challenging cases, and these cases were also reviewed at regular telephone conference calls.

### Statistical Analysis

We first characterized study patients using univariable methods. Readmissions were categorized as preventable if physician adjudicators rated the likelihood of preventability as 50% or more (4 on a 6-point scale), as done in previous studies.<sup>22,28</sup> Using bivariable methods, we then compared patients whose readmissions were judged to be preventable vs those whose readmissions were judged to be nonpreventable in terms of factors that contributed to the readmission.

We selected potential contributing factors after initially screening for those variables with an unadjusted P value for association with preventability of  $P \leq .20$ . Using these initial variables, we then constructed hierarchical multivariable models, including clustering at the hospital level to predict preventability of readmissions. If covariates had high bivariable correlation, we considered only one for model inclusion by excluding variables with lower face validity. We next used a backward stepwise approach to develop our final model by removing variables until the final covariates were associated with the outcome at  $P < .05$ . We then used our final model to calculate the percentage of the preventable readmissions that were potentially affected by each identified risk factor. Specifically, we calculated an adjusted risk difference of preventable readmission for the model between cases with and without the factor, and then multiplied this value by the prevalence in our data of the factor and divided by the overall proportion of preventable readmissions.<sup>31</sup> All analyses were performed using statistical software (SAS, version 9.4; SAS Institute, Inc).



## Results

### Patient and Hospitalization Characteristics and Readmission Preventability

One thousand patients were readmitted to study hospitals, were randomly selected for our study, and gave written informed consent to participate. Their median age was 55 years. Other characteristics of the cohort are listed in Table 1.

Of readmitted patients, 26.9% (269 of 1000) had a readmission that was considered potentially preventable after case review (Table 2). Among preventable readmissions, 52.0% (140 of 269) were thought to have been potentially preventable with efforts made during the index admission.

### Patient Reports of Care Processes During the Index Admission

Patients whose readmission was deemed preventable reported experiences similar to those of patients whose readmission was deemed nonpreventable in terms of inpatient care processes (eg, having enough time to say what they thought was important or perceiving that their physician took their preferences into account) and in terms of their ability to manage their care after discharge. However, patients who reported problems with drugs or alcohol were less likely to have their readmission considered preventable (4.5% [12 of 269] vs 8.1% [59 of 731];  $P = .048$ ) (Table 3), while patients who did not know how to reach their physician after discharge were more likely to have their readmission considered preventable (18.6% [50 of 269] vs 12.6% [92 of 731];  $P = .02$ ).

### Factors Associated With Potentially Preventable Readmissions

Multiple potential underlying factors were noted when we compared preventable and nonpreventable readmissions in the domains of medication safety, care coordination, discharge planning, advance care planning, promotion of self-management, enlisting of help and social supports, diagnostic and therapeutic problems, and monitoring and managing of symptoms after discharge. Of potential underlying factors, those variables with the largest absolute differences in prevalence between preventable and nonpreventable readmissions were the following: inadequate treatment of symptoms other than pain (20.8% [56 of 269] vs 6.4% [47 of 731]), inadequate monitoring for medication adverse effects or nonadherence (14.9% [40 of 269] vs 4.4% [32 of 731]), follow-up appointments not scheduled sufficiently soon after discharge (16.0% [43 of 269] vs 5.7% [42 of 731]), patient lack of awareness of whom to contact after discharge or when to go (or not to go) to the emergency department (18.6% [50 of 269] vs 5.7% [42 of 731]), patient need for additional or different home services than those services included in discharge plans (17.8% [48 of 269] vs 7.8% [57 of 731]), discharge of patients too soon (eg, symptoms such as inability to eat or dyspnea not completely managed) from the index hospitalization (19.3% [52 of 269] vs 4.0% [29 of 731]), and issues related to the decision to admit the patient made in the emergency department (eg, the patient may not have required an inpatient stay, or useful information from the primary care physician was not available or reviewed) (12.6% [34 of 269] vs 2.6% [19 of 731]) (Table 4).

## Factors Independently Associated With Potentially Preventable Readmissions

In multivariable models, 4 factors were most strongly associated with potentially preventable readmissions. These included premature discharge from the index hospitalization (adjusted odds ratio [aOR], 3.88; 95% CI, 2.44–6.17), failure to relay important information to outpatient healthcare professionals (aOR, 4.19; 95% CI, 2.17–8.09), lack of discussions about care goals among patients with serious illnesses (aOR, 3.84; 95% CI, 1.39–10.64), and emergency department decision making to admit a patient who may not have required an inpatient stay (aOR, 9.13; 95% CI, 5.23–15.95). The most common factors associated with potentially preventable readmissions included emergency department decision making (affecting 9.0%, 95% CI, 7.1%–10.3%), inability to keep appointments after discharge (affecting 8.3%; 95% CI, 4.1%–12.0%), premature discharge from the hospital (affecting 8.7%; 95% CI, 5.8%–11.3%), and patient lack of awareness of whom to contact after discharge (affecting 6.2%; 95% CI, 3.5%–8.7%) (Table 5).

In sensitivity analyses, we performed multivariable models that excluded data from sites with fewer than 50 patients, and these results were similar to those findings already presented. We also performed 2 additional analyses that excluded sites whose aggregate estimates of preventability were in the top or lower 2 of sites. Results from these analyses also did not reveal any significant changes in the factors identified.

## Discussion

In this multicenter, multiperspective study of readmitted patients, 26.9% (269 of 1000) of readmissions were considered potentially preventable, with half of these readmissions thought to represent gaps in care during the initial inpatient stay. Structured case review with multiple viewpoints, including perspectives of patients, identified a prioritized list of targets for refined care transitions programs.

Our estimates of readmission preventability are within the ranges suggested by other researchers<sup>3</sup> but extend previous work in important ways. Our review process linked a comprehensive picture of clinical care, one that included viewpoints of patients, to a rigorous case review process that sought to identify not only readmission preventability but also opportunities for improvement. The process whereby we identified potential improvement targets also represents an important feature of our work. That is, our focus on an ideal health system lens for determining preventability provides a safeguard against fatalistic interpretations of readmissions as “nonpreventable” or solely owing to advancing illnesses, while also allowing us to identify factors that should be addressed so that improvement leads toward an “ideal.”

An ideal transition of care<sup>1,8</sup> can include a dauntingly wide range of potential programs<sup>30</sup> for health systems to implement and manage. Our calculations providing estimates of the proportion of potentially preventable readmissions affected by each risk factor can help prioritize efforts by weighting the odds of individual associations using the prevalence of the risk factor in our population. While the effectiveness of individual programs addressing individual gaps in care likely varies across issues, our study adds substantially to previous work by providing a prioritization schema that is useful in the beginning of program



development. Perhaps not surprisingly, the use of population-based estimation produced a ranked list of important underlying causes for readmission that differed slightly from the list of factors ranked by adjusted odds. The list of factors that overlap in terms of risk and potential effect is shorter still, providing a potential approach to prioritizing readmission reduction efforts.

One key observation in our cohort related to improving decision making for patients arriving in the emergency department, a factor that represents not a shortcoming of emergency medicine or emergency departments, but a limitation of the health system itself. Overcoming gaps in care in the attempt to avoid potentially unnecessary admissions from the emergency department may need to involve improved communication among primary care health care professionals, hospital-based physicians, and emergency medicine physicians about criteria for admission and resources available in the community, in addition to providing greater access to urgent care for patients who would otherwise seek care in an emergency department and improving patients' understanding of how and when to seek emergency care.

Our research also adds to the existing literature on readmissions by identifying the possibility that premature discharge from the hospital may contribute to readmission risk. While secondary data analyses have not demonstrated a correlation between shortening lengths of stay and readmission rates nationally,<sup>32</sup> our data suggest that in the current era some proportion of readmissions may be prevented with better attention to patients' readiness for discharge<sup>33</sup> in terms of their ability to manage care after discharge or recover from (or develop an effective management plan for) symptoms, such as dyspnea, vomiting, and pain.

Our results were also notable for factors that were not found to be key underlying contributors. Functional status is a clear risk factor for readmission<sup>34,35</sup> but in our cohort of readmitted patients was not associated with potential preventability. Patient reports of care processes and satisfaction with care were not associated with readmission preventability in our data, suggesting that patient satisfaction with care, while valuable for other reasons, may not be a valid approach to identifying readmission program priorities. Disconnect between most patients' perceptions of care and readmission preventability may also represent gaps in the ability of satisfaction measures to detect patients' actual ability to carry out the discharge plan.

Our study has some limitations. While our case review process has strengths, it was limited by the subjective nature of determining preventability of readmissions. For example, we cannot rule out biases of our reviewers regarding which factors may have contributed to readmission preventability. However, our results are similar to other estimates of preventability, and our training and quality assurance processes sought to maintain consistency of our approach across sites. Also, no patient factors were retained in our final models, but we cannot rule out the possibility of confounding by patient factors that were associated with both the identified risk factors and potential preventability. In addition, it is possible that our medical record tools may have led to instrument bias that may have limited our ability to detect factors outside of our tool's list. That said, the list of factors we collected from patients, physicians, and medical records was large and is based on existing

frameworks.<sup>30</sup> In addition, the large number of factors that were found to be significant makes the threat of this bias less likely. While our study included patients from a variety of hospitals, most were large academic medical centers, potentially limiting generalizability. Also limiting generalizability are our criteria that excluded non-English-speaking patients and patients unable to provide informed consent. We also did not track reasons for refusal among potentially eligible patients. That said, our cohort is similar to previous studies<sup>36,37</sup> of readmitted patients from our sites that did not use exclusion criteria. Our approach was associated with variation in rates of preventability across sites, which could represent true variation in care processes but also possible inconsistency of case review across sites. However, despite potential variation in case review processes, the factors we identified were robust in sensitivity analyses that excluded patients from the sites with the highest and lowest rates of preventability. Finally, population-attributable estimates can be used to prioritize potential benefits but do not take into account the effectiveness or cost of those programs. These estimates are best-case scenarios in terms of the proportion of readmissions that could be prevented, assuming 100% preventability owing to that factor and 100% efficacy of an intervention designed to address it.

## Conclusions

Multicomponent care transitions programs are a desired approach to improving patient outcomes in the period after acute care. Because our study cannot ascribe causality to the factors we have identified, our results cannot support the conclusion that eliminating the factors we identified will surely reduce readmissions. The answer to that question will require further studies. Our study formulates a potential approach for prioritizing local efforts, as well as monitoring the effectiveness of programs in place. Finally, our results suggest a potential approach to focus interventions in ways that span the continuum of care, prioritize efforts to prepare patients more effectively for discharge, and provide better ability for patients, caregivers, and health care professionals to support patients and improve outcomes during the period after hospitalization.

## Acknowledgments

**Funding/Support:** Dr Auerbach is supported by grant K24HL098372 from the National Heart, Lung, and Blood Institute. This work was supported by an unrestricted research grant from the American Association of Medical Colleges and in part by grant 2 UL1 TR000445–06 from the National Institute on Aging.

**Role of the Funder/Sponsor:** The funding sources had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

## REFERENCES

1. Kripalani S, Theobald CN, Anctil B, Vasilevskis EE. Reducing hospital readmission rates: current strategies and future directions. *Annu Rev Med.* 2014;65:471–485. [PubMed: 24160939]
2. Vest JR, Gamm LD, Oxford BA, Gonzalez MI, Slawson KM. Determinants of preventable readmissions in the United States: a systematic review. *Implement Sci.* 2010;5:88. [PubMed: 21083908]
3. van Walraven C, Bennett C, Jennings A, Austin PC, Forster AJ. Proportion of hospital readmissions deemed avoidable: a systematic review. *CMAJ.* 2011;183(7):E391–E402. doi:10.1503/cmaj.101860. [PubMed: 21444623]

4. van Walraven C, Jennings A, Forster AJ. A meta-analysis of hospital 30-day avoidable readmission rates. *J Eval Clin Pract.* 2012;18(6): 1211–1218. [PubMed: 22070191]
5. White B, Carney PA, Flynn J, Marino M, Fields S. Reducing hospital readmissions through primary care practice transformation. *J Fam Pract.* 2014;63(2):67–73. [PubMed: 24527477]
6. Herrin J, St Andre J, Kenward K, Joshi MS, Audet AM, Hines SC. Community factors and hospital readmission rates. *Health Serv Res.* 2015;50(1): 20–39. [PubMed: 24712374]
7. Bradley EH, Curry LA, Spatz ES, et al. Hospital strategies for reducing risk-standardized mortality rates in acute myocardial infarction. *Ann Intern Med.* 2012;156(9):618–626. [PubMed: 22547471]
8. Hansen LO, Young RS, Hinami K, Leung A, Williams MV. Interventions to reduce 30-day rehospitalization: a systematic review. *Ann Intern Med.* 2011;155(8):520–528. [PubMed: 22007045]
9. Goldman LE, Sarkar U, Kessell E, et al. Support from hospital to home for elders: a randomized trial. *Ann Intern Med.* 2014;161(7):472–481. [PubMed: 25285540]
10. Lavenberg JG, Leas B, Umscheid CA, Williams K, Goldmann DR, Kripalani S. Assessing preventability in the quest to reduce hospital readmissions. *J Hosp Med.* 2014;9(9):598–603. [PubMed: 24961204]
11. van Walraven C, Forster AJ. When projecting required effectiveness of interventions for hospital readmission reduction, the percentage that is potentially avoidable must be considered. *J Clin Epidemiol.* 2013;66(6):688–690. [PubMed: 23245581]
12. Jackson AH, Fireman E, Feigenbaum P, Neuwirth E, Kipnis P, Bellows J. Manual and automated methods for identifying potentially preventable readmissions: a comparison in a large healthcare system. *BMC Med Inform Decis Mak.* 2014;14:28. [PubMed: 24708889]
13. Cawthon C, Walia S, Osborn CY, Niesner KJ, Schnipper JL, Kripalani S. Improving care transitions: the patient perspective. *J Health Commun.* 2012;17(suppl 3):312–324. [PubMed: 23030579]
14. Jeffs L, Dhalla I, Cardoso R, Bell CM. The perspectives of patients, family members and healthcare professionals on readmissions: preventable or inevitable? *J Interprof Care.* 2014;28(6): 507–512. [PubMed: 24913271]
15. Auerbach AD, Patel MS, Metlay JP, et al. The Hospital Medicine Reengineering Network (HOMERuN): a learning organization focused on improving hospital care. *Acad Med.* 2014;89(3): 415–420. [PubMed: 24448050]
16. National Quality Forum. National voluntary consensus standards for coordination of care across episodes of care and care transitions. [http://www.qualityforum.org/Projects/c-d/Care\\_Coordination\\_Endorsement\\_Maintenance/Care\\_Coordination\\_Endorsement\\_Maintenance.aspx](http://www.qualityforum.org/Projects/c-d/Care_Coordination_Endorsement_Maintenance/Care_Coordination_Endorsement_Maintenance.aspx). Published 2012 Accessed October 13, 2015.
17. Gandara E, Ungar J, Lee J, Chan-Macrae M, O'Malley T, Schnipper JL. Discharge documentation of patients discharged to subacute facilities: a three-year quality improvement process across an integrated health care system. *Jt Comm J Qual Patient Saf.* 2010;36(6):243–251. [PubMed: 20564885]
18. Coleman EA, Parry C, Chalmers SA, Chugh A, Mahoney E. The central role of performance measurement in improving the quality of transitional care. *Home Health Care Serv Q.* 2007; 26(4): 93–104. [PubMed: 18032202]
19. Stewart AL, Nápoles-Springer A, Pérez-Stable EJ. Interpersonal processes of care in diverse populations. *Milbank Q.* 1999;77(3):305–339, 274. [PubMed: 10526547]
20. Kripalani S, Jacobson TA, Mugalla IC, Cawthon CR, Niesner KJ, Vaccarino V. Health literacy and the quality of physician-patient communication during hospitalization. *J Hosp Med.* 2010;5(5): 269–275. [PubMed: 20533572]
21. Salanitro AH, Kripalani S, Resnic J, et al. Rationale and design of the Multicenter Medication Reconciliation Quality Improvement Study (MARQUIS). *BMC Health Serv Res.* 2013;13:230. [PubMed: 23800355]
22. Kripalani S, Roumie CL, Dalal AK, et al.; PILL-CVD (Pharmacist Intervention for Low Literacy in Cardiovascular Disease) Study Group. Effect of a pharmacist intervention on clinically important medication errors after hospital discharge: a randomized trial. *Ann Intern Med.* 2012;157(1):1–10. [PubMed: 22751755]

23. Bates DW, Cullen DJ, Laird N, et al.; ADE Prevention Study Group. Incidence of adverse drug events and potential adverse drug events: implications for prevention. *JAMA*. 1995;274(1): 29–34. [PubMed: 7791255]
24. Leape LL, Bates DW, Cullen DJ, et al.; ADE Prevention Study Group. Systems analysis of adverse drug events. *JAMA*. 1995;274(1):35–43. [PubMed: 7791256]
25. Forster AJ, Murff HJ, Peterson JF, Gandhi TK, Bates DW. The incidence and severity of adverse events affecting patients after discharge from the hospital. *Ann Intern Med*. 2003;138(3):161–167. [PubMed: 12558354]
26. Gandhi TK, Weingart SN, Borus J, et al. Adverse drug events in ambulatory care. *N Engl J Med*. 2003;348(16):1556–1564. [PubMed: 12700376]
27. Forster AJ, Murff HJ, Peterson JF, Gandhi TK, Bates DW. Adverse drug events occurring following hospital discharge. *J Gen Intern Med*. 2005;20(4): 317–323. [PubMed: 15857487]
28. Schnipper JL, Kirwin JL, Cotugno MC, et al. Role of pharmacist counseling in preventing adverse drug events after hospitalization. *Arch Intern Med*. 2006;166(5):565–571. [PubMed: 16534045]
29. Schnipper JL, Roumie CL, Cawthon C, et al.; PILL-CVD Study Group. Rationale and design of the Pharmacist Intervention for Low Literacy in Cardiovascular Disease (PILL-CVD) study. *Circ Cardiovasc Qual Outcomes*. 2010;3(2):212–219. [PubMed: 20233982]
30. Burke RE, Guo R, Prochazka AV, Misky GJ. Identifying keys to success in reducing readmissions using the Ideal Transitions in Care framework. *BMC Health Serv Res*. 2014;14:423. [PubMed: 25244946]
31. Zhang J, Yu KF. What's the relative risk? a method of correcting the odds ratio in cohort studies of common outcomes. *JAMA*. 1998;280 (19):1690–1691. [PubMed: 9832001]
32. Kaboli PJ, Go JT, Hockenberry J, et al. Associations between reduced hospital length of stay and 30-day readmission rate and mortality: 14-year experience in 129 Veterans Affairs hospitals. *Ann Intern Med*. 2012;157(12):837–845. [PubMed: 23247937]
33. Krumholz HM. Post-hospital syndrome: an acquired, transient condition of generalized risk. *N Engl J Med*. 2013;368(2):100–102. [PubMed: 23301730]
34. Hoyer EH, Needham DM, Miller J, Deutschendorf A, Friedman M, Brotman DJ. Functional status impairment is associated with unplanned readmissions. *Arch Phys Med Rehabil*. 2013;94(10): 1951–1958. [PubMed: 23810355]
35. Kansagara D, Englander H, Salanitro A, et al. Risk prediction models for hospital readmission: a systematic review. *JAMA*. 2011;306(15): 1688–1698. [PubMed: 22009101]
36. Donze J, Williams M, Robinson EJ, et al. Multicenter validation of the HOSPITAL score to predict 30 day potentially avoidable readmissions in medical patients. *J Gen Intern Med*. 2015;30(suppl 2):45–551. [PubMed: 25869016]
37. Allaudeen N, Vidyarthi A, Maselli J, Auerbach A. Redefining readmission risk factors for general medicine patients. *J Hosp Med*. 2011;6(2):54–60. [PubMed: 20945293]

Table 1.

Characteristics of Patients and Their Index Hospitalization<sup>a</sup>

Characteristic	Preventable (n = 269)	Nonpreventable (n = 731)	P Value for Nonpre- ventable vs Preventable
Patient age, mean (SD), y	56.1 (17.9)	54.5 (18.1)	.23
Married, No./total No. (%)	104 (38.7)	250/727 (34.4)	.21
English as primary language, No. (%)	249 (92.6)	682/727 (93.8)	.48
Where admitted from, No. (%)			
Outpatient clinic	22 (8.2)	76/728 (10.4)	
Another facility	35 (13.0)	96/728 (13.2)	.77
Home	186 (69.1)	490/728 (67.3)	
Other	26 (9.7)	66/728 (9.1)	
Patient has an identified caregiver other than spouse or family, No. (%)	49 (18.2)	115/727 (15.8)	.37
Screened for low health literacy at the index admission, No. (%)			
Yes	88 (32.7)	169/727 (23.2)	.009
No or not documented	181 (67.3)	558/727 (76.8)	
Documentation that the patient's primary care physician was contacted at the index admission, No. (%)			
Yes	118 (43.9)	336/727 (46.2)	
No	124 (46.1)	337/727 (46.4)	.39
No primary care or regular health care professional	27 (10.0)	54/727 (7.4)	
Active serious illness, No. (%)			
Stage III or IV congestive heart failure	16 (5.9)	45 (6.2)	.89
Hemorrhagic or ischemic stroke	22 (8.2)	46 (6.3)	.30
Parkinson disease or other degenerative nervous system disorder	8 (3.0)	18 (2.5)	.66
Cancer	30 (11.2)	90 (12.3)	.60
Chronic obstructive pulmonary disease	20 (7.4)	52 (7.1)	.87
Stage IV renal failure or hemodialysis	35 (13.0)	90 (12.3)	.78
Active clinical issue at the beginning of the index hospitalization, No. (%)			
Abnormal cognition	35 (13.0)	78 (10.7)	.31

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Characteristic	Preventable (n = 269)	Nonpreventable (n = 731)	P Value for Nonpre- ventable vs Preventable
Alcohol or drug abuse	29 (10.8)	120 (16.4)	.03
Impaired mobility	92 (34.2)	228 (31.2)	.39
Nonhealing ulcer or wound	28 (10.4)	49 (6.7)	.05
Nutritional impairment	55 (20.4)	102 (14.0)	.01
Functional need when discharged after the index admission, No. (%)			
Crutches, cane, or walker	57 (21.2)	168 (23.0)	.53
Wheelchair	35 (13.0)	64 (8.8)	.048
Difficulty dressing, bathing, or eating	35 (13.0)	85 (11.6)	.57
Bed bound or "total care"	7 (2.6)	17 (2.3)	.81
Service or care transitions activity arranged during the index admission, No. (%)			
Referral for home care services	75 (27.9)	189 (25.9)	.54
Referral for substance abuse	6 (2.2)	35 (4.8)	.07
Referral for shelter or temporary housing	6 (2.2)	23 (3.1)	.44
Referral for physical or occupational therapy	72 (26.8)	148 (20.2)	.03
Multidisciplinary meeting to discuss the patient outside of routine rounding	51 (19.0)	157 (21.5)	.37
Congestive heart failure or other specific case management program	26 (9.7)	49 (6.7)	.12
Pharmacy counseling	39 (14.5)	104 (14.2)	.93
Postdischarge follow-up telephone call made within 72 h after the index admission, No./total No. (%)			
Yes	35 (13.0)	95/727 (13.1)	.006
No or not documented	234 (87.0)	632/727 (86.9)	
Physician discharge summary dated or timed within 24 h of discharge, No./total No. (%)	214 (79.6)	570/727 (78.4)	.69
Postdischarge appointment scheduled at the time of discharge, No./total No. (%)	162 (60.2)	471/727 (64.8)	.19
Medication reconciliation documentation, No./total No. (%)			
At admission only	9 (3.3)	23/726 (3.2)	
At discharge only	45 (16.7)	162/726 (22.3)	.29
At admission and discharge	211 (78.4)	530/726 (73.0)	
None documented	4 (1.5)	11/726 (1.5)	
Documentation that the patient received a reconciled medication list at discharge, No./total No. (%)	205 (76.2)	639/727 (87.9)	<.001



Characteristic	Preventable (n = 269)	Nonpreventable (n = 731)	P Value for Nonpre- ventable vs Preventable
Documentation that the patient's primary care or regular outpatient health care professional had been contacted before discharge, No./total No. (%)	114 (42.4)	296/727 (40.7)	.67
No primary care or regular health care professional, No. (%)	24 (8.9)	56 (7.7)	
Patient discharge location, No./total No. (%)			
Home with home services	144 (53.5)	386/728 (53.0)	
Home without home services	70 (26.0)	200/728 (27.5)	
Skilled nursing or rehabilitation facility	30 (11.2)	82/728 (11.3)	
No home or homeless shelter	11 (4.1)	28/728 (3.8)	.33
Chronic care facility	5 (1.9)	16/728 (2.2)	
Against medical advice	4 (1.5)	13/728 (1.8)	
Other	5 (1.9)	3/728 (0.4)	

<sup>4</sup>There were 1007 index hospitalizations, but the data on preventability were missing for 7 patients. Other missing data include the following: age (n = 4), primary language (n = 4), admitted from (n = 3), patient has identified caregiver (n = 4), screened for low health literacy (n = 4), primary care physician contacted at admission (n = 4), active serious illness (n = 3), active clinical issues (n = 3), functional needs when discharged (n = 3), service or care transitions activity arranged (n = 3), postdischarge follow-up telephone call made (n = 4), physician discharge summary dated (n = 4), postdischarge appointment scheduled (n = 4), medication reconciliation documentation (n = 5), patient received a reconciled medication list at discharge (n = 4), patient's primary care or regular outpatient health care professional had been contacted before discharge (n = 4), and patient discharge location (n = 3).

**Table 2.**

## Readmission Preventability After Case Review

Variable	No. (%)
<b>Readmission Preventability Among 1000 Patients</b>	
No evidence for preventability	286 (28.6)
Slight evidence for preventability	297 (29.7)
Preventability less than 50–50 but close call	148 (14.8)
Preventability at least 50–50 but close call	119 (11.9)
Strong evidence for preventability	128 (12.8)
Virtually certain evidence for preventability	22 (2.2)
<b>Location Where Interventions to Reduce Readmissions Would Have Been Most Effective Among 269 Patients With 50% Preventability</b>	
During the index admission	140 (52.0)
At home after the index admission	47 (17.5)
Health care professional's clinic	38 (14.1)
Emergency department	16 (5.9)
Multiple locations	28 (10.4)

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Unadjusted Comparison of Patient-Reported Care Processes Identified During Readmission

Patient-Reported Care Process	No. (%)		P Value
	Preventable (n = 269)	Nonpreventable (n = 731)	
How often did they give you enough time to say what you thought was important? (always or often vs other)	191 (71.0)	537 (73.5)	.44
How often did you feel pressured by them to have a treatment you were not sure you wanted? (never or rarely vs other)	216 (80.3)	561 (76.7)	.23
How often did they ask if you might have problems actually doing the recommended treatment (for example, taking the medication correctly)? (always or often vs other)	99 (36.8)	277 (37.9)	.75
“When I left the hospital, I understood what I was supposed to do to take care of myself.” (strongly agree or agree vs other)	240 (89.2)	663 (90.7)	.48
“When I left the hospital, they took my preferences into account when they decided on the plan for my care.” (strongly agree or agree vs other)	194 (72.1)	556 (76.1)	.20
“After I left the hospital, I had difficulty taking each of my medications correctly every day.” (strongly agree or agree vs other)	52 (19.3)	128 (17.5)	.51
“After I left the hospital, I did not know how to contact my doctor if I needed to.” (strongly agree or agree vs other)	50 (18.6)	92 (12.6)	.02
“After I left the hospital, I had difficulty with transportation to my doctor’s appointment or other tests.” (strongly agree or agree vs other)	56 (20.8)	146 (20.0)	.77
“After I left the hospital, I had difficulty meeting basic needs, such as food and shelter.” (strongly agree or agree vs other)	36 (13.4)	74 (10.1)	.14
“After I left the hospital, I had difficulty following the diet my doctor recommended to keep me healthy.” (strongly agree or agree vs other)	59 (21.9)	156 (21.3)	.84
“After I left the hospital, I did not have enough support from friends, family, neighbors, and/or others who care for me to follow the hospital discharge instructions and recover from my illness.” (strongly agree or agree vs other)	44 (16.4)	107 (14.6)	.50
“After I left the hospital, I had problems related to drinking alcohol or using drugs.” (strongly agree or agree vs other)	12 (4.5)	59 (8.1)	.048

Table 4.

## Unadjusted Comparison of Risk Factors Associated With Readmission

Risk Factor	No. (%)		P Value
	Preventable (n = 269)	Nonpreventable (n = 731)	
<b>Discharge Planning</b>			
Inappropriate choice of discharge location (eg, skilled nursing facility vs home)	35 (13.0)	32 (4.4)	<.001
Follow-up appointments were not scheduled before discharge	44 (16.4)	67 (9.2)	.001
Patient discharged too soon from the index hospitalization	52 (19.3)	29 (4.0)	<.001
Inappropriately long time between discharge and the first follow-up with outpatient health care professionals	40 (14.9)	46 (6.3)	<.001
Follow-up appointments in general were not sufficiently soon after discharge	43 (16.0)	42 (5.7)	<.001
<b>Enlisting Help of Social and Community Supports</b>			
Patient required additional or different home services than those services included in discharge plans	48 (17.8)	57 (7.8)	<.001
Patient was not able to access services at home or turned them down after plans were made	14 (5.2)	24 (3.3)	.16
Patient required additional help from his or her family, caregivers, or friends that was not available or sufficient	44 (16.4)	94 (12.9)	.16
Patient required community programs (eg, elder day programs, meals-on-wheels) not included in discharge plans	16 (5.9)	28 (3.8)	.15
Inpatient assessment of physical needs (eg, commode, transportation) was incomplete or missed important patient requirements	21 (7.8)	13 (1.8)	<.001
<b>Educating Patients and Promoting Self-management</b>			
Patient lacked awareness of whom to contact after discharge or when to go (or not to go) to the emergency department	50 (18.6)	42 (5.7)	<.001
Patient lacked awareness of follow-up appointments or other postdischarge plans	24 (8.9)	24 (3.3)	<.001
Patient or family had difficulty managing symptoms at home	115 (42.8)	249 (34.1)	.01
Patient or family had difficulty managing other self-care activities at home	59 (21.9)	106 (14.5)	.005
<b>Coordinating Care Among Team Members</b>			
Team did not ensure that the patient had a primary care physician	7 (2.6)	14 (1.9)	.50
Team did not relay important information to outpatient health care professionals	29 (10.8)	17 (2.3)	<.001
Test results ordered by the initial team were not followed up appropriately	3 (1.1)	5 (0.7)	.45
<b>Advance Care Planning</b>			
Patient nearing end of life but still wants hospitalization and full treatment measures	8 (3.0)	56 (7.7)	.007
Patient with end-stage illness but palliative care not consulted	17 (6.3)	28 (3.8)	.09
Patient with end-stage illness and goals of care discussion not documented	20 (7.4)	23 (3.1)	.003

Risk Factor	No. (%)		P Value
	Preventable (n = 269)	Nonpreventable (n = 731)	
<b>Monitoring and Managing Symptoms After Discharge</b>			
Lack of disease monitoring (eg, following daily weights, etc)	54 (20.1)	76 (10.4)	<.001
Patient was not able to be reached for postdischarge monitoring (eg, follow-up telephone calls)	5 (1.9)	9 (1.2)	.45
Patient was not able to keep postdischarge appointments	44 (16.4)	51 (7.0)	<.001
<b>Diagnostic or Therapeutic Problems</b>			
Missed diagnosis during the index admission	30 (11.2)	28 (3.8)	<.001
Inadequate treatment of medical conditions during the index admission other than pain	56 (20.8)	47 (6.4)	<.001
Discharge without a needed procedure	15 (5.6)	18 (2.5)	.01
Inadequate treatment of pain during the index admission	17 (6.3)	14 (1.9)	<.001
Emergency department decided to admit a patient who may not have required an inpatient stay	34 (12.6)	19 (2.6)	<.001
<b>Medication Safety</b>			
Errors in taking the preadmission medication history during the index admission	3 (1.1)	4 (0.5)	.39
Errors in discharge orders	10 (3.7)	8 (1.1)	.006
Drug-drug or drug-disease interaction	18 (6.7)	24 (3.3)	.02
Patient or caregiver misunderstanding of the discharge medication regimens	28 (10.4)	28 (3.8)	<.001
Patient or caregiver inability to manage medications or inadequate drug level monitoring	42 (15.6)	67 (9.2)	.004
Inadequate monitoring for adverse effects or nonadherence	40 (14.9)	32 (4.4)	<.001
Inadequate steps to ensure the patient could afford medications	13 (4.8)	10 (1.4)	.001

**Table 5.** Adjusted Odds of Preventability and Adjusted Differences in Preventability Among Potential Underlying Risk Factors<sup>a</sup>

Risk Factor	Value (95% CI)	Proportion of Preventable Readmissions Risk Factor, %
<b>Discharge Planning</b>		
Inappropriate choice of discharge location (eg, skilled nursing facility vs home)	2.50 (1.24 to 5.04)	5.0 (1.1 to 8.6)
Patient discharged too soon from the index hospitalization	3.88 (2.44 to 6.17)	8.7 (5.8 to 11.3)
<b>Educating Patients and Promoting Self-management</b>		
Patient lacked awareness of whom to contact after discharge or when to go (or not to go) to the emergency department	2.33 (1.64 to 3.30)	6.2 (3.5 to 8.7)
<b>Coordinating Care Among Team Members</b>		
Team did not relay important information to outpatient health care professionals	4.19 (2.17 to 8.09)	5.4 (2.9 to 7.6)
<b>Advance Care Planning</b>		
Patient nearing end of life but still wants hospitalization and full treatment measures	0.24 (0.10 to 0.57)	-4.7 (-5.9 to -2.3)
Patient with end-stage illness and goals of care discussion not documented	3.84 (1.39 to 10.64)	4.8 (1.1 to 7.7)
<b>Monitoring and Managing Symptoms After Discharge</b>		
Lack of disease monitoring (eg, following daily weights, etc)	1.75 (1.37 to 2.24)	5.6 (3.1 to 8.1)
Patient was not able to keep postdischarge appointments	3.01 (1.75 to 5.18)	8.3 (4.1 to 12.0)
<b>Diagnostic or Therapeutic Problems</b>		
Missed diagnosis during the index admission	2.34 (1.26 to 4.34)	4.0 (1.0 to 6.9)
Inadequate treatment of pain during the index admission	3.03 (1.22 to 7.57)	2.9 (0.5 to 5.1)
Emergency department decided to admit a patient who may not have required an inpatient stay	9.13 (5.23 to 15.95)	9.0 (7.1 to 10.3)
<b>Medication Safety</b>		
Inadequate monitoring for adverse effects or nonadherence	2.41 (1.18 to 4.90)	5.1 (0.9 to 9.1)

<sup>a</sup>Using hierarchical logistic regression model clustering at the site level and adjusting for the location of the intervention.