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Title: Acute care hospital utilization among medical inpatients discharged with a substance use disorder diagnosis

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Abstract: Background: Hospital discharge may be a high yield opportunity to intervene among patients with substance use disorders to decrease subsequent acute care utilization.

Methods: To determine whether having a substance use disorder diagnosis was associated with subsequent acute care utilization, we conducted an observational cohort study among 738 patients on a general medical service at an urban, academic, safety-net hospital. The main outcomes were rate and risk of an emergency department visit or rehospitalization within 30 days of the index discharge. The main independent variable was presence of a substance use disorder defined by primary or secondary discharge diagnosis code at the index hospitalization.

Results: At discharge, 17% of subjects had a substance use disorder diagnosis. These patients had higher rates of recurrent acute care utilization compared to patients without substance use disorder diagnoses (0.63 vs. 0.32 events per subject at 30 days, $p < 0.01$) and increased risk of any recurrent acute care utilization (33% vs. 22% at 30 days, $p < 0.05$). In adjusted Poisson regression models, the incident rate ratio at 30 days was 1.49 (95% confidence interval 1.12 to 1.98) for patients with substance use disorder diagnoses compared to those without. In subgroup analyses, the higher utilization was attributable to those with drug diagnoses or a combination of drug and alcohol diagnoses, but not to those with exclusively alcohol diagnoses.

Conclusions: Medical patients with substance use disorder diagnoses, specifically those with drug use-related diagnoses, have higher rates of recurrent acute care utilization than those without substance use disorder diagnoses.

September 5, 2010

Dear Editors of Drug and Alcohol Dependence:

Please consider our original research manuscript, "Acute care hospital utilization among medical inpatients discharged with a substance use disorder diagnosis" for publication in Drug and Alcohol Dependence.

This study finds increased subsequent acute care utilization among general medical inpatients discharged with a substance use disorder diagnoses compared to inpatients without such a diagnosis. These findings have important implications for the design and implementation of improved discharge planning and coordination for patients with substance use disorder diagnoses.

The work that this manuscript represents has not been published in any media, peer-reviewed or otherwise, other than in abstract form. It is not currently under review at any other journal. All of the authors listed on the manuscript have contributed substantially to the conception, design, collection, analysis or interpretation of the study, have participated in drafting or revising the manuscript and have had final approval of the published version.

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Please contact me if you have any questions or require any additional information.

Sincerely,

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1. Introduction:

Beginning in 2009, the Centers for Medicare and Medicaid Services started requiring all hospitals to regularly report 30 day hospital readmission rates due to the recognition that among medical patients, subsequent emergency department visits and rehospitalization are expensive and potentially preventable events.(Zook et al., 1980; Frankl et al., 1991; Friedman and Basu, 2004; Jencks et al., 2009) If patients with increased risk of subsequent acute care utilization can be identified, it may be possible to target interventions to reduce future utilization. Known risk factors for rehospitalization include prior hospitalization, advanced age, severity of illness, length of stay, low socioeconomic status, depression, health literacy, poor coordination between inpatient and outpatient care, and absence of physician follow-up.(Phillips et al., 1987; Weissman et al., 1994; Librero et al., 1999; van Walraven et al., 2002; Kartha et al., 2007; Jasti et al., 2008; Capelastegui et al., 2009; Mitchell et al., 2010)

Substance use might be an additional factor undermining discharge planning and leading to the need to return for acute care services.(Strunin et al., 2007) Substance use disorders are generally associated with high rates of emergency department visits and inpatient hospitalizations.(Stein et al., 1993; Cherpitel, 2003; Masson et al., 2004; Rockett et al., 2005)The problem of rehospitalizations among patients with substance use has been examined in specific populations and has shown mixed results. Several studies of psychiatric inpatients have demonstrated higher rates of rehospitalization among patients with both alcohol and drug use disorders compared to those without substance

use disorders.(Bimerew et al., 2007; Lin et al., 2007; Prince et al., 2008; Prince et al., 2009) One retrospective study of AIDS patients admitted for pneumonia prior to the availability of antiretroviral therapy identified crack cocaine use, but neither injection drug use nor alcoholism, as a strong predictor of rehospitalization.(Grant et al., 1999) Another study, conducted after the availability of antiretroviral therapy, found no association between injection drug use and rehospitalization.(Palepu et al., 2003b) A prospective cohort study among 144 medical inpatients did not find a significant association between alcohol or drug use disorders on screening instruments and rehospitalization, though the frequency of drug use disorders was low.(Karthi et al., 2007) In studies among patients with known drug use disorders, engagement in addiction and medical care treatment has been associated with lower rehospitalisation rates (Laine et al., 2001) and repeated emergency department use.(Laine et al., 2005) Several previous intervention trials targeting rehospitalization among medical patients have usually either excluded subjects with alcohol or drug use(Hughes et al., 2000; Fine et al., 2003; Stone et al., 2005) or have not examined it as a potentially contributing factor.(Evans and Hendricks, 1993; Fitzgerald et al., 1994; Siu et al., 1996; Naylor et al., 1999; Andersen et al., 2000; Dudas et al., 2001; Phillips et al., 2004; Shepperd et al., 2004; Holland et al., 2005; Coleman et al., 2006; Balaban et al., 2008)

Project RED, a randomized trial of re-engineered discharge services in 738 hospitalized general medical patients, demonstrated reduced hospital utilization and reduced costs within 30 days of discharge with a package of pre-

discharge services, a patient-centered comprehensive after-hospital care plan and a post-discharge follow-up phone call with a clinical pharmacist.(Jack et al., 2009) We used data from this study to determine whether substance use disorder diagnoses are associated with subsequent emergency department visits and rehospitalization.

2. Methods:

2.1 Study Design and Population

In order to determine whether a substance use diagnosis during an acute medical hospitalization is associated with recurrent acute care hospital utilization, we conducted an observational cohort study using data collected for the Project RED study which has been described in detail.(Jack et al., 2009) Project RED was a randomized, controlled trial of a package of services to improve the discharge process and included 738 adults (age \geq 18 years), admitted to the medical teaching service of Boston Medical Center in Boston, Massachusetts, from January 2006 through October 2007. Patients had to have a telephone, plan to live in the United States after discharge, and be able to provide informed consent in English. Patients were excluded if they were on hospital precautions or suicide watch, transferred from another medical facility, admitted for a planned procedure, or were deaf or blind. This study was approved by the institutional review board of Boston Medical Center and all patients provided informed consent.

2.2 Data Collection and Measures

Data were collected via private in-person interviews at study recruitment during the index hospitalization. Follow-up utilization was determined by querying the Boston Medical Center electronic medical record at 30 days after discharge. A telephone interview was conducted at 30 days after discharge to inquire about any inpatient utilization outside the Boston Medical Center system and the discharge and follow-up care process.

The primary independent variable of interest was presence of a substance use disorder defined by discharge ICD9 diagnosis code for the index hospitalization. Discharge diagnostic codes were assigned by the treating physicians who authored each discharge summary. We searched both primary and secondary discharge codes. Each discharge record could include up to 4 primary diagnosis codes and an unlimited number of secondary codes.

Diagnostic codes included: 303 (alcohol dependence), 305.0 (alcohol abuse), 291 (alcohol induced mental disorders), 304 (drug dependence), 305.2-305.7, 305.9 (drug abuse) and 292 (drug-induced mental disorders). For exploratory analyses, the substance use disorders variable was split into 3 categories: alcohol diagnosis only, drug diagnosis only, and concurrent alcohol and drug diagnoses.

The main outcomes of interest were: (1) *Rate* of recurrent acute care utilization - defined as the total number of emergency department visits and rehospitalizations per subject within 30 days of the index discharge, and (2) *Risk* of recurrent acute care utilization – defined as the proportion of subjects with an emergency department visit or rehospitalization within 30 days of the index

discharge. An emergency department visit that led to a rehospitalization was counted only once as a rehospitalization. This outcome was determined by medical record review for utilizations occurring at Boston Medical Center and the 30 day phone interview for utilizations elsewhere. Self-report has demonstrated reliability for hospitalization events.(Weissman et al., 1996; Wolinsky et al., 2007)

To describe this sample and to control for potential confounding in multivariable models, we assessed covariates with known associations with rehospitalization in prior studies or that we suspected clinically may be associated. Covariates that were collected by interview at recruitment included age, gender, race/ethnicity, having a PCP, depression symptoms, homelessness in the last 3 months, and employment. Covariates that were collected via medical record review included insurance status and the Charlson Comorbidity Index score. Project RED group assignment was also recorded. Depression was determined using the depression subscale of the Patient Health Questionnaire (PHQ-9): 9-item 4-point Likert scale, standard scoring algorithm to screen for major depression and depressive symptoms.(Kroenke et al., 2001) For the insurance covariate, Free Care refers to a Massachusetts state program for uninsured patients who are not eligible for medicaid. The Charlson Comorbidity Index was used to reflect patients' level of comorbid illnesses. The Charlson Index has been validated to predict risk of mortality based on 22 disease conditions.(Charlson et al., 1987)

2.3 Analyses

For descriptive purposes, all independent variables of interest were stratified by substance use disorder status. Comparisons in Table 1 were conducted using t-tests for continuous variables and chi square tests for categorical variables.

Poisson and binomial regression models were used, respectively, to examine the association of a substance use disorder with *rate* (number of events per subject) and *risk* (proportion of subjects with any event) of acute care hospital utilization. Poisson regression accommodates recurrent outcomes over follow-up allowing for calculation of incident rate ratios. Model fit was assessed by calculating deviances which were no greater than 1.06. We conducted these models with the inclusion of all covariates above, except race/ ethnicity and group assignment. Race/ethnicity was not included in adjusted models because this variable had a similar distribution in both groups. Charlson Comorbidity Index score was included because, while not associated statistically with substance use disorder, medical comorbidities are a known important strong predictor of rehospitalization.(Jasti et al., 2008; Capelastegui et al., 2009) To determine whether any association between substance use disorder and utilization was modified by assignment to the Project RED intervention, additional models were also adjusted for group assignment, as well as models including an interaction term between Project RED assignment and substance use diagnosis. As a secondary analysis, to explore the relative contributions from alcohol disorders and drug disorders, an additional set of models were constructed for three subsets of the population with substance use disorder diagnoses (alcohol

disorder only, drug disorder only, both alcohol and drug disorder) and were each compared to subjects with no substance use disorders.

All analyses were performed using S-Plus, version 8.0 (Insightful, Seattle, Washington).

3. Results:

Among 738 subjects in the Project Red cohort, 123 (17%) subjects had at least one substance use discharge diagnosis. Characteristics of the cohort, stratified by substance use disorder status are in Table 1. Subjects with a substance use disorder were more likely to be male, have Medicaid, be unemployed or disabled, be homeless, and screen positive for major depression. They were less likely to have a primary care physician at enrollment.

Subjects with substance use disorders had higher rates of acute care service re-utilization, including ED visits and rehospitalizations, at 30 days. The proportions of subjects who were rehospitalized or visited the ED were also higher. (Table 2)

In models adjusted for age, gender, depressive symptoms, having a PCP, insurance, homelessness in the last 3 months, employment, and the Charlson score, the incidence rate ratios for overall acute care re-utilization and re-hospitalization, but not ED visits, remained statistically significant. (Table 3) T odds ratios for the 30-day risk of utilization were higher in subjects with substance use diagnoses but not statistically significant. Adding Project RED group assignment to the models did not change the findings. In addition, the

interaction term for Project RED group assignment and substance use diagnosis was not significant (data not shown).

To assess the relative contributions of alcohol and drug diagnoses to the associations with acute care hospital re-utilization, we ran models with subcategories of substance use diagnoses. (Table 4) The group with exclusively an alcohol diagnosis did not have a higher rate or risk of re-utilization at 30 days in adjusted models. For the patients with both a drug and alcohol diagnosis or with exclusively a drug diagnosis, the rate and risk of re-utilization at 30 days is higher and statistically significant.

4. Discussion:

Within the Project RED cohort of general medical patients, 17% had a substance use diagnosis recorded upon discharge. Subjects with a substance use diagnosis were more likely to re-utilize and re-utilized more often at 30 days than those without a substance use diagnosis. In analyses adjusted for known re-utilization risk factors, these associations were attenuated, yet sustained for the rate of re-utilization. In subgroup analyses, these associations were attributable to subjects with drug only or drug and alcohol diagnoses and not due to subjects with exclusively an alcohol diagnosis.

By demonstrating that patients with substance use diagnoses, specifically drug use diagnoses, have higher acute care hospital re-utilization, this study demonstrates the need for tailored re-engineered discharge programs that could augment Project RED services and further reduce subsequent utilization among

patients with substance use disorders. Previous research, among patients with substance use disorders, has demonstrated that factors affecting acute care utilization include co-occurring medical and mental health conditions, engagement in primary care and substance use treatment.(Stenbacka et al., 1998; Parthasarathy et al., 2001; Weisner et al., 2001; Palepu et al., 2003a; Saxon et al., 2006; Gourevitch et al., 2007; Stecker et al., 2007) Services tailored to the needs of substance users could include initiation of addiction pharmacotherapy during hospitalization and facilitated linkage to outpatient mental health, medical, and addiction treatment.(Shanahan et al., 2010)

Discharge interventions targeting specific patient populations have been shown to be effective and cost saving for geriatric, stroke and congestive heart failure patients.(Naylor et al., 1999; Andersen et al., 2000; Phillips et al., 2004; Coleman et al., 2006) In the setting of United States Preventive Services Task Force recommendations to provide screening and behavioral counseling for unhealthy alcohol use in primary care settings(U.S. Preventive Services Task Force, 2004) and the Substance Abuse Mental Health Services Administration's efforts to expand screening and brief interventions for alcohol and drug misuse in many healthcare settings, including inpatient settings(Madras et al., 2009), it is likely that substantially more inpatients will be identified with substance use disorders and targeted for brief interventions. However, studies of brief interventions alone for substance use in inpatients have found little or no effects on substance use outcomes, (Saitz et al., 2007; Freyer-Adam et al., 2008; McQueen et al., 2009) except in alcohol-using trauma patients. One trial found a

strong effect of brief interventions for alcohol use on re-hospitalization among trauma patients with alcohol use, (Gentilello et al., 1999) whereas another trial did not find an effect. (Sommers et al., 2006) For the medically ill inpatient with a substance use disorder, it may be more effective for interventions to focus on engagement in integrated outpatient medical and addiction care,(Laine et al., 2001; Laine et al., 2005) in order to reduce inpatient utilization and fulfill the medical discharge plan.

The results of the subgroup analyses demonstrating an association with drug only and drug and alcohol disorders, but not alcohol only disorders, was unexpected. Drug use disorders may have medical complications that are more acutely manifested in a 30 day period, whereas the chronic nature of the medical complications of alcohol use may require longer follow-up to detect utilization differences. Also the sensitivity of discharge diagnoses among medical inpatients likely varies between alcohol and drug users. While the general hospitalized population is more likely to have an alcohol use disorder than a drug use disorder, approximately equal numbers of subjects were classified this way via discharge diagnoses.(Table 1) Patients with recognized alcohol use disorders may be more likely than patients with drug use disorders to be admitted to the trauma service than the medicine service. A similar distribution of alcohol and drug disorders has been seen in another study that defined substance use based on diagnostic codes. A cohort study of 129,524 Medicaid enrollees with a mood disorder, where substance use disorder was measured by discharge diagnoses, categorized more subjects with drug use disorders than alcohol disorders (13%

vs. 6%) and the risk of psychiatric rehospitalization at 90 days was higher for both alcohol and drug use disorders (adjusted hazards ratio of 1.46 and 1.58, respectively).(Prince et al., 2009) To better understand the absence of effect for alcohol use disorders in the subanalyses, a larger study with multiple measures of substance use disorder is needed.

This study has several strengths and limitations. We conducted both event and subject level analyses, which allow us to conclude that patients with substance use disorders were more likely to re-utilize and re-utilized more often. The subjects, while limited to one large academic medical center, included general medical patients with relatively few restrictions compared to previous discharge studies which have focused on medical patients with specific age limits, diagnoses or psychiatric patients. The measures of substance use disorders were from discharge ICD9 codes, a crude measure prone to misclassification, yet a practical measure that is universally available for discharged patients. The outcomes were based on self-report and the electronic medical record at 30 days. Each method alone has its limitations, which we mitigated by using both. Previous studies of patient self-report of hospital utilization have demonstrated high concordance with billing databases and chart review.(Weissman et al., 1996; Wolinsky et al., 2007) This study may have underestimated the utilization among substance users because it did not specifically measure non-medical subsequent utilizations such as admissions to psychiatric hospitals and detoxification programs that are likely to be more common among subject with substance use diagnoses. Stronger focus on these

admissions would have likely shown an even stronger association between substance use disorder diagnoses and recurrent acute care utilization.

In this study, we found that medical inpatients with substance use disorder diagnoses, specifically drug use disorder diagnoses, have higher rates of recurrent acute care utilization. In setting of the success of the Project RED intervention, these findings offer promise that feasible and successful interventions can be designed and implemented to reduce costly utilization among medical patients with substance use disorders.

5. References

- Andersen, H.E., Schultz-Larsen, K., Kreiner, S., Forchhammer, B.H., Eriksen, K., Brown, A., 2000. Can readmission after stroke be prevented? Results of a randomized clinical study: a postdischarge follow-up service for stroke survivors. *Stroke*. 31, 1038-1045.
- Balaban, R.B., Weissman, J.S., Samuel, P.A., Woolhandler, S., 2008. Redefining and redesigning hospital discharge to enhance patient care: a randomized controlled study. *J Gen Intern Med*. 23, 1228-1233.
- Bimerew, M.S., Sonn, F.C., Kortenbort, W.P., 2007. Substance abuse and the risk of readmission of people with schizophrenia at Amanuel Psychiatric Hospital, Ethiopia. *Curationis*. 30, 74-81.
- Capelastegui, A., Espana, P.P., Quintana, J.M., Bilbao, A., Diez, R., Pascual, S., Pulido, E., Egurrola, M., 2009. Predictors of Short-term Rehospitalization Following Discharge of Patients Hospitalized With Community-Acquired Pneumonia. *Chest*.
- Charlson, M.E., Pompei, P., Ales, K.L., MacKenzie, C.R., 1987. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis*. 40, 373-383.
- Cherpitel, C.J., 2003. Changes in substance use associated with emergency room and primary care services utilization in the United States general population: 1995-2000. *Am J Drug Alcohol Abuse*. 29, 789-802.
- Coleman, E.A., Parry, C., Chalmers, S., Min, S.J., 2006. The care transitions intervention: results of a randomized controlled trial. *Arch Intern Med*. 166, 1822-1828.
- Dudas, V., Bookwalter, T., Kerr, K.M., Pantilat, S.Z., 2001. The impact of follow-up telephone calls to patients after hospitalization. *Am J Med*. 111, 26S-30S.
- Evans, R.L., Hendricks, R.D., 1993. Evaluating hospital discharge planning: a randomized clinical trial. *Med Care*. 31, 358-370.
- Fine, M.J., Stone, R.A., Lave, J.R., Hough, L.J., Obrosky, D.S., Mor, M.K., Kapoor, W.N., 2003. Implementation of an evidence-based guideline to reduce duration of intravenous antibiotic therapy and length of stay for patients hospitalized with community-acquired pneumonia: a randomized controlled trial. *Am J Med*. 115, 343-351.
- Fitzgerald, J.F., Smith, D.M., Martin, D.K., Freedman, J.A., Katz, B.P., 1994. A case manager intervention to reduce readmissions. *Arch Intern Med*. 154, 1721-1729.
- Frankl, S.E., Breeling, J.L., Goldman, L., 1991. Preventability of emergent hospital readmission. *Am J Med*. 90, 667-674.
- Freyer-Adam, J., Coder, B., Baumeister, S.E., Bischof, G., Riedel, J., Paatsch, K., Wedler, B., Rumpf, H.J., John, U., Hapke, U., 2008. Brief alcohol

- intervention for general hospital inpatients: a randomized controlled trial. *Drug Alcohol Depend.* 93, 233-243.
- Friedman, B., Basu, J., 2004. The rate and cost of hospital readmissions for preventable conditions. *Med Care Res Rev.* 61, 225-240.
- Gentilello, L.M., Rivara, F.P., Donovan, D.M., Jurkovich, G.J., Daranciang, E., Dunn, C.W., Villaveces, A., Copass, M., Ries, R.R., 1999. Alcohol interventions in a trauma center as a means of reducing the risk of injury recurrence. *Ann Surg.* 230, 473-80.
- Gourevitch, M.N., Chatterji, P., Deb, N., Schoenbaum, E.E., Turner, B.J., 2007. On-site medical care in methadone maintenance: associations with health care use and expenditures. *J Subst Abuse Treat.* 32, 143-151.
- Grant, R.W., Charlebois, E.D., Wachter, R.M., 1999. Risk factors for early hospital readmission in patients with AIDS and pneumonia. *J Gen Intern Med.* 14, 531-536.
- Holland, R., Lenaghan, E., Harvey, I., Smith, R., Shepstone, L., Lipp, A., Christou, M., Evans, D., Hand, C., 2005. Does home based medication review keep older people out of hospital? The HOMER randomised controlled trial. *BMJ.* 330, 293.
- Hughes, S.L., Weaver, F.M., Giobbie-Hurder, A., Manheim, L., Henderson, W., Kubal, J.D., Ulasevich, A., Cummings, J., Department of Veterans Affairs Cooperative Study Group on Home-Based Primary Care, 2000. Effectiveness of team-managed home-based primary care: a randomized multicenter trial. *JAMA.* 284, 2877-2885.
- Jack, B.W., Chetty, V.K., Anthony, D., Greenwald, J.L., Sanchez, G.M., Johnson, A.E., Forsythe, S.R., O'Donnell, J.K., Paasche-Orlow, M.K., Manasseh, C., Martin, S., Culpepper, L., 2009. A reengineered hospital discharge program to decrease rehospitalization: a randomized trial. *Ann Intern Med.* 150, 178-187.
- Jasti, H., Mortensen, E.M., Obrosky, D.S., Kapoor, W.N., Fine, M.J., 2008. Causes and risk factors for rehospitalization of patients hospitalized with community-acquired pneumonia. *Clin Infect Dis.* 46, 550-556.
- Jencks, S.F., Williams, M.V., Coleman, E.A., 2009. Rehospitalizations among patients in the Medicare fee-for-service program. *N Engl J Med.* 360, 1418-1428.
- Kartha, A., Anthony, D., Manasseh, C.S., Greenwald, J.L., Chetty, V.K., Burgess, J.F., Culpepper, L., Jack, B.W., 2007. Depression Is a Risk Factor for Rehospitalization in Medical Inpatients. *Prim Care Companion J Clin Psychiatry.* 9, 256-262.
- Kroenke, K., Spitzer, R.L., Williams, J.B., 2001. The PHQ-9: validity of a brief depression severity measure. *J Gen Intern Med.* 16, 606-613.

- Laine, C., Hauck, W.W., Gourevitch, M.N., Rothman, J., Cohen, A., Turner, B.J., 2001. Regular outpatient medical and drug abuse care and subsequent hospitalization of persons who use illicit drugs. *JAMA*. 285, 2355-2362.
- Laine, C., Lin, Y.T., Hauck, W.W., Turner, B.J., 2005. Availability of medical care services in drug treatment clinics associated with lower repeated emergency department use. *Med Care*. 43, 985-995.
- Librero, J., Peiro, S., Ordinana, R., 1999. Chronic comorbidity and outcomes of hospital care: length of stay, mortality, and readmission at 30 and 365 days. *J Clin Epidemiol*. 52, 171-179.
- Lin, C.H., Chen, Y.S., Lin, C.H., Lin, K.S., 2007. Factors affecting time to rehospitalization for patients with major depressive disorder. *Psychiatry Clin Neurosci*. 61, 249-254.
- Madras, B.K., Compton, W.M., Avula, D., Stegbauer, T., Stein, J.B., Clark, H.W., 2009. Screening, brief interventions, referral to treatment (SBIRT) for illicit drug and alcohol use at multiple healthcare sites: comparison at intake and 6 months later. *Drug Alcohol Depend*. 99, 280-295.
- Masson, C.L., Sorensen, J.L., Phibbs, C.S., Okin, R.L., 2004. Predictors of medical service utilization among individuals with co-occurring HIV infection and substance abuse disorders. *AIDS Care*. 16, 744-755.
- McQueen, J., Howe, T.E., Allan, L., Mains, D., 2009. Brief interventions for heavy alcohol users admitted to general hospital wards. *Cochrane Database Syst Rev*. (3), CD005191.
- Mitchell, S.E., Paasche-Orlow, M.K., Forsythe, S.R., Chetty, V.K., O'Donnell, J.K., Greenwald, J.L., Culpepper, L., Jack, B.W., 2010. Post-discharge hospital utilization among adult medical inpatients with depressive symptoms. *J Hosp Med*.
- Naylor, M.D., Brooten, D., Campbell, R., Jacobsen, B.S., Mezey, M.D., Pauly, M.V., Schwartz, J.S., 1999. Comprehensive discharge planning and home follow-up of hospitalized elders: a randomized clinical trial. *JAMA*. 281, 613-620.
- Palepu, A., Horton, N.J., Tibbetts, N., Dukes, K., Meli, S., Samet, J.H., 2003a. Substance abuse treatment and emergency department utilization among a cohort of HIV-infected persons with alcohol problems. *J Subst Abuse Treat*. 25, 37-42.
- Palepu, A., Sun, H., Kuyper, L., Schechter, M.T., O'Shaughnessy, M.V., Anis, A.H., 2003b. Predictors of early hospital readmission in HIV-infected patients with pneumonia. *J Gen Intern Med*. 18, 242-247.
- Parthasarathy, S., Weisner, C., Hu, T.W., Moore, C., 2001. Association of outpatient alcohol and drug treatment with health care utilization and cost: revisiting the offset hypothesis. *J Stud Alcohol*. 62, 89-97.

- Phillips, C.O., Wright, S.M., Kern, D.E., Singa, R.M., Shepperd, S., Rubin, H.R., 2004. Comprehensive discharge planning with postdischarge support for older patients with congestive heart failure: a meta-analysis. *JAMA*. 291, 1358-1367.
- Phillips, R.S., Safran, C., Cleary, P.D., Delbanco, T.L., 1987. Predicting emergency readmissions for patients discharged from the medical service of a teaching hospital. *J Gen Intern Med*. 2, 400-405.
- Prince, J.D., Akincigil, A., Hoover, D.R., Walkup, J.T., Bilder, S., Crystal, S., 2009. Substance abuse and hospitalization for mood disorder among Medicaid beneficiaries. *Am J Public Health*. 99, 160-167.
- Prince, J.D., Akincigil, A., Kalay, E., Walkup, J.T., Hoover, D.R., Lucas, J., Bowblis, J., Crystal, S., 2008. Psychiatric rehospitalization among elderly persons in the United States. *Psychiatr Serv*. 59, 1038-1045.
- Rockett, I.R., Putnam, S.L., Jia, H., Chang, C.F., Smith, G.S., 2005. Unmet substance abuse treatment need, health services utilization, and cost: a population-based emergency department study. *Ann Emerg Med*. 45, 118-127.
- Saitz, R., Palfai, T.P., Cheng, D.M., Horton, N.J., Freedner, N., Dukes, K., Kraemer, K.L., Roberts, M.S., Guerriero, R.T., Samet, J.H., 2007. Brief intervention for medical inpatients with unhealthy alcohol use: a randomized, controlled trial. *Ann.Intern.Med*. 146, 167-176.
- Saxon, A.J., Malte, C.A., Sloan, K.L., Baer, J.S., Calsyn, D.A., Nichol, P., Chapko, M.K., Kivlahan, D.R., 2006. Randomized trial of onsite versus referral primary medical care for veterans in addictions treatment. *Med Care*. 44, 334-342.
- Shanahan, C.W., Beers, D., Alford, D.P., Brigandi, E., Samet, J.H., 2010. A Transitional Opioid Program to Engage Hospitalized Drug Users. *J Gen Intern Med*.
- Shepperd, S., Parkes, J., McClaren, J., Phillips, C., 2004. Discharge planning from hospital to home. *Cochrane Database Syst Rev*. (1), CD000313.
- Siu, A.L., Kravitz, R.L., Keeler, E., Hemmerling, K., Kington, R., Davis, J.W., Mitchell, A., Burton, T.M., Morgenstern, H., Beers, M.H., Reuben, D.B., 1996. Postdischarge geriatric assessment of hospitalized frail elderly patients. *Arch Intern Med*. 156, 76-81.
- Sommers, M.S., Dyehouse, J.M., Howe, S.R., Fleming, M., Fargo, J.D., Schafer, J.C., 2006. Effectiveness of brief interventions after alcohol-related vehicular injury: A randomized controlled trial. *J Trauma*. 61, 523-31; discussion 532-3.
- Stecker, T., Curran, G.M., Han, X., Booth, B.M., 2007. Patterns of health services use associated with Veterans Affairs outpatient substance-use treatment. *J Stud Alcohol Drugs*. 68, 510-518.

- Stein, M.D., O'Sullivan, P.S., Ellis, P., Perrin, H., Wartenberg, A., 1993. Utilization of medical services by drug abusers in detoxification. *J Subst Abuse*. 5, 187-193.
- Stenbacka, M., Leifman, A., Romelsjo, A., 1998. The impact of methadone on consumption of inpatient care and mortality, with special reference to HIV status. *Subst Use Misuse*. 33, 2819-2834.
- Stone, R.A., Mor, M.K., Lave, J.R., Hough, L.J., Fine, M.J., 2005. Implementation of an inpatient management and discharge strategy for patients with community-acquired pneumonia. *Am J Manag Care*. 11, 491-499.
- Strunin, L., Stone, M., Jack, B., 2007. Understanding rehospitalization risk: can hospital discharge be modified to reduce recurrent hospitalization? *J Hosp Med*. 2, 297-304.
- U.S. Preventive Services Task Force, 2004. Screening and behavioral counseling interventions in primary care to reduce alcohol misuse: recommendation statement. *Ann Intern Med*. 140, 554-556.
- van Walraven, C., Seth, R., Austin, P.C., Laupacis, A., 2002. Effect of discharge summary availability during post-discharge visits on hospital readmission. *J Gen Intern Med*. 17, 186-192.
- Weisner, C., Mertens, J., Parthasarathy, S., Moore, C., Lu, Y., 2001. Integrating primary medical care with addiction treatment: a randomized controlled trial. *JAMA*. 286, 1715-23.
- Weissman, J.S., Levin, K., Chasan-Taber, S., Massagli, M.P., Seage, G.R., 3rd, Scampini, L., 1996. The validity of self-reported health-care utilization by AIDS patients. *AIDS*. 10, 775-783.
- Weissman, J.S., Stern, R.S., Epstein, A.M., 1994. The impact of patient socioeconomic status and other social factors on readmission: a prospective study in four Massachusetts hospitals. *Inquiry*. 31, 163-172.
- Wolinsky, F.D., Miller, T.R., An, H., Geweke, J.F., Wallace, R.B., Wright, K.B., Chrischilles, E.A., Liu, L., Pavlik, C.B., Cook, E.A., Ohsfeldt, R.L., Richardson, K.K., Rosenthal, G.E., 2007. Hospital episodes and physician visits: the concordance between self-reports and medicare claims. *Med Care*. 45, 300-307.
- Zook, C.J., Savickis, S.F., Moore, F.D., 1980. Repeated hospitalization for the same disease: a multiplier of national health costs. *Milbank Mem Fund Q Health Soc*. 58, 454-471.

Table 1. Characteristics of Project RED study participants

Characteristics	No substance use (n=615)	Substance use (n=123)	P-value	*
Age in years, mean (SD)	50.2 (15.8)	47.8 (11.4)	0.06	N
Gender, No. (%)				o
Male	287 (47%)	80 (65%)	<0.01	t
Race, * No. (%)				a
White non-Hispanic	168 (27%)	37 (30%)	0.91	l
Black non-Hispanic	326 (53%)	60 (49%)		l
Hispanic	60 (10%)	14 (11%)		c
Other race or mixed race	13 (2.1%)	3 (2.4%)		o
Health insurance, No. (%)				l
Private	108 (18%)	11 (9.0%)	<0.01	u
Medicaid	274 (45%)	82 (67%)		m
Medicare	89 (15%)	9 (7.4%)		n
Free Care [†]	137 (23%)	20 (16%)		p
Current employment status, No. (%)				e
Full time	159 (26%)	19 (5.0%)	<0.01	r
Part time	77 (13%)	10 (8.1%)		c
Retired	116 (19%)	15 (12%)		e
Disabled	124 (20%)	40 (33%)		n
Unemployed	106 (17%)	36 (29%)		t
Other	29 (4.7%)	3 (2.4%)		a
Homeless in last 3 months, No. (%)	51 (8.1%)	24 (20%)	<0.01	g
PCP at enrollment, No (%)	506 (82%)	89 (72%)	0.01	e
Major depression, * No (%)	85 (14%)	35 (29%)	<0.01	s
RED intervention group, No (%)	313 (51%)	57 (46%)	0.36	u
Charlson comorbidity score, mean (SD)	1.2 (1.9)	1.3 (2.2)	0.61	m
Length of stay in days, mean (SD)	2.7 (3.2)	2.6 (2.5)	0.82	t
Alcohol use diagnosis only	-	54 (44%)	-	o
Drug use diagnosis only	-	52 (42%)	-	1
Alcohol and drug diagnoses	-	17 (11%)	-	0
				0
				%

due to missing values.

† Free Care is a means-tested Massachusetts state program for patients not eligible for Medicaid.

** Determined using Patient Health Questionnaire (PHQ-9): 9-item 4-point Likert scale, standard scoring algorithm to screen for major depression and depressive symptoms.

Table 2. Crude rates and risks of recurrent acute care hospital utilization within 30 after index hospitalization

	No substance use (n=615)	Substance use (n=123)	P- value
30-day rates of re-utilization:			
No. visits/patient: acute care re-utilizations*	0.32	0.63	<0.01
No. visits/patient: ED [†] visits	0.16	0.37	0.02
No. visits/patient: rehospitalization	0.16	0.26	0.09
30-day risks of re-utilization:			
Subjects with any acute care re-utilization*	38%	52%	<0.01
Subjects with any ED [†] visit	23%	34%	<0.01
Subjects with any rehospitalization	23%	33%	0.02

* Defined as sum of emergency department visits plus rehospitalizations. Note, an emergency department visit that leads to a rehospitalization is counted only as a rehospitalization.

† ED refers to emergency department visit

Table 3. Adjusted Incident Rate (IRR) and Odds (OR) Ratios for the rates and risks of recurrent acute care hospital utilization within 30 days after index hospitalization

	Adjusted IRR (95% CI)[†]	
	No substance use diagnosis (n=615)	Substance use diagnosis (n=123)
30-day rates of re-utilization:		
No. visits/patient: acute care re-utilizations*	REF	1.49 (1.12 , 1.98)
No. visits/patient: ED [‡] visits	REF	1.42 (0.97 , 2.07)
No. visits/patient: rehospitalization	REF	1.60 (1.04 , 2.46)
	Adjusted OR (95% CI)[†]	
30-day risks of re-utilization:		
Subjects with any acute care re-utilization*	REF	1.38 (0.88 , 2.17)
Subjects with any ED [‡] visit	REF	1.22 (0.70 , 2.12)
Subjects with any rehospitalization	REF	1.71 (1.00 , 2.94)

* Defined as sum of emergency department visits plus rehospitalizations. Note, an emergency department visit that leads to a rehospitalization is counted only as a rehospitalization.

† Covariates for adjustment include age, gender, depressive symptoms, having a PCP, insurance, homelessness in the last 3 months, employment, and the Charlson score.

‡ ED refers to emergency department visit

Table 4. Adjusted Incident Rate (IRR) and Odds (OR) Ratios for the rate and risk of recurrent acute care hospital utilization within 30 days after index hospitalization among patients with alcohol only, drug only, and both alcohol and drug diagnoses compared to patients without substance use diagnoses

Adjusted IRR (95% CI)[†]				
	No substance use diagnosis (n=615)	Alcohol diagnosis only (n=54)	Drug diagnosis only (n=52)	Both alcohol and drug diagnoses (n=17)
30 day rate of re-utilization:				
No. visits/patient: acute care re-utilizations*	REF	1.00 (0.64, 1.57)	1.78 (1.23, 2.56)	2.17 (1.29, 3.67)
Adjusted OR (95% CI)[†]				
30 day risk of re-utilization:				
Subjects with any acute care re-utilization*	REF	0.82 (0.41, 1.66)	1.97 (1.06, 3.63)	1.91 (0.69, 5.24)

* Defined as sum of emergency department visits plus rehospitalizations. Note an emergency department visit that leads to a rehospitalization is counted only as a rehospitalization.

† Covariates for adjustment include age, gender, depressive symptoms, having a PCP, insurance, homelessness in the last 3 months, employment, and the Charlson score

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Contributors: Authors Walley, Paasche-Orlow, and Jack conceived and designed the study. Authors Lee and Chetty undertook the statistical analyses. Author Walley wrote the first draft of the manuscript and managed the submission. All authors contributed to the writing and editing of the final manuscript and have approved it.

Potential Conflicts of Interest

Dr. Walley owns stock in Heineken Holding.

Dr. Paasche-Orlow has served as a consultant for Engineered Care, Inc. Engineered Care, Inc. has a license from Boston University to commercialize Project ReEngineered Discharge (RED), in which royalties are distributed.

Dr. Mitchell has received honoraria as a speaker on cultural competency for Merck and Co. No product promotion or disease/ treatment related programs were done.

Dr. Jack is part of a licensing agreement between Boston University and Engineered Care, Inc., in which royalties are distributed.

All other authors declare that they have no conflicts of interest.