Screening for Unhealthy Alcohol Use: Associations with Health Care Utilization, Costs, and Health-Related Quality of Life

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Abstract

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Background. Hospital readmissions and emergency department (ED) visits within 30 days of discharge are common among older adults. Unhealthy alcohol use could be a risk factor due to greater risk for injuries, poorer medication adherence and self-care, and medication interactions. As alcohol screening becomes more widely implemented, research is needed to determine whether screening results could identify patients at risk for post-discharge acute care and expenditures, and who may benefit from post-discharge interventions. Cost utility analyses (CUA) could help health care systems determine how to invest scarce resources. However, CUAs for alcohol interventions are limited due to the lack of preference weights for the full spectrum of alcohol use. **Objectives.** Research objectives are to 1) examine the association

between unhealthy alcohol use and 30-day readmissions and ED visits, 2) examine the association between unhealthy alcohol use and 30-day acute care expenditures, and 3) estimate preference weights for the spectrum of alcohol use in the U.S. population. **Methods.** Objectives 1 and 2 were conducted among 579,330 older VA patients hospitalized for a medical/surgical condition who were screened for unhealthy alcohol use in the year prior to hospitalization. Objective 3 was conducted among 17,440 respondents to the National Health Interview and Medical Expenditure Panel Surveys. Adjusted preference-weights for two health-related quality of life (HRQOL) measures were estimated for different categories of alcohol use. **Results.** High-risk drinking was associated with increased risk for readmissions relative to low-risk drinking, but only among medical inpatients and not after adjusting for differences in SES and social support. High-risk drinking in medical inpatients was associated with increased acute care utilization but not increased acute care expenditures in the 30 days post-discharge. Nondrinking was associated with increased risk for readmissions, ED visits, and acute care expenditures. Preference weights did not differ with respect to low-risk drinking, with the exception of nondrinking and moderate-risk drinking. **Conclusions**. Patients with high-risk drinking based on alcohol screening results may not need targeting for post-discharge interventions. Self-reported unhealthy alcohol use may not be associated with poorer HRQOL, but lack of differences could also reflect the insensitivity of generic HRQOL measures to alcohol-specific domains.

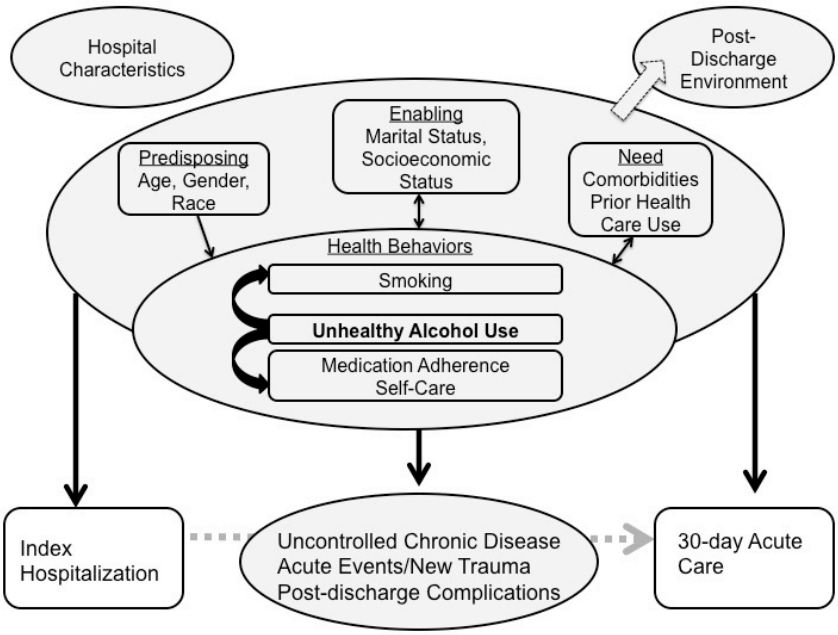
Introduction

Reducing unnecessary acute care utilization following hospital discharge is a health care quality improvement and patient safety priority. Nearly 20% of Medicare patients who are discharged from the hospital for a medical or surgical condition are readmitted within 30 days,[1] and a large portion of these patients visit emergency departments (ED) during the same period.[2] The Centers for Medicare & Medicaid Services (CMS) recently introduced policies to reduce readmissions, including the Readmissions Reduction Program[3] and implementation of care coordination for discharged patients.[4] However, the benefits of care coordination interventions for reducing readmissions in research settings[5-7] may not translate to real world hospital initiatives.[8] Limitations to the success of such programs outside research settings could be influenced by patient characteristics that are important predictors of hospital outcomes, but are not modifiable characteristics and are beyond the control of hospitals (e.g. patient comorbidities, socioeconomic status, or demographics).[9-11]

Unhealthy alcohol use[12] is one patient-level risk factor that is potentially modifiable, could be effectively managed through evidence-based treatments,[13-15] and is often overlooked among hospitalized patients.[16] Unhealthy alcohol use represents a spectrum ranging from drinking above recommended limits to meeting criteria for alcohol use disorders (AUD).[12] Approximately 28% of U.S. adults have unhealthy alcohol use and although alcohol use decreases with age, nearly one third of Medicare beneficiaries consume alcohol and 9% drink at unhealthy levels (16% men, 4% women).[17,18] Although low-level drinking is associated with some cardiovascular and survival benefits,[19,20] these benefits diminish rapidly and are reversed with greater levels of alcohol consumption.[21,22] Even moderate amounts of alcohol can be harmful for some older adults with health conditions that can be worsened due to drinking (e.g.

hypertension, gastrointestinal conditions, depression, liver disease).[23] Nearly 30% of older adults who drink alcohol take medications that are known to interact with alcohol.[24] Despite greater sensitivity to alcohol and the potential for adverse health outcomes, clinicians are less likely to discuss alcohol with their older patients,[25] even among those who are taking medications that can interact with alcohol.[26] If routinely collected outpatient alcohol screening results are available to hospitals through electronic medical records, this information could be used to identify patients with unhealthy alcohol use who may be at greater risk for readmissions and might benefit from post-discharge interventions.

Figure. Conceptual Model for the Association of Unhealthy Alcohol Use with 30-day Post-discharge Acute Care



Conceptual Framework

Hospitalized patients with unhealthy alcohol use may be at risk of poor outcomes following inpatient care that require acute care utilization within 30-days of discharge (Figure). The conceptual framework guiding the research is adapted from Andersen's Behavioral Model of Health Services Use.[27] Unhealthy alcohol use is conceptualized as a health behavior that

determines use of health services, and ultimately influences outcomes of care (e.g. 30-day post-discharge acute care). Consistent with Andersen's model, evidence suggests that many patient-level predisposing (e.g. older age, male gender, Black race), enabling (e.g. unmarried, lower socioeconomic status), and need characteristics (e.g. comorbidities, prior health care use) that are known to influence initial hospitalization, also influence 30-day acute care utilization following discharge.[9,11,28] Unhealthy alcohol use is associated with many of these characteristics. Patients with unhealthy alcohol use tend to be younger, male, unmarried, have lower health status, and lower socioeconomic status.[29-31] Unhealthy alcohol use is also associated with acute care utilization.[32-34] After hospital discharge, patients may seek acute care due to uncontrolled chronic disease, acute events, or post-discharge complications.[35] Unhealthy alcohol use could contribute to 30-day acute care utilization through these mechanisms in several ways. First, unhealthy alcohol use is associated with other health risk behaviors such as smoking,[31,36] poor medication adherence,[37,38] and poor self-care,[39,40] which can lead to suboptimal control of chronic conditions. Second, acute intoxication[41] or alcohol-related interactions with medications[23] could increase risk for falls or other new trauma. Unhealthy alcohol use is associated with poor wound healing and suppressed immune response,[42,43] as well as greater risk for surgical complications[44] and hospital-acquired conditions.[45,46] These vulnerabilities could put patients at increased risk for post-discharge complications. The post-discharge environment, or the living conditions patients return to after discharge, is another important contributor to risk for readmissions.[9] Patients' enabling resources such as marital status, which influence whether patients live alone, may be another indirect pathway through which unhealthy alcohol use could increase risk for readmissions. Hospital characteristics are also important for determining the quality of care patients receive and whether patient health behaviors are documented in health

records. Hospitals' varying approaches to alcohol screening[47] may explain known differences in the detection of unhealthy alcohol use.[48]

Previous Research

Although some previous studies have evaluated the association of unhealthy alcohol use with readmissions,[49-51] none have used alcohol screening results collected as part of routine outpatient care. Diagnoses of AUD or alcohol-related conditions under-identify patients with unhealthy alcohol use[16] and this may have limited prior research, which has found mixed associations with risk for readmissions.[49,52] Associations of patient-reported unhealthy alcohol use, based on alcohol screening measures, with risk for readmissions have not been significant in prior studies.[50,51] However, one prior study included a small sample of patients recruited to a randomized trial and may have been under-powered to detect small to moderate associations.[51] A second study used alcohol screening results collected through mailed surveys,[50] but patients with severe unhealthy alcohol use may be less likely to respond to mailed surveys.[53] However, the Veterans Affairs (VA) Health Care System has achieved high rates of annual outpatient alcohol screening and results are available in electronic medical records,[54] providing a unique opportunity to examine their potential association with adverse post-discharge outcomes.

Health care systems seeking to determine how to invest scare resources for prevention that can improve patient outcomes, such as interventions to address unhealthy alcohol use, could benefit from economic evaluations of alcohol interventions. Although some economic evaluations have evaluated the cost-effectiveness of improving drinking outcomes, few have conducted cost-utility analyses.[55] The advantage of CUAs is that a common metric is used—the QALY—which allows for comparison of cost-effectiveness of interventions targeting different conditions. However, a barrier to CUAs for alcohol interventions is the lack of preference

weights for the full spectrum of alcohol use. Previous studies have developed preference weights in population-based samples in rural Australia,[56] England,[57] and Finland,[58] and among a convenience sample of primary care patients in Philadelphia.[59] However, no known studies have been conducted among a U.S. general population sample, which might be targeted with population-based alcohol interventions. The development of preference weights representative of a US adult population for different categories of alcohol use would allow for much needed research and could facilitate future CUAs for alcohol interventions designed to reduce readmissions, if patients with unhealthy alcohol use are at greater risk for post-discharge acute care utilization and expenditures.

Overview of Research Objectives

The dissertation research addresses important gaps in the literature with three manuscripts. The first two manuscripts evaluated the association of unhealthy alcohol use, based on alcohol screening results, with post-discharge acute care utilization and expenditures in an older adult VA patient sample. The third manuscript evaluated the association of alcohol consumption with preference weights that could be used for future CUAs in a U.S. general population sample. The overall objectives of the dissertation research were the following:

1) Examine the association between unhealthy alcohol use and 30-day all-cause readmissions and ED visits

2) Examine the association between unhealthy alcohol use and 30-day acute care expenditures

3) Estimate preference weights for the spectrum of alcohol use in the U.S. population.

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Title:
Unhealthy Alcohol Use in Older Adults: Association with Readmissions and Emergency Department Use in the 30 days after Hospital Discharge

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Abbreviated Title: Unhealthy Drinking, Readmissions, and ED use

Abstract

Background. Patient-reported alcohol use is increasingly available in medical records through alcohol screening programs, but it is unknown whether screening results are associated with 30-day readmissions or emergency department (ED) visits and merit consideration when targeting post-discharge intervention efforts. This study examined the association between AUDIT-C alcohol screening results and 30-day readmissions or ED visits.

Methods. Veterans Affairs (VA) patients age≥65 years, hospitalized for medical or surgical conditions (2/1/2009-10/1/2011), were eligible if they had an AUDIT-C score documented in their VA medical record 1-365 days before hospitalization. VA and Medicare data identified VA or non-VA index hospitalizations, readmissions, and ED visits. Primary analyses adjusted for demographics, comorbid conditions, and past-year health care utilization. Secondary analyses additionally adjusted for indicators of social support and SES.

Results. Among 579,330 hospitalized patients, 13.7% were readmitted and 12.0% visited an ED within 30 days. In primary analyses, high-risk drinking (n=7,167; 13.8%, 95% CI 13.0-14.6%) and nondrinking (n=357,086; 14.2%, 95% CI 14.1-14.3%) were associated with increased probability of readmission, relative to low-risk drinking (n=156,928; 12.9%, 95% CI 12.7-13.0%). High-risk drinking was not associated with increased risk for readmissions in secondary analyses. Only nondrinkers had increased risk for ED visits.

Conclusions. Alcohol screening results available in medical records may not be useful for identifying high-risk drinkers at greater risk of 30-day readmissions or ED visits. Future research may consider focusing on social risk factors, such as lower social support, that appear to account for modest increased risk of poor outcomes following hospital discharge among high-risk drinkers.

1. Introduction

Efforts to improve the quality of hospital care often focus on readmissions within 30 days of hospital discharge because readmissions can reflect both a poor outcome for patients and higher costs for the health care system [1]. Hospital readmissions are common among Medicare beneficiaries, affecting approximately 20% of inpatients [1,2]. The Centers for Medicare and Medicaid Services (CMS) recently implemented the hospital readmission reduction program [3] and funded implementation of care coordination interventions [4,5], based on evidence that readmissions can be prevented with proper transitional support and discharge planning [6,7]. Use of emergency departments may also be a marker for poor transitions following inpatient care [8,9], but has received less attention from policy makers and is not currently monitored as a hospital quality metric.

Unhealthy alcohol use is a potentially modifiable health behavior that may be a risk factor for readmissions, but has been examined in only a few prior studies [10-12]. However, prior studies have not utilized alcohol screening questionnaires collected as part of routine care, examined emergency department (ED) visits within 30 days, or specifically focused on older adults. While unhealthy alcohol use is less common among older adults, nearly 9% drink at unhealthy levels [13]. Older adults are particularly vulnerable to the adverse effects of alcohol use [14], but are less likely than younger patients to have alcohol use assessed during clinical care [15,16].

Routine alcohol screening with the Alcohol Use Disorder Identification Test-Consumption (AUDIT-C) screening questionnaire was implemented in the Veterans Health Administration (VA) in 2004 [17]. Alcohol screening is also increasingly implemented in other health care systems as an essential benefit under U.S. health reform, due to its ranking as a prevention priority and evidence of the effectiveness of brief interventions for reducing drinking

[18]. However, it is currently unknown whether alcohol screening results collected at outpatient visits could be utilized to identify hospitalized older adults at increased risk for hospital readmissions and ED visits within 30 days of hospital discharge. An association might suggest that unhealthy alcohol use merits future evaluation for inclusion in post-discharge planning or other readmission reduction intervention strategies. The present study examines whether unhealthy alcohol use, according to AUDIT-C scores documented in the electronic health record (EHR), is associated with increased risk for readmissions or ED visits in the 30 days following index hospitalization for a medical or surgical condition in a national sample of older VA patients.

2. Methods

2.1 Data Sources and Study Sample

The VA's Corporate Data Warehouse (CDW) provided data for VA acute care hospitalizations, outpatient utilization, AUDIT-C scores, demographics, and date of birth and death. The VA Information Resource Center (VIReC) provided CMS Inpatient, Outpatient, and Carrier standard analytic files for non-VA inpatient and outpatient utilization.

The sampling frame included all VA outpatients age 65 or older who were hospitalized for a medical or surgical condition at a VA or non-VA hospital (2/1/2009-12/31/2011) and had at least one AUDIT-C score available in their medical record (2/1/2008-12/31/2011). Study eligibility criteria were then applied to this sample based on 30-day readmission measures developed for CMS [19] with some modifications in order to include only community-dwelling older adults discharged to the community, because it was hypothesized that continued unhealthy alcohol use after discharge could decrease medication adherence and self-care, potentially increasing readmission and ED visit risk. Patients were included if they met the following

criteria: 1) survived the hospital stay, 2) length of stay <30 days, 3) primary diagnosis not for a psychiatric condition, cancer, or physical rehabilitation, 4) admitted from the community, 5) not discharged to another facility, 6) not discharged against medical advice, 7) discharged before 10/1/2011 (to allow adequate follow-up), 8) documented AUDIT-C score 1-365 days prior to admission (Figure 1). Hospitalizations were categorized as medical or surgical based on the Diagnosis Related Group (DRG) code; hospitalizations without a valid DRG were excluded. Finally, patients were excluded if they were enrolled in a Medicare managed care plan in the year before hospitalization or 30 days after discharge because information on comorbidities and readmissions would be incomplete. The final study cohort included 579,330 eligible patients (54 % of total hospitalized patients). For patients with multiple eligible index hospitalizations, only the first stay was included. This study received human subjects approval, including waivers of informed consent and HIPAA authorization, from the University of Washington and VA Puget Sound Institutional Review Boards.

2.2 Outcomes

This study assessed two outcomes, any readmission and any ED visit within 30 days of discharge. Readmissions were defined as any unplanned readmission occurring during the 30 days after discharge. The algorithm for identifying eligible readmissions was adapted from the CMS hospital-wide all-cause readmission measure (Appendix 1)[19]. Bone marrow or organ transplants were considered always planned and excluded. Potentially planned procedures were identified based on DRG codes considered likely to be planned in a previous study [1] and excluded unless an acute principal diagnosis was present. ED visits were defined as any treat-and-release ED visit within 30 days of discharge not resulting in hospitalization.

2.3 Alcohol Risk Group

Alcohol risk group was the independent variable of interest, based on each patient's most recent AUDIT-C score (1-365 days before index hospitalization). The AUDIT-C is a brief 3-item screening questionnaire that was validated against in-depth interviews for identifying past-year hazardous drinking and/or DSM-IV alcohol use disorders (AUD)[20,21]. The AUDIT-C is scored from 0-12 points with scores of 0 indicating no past-year alcohol use and increasing scores associated with increasing consumption [22] and probability of AUD [23]. Patients were assigned to one of four AUDIT-C score categories: nondrinking (0 points), low-risk drinking (1-2 women, 1-3 men), moderate-risk drinking (3-7 women, 4-7 men), and high-risk drinking (8-12). Categories were chosen to reflect gender-specific differences in positive screens for alcohol misuse (≥3 points for women, ≥4 for men)[20,21] and increased risk associated with scores ≥8 points of hospitalizations for trauma [24] and gastrointestinal conditions [25]. Nondrinkers have been consistently shown to have poorer health outcomes relative to low-risk drinkers, including increased risk of trauma [24], gastrointestinal conditions [25], post-operative complications [26], and mortality [27].

2.4 Covariates

Patient demographic and clinical characteristics that have known associations with alcohol use and acute care utilization were selected as potential covariates. Demographic covariates included age at time of index hospitalization, gender, and race (white/nonwhite). Patients for whom race was unknown/missing were categorized as nonwhite, given that patients missing race/ethnicity in administrative data more often report nonwhite race [28]. Measures of prior health care utilization included the number of past-year hospitalizations, number of past-year ED visits, index length of stay, and an indicator for any past-year discharge against medical advice. Year of discharge was included as a covariate to account for potential time trends (2009-

2011). Binary indicators for inpatient or outpatient past-year diagnosis (during the index stay and prior year) of health conditions in a previously validated comorbidity index [29] were constructed for each patient (conditions listed in Supplemental Table 1). The overall comorbidity index score was also calculated to describe the level of comorbidity in the sample. Additional indicators for diagnoses of past-year tobacco use disorder and post-traumatic stress disorder (PTSD) were also used. Elapsed time from AUDIT-C screen to the index hospitalization (0-3, 3-6, 6-12 months) was included to account for potential changes in alcohol use over time. VA copayment status due to disability or low income (copayment exempt vs copayment required) was used as a proxy for socioeconomic status (SES) and lower health status [30]. Marital status (married, unmarried, unknown/missing) was used as an indicator of social support.

2.5 Analyses

Analyses were conducted in the total sample and separately for patients with either a medical or surgical index stay, due to known differences in medical and surgical inpatients [1,31]. Descriptive analyses described patient characteristics, comorbidities, and the most common conditions responsible for index stays and readmissions across alcohol risk groups. Three models were planned *a priori.* The primary multivariable logistic regression model adjusted for age, gender, race, tobacco use disorder, PTSD diagnosis, time from AUDIT-C screen to hospitalization, comorbid conditions, number of prior year hospitalizations (or ED visits), index length of stay, any prior year discharge against medical advice, and year of discharge. These covariates were selected a priori for the primary model because they represent types of clinical and demographic characteristics that are more often included in 30-day readmission models [32] and are available in or could be readily generated from administrative data sources. Fixed effects

for the VA facility where each patient was screened (n=130) were included to account for unobserved facility-level characteristics that may influence both patients' AUDIT-C scores and health care utilization. In secondary analyses, the primary multivariable logistic regression model was additionally adjusted for marital status and VA copayment exempt status, indicators of social support and SES, respectively. These covariates were not included in the primary analysis because they are thought to characterize the patient's post-discharge environment [33] and reflect social risk factors often omitted from analyses of 30-day readmissions [34]. Finally, analyses that adjusted for age, gender, race, and year of discharge were conducted for comparison with primary and secondary analyses, and in order to account for basic demographic characteristics available to clinicians and thought to have clinical relevance. The method of recycled predictions was used to estimate the average adjusted probability of readmissions and ED visits, for each alcohol risk group [35]. Post-estimation Wald tests evaluated differences in outcomes for alcohol risk groups relative to low-risk drinkers. Low-risk drinkers were selected a priori as the referent group rather than nondrinkers because nondrinkers are known to have poorer health outcomes, as above.

3. Results

Among VA patients at least 65 years old at the time of hospitalization and potentially eligible for the study, 579,330 patients had a hospitalization for a medical or surgical condition that met all eligibility criteria (Figure 1). Overall, the mean age was 77 (SD=7.4) and the majority of patients was white, male, exempt from VA copayments, and married (Table 1). High-risk drinkers tended to be younger and a greater proportion unmarried, relative to low-risk drinkers. A higher proportion of both high-risk and nondrinkers were nonwhite and VA copay-exempt, relative to low-risk drinkers. Comorbidity index scores were highest among

nondrinkers, compared to other groups, and there was variation in the proportions of patients in each alcohol risk group with past-year diagnosis of some conditions (Table 1, Appendix 2). For example, relative to low-risk drinking, those with high-risk drinking had a greater prevalence of past-year AUD, liver disease, and chronic pulmonary disease (Appendix 2). Nondrinkers had a higher prevalence of congestive heart failure (CHF), complicated diabetes, and dementia, compared to low-risk drinking. Surgical patients were generally younger, more likely to be married, less likely to be nondrinkers, and had a lower prevalence of some past-year conditions (e.g. AUD, CHF, complicated diabetes, psychosis) than medical patients (Appendix 3).

In primary analyses, 30-day readmission rates in the total sample were highest among nondrinkers (14.2%; 95% CI 14.1-14.3%, $p<0.001$) and high-risk drinkers (13.8%; 95% CI 13.0-14.6%, $p<0.05$), relative to low-risk drinkers (12.9%; 95% CI 12.7-13.0%)(Table 2). These associations were attenuated from those in analyses adjusted only for demographics. However, for high-risk drinkers relative to low-risk drinkers, the difference was no longer significant after adjusting for indicators of social support (marital status) and SES (VA copay-exempt).

Among patients hospitalized for a medical condition, nondrinkers (15.6%; 95% CI 15.5-15.7%, $p<0.001$) and high-risk drinkers (15.3%; 95% CI 14.4-16.3%, $p<0.05$) had increased readmission rates relative to low-risk drinkers (14.3%; 95% CI 14.0-14.5%) in primary analyses (Table 2). These associations were attenuated from those observed in analyses adjusted only for demographics, and again were no longer significant for high-risk drinkers in secondary analyses. Among patients hospitalized for a surgical condition, nondrinkers had higher readmission rates relative to low-risk drinkers in all analytic models. However, there were no significant differences in readmission rates for surgical patients with high-risk drinking relative to low-risk drinking.

Nondrinkers had significantly greater risk for 30-day ED visits (12.4%; 95% CI 12.3-12.5%) relative to low-risk drinkers (11.4%; 95% CI 11.3-11.6%) in primary analyses for the total sample (Table 3). However, differences in the probability of ED visits among high-risk drinkers relative to low-risk drinkers were not significant in primary or secondary analyses in the total sample or the subset of patients hospitalized for medical conditions. Among patients hospitalized for surgical conditions, only nondrinkers had significantly higher rates of 30-day ED visits compared to low-risk drinkers in primary analyses, 11.3% (95% CI 11.1-11.5%) and 10.5% (95% CI 10.2-10.7%), respectively.

Reasons for index hospitalization and readmission differed markedly by alcohol risk group and by whether the index hospitalization was for a medical or surgical condition (Appendixes 4-9). Overall, the most common reason for index hospitalizations was pneumonia, followed by coronary atherosclerosis and cardiac dysrhythmias (Appendix 4). The most common reason for both the index hospitalization and readmission among high-risk drinkers was alcohol-related disorders, followed by chronic obstructive pulmonary disease (COPD), while among all other groups the most common condition at readmission was CHF (Appendix 4 & 7).

4. Discussion

This study of a large sample of older adults hospitalized for a medical or surgical condition demonstrates that routinely collected alcohol screening scores may not be useful for identifying high-risk drinking patients at increased risk of returning to the hospital within 30 days after discharge. Nondrinkers had consistently increased risk of readmission and ED use after discharge in all models, compared to low-risk drinkers. High risk drinkers had approximately 1% greater risk of readmissions relative to low-risk drinkers in primary analyses that adjusted for demographics, comorbid conditions, and prior utilization, but not in secondary

analyses additionally adjusted for indicators of SES and social support. Significant results comparing patients with high-risk drinking to those with low-risk drinking were observed among patients hospitalized for medical conditions, but not among those hospitalized for surgical conditions. Patients with high-risk drinking were not at significantly increased risk for 30-day ED visits in primary or secondary analyses.

As expected based on previous research, patients reporting nondrinking were at increased risk for 30-day readmissions and ED visits compared to patients with low-risk drinking. Prior studies have shown patients who report no past-year alcohol use to have lower health status [36] and greater all-cause mortality [27,37] than current drinkers. Nondrinking based on alcohol screening scores may serve as a marker for poorer health status and greater health care need. Although analyses adjusted for comorbidities and prior utilization, it is likely that residual confounding influenced results. Nevertheless, patient-reported nondrinking was common among older adults in this study (62%) and routine alcohol screening conducted prior to admission may be useful for identifying nondrinking patients at heightened risk for poor outcomes following discharge who need additional post-discharge support.

Few studies have examined the association between unhealthy alcohol use and readmissions [10-12,38]. One study examined diagnoses for AUD during index hospitalization as a risk factor for 30-day readmissions, but found a significant association with increased readmissions only among patients with AUD and comorbid substance use disorders [12]. An hospital quality improvement implementation study reported that inpatients with alcohol-related diagnoses had higher rates of 30-day readmissions than those without diagnoses [38]. However, alcohol-related diagnoses under-identify inpatients with AUD [39] and as a result, may not have adequately characterized alcohol use. Two studies examined alcohol use based on the AUDIT-C

[10] or 10-item AUDIT [11] and risk for readmissions. The first found no significant association between screening scores and readmissions among surgical inpatients [10], while the second found no association among general medical inpatients [11]. However, neither focused on older adults, assessed 30-day ED visits, or utilized screening results documented in routine care.

This study extends the literature by examining unhealthy alcohol use, using routinely collected outpatient AUDIT-C scores, as a potentially modifiable risk factor for 30-day readmissions and ED visits among a large sample of older VA patients. In the present study, 62% of patients with high-risk drinking had a past-year diagnosis of AUD and 10% were hospitalized for alcohol-related conditions during the index hospital stay. Older adults with high-risk drinking experienced a 1% greater absolute risk for 30-day readmissions, which was not explained by differences in demographics, prior utilization, or comorbidities. However, patients with high-risk drinking were a small proportion of hospitalized patients (1%) and in analyses additionally adjusted for indicators of SES and social support the modest association was not significant. Heavier alcohol consumption is associated with lower SES [40,41], which may diminish access to enabling resources that positively influence health promoting behaviors. Adults with high-risk drinking are also less likely to be married [42], which may provide social support in the post-discharge environment [33]. These types of social risk factors may not be available in all administrative data systems, but when routinely collected information on unhealthy alcohol use is available, it may provide valuable information on readmission risk for some patients.

The lack of a significant association between high-risk drinking and readmissions for surgical patients is consistent with one prior study [10]. Differences in the patient characteristics between medical and surgical inpatients, as well as conditions treated, could explain why

associations between high-risk drinking and readmissions were observed only among medical patients. Surgical patients in our sample and elsewhere were generally younger, had fewer comorbid conditions (including AUD and other mental health conditions) [31], and lower readmission rates [1,31] than medical patients. The most common reasons for readmissions among surgical patients were complications of medical care. Reasons for readmissions among medical patients were varied and included conditions that may be more influenced by post-discharge health behaviors (CHF, COPD). Unhealthy alcohol use is associated with poorer adherence to medications [43] and poorer self-care [44], and may play a greater role in influencing readmission risk for medical patients.

This study has several limitations. First, although analyses included numerous covariates typical of readmission studies, these measures are unlikely to capture all differences correlated with both alcohol use and study outcomes, such as mental health conditions. Second, routinely administered AUDIT-C screens may under-identify patients with unhealthy alcohol use. Approximately 61% of VA patients who screened positive for alcohol misuse on a confidential, mailed survey were not identified during a recent outpatient visit [45]. Therefore, some patients categorized as nondrinkers or low-risk drinkers may have been misclassified and differences in outcomes for alcohol risk groups relative to low-risk drinkers may be attenuated. Third, patients were excluded from the study sample if they did not have an AUDIT-C score in the year prior to hospitalization. Relative to the study sample, VA patients missing AUDIT-C scores had a lower prevalence of some conditions, such as chronic pulmonary disease, psychosis, AUD, and tobacco use disorders (Appendix 10), consistent with previous studies characterizing higher utilizers of VA care [46,47] Thus, AUDIT-C scores do not appear to be missing at random and we do not know whether similar associations would be observed between alcohol risk groups

and study outcomes had AUDIT-C scores been available for excluded patients. Study findings may be most generalizable to populations with greater burden of comorbidity, particularly mental health conditions.

5. Conclusion

The present study suggests that hospitalized patients who are nondrinkers and those who screen positive for high-risk drinking prior to hospitalization are at greater risk for 30-day readmissions relative to low-risk drinking, after adjusting for demographic characteristics, comorbidities, and prior utilization. However, the modest association between high-risk drinking and increased risk of readmissions was restricted to medical patients and appeared to be accounted for by lower social support and SES among these patients. These results suggest that indicators of social risk, when available in health system data, may be of greater utility for identifying patients in need of post-discharge support following hospital discharge than information on patient-reported alcohol consumption.

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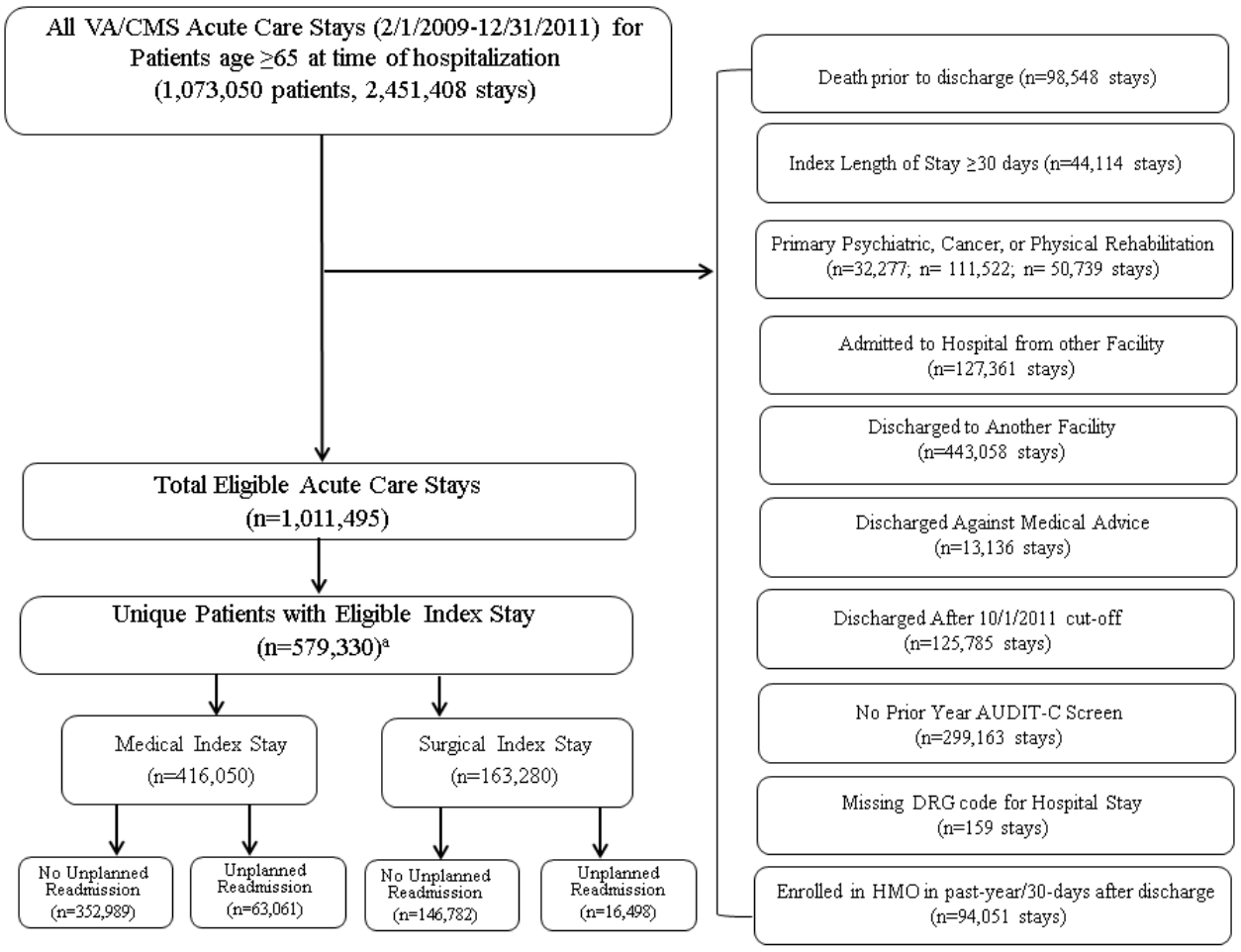
Figure 1: Study Flow Diagram and Eligibility Criteria



[a]The first eligible index stay is used for patients with multiple potentially eligible index stays.

Table 1. Demographic and Clinical Characteristics of Study Sample, by Alcohol Risk Group

	Nondrinker n=357,086		Low-risk Drinking n=156,928		Moderate-Risk Drinking n=58,149		High-Risk Drinking n=7,167		Total n=579,330	
Age, mean (SD)	77.4	(7.4)	76.6	(7.3)	76.6	(7.3)	71.1	(6.0)	77.0	(7.4)
Male, n (%)	350,171	(98.1%)	154,903	(98.7%)	57,324	(98.6%)	7,149	(99.7%)	569,547	(98.3%)
Race, n (%)										
White	300,743	(84.2%)	139,499	(88.9%)	53,628	(92.2%)	6,011	(83.9%)	499,881	(86.3%)
Nonwhite	56,343	(15.8%)	17,429	(11.1%)	4,521	(7.8%)	1,156	(16.1%)	79,449	(13.7%)
Marital Status, n (%)										
Unmarried	122,557	(34.3%)	50,326	(32.1%)	19,259	(33.1%)	3,944	(55.0%)	196,086	(33.8%)
Married	233,301	(65.3%)	106,084	(67.6%)	38,642	(66.5%)	3,202	(44.7%)	381,229	(65.8%)
Missing/Unknown	1,228	(0.3%)	518	(0.3%)	248	(0.4%)	21	(0.3%)	2,015	(0.3%)
Copay Exempt Status, n (%)										
Copay Required	99,657	(27.9%)	62,095	(39.6%)	25,087	(43.1%)	1,679	(23.4%)	188,518	(32.5%)
Copay Exempt	255,174	(71.5%)	93,883	(59.8%)	32,728	(56.3%)	5,444	(76.0%)	387,229	(66.8%)
Missing/Unknown	2,255	(0.6%)	950	(0.6%)	334	(0.6%)	44	(0.6%)	3,583	(0.6%)
Tobacco, n (%)	47,292	(13.2%)	22,620	(14.4%)	10,888	(18.7%)	3,218	(44.9%)	84,018	(14.5%)
PTSD, n (%)	19,842	(5.6%)	7,053	(4.5%)	2,207	(3.8%)	681	(9.5%)	29,783	(5.1%)
AUD, n (%)	10,245	(2.9%)	7,422	(4.7%)	9,314	(16.0%)	4,412	(61.6%)	31,393	(5.4%)
Comorbidity Index, mean (SD)[a]	3.7	(3.0)	3.2	(2.9)	3.1	(2.8)	3.3	(2.7)	3.5	(2.9)
Past-yr hospitalizations, mean (SD)	0.5	(1.0)	0.3	(0.8)	0.3	(0.8)	0.5	(1.1)	0.4	(0.9)
Past-yr ED visits, mean (SD)	1.2	(2.0)	0.8	(1.6)	0.8	(1.5)	1.3	(2.4)	1.0	(1.9)
Index Length of Stay, mean (SD)	4.0	(3.6)	3.7	(3.3)	3.7	(3.4)	4.4	(4.1)	3.9	(3.5)
Any AMA, n (%)	2,145	(0.6%)	755	(0.5%)	301	(0.5%)	150	(2.1%)	3,351	(0.6%)

[a] Prevalence of specific comorbid conditions included in primary analyses available in Supplemental Table 1

Table 2. Probability of Post-Discharge 30-Day Readmissions, Across AUDIT-C Risk Groups

	Nondrinking		Low-Risk Drinking		Moderate-Risk Drinking		High-Risk Drinking	
	%	(95% CI)	%	(95% CI)	%	(95% CI)	%	(95% CI)
Total 30-Day Readmissions								
Unadjusted	14.7%	(14.6%-14.9%)***	12.1%	(11.9%-12.2%)	12.0%	(11.7%-12.3%)	14.5%	(13.7%-15.3%)***
Adjusted for Demographics[a]	14.6%	(14.5%-14.7%)***	12.2%	(12.0%-12.3%)	12.2%	(11.9%-12.5%)	15.4%	(14.5%-16.3%)***
Primary Model[b]	14.2%	(14.1%-14.3%)***	12.9%	(12.7%-13.0%)	12.9%	(12.6%-13.1%)	13.8%	(13.0%-14.6%)*
Secondary Model[c]	14.2%	(14.0%-14.3%)***	12.9%	(12.8%-13.1%)	13.0%	(12.8%-13.3%)	13.7%	(12.9%-14.5%)
30-Day Readmissions After Medical Index Hospitalization								
Unadjusted	16.0%	(15.8%-16.1%)***	13.6%	(13.4%-13.8%)	13.7%	(13.4%-14.1%)	16.2%	(15.2%-17.2%)***
Adjusted for Demographics[a]	15.9%	(15.8%-16.0%)***	13.6%	(13.4%-13.9%)	13.8%	(13.5%-14.2%)	16.8%	(15.8%-17.8%)***
Primary Model[b]	15.6%	(15.5%-15.7%)***	14.3%	(14.0%-14.5%)	14.4%	(14.0%-14.7%)	15.3%	(14.4%-16.3%)*
Secondary Model[c]	15.5%	(15.4%-15.7%)***	14.3%	(14.1%-14.6%)	14.6%	(14.2%-14.9%)	15.3%	(14.3%-16.3%)
30-Day Readmissions After Surgical Index Hospitalization								
Unadjusted	11.1%	(10.9%-11.3%)***	9.0%	(8.7%-9.2%)	8.8%	(8.4%-9.2%)	9.6%	(8.3%-11.0%)
Adjusted for Demographics[a]	10.9%	(10.7%-11.2%)***	9.1%	(8.8%-9.3%)	8.9%	(8.5%-9.3%)	10.4%	(9.0%-11.9%)
Primary Model[b]	10.5%	(10.3%-10.7%)***	9.6%	(9.3%-9.9%)	9.6%	(9.2%-10.1%)	9.6%	(8.3%-11.0%)
Secondary Model[c]	10.4%	(10.2%-10.6%)***	9.7%	(9.4%-9.9%)	9.7%	(9.3%-10.2%)	9.6%	(8.2%-10.9%)

[a]Adjusted for age, gender, race, year of discharge

[b]Adjusted for age, gender, race, year of discharge, past-year tobacco diagnosis, past-year PTSD diagnosis, comorbid condition indicators, days from AUDIT-C screen to index stay, index length of stay, number of past-year hospitalizations, any past-year discharge AMA

[c]Adjusted for age, gender, race, year of discharge, past-year tobacco diagnosis, past-year PTSD diagnosis, comorbid condition indicators, days from AUDIT-C screen to index stay, index length of stay, number of past-year hospitalizations, any past-year discharge AMA, VA copay exempt status, marital status

***$p<0.001$, **$p<0.01$, * $p<0.05$ compared low-risk drinking (referent group)

Table 3. Probability of Post-Discharge 30-Day Treat and Release ED Visits, Across AUDIT-C Risk Groups

	Nondrinking		Low-Risk Drinking		Moderate-Risk Drinking		High-Risk Drinking	
	%	(95% CI)	%	(95% CI)	%	(95% CI)	%	(95% CI)
30-Day ED Visits								
Unadjusted	12.9%	(12.8%-13.0%)***	10.7%	(10.5%-10.8%)	10.4%	(10.1%-10.6%)*	12.7%	(11.9%-13.5%)***
Adjusted for Demographics[a]	12.8%	(12.7%-12.9%)***	10.9%	(10.7%-11.0%)	10.5%	(10.3%-10.8%)*	12.5%	(11.8%-13.3%)***
Primary Model[b]	12.4%	(12.3%-12.5%)***	11.4%	(11.3%-11.6%)	11.2%	(10.9%-11.4%)	11.1%	(10.4%-11.8%)
Secondary Model[c]	12.3%	(12.2%-12.5%)***	11.5%	(11.4%-11.7%)	11.4%	(11.1%-11.6%)	11.1%	(10.4%-11.8%)
30-Day ED Visits After Medical Index Hospitalization								
Unadjusted	13.2%	(13.1%-13.4%)***	11.1%	(10.9%-11.3%)	10.9%	(10.6%-11.2%)	13.8%	(12.8%-14.7%)***
Adjusted for Demographics[a]	13.2%	(13.0%-13.3%)***	11.2%	(11.0%-11.4%)	11.0%	(10.7%-11.3%)	13.3%	(12.4%-14.2%)***
Primary Model[b]	12.9%	(12.7%-13.0%)***	11.8%	(11.6%-12.0%)	11.7%	(11.3%-12.0%)	11.9%	(11.1%-12.8%)
Secondary Model[c]	12.8%	(12.7%-12.9%)***	11.9%	(11.7%-12.1%)	11.8%	(11.5%-12.2%)	11.9%	(11.0%-12.7%)
30-Day ED Visits After Surgical Index Hospitalization								
Unadjusted	11.7%	(11.5%-12.0%)***	9.9%	(9.7%-10.2%)	9.4%	(9.0%-9.8%)*	9.7%	(8.4%-11.1%)
Adjusted for Demographics[a]	11.6%	(11.4%-11.9%)***	10.0%	(9.8%-10.3%)	9.5%	(9.1%-9.9%)*	9.8%	(8.5%-11.2%)
Primary Model[b]	11.3%	(11.1%-11.5%)***	10.5%	(10.2%-10.7%)	10.1%	(9.6%-10.5%)	9.0%	(7.7%-10.3%)*
Secondary Model[c]	11.2%	(11.0%-11.4%)***	10.5%	(10.3%-10.8%)	10.2%	(9.7%-10.6%)	9.0%	(7.7%-10.2%)*

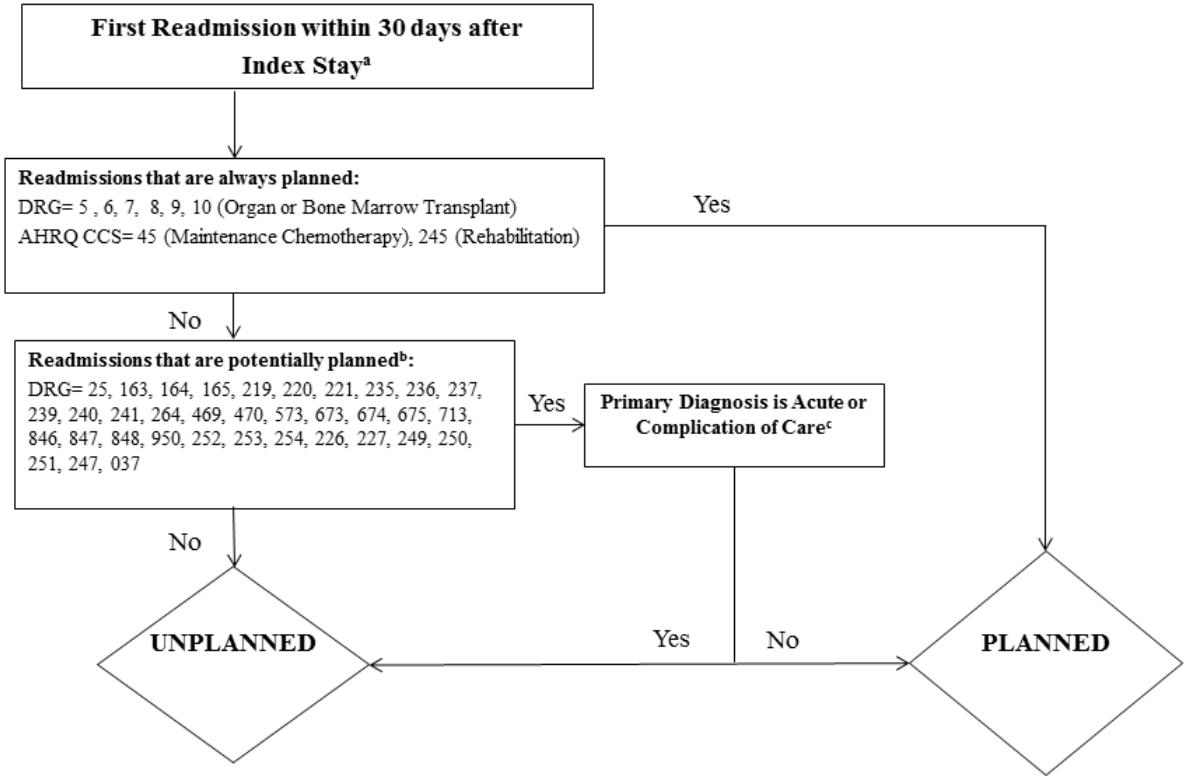
[a]Adjusted for age, gender, race, year of discharge

[b]Adjusted for age, gender, race, year of discharge, past-year tobacco diagnosis, past-year PTSD diagnosis, comorbid condition indicators, days from AUDIT-C screen to index stay, index length of stay, number of past-year ED visits, any past-year discharge AMA

[c]Adjusted for age, gender, race, year of discharge, past-year tobacco diagnosis, past-year PTSD diagnosis, comorbid condition indicators, days from AUDIT-C screen to index stay, index length of stay, number of past-year ED visits, any past-year discharge AMA, VA copay exempt status, marital status

***$p<0.001$, **$p<0.01$, *$p<0.05$ compared to low-risk drinkers (referent group)

Appendix 1. Algorithm for Identifying Planned Readmissions



[a]Readmissions within 30 days of discharge that occur after the first readmission are not considered

[b]DRG codes for potentially planned procedures are based on Jencks et al. 2009 and updated to be consistent with MS-DRG v25

[c]Based on list of acute conditions that are excluded from CMS Hospital-Wide All Cause Unplanned Readmission Measure (version 2.0).

Appendix 2. Prevalence of Comorbid Conditions for Study Sample, by Alcohol Risk Group

	Nondrinker n=357,086		Low-risk n=156,928		Moderate-Risk n=58,149		High-Risk n=7,167		Total n=579,330	
Alcohol Use Disorders, n (%)	10,245	(2.9%)	7,422	(4.7%)	9,314	(16.0%)	4,412	(61.6%)	31,393	(5.4%)
Deficiency Anemias, n (%)	135,635	(38.0%)	52,375	(33.4%)	18,991	(32.7%)	2,062	(28.8%)	209,063	(36.1%)
Cardiac Arrythmias, n (%)	165,033	(46.2%)	71,381	(45.5%)	26,743	(46.0%)	2,426	(33.8%)	265,583	(45.8%)
Congestive Heart Failure, n (%)	146,486	(41.0%)	55,693	(35.5%)	19,273	(33.1%)	1,862	(26.0%)	223,314	(38.5%)
Coagulopathy, n (%)	36,597	(10.2%)	15,900	(10.1%)	5,867	(10.1%)	665	(9.3%)	59,029	(10.2%)
Complicated Diabetes, n (%)	76,346	(21.4%)	24,908	(15.9%)	5,932	(10.2%)	594	(8.3%)	107,780	(18.6%)
Dementia, n (%)	28,974	(8.1%)	6,969	(4.4%)	2,167	(3.7%)	210	(2.9%)	38,320	(6.6%)
Fluid and Electrolyte Disorders, n (%)	121,800	(34.1%)	45,739	(29.1%)	17,481	(30.1%)	2,730	(38.1%)	187,750	(32.4%)
Hemiplegia, n (%)	9,523	(2.7%)	3,093	(2.0%)	997	(1.7%)	129	(1.8%)	13,742	(2.4%)
HIV/AIDS, n (%)	597	(0.2%)	299	(0.2%)	72	(0.1%)	9	(0.1%)	977	(0.2%)
Hypertension, n (%)	324,880	(91.0%)	141,318	(90.1%)	52,364	(90.1%)	6,285	(87.7%)	524,847	(90.6%)
Liver Disease, n (%)	12,735	(3.6%)	5,085	(3.2%)	2,252	(3.9%)	780	(10.9%)	20,852	(3.6%)
Metastatic cancer, n (%)	13,583	(3.8%)	5,682	(3.6%)	2,086	(3.6%)	221	(3.1%)	21,572	(3.7%)
Psychosis, n (%)	43,219	(12.1%)	12,506	(8.0%)	4,060	(7.0%)	972	(13.6%)	60,757	(10.5%)
Pulmonary circulation disorders, n (%)	23,029	(6.4%)	9,631	(6.1%)	3,584	(6.2%)	346	(4.8%)	36,590	(6.3%)
Chronic pulmonary disease, n (%)	148,171	(41.5%)	58,166	(37.1%)	23,004	(39.6%)	3,440	(48.0%)	232,781	(40.2%)
Peripheral vascular disorder, n (%)	120,221	(33.7%)	50,767	(32.4%)	18,786	(32.3%)	1,865	(26.0%)	191,639	(33.1%)
Renal Failure, n (%)	109,620	(30.7%)	39,572	(25.2%)	11,434	(19.7%)	860	(12.0%)	161,486	(27.9%)
Tumor, n (%)	97,657	(27.3%)	44,243	(28.2%)	16,231	(27.9%)	1,589	(22.2%)	159,720	(27.6%)
Weight loss, n (%)	12,846	(3.6%)	3,974	(2.5%)	1,678	(2.9%)	373	(5.2%)	18,871	(3.3%)
Myocardial infarction, n (%)	71,671	(20.1%)	29,992	(19.1%)	9,631	(16.6%)	957	(13.4%)	112,251	(19.4%)
Cerebrovascular disease, n (%)	25,359	(7.1%)	7,596	(4.8%)	2,652	(4.6%)	276	(3.9%)	35,883	(6.2%)
Rheumatoid Arthritis, n (%)	33,314	(9.3%)	15,042	(9.6%)	5,395	(9.3%)	371	(5.2%)	54,122	(9.3%)
Ulcer disease, n (%)	15,617	(4.4%)	6,354	(4.0%)	2,405	(4.1%)	344	(4.8%)	24,720	(4.3%)
Uncomplicated diabetes, n (%)	168,644	(47.2%)	62,500	(39.8%)	17,315	(29.8%)	1,940	(27.1%)	250,399	(43.2%)
Valvular disease, n (%)	83,084	(23.3%)	38,640	(24.6%)	14,329	(24.6%)	1,040	(14.5%)	137,093	(23.7%)
Paralysis, n (%)	16,488	(4.6%)	4,663	(3.0%)	1,535	(2.6%)	185	(2.6%)	22,871	(3.9%)
Hypothyroidism, n (%)	64,506	(18.1%)	25,509	(16.3%)	8,618	(14.8%)	698	(9.7%)	99,331	(17.1%)

Obesity, n (%)	57,788	(16.2%)	26,877	(17.1%)	7,543	(13.0%)	1,077	(15.0%)	93,285	(16.1%)
Blood loss anemia, n (%)	11,373	(3.2%)	4,551	(2.9%)	1,710	(2.9%)	186	(2.6%)	17,820	(3.1%)
Drug use disorders, n (%)	5,321	(1.5%)	2,067	(1.3%)	928	(1.6%)	659	(9.2%)	8,975	(1.5%)
Depression, n (%)	18,058	(5.1%)	6,333	(4.0%)	2,149	(3.7%)	432	(6.0%)	26,972	(4.7%)
Neurodegenerative disorders, n (%)	82,918	(23.2%)	26,198	(16.7%)	9,072	(15.6%)	1,238	(17.3%)	119,426	(20.6%)

Appendix 3. Demographic and Clinical Characteristics of Patients with Eligible Index Hospital Stay for Medical/Surgical Conditions

	Patients with Medical Index Stay n=424,343		Patients with Surgical Index Stay n=164,178		Total Patients n=588,521	
Age, mean (SD)	77.7	(7.5)	75.4	(6.9)	77.0	(7.4)
Male, n (%)	408,385	(98.2%)	161,162	(98.7%)	569,547	(98.3%)
Race, n (%)						
White	353,428	(84.9%)	146,453	(89.7%)	499,881	(86.3%)
Nonwhite	62,622	(15.1%)	16,827	(10.3%)	79,449	(13.7%)
Marital Status, n (%)						
Unmarried	151,383	(36.4%)	44,703	(27.4%)	196,086	(33.8%)
Married	263,245	(63.3%)	117,984	(72.3%)	381,229	(65.8%)
Missing/Unknown	1,422	(0.3%)	593	(0.4%)	2,015	(0.3%)
Copay Exempt Status, n (%)						
Copay Required	124,506	(29.9%)	64,012	(39.2%)	188,518	(32.5%)
Copay Exempt	288,877	(69.4%)	98,352	(60.2%)	387,229	(66.8%)
Missing/Unknown	2,667	(0.6%)	916	(0.6%)	3,583	(0.6%)
Alcohol Risk Group, n (%)						
Nondrinker	267,746	(64.4%)	89,340	(54.7%)	357,086	(61.6%)
Low-risk,1-2(W)1-3(M)	105,023	(25.2%)	51,905	(31.8%)	156,928	(27.1%)
Mod-risk,3-7(W)4-7(M)	37,981	(9.1%)	20,168	(12.4%)	58,149	(10.0%)
High-risk,8-12	5,300	(1.3%)	1,867	(1.1%)	7,167	(1.2%)
Past-year Tobacco diagnosis, n (%)	60,992	(14.7%)	23,026	(14.1%)	84,018	(14.5%)
Past-year PTSD diagnosis, n (%)	22,055	(5.3%)	7,728	(4.7%)	29,783	(5.1%)
Comorbidity Index	3.9	(3.0)	2.6	(2.7)	3.5	(3.0)
Alcohol Use Disorders, n (%)	25,095	(6.0%)	6,298	(3.9%)	31,393	(5.4%)
Deficiency Anemias, n (%)	162,048	(38.9%)	47,015	(28.8%)	209,063	(36.1%)
Cardiac Arrythmias, n (%)	197,500	(47.5%)	68,083	(41.7%)	265,583	(45.8%)
Congestive Heart Failure, n (%)	173,757	(41.8%)	49,557	(30.4%)	223,314	(38.5%)
Coagulopathy, n (%)	44,929	(10.8%)	14,100	(8.6%)	59,029	(10.2%)
Complicated Diabetes, n (%)	81,336	(19.5%)	26,444	(16.2%)	107,780	(18.6%)
Dementia, n (%)	33,410	(8.0%)	4,910	(3.0%)	38,320	(6.6%)
Fluid and Electrolyte Disorders, n (%)	155,171	(37.3%)	32,579	(20.0%)	187,750	(32.4%)
Hemiplegia, n (%)	11,387	(2.7%)	2,355	(1.4%)	13,742	(2.4%)
HIV/AIDS, n (%)	801	(0.2%)	176	(0.1%)	977	(0.2%)
Hypertension, n (%)	377,076	(90.6%)	147,771	(90.5%)	524,847	(90.6%)
Liver Disease, n (%)	16,139	(3.9%)	4,713	(2.9%)	20,852	(3.6%)
Metastatic cancer, n (%)	18,110	(4.4%)	3,462	(2.1%)	21,572	(3.7%)
Psychosis, n (%)	49,899	(12.0%)	10,858	(6.6%)	60,757	(10.5%)
Pulmonary circulation disorders, n (%)	29,189	(7.0%)	7,401	(4.5%)	36,590	(6.3%)
Chronic pulmonary disease, n (%)	181,946	(43.7%)	50,835	(31.1%)	232,781	(40.2%)
Peripheral vascular disorder, n (%)	133,841	(32.2%)	57,798	(35.4%)	191,639	(33.1%)

Renal Failure, n (%)	127,186	(30.6%)	34,300	(21.0%)	161,486	(27.9%)
Tumor, n (%)	119,188	(28.6%)	40,532	(24.8%)	159,720	(27.6%)
Weight loss, n (%)	15,681	(3.8%)	3,190	(2.0%)	18,871	(3.3%)
Myocardial infarction, n (%)	76,210	(18.3%)	36,041	(22.1%)	112,251	(19.4%)
Cerebrovascular disease, n (%)	29,669	(7.1%)	6,214	(3.8%)	35,883	(6.2%)
Rheumatoid Arthritis, n (%)	38,393	(9.2%)	15,729	(9.6%)	54,122	(9.3%)
Ulcer disease, n (%)	19,586	(4.7%)	5,134	(3.1%)	24,720	(4.3%)
Uncomplicated diabetes, n (%)	184,487	(44.3%)	65,912	(40.4%)	250,399	(43.2%)
Valvular disease, n (%)	97,724	(23.5%)	39,369	(24.1%)	137,093	(23.7%)
Paralysis, n (%)	19,132	(4.6%)	3,739	(2.3%)	22,871	(3.9%)
Hypothyroidism, n (%)	73,990	(17.8%)	25,341	(15.5%)	99,331	(17.1%)
Obesity, n (%)	64,614	(15.5%)	28,671	(17.6%)	93,285	(16.1%)
Blood loss anemia, n (%)	14,386	(3.5%)	3,434	(2.1%)	17,820	(3.1%)
Drug use disorders, n (%)	7,472	(1.8%)	1,503	(0.9%)	8,975	(1.5%)
Depression, n (%)	20,941	(5.0%)	6,031	(3.7%)	26,972	(4.7%)
Neurodegenerative disorders, n (%)	99,154	(23.8%)	20,272	(12.4%)	119,426	(20.6%)
Past-year hospitalizations, mean (SD)	0.5	(1.0)	0.3	(0.7)	0.4	(0.9)
Past-year ED visits, mean (SD)	1.2	(2.0)	0.7	(1.3)	1.0	(1.9)
Index Length of Stay, mean (SD)	3.8	(3.3)	4.2	(4.0)	3.9	(3.5)
Any AMA, past-year, n (%)	2,798	(0.7%)	553	(0.3%)	3,351	(0.6%)

Appendix 4. Top 10 Reasons for Index Hospital Stay Among Study Sample[a]

	Nondrinking n=357,086	Low-risk Drinking, n=156,928	Moderate-Risk Drinking n=58,149	High-risk Drinking n=7,167	Total n=579,330
1 Condition	*Pneumonia* 6.2%	*Coronary atherosclerosis* 6.2%	*Cardiac dysrhythmias* 6.5%	*Alcohol-related disorders* 9.6%	*Pneumonia* 5.7%
2 Condition	*CHF* 5.9%	*Cardiac dysrhythmias* 6.0%	*Osteoarthritis* 6.0%	*COPD* 6.0%	*Coronary atherosclerosis* 5.6%
3 Condition	*Coronary atherosclerosis* 5.4%	*Osteoarthritis* 5.2%	*Coronary atherosclerosis* 5.3%	*Coronary atherosclerosis* 4.7%	*Cardiac dysrhythmias* 5.6%
4 Condition	*Cardiac dysrhythmias* 5.3%	*Pneumonia* 5.1%	*Pneumonia* 5.0%	*Pneumonia* 4.4%	*CHF* 5.5%
5 Condition	COPD 5.0%	*CHF* 4.8%	*CHF* 4.6%	Cardiac dysrhythmias 4.4%	COPD 4.7%
6 Condition	Osteoarthritis 3.0%	COPD 4.0%	COPD 4.3%	*CHF* 3.7%	Osteoarthritis 3.9%
7 Condition	*MI* 3.0%	*MI* 3.0%	*Back problems* 3.1%	*Osteoarthritis* 3.4%	*MI* 2.9%
8 Condition	*Nonspecific chest pain* 2.5%	*Back problems* 2.9%	*MI* 2.5%	*Back problems* 2.5%	*Nonspecific chest pain* 2.5%
9 Condition	*Urinary tract infections* 2.5%	*Complication of device* 2.4%	*Occlusion of precerebral arteries* 2.2%	*Fluid and electrolyte disorders* 2.3%	*Back problems* 2.3%
10 Condition	*Complication of device* 2.2%	*Nonspecific chest pain* 2.4%	*Complication of device* 2.2%	*Gastrointestinal hemorrhage* 2.2%	*Complication of device* 2.2%

Appendix 5. Top 10 Reasons for Index Hospital Stay among Patients with Medical Index Hospitalization

	Nondrinking n=267,746	Low-risk Drinking, n=105,023	Moderate-Risk Drinking n=37,981	High-risk Drinking n=5,300	Total n=416,050
1 *Condition*	*Pneumonia*	*Pneumonia*	*Pneumonia*	*Alcohol-related disorders*	*Pneumonia*
	8.1%	7.4%	7.5%	13.0%	7.8%
2 *Condition*	*CHF*	*Cardiac dysrhythmias*	*Cardiac dysrhythmias*	*COPD*	*CHF*
	7.4%	6.6%	7.1%	8.0%	7.0%
3 *Condition*	*COPD*	*CHF*	*COPD*	*Pneumonia*	*COPD*
	6.6%	6.6%	6.6%	5.8%	6.5%
4 *Condition*	*Cardiac dysrhythmias*	*COPD*	*CHF*	*Cardiac dysrhythmias*	*Cardiac dysrhythmias*
	5.2%	6.0%	6.4%	4.7%	5.7%
5 *Condition*	Nonspecific chest pain	*Nonspecific chest pain*	*Nonspecific chest pain*	*CHF*	Nonspecific chest pain
	3.4%	3.6%	3.1%	4.5%	3.4%
6 *Condition*	Coronary atherosclerosis	Coronary atherosclerosis	Gastrointestinal hemorrhage	*Fluid and electrolyte disorders*	Coronary atherosclerosis
	3.2%	3.4%	3.0%	3.0%	3.2%
7 *Condition*	*Urinary tract infections*	*Gastrointestinal hemorrhage*	*Acute cerebrovascular disease*	*Gastrointestinal hemorrhage*	*Urinary tract infections*
	3.2%	2.7%	2.8%	2.8%	2.8%
8 *Condition*	*Septicemia*	*Septicemia*	Coronary atherosclerosis	*Skin and tissue infections*	*Septicemia*
	2.7%	2.7%	2.7%	2.6%	2.7%
9 *Condition*	*Skin and tissue infections*	*Acute cerebrovascular disease*	*Skin and tissue infections*	*Acute cerebrovascular disease*	*Skin and tissue infections*
	2.5%	2.6%	2.5%	2.6%	2.5%
10 *ondition*	*Renal failure*	*Skin and tissue infections*	*Syncope*	Coronary atherosclerosis	*Fluid and electrolyte disorders*
	2.5%	2.5%	2.5%	2.4%	2.4%

Appendix 6. Top 10 Reasons for Index Stay Among Patients with Surgical Index Hospitalization

	Nondrinking n=89,340	Low-risk Drinking, n=51,905	Moderate-Risk Drinking n=20,168	High-risk Drinking n=1,867	Total n=163,280
1	*Coronary atherosclerosis*	*Osteoarthritis*	*Osteoarthritis*	*Osteoarthritis*	*Osteoarthritis*
Condition	12.00%	15.20%	16.80%	12.60%	13.30%
2	*Osteoarthritis*	*Coronary atherosclerosis*	*Coronary atherosclerosis*	*Coronary atherosclerosis*	*Coronary atherosclerosis*
Condition	11.40%	12.00%	10.20%	11.10%	11.80%
3	*MI*	*Back problems*	*Back problems*	*Back problems*	*Back problems*
Condition	6.10%	7.30%	7.60%	7.70%	6.60%
4	*Back problems*	*MI*	*Occlusion of precerebral arteries*	*Occlusion of precerebral arteries*	*MI*
Condition	5.90%	5.60%	5.50%	7.10%	5.70%
5	Complication of device	Complication of device	*Cardiac dysrhythmias*	Peripheral and visceral atherosclerosis	Complication of device
Condition	5.70%	5.30%	5.30%	5.10%	5.40%
6	Cardiac dysrhythmias	*Occlusion of precerebral arteries*	Complication of device	*MI*	Cardiac dysrhythmias
Condition	5.50%	5.00%	4.80%	4.80%	5.30%
7	*Occlusion of precerebral arteries*	*Cardiac dysrhythmias*	*MI*	Complication of device	*Occlusion of precerebral arteries*
Condition	5.00%	5.00%	4.40%	3.70%	5.10%
8	*Biliary tract disease*	*Biliary tract disease*	*Aneurysm*	*Aneurysm*	*Biliary tract disease*
Condition	4.10%	3.80%	3.80%	3.40%	3.90%
9	*Aneurysm*	*Aneurysm*	*Peripheral and visceral atherosclerosis*	*Cardiac dysrhythmias*	*Aneurysm*
Condition	3.50%	3.70%	3.40%	3.30%	3.60%
10	*Hyperplasia of prostate*	*Hyperplasia of prostate*	*Biliary tract disease*	*Biliary tract disease*	*Hyperplasia of prostate*
ondition	3.40%	3.10%	3.30%	3.20%	3.20%

Appendix 7. Top 10 Reasons for Unplanned Readmission Among Readmitted Patients in Study Sample[a]

	Nondrinking n=52,621	Low-risk Drinking, n=18,917	Moderate-Risk Drinking n=6,982	High-risk Drinking n=1,039	Total n=79,559
1	*CHF*	*CHF*	*CHF*	*Alcohol-related disorders*	*CHF*
	9.0%	7.8%	6.8%	10.1%	8.4%
2	*Pneumonia*	*Complication of care*	*Complication of care*	*COPD*	*Pneumonia*
	5.3%	5.2%	5.7%	5.2%	5.1%
3	*COPD*	*Cardiac dysrhythmias*	*Cardiac dysrhythmias*	*Complication of care*	*Cardiac dysrhythmias*
	4.4%	5.2%	5.2%	5.0%	4.5%
4	*Cardiac dysrhythmias*	*Pneumonia*	*Pneumonia*	*CHF*	*COPD*
	4.1%	4.7%	4.8%	4.4%	4.4%
5	*Complication of care*	*COPD*	*COPD*	*Cardiac dysrhythmias*	*Complication of care*
	3.6%	4.4%	4.4%	4.2%	4.1%
6	*Septicemia*	*Complication of device*	*Complication of device*	*Pneumonia*	*Septicemia*
	3.4%	3.1%	3.5%	3.7%	3.3%
7	*Renal failure*	*Septicemia*	*Septicemia*	*Septicemia*	*Renal failure*
	3.2%	3.0%	3.2%	2.6%	3.0%
8	*Complication of device*	*Renal Failure*	*Renal failure*	*Gastrointestinal hemorrhage*	*Complication of device*
	2.7%	2.7%	3.0%	2.5%	2.9%
9	*Urinary tract infections*	*Gastrointestinal hemorrhage*	*Gastrointestinal hemorrhage*	*Complication of device*	*Fluid and electrolyte disorders*
	2.6%	2.3%	2.3%	2.3%	2.4%
10	*Fluid and electrolyte disorders*	*Coronary atherosclerosis*	*Fluid and electrolyte disorders*	*Fluid and electrolyte disorders*	*Coronary atherosclerosis*
	2.5%	2.3%	2.3%	2.3%	2.3%

Appendix 8. Top 10 Reasons for Readmission among Readmitted Patients for Patients with a Medical Index Hospitalization

	Nondrinking n=42739	Low-Risk Drinking n=14256	Moderate-Risk Drinking n=5207	High-Risk Drinking n=859	Total n=63061
1 Condition	*CHF* 9.3%	*CHF* 8.4%	*CHF* 7.2%	*Alcohol-related disorders* 11.8%	*CHF* 8.8%
2 Condition	*Pneumonia* 5.8%	*Cardiac dysrhythmias* 5.3%	*Pneumonia* 5.5%	*COPD* 5.8%	*Pneumonia* 5.6%
3 Condition	*COPD* 5.1%	*Pneumonia* 5.2%	*COPD* 5.4%	*CHF* 4.5%	COPD 5.1%
4 Condition	*Cardiac dysrhythmias* 4.1%	*COPD* 5.2%	*Cardiac dysrhythmias* 5.3%	*Pneumonia* 3.7%	*Cardiac dysrhythmias* 4.5%
5 Condition	*Septicemia* 3.5%	*Septicemia* 3.2%	*Septicemia* 3.4%	*Cardiac dysrhythmias* 3.7%	*Septicemia* 3.4%
6 Condition	*Renal failure* 3.3%	*Renal failure* 2.9%	*Renal failure* 3.2%	*Septicemia* 2.7%	*Renal failure* 3.2%
7 Condition	*Fluid and electrolyte disorders* 2.6%	*Fluid and electrolyte disorders* 2.2%	*Fluid and electrolyte disorders* 2.6%	*Fluid and electrolyte disorders* 2.4%	*Fluid and electrolyte disorders* 2.5%
8 Condition	*Urinary tract infections* 2.6%	*Gastrointestinal hemorrhage* 2.2%	*Gastrointestinal hemorrhage* 2.4%	*Respiratory failure* 2.4%	*Urinary tract infections* 2.4%
9 Condition	*Gastrointestinal hemorrhage* 2.1%	*Coronary atherosclerosis* 2.1%	*Coronary atherosclerosis* 2.3%	*Skin and tissue infections* 2.2%	*MI* 2.1%
10 Condition	*Coronary atherosclerosis* 2.1%	*Complication of device* 2.1%	*Complication of device* 2.0%	*Gastrointestinal hemorrhage* 2.1%	*Coronary atherosclerosis* 2.1%

Appendix 9. Top 10 Reasons for Readmission among Readmitted Patients for Patients with a Surgical Index Hospitalization

	Nondrinking n=9,882	Low-Risk Drinking n=4,661	Moderate-Risk Drinking n=1,775	High-Risk Drinking n=180	Total n=16,498
1 Condition	*Complications of care* 12.6%	*Complications of care* 15.5%	*Complications of care* 17.0%	*Complications of care* 19.4%	*Complications of care* 14.0%
2 Condition	*CHF* 7.7%	*Complication of device* 6.2%	*Complication of device* 7.9%	*Cardiac dysrhythmias* 6.7%	*CHF* 7.0%
3 Condition	*Complication of device* 5.7%	*CHF* 6.0%	*CHF* 5.7%	*Complication of device* 5.0%	*Complication of device* 6.1%
4 Condition	*Cardiac dysrhythmias* 4.0%	*Cardiac dysrhythmias* 5.0%	*Cardiac dysrhythmias* 4.8%	*Gastrointestinal hemorrhage* 4.4%	*Cardiac dysrhythmias* 4.4%
5 Condition	*Pneumonia* 3.3%	*Pneumonia* 3.3%	*Cardiac dysrhythmias* 2.6%	*CHF* 3.9%	*Pneumonia* 3.2%
6 Condition	*MI* 3.2%	*Coronary atherosclerosis* 2.8%	*Renal failure* 2.5%	*Pneumonia* 3.3%	*MI* 3.0%
7 Condition	*Septicemia* 3.2%	*MI* 2.7%	*Coronary atherosclerosis* 2.3%	*Coronary atherosclerosis* 3.3%	*Septicemia* 2.9%
8 Condition	*Coronary atherosclerosis* 3.1%	*Septicemia* 2.6%	*Septicemia* 2.3%	*Septicemia* 2.2%	*Coronary atherosclerosis* 2.9%
9 Condition	*Renal failure* 2.6%	*Gastrointestinal hemorrhage* 2.4%	*MI* 2.3%	*COPD* 2.2%	*Renal failure* 2.4%
10 Condition	*UTI* 2.6%	*Renal failure* 2.2%	*Gastrointestinal hemorrhage* 2.1%	*Intestinal obstruction without hernia* 2.2%	*UTI* 2.3%

Appendix 10. Comparison of Patient Characteristics for Study Sample and Patients Missing AUDIT-C scores

	Study Sample n=579,330		Missing AUDIT-C Screen n=122,739		Total n=702,069	
Age, mean (SD)	77.0	(7.4)	77.2	(7.5)	77.1	(7.4)
Male	569,547	(98.3%)	120,684	(98.3%)	690,231	(98.3%)
Race						
White	499,881	(86.3%)	105,993	(86.4%)	605,874	(86.3%)
NonWhite	79,449	(13.7%)	16,746	(13.6%)	96,195	(13.7%)
Marital Status						
unmarried	196,086	(33.8%)	24,437	(19.9%)	220,523	(31.4%)
married	381,229	(65.8%)	46,122	(37.6%)	427,351	(60.9%)
missing	2,015	(0.3%)	52,180	(42.5%)	54,195	(7.7%)
Copay Exempt Status						
Copay Required	188,518	(32.5%)	23,799	(19.4%)	212,317	(30.2%)
Copay Exempt	387,229	(66.8%)	45,654	(37.2%)	432,883	(61.7%)
missing	3,583	(0.6%)	53,286	(43.4%)	56,869	(8.1%)
Tobacco	84,018	(14.5%)	15,007	(12.2%)	99,025	(14.1%)
PTSD	29,783	(12.5%)	2,681	(6.3%)	32,464	(11.5%)
Comorbidity Index	3.5	(3.0)	3.2	(2.9)	3.5	(3.0)
Alcohol User Disorders, n (%)	31,393	(5.4%)	5,808	(4.7%)	37,201	(5.3%)
Deficiency Anemias, n (%)	209,063	(36.1%)	39,942	(32.5%)	249,005	(35.5%)
Cardiac Arrythmias, n (%)	265,583	(45.8%)	52,826	(43.0%)	318,409	(45.4%)
Congestive Heart Failure, n (%)	223,314	(38.5%)	42,711	(34.8%)	266,025	(37.9%)
Coagulopathy, n (%)	59,029	(10.2%)	11,745	(9.6%)	70,774	(10.1%)
Complicated Diabetes, n (%)	107,780	(18.6%)	17,980	(14.6%)	125,760	(17.9%)
Dementia, n (%)	38,320	(6.6%)	10,346	(8.4%)	48,666	(6.9%)
Fluid and Electrolyte Disorders, n (%)	187,750	(32.4%)	38,237	(31.2%)	225,987	(32.2%)
Hemiplegia, n (%)	13,742	(2.4%)	2,755	(2.2%)	16,497	(2.3%)
HIV/AIDS, n (%)	977	(0.2%)	182	(0.1%)	1,159	(0.2%)
Hypertension, n (%)	524,847	(90.6%)	104,421	(85.1%)	629,268	(89.6%)
Liver Disease, n (%)	20,852	(3.6%)	3,971	(3.2%)	24,823	(3.5%)
Metastatic cancer, n (%)	21,572	(3.7%)	4,274	(3.5%)	25,846	(3.7%)
Psychosis, n (%)	60,757	(10.5%)	10,492	(8.5%)	71,249	(10.1%)
Pulmonary circulation disorders, n (%)	36,590	(6.3%)	6,717	(5.5%)	43,307	(6.2%)
Chronic pulmonary disease, n (%)	232,781	(40.2%)	42,421	(34.6%)	275,202	(39.2%)
Peripheral vascular disorder, n (%)	191,639	(33.1%)	36,810	(30.0%)	228,449	(32.5%)
Renal Failure, n (%)	161,486	(27.9%)	28,836	(23.5%)	190,322	(27.1%)
Tumor, n (%)	159,720	(27.6%)	30,342	(24.7%)	190,062	(27.1%)
Weight loss, n (%)	18,871	(3.3%)	4,414	(3.6%)	23,285	(3.3%)
Myocardial infarction, n (%)	112,251	(19.4%)	22,185	(18.1%)	134,436	(19.1%)
Cerebrovascular disease, n (%)	35,883	(6.2%)	7,618	(6.2%)	43,501	(6.2%)
Rheumatoid Arthritis, n (%)	54,122	(9.3%)	10,170	(8.3%)	64,292	(9.2%)
Ulcer disease, n (%)	24,720	(4.3%)	4,350	(3.5%)	29,070	(4.1%)

Uncomplicated diabetes, n (%)	250,399	(43.2%)	47,025	(38.3%)	297,424	(42.4%)
Valvular disease, n (%)	137,093	(23.7%)	28,186	(23.0%)	165,279	(23.5%)
Paralysis, n (%)	22,871	(3.9%)	4,671	(3.8%)	27,542	(3.9%)
Hypothyroidism, n (%)	99,331	(17.1%)	20,165	(16.4%)	119,496	(17.0%)
Obesity, n (%)	93,285	(16.1%)	13,027	(10.6%)	106,312	(15.1%)
Blood loss anemia, n (%)	17,820	(3.1%)	3,770	(3.1%)	21,590	(3.1%)
Drug use disorders, n (%)	8,975	(1.5%)	1,446	(1.2%)	10,421	(1.5%)
Depression, n (%)	26,972	(4.7%)	4,099	(3.3%)	31,071	(4.4%)
Neurodegenerative disorders, n (%)	119,426	(20.6%)	26,524	(21.6%)	145,950	(20.8%)
Past-year VA medical care visit	5.6	(6.4)	1.7	(3.8)	4.9	(6.2)
Past-year VA mental health care visit	0.9	(5.5)	0.3	(2.8)	0.8	(5.2)
Past-yr hospitalizations	0.4	(0.9)	0.3	(0.7)	0.4	(0.9)
Past-yr ED visits	1.0	(1.8)	0.6	(1.3)	1.0	(1.8)
Index Length of Stay	3.9	(3.5)	3.8	(3.5)	3.9	(3.5)
Any AMA	3,351	(0.6%)	468	(0.4%)	3,819	(0.5%)
30-Day Readmissions	85,784	(14.8%)	15,227	(12.4%)	101,011	(14.4%)
30-Day Unplanned Readmissions	79,559	(13.7%)	13,905	(11.3%)	93,464	(13.3%)

The Association between Unhealthy Alcohol use and Acute Care Expenditures in the 30 days Following Hospital Discharge for a Medical Condition

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Abstract

Hospital readmissions and emergency department (ED) visits within 30 days of discharge are common and costly. Heavy alcohol use is associated with a number of conditions that could increase risk for post-discharge acute care in older adults, but whether heavy alcohol use increases 30-day expenditures for acute care is unknown. The objective of this study was to assess acute care expenditures within 30 days of hospital discharge for different categories of alcohol use based on AUDIT-C alcohol screening scores (nondrinking, low-risk drinking, moderate-risk drinking, and high-risk drinking). The sample included VA patients age 65 or older who had documented alcohol screening during the year prior to being hospitalized for medical conditions. Study data were obtained from the VA's Corporate Data Warehouse, the Health Economics Resource Center's Average Cost Data, and Medicare standard analytic files. Analyses used a two-part model to adjust for patient demographics (age, gender, race, year of discharge) and account for large proportion of patients with zero expenditures. Among 416,050 hospitalized patients, 25% were readmitted or had an ED visit within 30 days of discharge. High-risk drinking (n=5,300) was associated with increased probability of any acute care visit, increased acute care utilization days, but not increased acute care expenditures, in the 30 days post discharge. Nondrinking (n=267,746) was associated with increased probability of any acute care visit, increased acute care utilization days, and increased expenditures ($345; 95% CI $268-$423). Health care systems seeking to identify patients with the highest post-discharge acute care expenditures may not need to use available outpatient alcohol screening results reflecting high-risk drinking.

Introduction

Readmissions and emergency department (ED) visits within 30 days of hospital discharge are common and costly.[1,2] Medicare's Hospital Readmissions Reductions Program[3] and shared savings programs for Accountable Care Organizations (ACOs)[4] have created new incentives for health care systems to reduce readmissions and potentially avoidable health care expenditures for acute care following hospital discharge. Post-discharge care interventions have been found to be effective for reducing readmissions[5,6] and are increasingly implemented in hospital settings.[7,8] However, these interventions can be expensive[9,10] and health care systems might use limited resources more efficiently by targeting high utilizers of care. Yet, average expenditures for readmissions and ED visits following discharge among general samples of inpatients are seldom reported.[11]

Patients with unhealthy alcohol use may have greater acute care utilization and higher health care expenditures following hospitalizations. Unhealthy alcohol use includes a spectrum that ranges from hazardous drinking (i.e. drinking above recommended limits) to meeting criteria for alcohol use disorders (AUD).[12] Unhealthy alcohol use is associated with poorer medication adherence[13,14] and self-care for chronic conditions,[15,16] hospital acquired infections,[17] and increased risk for injuries.[18,19] Alcohol consumption after hospital discharge could put patients at risk for readmission due to injuries or trauma resulting from acute intoxication[20] or interactions with medications.[21] However, to our knowledge, the acute care utilization and expenditures for older adults with unhealthy alcohol use in the 30 days following hospital discharge has not been previously evaluated. If unhealthy alcohol use is associated with increased acute care expenditures, this could suggest that this patient subgroup merits focused attention of health care systems interested in targeting intervention resources.

Unhealthy alcohol use can be identified through routine outpatient alcohol screening[22] and results are increasingly available in electronic medical records (EMR) due to increasing implementation of routine alcohol screening.[23,24] Alcohol screening is recommended by the U.S. Preventive Services Task Force,[25,26] is considered an essential benefit under the Affordable Care Act,[27] and alcohol screening with the 3- item AUDIT-C has been proposed as a criteria for electronic medical records to meet meaningful use requirements.[28] In a previous study, older Veterans Affairs (VA) patients with severe unhealthy alcohol use, based on alcohol screening documented in their VA EMR, who were hospitalized for a medical condition had increased risk of 30-day readmission (1% absolute difference), relative to low-risk drinking patients.[29] Patients with severe unhealthy alcohol use also had longer lengths of stay during their index hospitalization. However, it is not known whether utilization and expenditures for acute care, in the 30 days after discharge, were increased among these patients.

The present study had two aims. The first aim was to evaluate acute care utilization in older VA patients with unhealthy alcohol use in the 30 days after discharge from a medical hospitalization, including readmission hospital days, ED visits, and combined acute care visit days. The second aim was to examine the acute care expenditures of these older VA patients with unhealthy alcohol use in the 30 days after hospital discharge, including expenditures for readmissions, ED visits, and total combined acute care utilization.

Methods

Data Sources and Study Sample

Data for VA inpatient and outpatient utilization were obtained from the VA's Corporate Data Warehouse (CDW). Data on patient demographic information, dates of birth and death, and AUDIT-C alcohol screening scores were also obtained from the CDW. Estimated VA

expenditures were obtained from the VA Health Economics Resource Center (HERC)'s average costs datasets. Non-VA inpatient and outpatient utilization data, including Medicare payments for services, were from Medicare Inpatient, Outpatient, and Carrier standard analytic files obtained from the VA Information Resource Center (VIReC).

The study sample included all VA outpatients who were at least 65 years of age and were hospitalized for a medical condition at a VA or non-VA hospital from 2/1/2009-12/31/2011. Study eligibility criteria also included at least one alcohol screening result documented in the VA EMR 1-365 days prior to hospitalization (2/1/2008-12/31/2011). Additional eligibility criteria were adapted from the CMS criteria used to assess all-cause readmissions and included the following: 1) surviving the initial ("index") hospital stay, 2) length of stay <30 days, 3) primary diagnosis at the index hospitalization not for a psychiatric condition, cancer, or physical rehabilitation, 4) index admission from the community, 5) index discharge not to another facility, 6) index discharge not against medical advice, 7) index discharge before 10/1/2011 (to allow adequate follow-up) (Figure 1). This study focused on patients with an index hospitalization for *medical* conditions because prior work found no associations between unhealthy alcohol use and 30-day readmissions or ED visits among surgical inpatients.[29] Patients whose index hospitalization had a Diagnosis Related Group (DRG) code for a surgical condition or was missing a DRG code were excluded. Finally, patients were excluded if they were enrolled in a Medicare managed care plan in the year before hospitalization or 30 days after discharge because information on comorbidities and readmissions would be incomplete due to lack of Medicare fee-for-service claims. For patients with multiple eligible index hospitalizations, only the first hospitalization was included. This study received human subjects approval, including waivers of

informed consent and HIPAA authorization, from the University of Washington and VA Puget Sound Institutional Review Boards.

Outcomes

Health care utilization

Several acute care utilization outcomes were assessed: total hospital days for unplanned readmissions, total ED visits, and total days of acute unplanned care. A binary indicator was created to reflect any health care use for each acute care utilization type in the 30 days after hospital discharge. The algorithm for determining whether readmissions were unplanned was based on methods used for the CMS all-cause readmission measure (Appendix 1).[30] This algorithm was chosen in order to be consistent with readmissions that are considered unplanned by CMS and modified to include only patients who lived in the community both before and after hospitalization because it was hypothesized that drinking before or after hospitalization may increase risk for post-discharge acute care. Moreover, drinking might not be allowed in nursing homes or other institutional care settings. Next, count variables were created to reflect the total number of readmission hospital days, total ED visits, and total acute care utilization days (combining both unplanned readmission days and ED visits) in the 30 days following hospital discharge. Total number of hospital days was based on the aggregated length of stay(s) for all unplanned readmissions (Appendix 1) within 30 days following hospital discharge. Total ED visits were defined as aggregate number of all "treat-and-release" ED visits in the 30 days after hospital discharge. ED visits were considered treat-and-release if the patient was not admitted to the hospital on the same day or the day immediately following the ED visit. Finally, both hospital days and ED visit days were combined to obtain total acute care utilization days within 30 days of discharge.

Health care expenditures

The VA's Health Economics Resource Center (HERC) Average Costs Datasets provided VA inpatient and outpatient expenditure data. VA does not routinely bill patients for services, and as a result, HERC uses a "pseudo-bill" approach whereby hypothetical Medicare payments are assigned to VA inpatient and outpatient visits based on Medicare's reimbursement rates.[31] For outpatient visits, HERC generates payment values based on reimbursement rates for Common Procedure Terminology (CPT) codes, which are adjusted to reflect aggregate costs of providing services in the VA.[32] For inpatient visits, HERC generates payment values based on hospitalization characteristics such Diagnostic Related Group (DRG) weights and length of stay.[33]

The expenditure outcomes of interest in the present study were based on the three different categories of acute care utilization in the 30 days after discharge: total unplanned readmission expenditures (hereafter "readmission expenditures"), total treat and release ED expenditures (hereafter "ED expenditures"), and total unplanned acute care expenditures, which were the sum of expenditures for readmissions and treat and release ED visits (hereafter "acute care expenditures"). Readmission expenditures for each patient were defined as the sum of all VA or non-VA inpatient expenditures for unplanned readmissions within 30 days of hospital discharge. Any expenditures for outpatient services received on the same day or during a readmission stay were also included with 30 day readmission expenditures. In addition, any expenditures for services received during an ED visit that occurred the day before a readmission were included with readmission expenditures, due to the possibility that many of these ED visits were for observational stays linked to a subsequent hospital stay. ED visit expenditures were defined as the sum of all VA or non-VA expenditures for ED visits not occurring on the same

day or day prior to an unplanned readmission. Acute care visit expenditures aggregated expenditures for total 30-day readmissions and ED visits.

Alcohol risk group

Each patient was assigned to an alcohol risk group based on their most recent AUDIT-C alcohol screening score documented in their EMR (1-365 days prior to hospitalization). Since 2004, the VA has required annual alcohol screening with the AUDIT-C screening questionnaire.[24] This 3-item, brief screen has been validated for identifying hazardous drinking and alcohol use disorders (AUD),[22] and increasing scores (0-12 points) are associated with increasing alcohol consumption and probability of AUD.[34,35] Alcohol risk was classified into four groups, including the following: *nondrinking* (0 points), *low-risk drinking* (1-2 for women, 1-3 for men), *moderate-risk drinking* (3-7 for women, 4-7 for men), and *high-risk drinking* (8-12). This classification was based on gender-specific thresholds for positive screens for alcohol misuse (≥3 points for women, ≥4 points for men)[22,36] and prior research documenting increased risk for scores ≥8 points hospitalizations for trauma,[37] gastrointestinal conditions,[38] and fractures.[39] Patients reporting nondrinking on the AUDIT-C are known to have poorer health status,[40] increased hospitalizations,[41] and increased mortality,[42] and as a result were also expected to have increased acute care utilization after hospital discharge.

Covariates

Patient-level characteristics were considered for inclusion in analyses that have known associations with both alcohol use and health care utilization. Demographic characteristics included patient age at index hospitalization, gender, race, and year of hospital discharge. Patient-level comorbidities were described using a validated comorbidity index[43] and a binary indicator was constructed of any past-year diagnoses for each condition included in the

comorbidity index (Appendix 2). Additional comorbid condition indicators were constructed for past-year diagnosis of post-traumatic stress disorder (PTSD) or tobacco use disorders. In addition to the length of stay of the index hospitalization, measures of health care utilization in the year prior to the index hospitalization were obtained including: the number of hospitalizations, number of ED visits, inpatient costs, ED visit costs, and any discharge against medical advice. Elapsed time from AUDIT-C screen to the index hospitalization (0-3, 3-6, 6-12 months) was included to account for potential changes in alcohol use over time. VA copayment status due to disability or low income (copayment exempt vs. copayment required) was used as a proxy for socioeconomic status (SES) and lower health status.[44] Marital status (married, unmarried, unknown/missing) was used as an indicator of social support.

Analyses

Descriptive statistics were used to characterize the study sample and results are presented across alcohol risk groups. A large proportion of the sample did not have any acute care utilization in the 30 days following hospital discharge. Several modeling approaches were evaluated to account for disproportionate number of zeroes for acute care visit days and expenditures, including both single-equation and two-part models.[45,46] Model fit was assessed using Pearson correlation coefficients between y-scale residuals and predicted mean values ($p>0.05$), modified Hosmer-Lemeshow tests (F-statistic $p>0.05$), and Pregobin's link test (t-statistic $p>0.05$). Two-part models appeared to perform adequately based on model fit tests and were used for modeling study outcomes.

The first part of the two-part model approach used a logit regression to predict the probability of any readmission, any ED use, or any acute care use in the 30 days following discharge. The second part used a Generalized Linear Model with a log-link and Gamma

distribution to predict utilization days or expenditures among the subset of individuals who had any use. The unconditional expected expenditures, hereafter "mean expenditures for total sample," for each alcohol risk group were then estimated for the combined two-part model using a method which holds covariates constant and allows alcohol risk group to vary.[47] A 95 % confidence interval was obtained for each estimate through bootstrapping (1000 replications).

Three separate multivariable models were estimated for each outcome using a stepped approach. The primary model included demographic covariates (age, gender, race, year of discharge) and was selected *a priori* because DRG-based systems for assigning payments are intended to allow payments to reflect average condition-specific resource use as well as condition complexity.[48] The primary model was selected in order to provide health systems with information about expected expenditures for different categories of alcohol consumption before further adjustment for health conditions, which vary depending on alcohol use.[29] However, to assess the influence of differences in conditions treated, a second model additionally adjusted for patient-level comorbid conditions and prior utilization, including comorbid condition indicators, time from past-year AUDIT-C screen to index hospitalization, index length of stay, any past-year discharge AMA, past-year expenditures (or utilization days). This model was chosen *a priori* as a secondary model because it included demographic and clinical characteristics more often included in readmission models[49] and would demonstrate whether expenditures varied after adjusting for comorbidity and prior utilization. Finally, a third model added indicators of SES (VA copay exempt status) and social support (marital status), which are often missing from readmission adjustment models,[50] to see if these factors accounted for any observed associations between unhealthy alcohol use and study outcomes. In each model, the referent alcohol risk

category was low-risk drinking because these patients generally have better health outcomes, whereas nondrinking patients are known to have poorer outcomes.

After exploring the distribution of readmission hospital days, a small minority of readmission records (<1%) had lengths of readmission stay that were longer than 90 days and the majority of these outliers were VA hospital admissions. It was anticipated that VA hospitalizations would have longer lengths of stay than non-VA hospitalizations[51] due to differences in discharge practices across health care systems. In order to ensure that VA outliers did not have undue influence on analytic results, readmission hospital days were truncated at 90 days.

Results

The study sample included 416,050 older adults who were hospitalized for a medical condition and met all study eligibility criteria (Figure 1). Overall, patients in the study sample were mostly male, White, married, and VA copayment exempt (Table 1). Relative to low-risk drinking, patients reporting high-risk drinking were younger (mean age 71 vs. 77 years) and a higher proportion was unmarried, nonwhite, and VA copay exempt (Table 1). In addition, a higher proportion of patients with high-risk drinking had a past-year diagnosis of AUD, PTSD, and tobacco use disorders, but a lower proportion had a diagnosis of congestive heart failure (CHF) (Table 1; Appendix 2). A higher proportion of patients reporting nondrinking was also nonwhite and copay exempt, had a past-year diagnosis of PTSD and CHF compared to patients with low-risk drinking, but had a lower proportion had a past-year AUD diagnosis. In the overall sample, 25% of hospitalized patients were readmitted or had an ED visit within 30 days of hospital discharge.

Acute care utilization in the 30 days post discharge. Relative to low-risk drinking, high-risk drinking patients had a 3% greater risk for readmission (part 1 of two-part models for utilization or expenditures) after adjusting for demographics, 16.7% (95% CI 15.7%, 17.7%) compared to 13.7% (95% CI 13.4%, 13.9%) (Table 2). High-risk drinking patients also had significantly greater risk for any ED visit (12.4% vs. 10.8%) and any acute care use (26.1% vs. 22.3%), but results were no longer significant after adjusting for comorbidity and prior use (Appendix 3). Among high-risk drinking patients with any readmission, any ED visit, or any acute care use (part 2 of two-part models), mean visit days and ED visits did not differ significantly from that for low-risk drinking patients (Table 2). However, for the total sample, visit days and ED visits were significantly greater, after adjustment for demographics. High-risk drinking patients had an additional 0.29 days of acute care use (95% CI 0.16, 0.41) relative to low-risk drinking patients (Appendix 4).

Nondrinking patients also had increased risk for any readmission, any ED visit, and any acute care visit, relative to low-risk drinking patients and results were significant in all adjusted models (Table 2, Appendix 3). Nondrinking patients had an overall mean number of readmission hospital days that was 0.22 (95% CI 0.19, 0.25) greater than that for low-risk drinking patients, after adjusting for demographics (Appendix 4). The overall mean number of acute care visit days for nondrinking patients was also greater and remained significantly higher from that of low-risk drinking patients in all adjusted models.

Acute Care Expenditures in the 30 days post discharge. Average adjusted expenditures for high-risk drinking patients who were readmitted (part two of two-part model) were consistently lower than expenditures for low-risk drinking patients across all adjusted models (Table 3; Appendix 5). However, for the total sample, mean 30-day readmission expenditures

and acute care expenditures, did not differ significantly between high-risk and low-risk drinking patients in adjusted models. However, high-risk drinking patients had greater overall mean ED expenditures with a difference of $16 per patient (95% CI $3, $29), after adjusting for demographics (Appendix 6).

There were no significant differences in average adjusted expenditures for nondrinking patients who were readmitted, who visited an ED, or who had any acute care visit days, compared to those with low risk drinking (part two of two-part models) (Table 3). However, in the total sample, the mean readmission expenditures of nondrinking patients were significantly higher than that of low-risk drinking patients, with an adjusted difference of $325 (95% CI $248, $402) after adjusting for demographics (Appendix 6). Nondrinking patients also had significantly increased mean ED expenditures ($19; 95% CI $16, $22) and acute care expenditures ($345, 95% CI $266, $425) across all adjusted models.

Discussion

In this study of older adults hospitalized for a medical condition and followed for 30 days to assess total acute care utilization and expenditures, high-risk drinking was associated with increased acute care utilization, adjusted for demographics, but not with increased acute care expenditures. In fact, among high-risk drinking patients who had any readmission, average adjusted readmission expenditures were significantly lower than for readmitted low-risk drinking patients. Only mean ED visit expenditures in the total sample were increased among high-risk drinking patients relative to low-risk drinking patients. However, nondrinking was consistently associated with increased acute care utilization, as well as increased overall mean expenditures.

The results of this study have important implications for health care systems seeking to address readmissions or post discharge ED use through the implementation of post-discharge

interventions. Alcohol-specific post-discharge interventions implemented in some health care systems have been found to reduce readmissions.[52] However, the routinely collected AUDIT-C screen for unhealthy alcohol used in the present study did not appear to identify high-risk drinking patients with increased expenditures in the 30 days following discharge. Even if the modestly increased post-discharge acute care utilization of older adults with high-risk drinking could be reduced to that of low-risk drinking patients, the lack of differences in acute care expenditures between these groups suggests that the cost offset potential for post-discharge interventions targeting alcohol use may be minimal. Both hospital readmission and total acute care utilization (including EDs use) appeared to be equally costly, based on expenditures, for all inpatients irrespective of the severity of unhealthy alcohol use. However, hospitals may nevertheless be motivated to implement post-discharge interventions in order to provide higher quality care for patients with high-risk drinking that satisfies Joint Commission metrics for discharged patients with alcohol use disorders.[53]

The lack of differences in health care expenditures for high-risk drinking patients relative to low-risk drinking patients, despite increased acute care utilization, was largely driven by the lower readmission expenditures among high-risk drinking patients who were readmitted. Inpatient expenditures are based on a DRG system for assigning payments, which is intended to take into account the costs of resources used to care for patients with specific conditions, based on both diagnoses and procedures during a hospital stay.[48] Patients with high-risk drinking may be treated for conditions considered less costly to care for, based on DRGs, than patients with low-risk drinking. The most common condition at readmission for high-risk drinking patients hospitalized for a medical condition during their index stay was alcohol-related conditions (12% of readmissions), while congestive heart failure (CHF) was the most common condition for low-

risk drinking patients (8%).[29] However, even though there were no significant differences in expenditures, if alcohol-related readmissions were more preventable than readmissions for conditions like CHF, health care systems may still be interested in targeting high-risk drinking patients at greater risk for readmissions related to their alcohol use. The 30-day readmission measures used by CMS have received strong criticism because numerous studies have found that only a minority of readmissions are judged preventable based on thorough chart reviews from clinical experts.[54,55] Future research would be needed to determine whether readmissions for alcohol-related conditions could be prevented if hospitals provide higher quality care during index hospital stays, or if patients receive alcohol-related follow-up care after discharge, and merit the attention of health care systems.

The results of this study support some previous research that found greater hospital and ED utilization for individuals who report nondrinking than for current drinkers.[56-58] In the present study, patients who reported nondrinking were not used as the referent group for that reason. Patients who reported no drinking in this study had consistently higher probability of acute care utilization, acute care utilization days, and expected 30-day acute care expenditures, relative to low-risk drinking patients. Although there was no difference in average expenditures among nondrinking patients relative to low-risk drinking patients among the subgroup of patients who had any readmission, the higher probability of readmission overall translated to higher expected 30-day expenditures, and similar results were observed for both ED use and total acute care use. Nondrinking patients made up the largest proportion of the study sample (64%) and given the large size of this subgroup, hospitals may not be able to feasibly target such patients at hospital discharge. Nevertheless, nondrinking appeared to explain increased utilization and expenditures over and above all comorbid conditions, prior utilization, and SES and social support indicators

included in adjusted two-part models. Patient report of nondrinking may be one of many factors that could identify patients in need of post-discharge support.

There are several limitations to the present study. First, the associations between alcohol risk groups and expenditures are observational and cannot be interpreted as causal. However, the results are most pertinent to health care systems interested in understanding the overall expenditures among patients with different categories of unhealthy alcohol use. Second, patient reported unhealthy alcohol use may be underestimated in the sample and patients with high-risk drinking may be misclassified as low-risk drinking when alcohol consumption is assessed in clinical practice.[59] However, the proportion of patients with unhealthy alcohol use (moderate-risk and high-risk drinking) in the present study (10%) is similar to that based on self-report in other older adult samples (9%).[60,61] Third, the VA estimated expenditures may not be comparable to Medicare expenditures because salaried VA providers may not have the same incentives for coding patient diagnoses and procedures that are used to assign DRG.[62,63] However, among Veterans who are dually eligible for VA and Medicare, veterans are more reliant on non-VA hospitals for inpatient care.[64] As a result, VA expenditures estimated through DRG-based relative value weights as used in this study would be the best available expenditure estimate for combining with Medicare expenditures. Finally, it is unknown whether the associations observed in this study of older VA patients screened with the AUDIT-C would be generalizable to other populations of older adults. VA patients who utilize VA outpatient care, and were therefore eligible for the present study due to past-year AUDIT-C screen, may be more likely to be VA copay exempt and have greater comorbidity burden.[65] Therefore, results of the present study may be most generalizable to patient samples with a higher burden of comorbidity and lower SES.

Conclusions

The present study finds that nondrinking, but not high-risk drinking, is associated with increased acute care expenditures, including readmissions and ED visits, in the 30-days following discharge from a hospitalization for a medical condition. These results suggest that older adults with high-risk drinking may not have the highest post-dischage cost burden, from the perspective of payers such as Medicare. Health systems seeking to reduce expenditures through post-discharge interventions may not decrease expenditures by directly targeting older adults with high-risk drinking. Nevertheless, high-risk drinking patients had greater acute care utilization than low-risk drinking patients and some health care systems may still consider targeting these patients with post-discharge intervention resources in an effort to decrease potentially avoidable acute care utilization and improve quality of care for these patients.

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Figure 1. Sample Eligibility Criteria

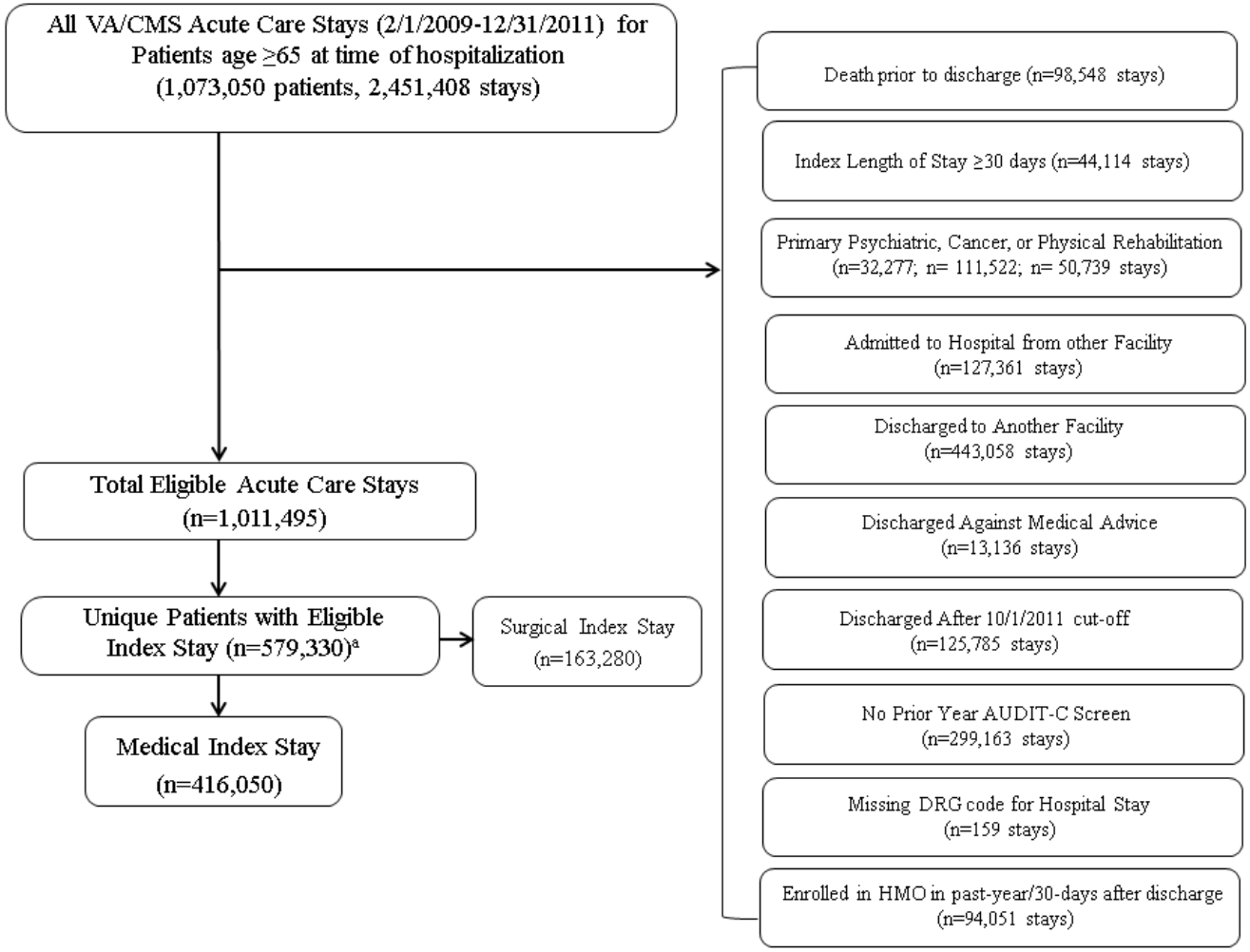


Table 1. Sample Characteristics of Medical Inpatients, By AUDIT-C Group.

	Nondrinker n=267,746		Low-risk Drinking n=105,023		Moderate-Risk Drinking n=37,981		High-Risk Drinking n=5,300		Total n=416,050	
Age, mean (SD)	77.4	(7.4)	76.6	(7.3)	76.6	(7.3)	71.1	(6.0)	77.0	(7.4)
Male, n (%)	262,188	(97.9)	103,548	(98.6)	37,362	(98.4)	5,287	(99.8)	408,385	(98.2)
Nonwhite Race, n (%)	45,393	(17.0)	12,944	(12.3)	3,340	(8.8)	945	(17.8)	62,622	(15.1)
Marital Status, n (%)										
Unmarried	97,523	(36.4)	36,887	(35.1)	13,882	(36.5)	3,091	(58.3)	151,383	(36.4)
Married	169,296	(63.2)	67,816	(64.6)	23,940	(63.0)	2,193	(41.4)	263,245	(63.3)
Missing/Unknown	927	(0.3)	320	(0.3)	159	(0.4)	16	(0.3)	1,422	(0.3)
VA Copay Exempt, n (%)										
Copay Required	69,213	(25.9)	38,889	(37.0)	15,316	(40.3)	1,088	(20.5)	124,506	(29.9)
Copay Exempt	196,806	(73.5)	65,470	(62.3)	22,424	(59.0)	4,177	(78.8)	288,877	(69.4)
Missing/Unknown	1,727	(0.6)	664	(0.6)	241	(0.6)	35	(0.7)	2,667	(0.6)
Tobacco, n (%)	35,411	(13.2)	15,612	(14.9)	7,499	(19.7)	2,470	(46.6)	60,992	(14.7)
PTSD, n (%)	15,053	(5.6)	4,926	(4.7)	1,531	(4.0)	545	(10.3)	22,055	(5.3)
AUD, n (%)	8,344	(3.1)	5,955	(5.7)	7,230	(19.0)	3,566	(67.3)	25,095	(6.0)
Comorbidity Index, mean (SD)[a]	4.1	(3.0)	3.6	(3.0)	3.6	(2.9)	3.6	(2.7)	3.9	(3.0)
PY[b] **hospitalizations, mean (SD)**	0.5	(1.1)	0.4	(0.9)	0.4	(0.8)	0.6	(1.2)	0.5	(1.0)
PY[b] **ED visits, mean (SD)**	1.3	(2.1)	1.0	(1.7)	0.9	(1.7)	1.5	(2.6)	1.2	(2.0)
PY[b] **hospital expenditures, mean (SD)**	$6482	($21,023)	$4562	($16,565)	$4103	($15,105)	$8378	($26,231)	$6518	($20,945)
PY[b] **ED expenditures, mean (SD)**	$785	($1,585)	$558	($1,235)	$508	($1,157)	$890	($1,813)	$790	($1,583)
Index Length of Stay, mean (SD)	3.9	(3.4)	3.6	(3.1)	3.6	(3.2)	4.3	(4.0)	3.8	(3.3)
Any AMA, n (%)	1,811	(0.7)	614	(0.6)	238	(0.6)	135	(2.5)	2,798	(0.7)

[a] PY= Past year

[b] Condition Indicators for Conditions in the Comorbidity Index available in Appendix 2

Table 2. Unadjusted and Adjusted Mean Hospital Days and ED Visits, Across AUDIT-C Groups

	Nondrinker (n=267,746)		Low-risk Drinking (n=105,023)		Moderate-Risk Drinking (n=37,981)		High-Risk Drinking (n=5,300)	
	Estimate	**(95% CI)**	**Estimate**	**(95% CI)**	**Estimate**	**(95% CI)**	**Estimate**	**(95% CI)**
Total 30-Day Readmission Days								
Unadjusted								
Probability of Any Readmission	**0.16**	**(0.16, , 0.16)**	0.14	(0.13 , 0.14)	0.14	(0.13 , 0.14)	**0.16**	**(0.15 , 0.17)**
Mean Readmission Days if Any Readmission	**8.41**	**(8.33 , 8.49)**	8.15	(8.00 , 8.30)	7.91	(7.69 , 8.13)	8.59	(8.04 , 9.14)
Mean Readmission Days in Total Sample	**1.34**	**(1.32 , 1.34)**	1.11	(1.08 , 1.11)	1.08	(1.04 , 1.08)	**1.39**	**(1.27 , 1.39)**
Adjusted for Demographics[a]								
Probability of Any Readmission	**0.16**	**(0.16 , 0.16)**	0.14	(0.13 , 0.14)	0.14	(0.13 , 0.14)	**0.17**	**(0.16 , 0.18)**
Mean Readmission Days if Any Readmission	8.40	(8.32 , 8.48)	8.17	(8.03 , 8.32)	7.97	(7.74 , 8.19)	8.42	(7.89 , 8.94)
Mean Readmission Days in Total Sample	**1.34**	**(1.32 , 1.35)**	1.12	(1.09 , 1.14)	1.10	(1.06 , 1.14)	**1.40**	**(1.28 , 1.52)**
Total 30-day ED Visits								
Unadjusted								
Probability of Any ED Visit	**0.13**	**(0.13 , 0.13)**	0.11	(0.11 , 0.11)	0.11	(0.10 , 0.11)	**0.13**	**(0.12 , 0.14)**
Mean ED Visits if Any ED Visit	1.25	(1.24 , 1.26)	1.23	(1.22 , 1.25)	1.23	(1.21 , 1.25)	1.32	(1.25 , 1.38)
Mean ED Visits in Total Sample	**0.16**	**(0.16 , 0.16)**	0.13	(0.13 , 0.13)	0.13	(0.13 , 0.13)	**0.17**	**(0.15 , 0.17)**
Adjusted for Demographics[a]								
Probability of Any	**0.13**	**(0.13 , 0.13)**	0.11	(0.11 , 0.11)	0.11	(0.10 , 0.11)	**0.12**	**(0.12 , 0.13)**
Mean ED Visits if Any ED Visit	1.25	(1.24 , 1.25)	1.23	(1.22 , 1.24)	1.23	(1.21 , 1.25)	1.29	(1.23 , 1.35)
Mean ED Visits in Total Sample	**0.16**	**(0.16 , 0.16)**	0.13	(0.13 , 0.14)	0.13	(0.13 , 0.14)	**0.16**	**(0.15 , 0.17)**
Total 30-day Acute Care Days								
Unadjusted								
Probability of Any Acute Care Use	**0.26**	**(0.26 , 0.26)**	0.22	(0.22 , 0.22)	0.22	(0.22 , 0.23)	**0.26**	**(0.25 , 0.27)**
Mean Acute Days if Any Acute Care Use	**5.80**	**(5.75 , 5.86)**	5.58	(5.48 , 5.68)	5.49	(5.33 , 5.64)	6.00	(5.61 , 6.40)
Mean Acute Days in Total Sample								
Adjusted for Demographics[a]								
Probability of Any Acute Care Use	**0.26**	**(0.26 , 0.26)**	0.22	(0.22 , 0.23)	0.22	(0.22 , 0.23)	**0.26**	**(0.25 , 0.27)**
Mean Acute Days if Any Acute Care Use	**5.79**	**(5.74 , 5.85)**	5.58	(5.48 , 5.68)	5.49	(5.34 , 5.65)	5.99	(5.60 , 6.37)
Mean Acute Days in Total Sample	**1.49**	**(1.48 , 1.51)**	1.25	(1.22 , 1.27)	1.23	(1.19 , 1.27)	**1.56**	**(1.44 , 1.69)**

Note: Bolded estimates indicate adjusted difference in mean from referent group (low-risk drinking) is significantly different from zero ($p<0.05$).

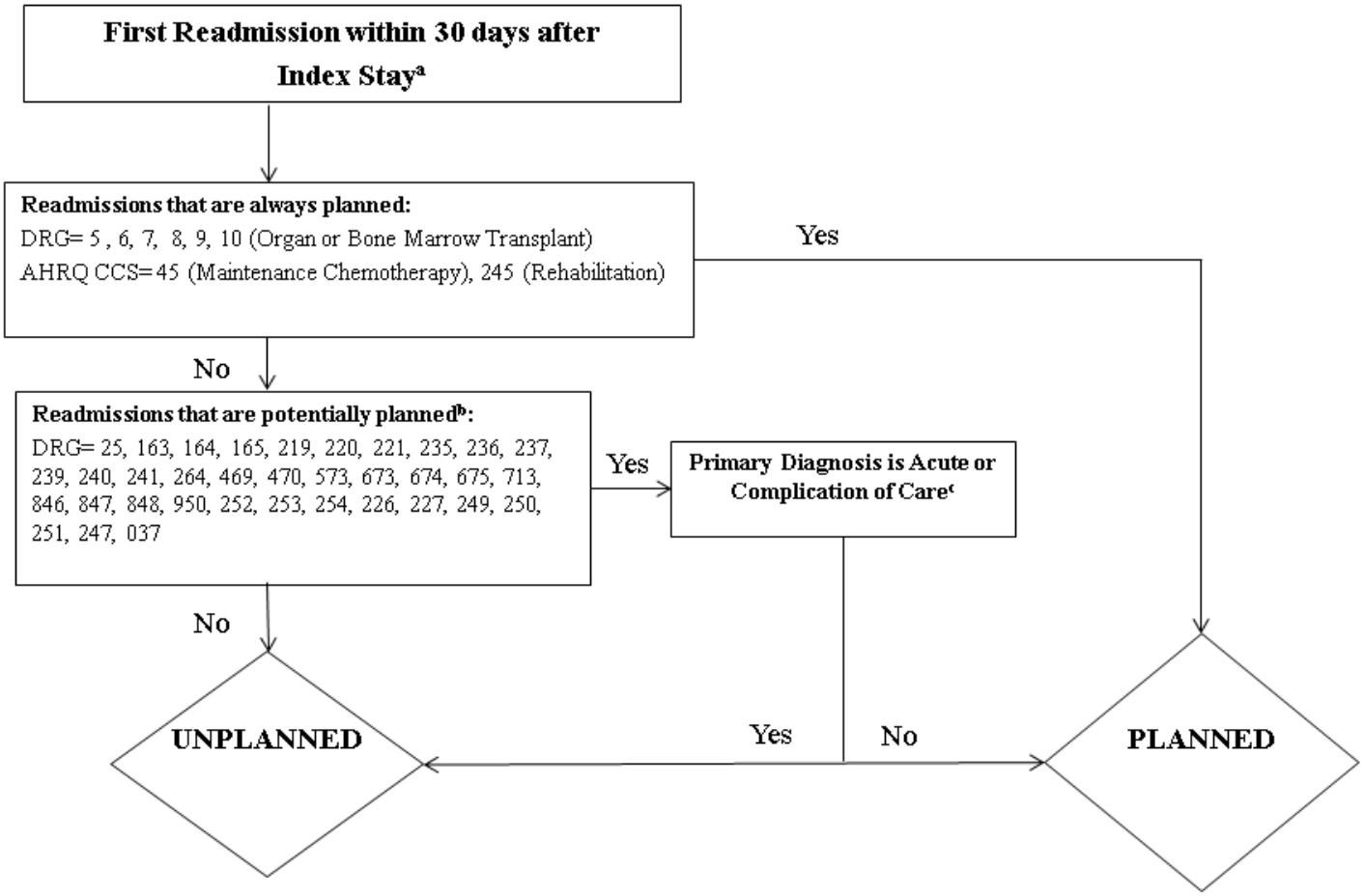
[a] Adjusted for age, gender, race, year of discharge

Table 3. Unadjusted and Adjusted Mean Expenditures, Across AUDIT-C Groups

	Nondrinker (n=267,746)		Low-risk Drinking (n=105,023)		Moderate-Risk Drinking (n=37,981)		High-Risk Drinking (n=5,300)	
	Estimate	**(95% CI)**	**Estimate**	**(95% CI)**	**Estimate**	**(95% CI)**	**Estimate**	**(95% CI)**
Total 30-Day Readmission Expenditures								
Unadjusted								
Mean Expenditures if Any Readmission	$16617	($16390, $16844)	$16998	($16585, $17411)	$16489	($15892, $17086)	$16088	($14762, $17414)
Mean Expenditures in Total Sample	**$2652**	**($2609, $2641)**	$2307	($2241, $2307)	$2261	($2161, $2261)	**$2608**	**($2340, $2608)**
Adjusted for Demographics[a]								
Mean Expenditures if Any Readmission	$16696	($16465, $16928)	$17066	($16670, $17462)	$16699	($16146, $17252)	**$14986**	**($13795, $16178)**
Mean Expenditures in Total Sample	**$2645**	**($2601, $2689)**	$2320	($2255, $2385)	$2294	($2197, $2391)	$2488	($2243, $2733)
Total 30-day ED Expenditures								
Unadjusted								
Mean Expenditures if Any ED Visit	$891	($880, $901)	$867	($849, $885)	$832	($804, $859)	$873	($799, $946)
Mean Expenditures in Total Sample	**$113**	**($111, $113)**	$93	($90, $93)	**$87**	**($84, $87)**	**$112**	**($100, $112)**
Adjusted for Demographics[a]								
Mean Expenditures if Any ED Visit	$890	($880, $901)	$868	($850, $885)	$833	($806, $860)	$882	($807, $958)
Mean Expenditures in Total Sample	**$113**	**($111, $114)**	$94	($91, $96)	$89	($85, $93)	**$109**	**($98, $121)**
Total 30-day Acute Care Expenditures								
Unadjusted								
Mean Expenditures if Any Acute Care Use	$10693	($10541, $10844)	$10809	($10537, $11081)	$10614	($10209, $11019)	$10453	($9537, $11369)
Mean Expenditures in Total Sample	**$2766**	**($2722, $2754)**	$2400	($2334, $2400)	$2348	($2248, $2348)	**$2720**	**($2451, $2720)**
Adjusted for Demographics[a]								
Mean Expenditures if Any Acute Care Use	$10702	($10545, $10858)	$10796	($10536, $11057)	$10632	($10251, $11012)	$9953	($9105, $10801)
Mean Expenditures in Total Sample	**$2759**	**($2715, $2802)**	$2413	($2348, $2478)	$2377	($2279, $2474)	$2597	($2348, $2845)

Note: Bolded estimates indicate adjusted difference in mean from referent group (low-risk drinking) is significantly different from zero ($p<0.05$).
[a]Adjusted for age, gender, race, year of discharge

Appendix 1. Algorithm for Identifying Unplanned Readmissions



Appendix 2. Clinical Characteristics Based on Diagnoses in Past-Year and Index Stay for Study Sample, by AUDIT-C Groups

	Nondrinker n=267,746		Low-risk Drinking n=105,023		Moderate-Risk Drinking n=37,981		High-Risk Drinking n=5,300		Total n=416,050	
Deficiency Anemias, n (%)	108,214	(40.4%)	38,511	(36.7%)	13,672	(36.0%)	1,651	(31.2%)	162,048	(38.9%)
Cardiac Arrythmias, n (%)	126,948	(47.4%)	50,338	(47.9%)	18,387	(48.4%)	1,827	(34.5%)	197,500	(47.5%)
Congestive Heart Failure, n (%)	117,095	(43.7%)	41,163	(39.2%)	14,036	(37.0%)	1,463	(27.6%)	173,757	(41.8%)
Coagulopathy, n (%)	28,825	(10.8%)	11,358	(10.8%)	4,219	(11.1%)	527	(9.9%)	44,929	(10.8%)
Complicated Diabetes, n (%)	58,993	(22.0%)	17,744	(16.9%)	4,149	(10.9%)	450	(8.5%)	81,336	(19.5%)
Dementia, n (%)	25,533	(9.5%)	5,872	(5.6%)	1,823	(4.8%)	182	(3.4%)	33,410	(8.0%)
Fluid and Electrolyte Disorders, n (%)	102,720	(38.4%)	36,378	(34.6%)	13,787	(36.3%)	2,286	(43.1%)	155,171	(37.3%)
Hemiplegia, n (%)	8,023	(3.0%)	2,487	(2.4%)	777	(2.0%)	100	(1.9%)	11,387	(2.7%)
HIV/AIDS, n (%)	499	(0.2%)	237	(0.2%)	56	(0.1%)	9	(0.2%)	801	(0.2%)
Hypertension, n (%)	243,536	(91.0%)	94,775	(90.2%)	34,158	(89.9%)	4,607	(86.9%)	377,076	(90.6%)
Liver Disease, n (%)	10,010	(3.7%)	3,729	(3.6%)	1,730	(4.6%)	670	(12.6%)	16,139	(3.9%)
Metastatic cancer, n (%)	11,531	(4.3%)	4,686	(4.5%)	1,699	(4.5%)	194	(3.7%)	18,110	(4.4%)
Psychosis, n (%)	36,086	(13.5%)	9,770	(9.3%)	3,212	(8.5%)	831	(15.7%)	49,899	(12.0%)
Pulmonary circulation disorders, n (%)	18,874	(7.0%)	7,345	(7.0%)	2,695	(7.1%)	275	(5.2%)	29,189	(7.0%)
Chronic pulmonary disease, n (%)	119,015	(44.5%)	43,362	(41.3%)	16,886	(44.5%)	2,683	(50.6%)	181,946	(43.7%)
Peripheral vascular disorder, n (%)	87,792	(32.8%)	33,049	(31.5%)	11,798	(31.1%)	1,202	(22.7%)	133,841	(32.2%)
Renal Failure, n (%)	88,179	(32.9%)	29,815	(28.4%)	8,511	(22.4%)	681	(12.8%)	127,186	(30.6%)
Tumor, n (%)	75,534	(28.2%)	31,245	(29.8%)	11,193	(29.5%)	1,216	(22.9%)	119,188	(28.6%)
Weight loss, n (%)	10,789	(4.0%)	3,195	(3.0%)	1,381	(3.6%)	316	(6.0%)	15,681	(3.8%)
Myocardial infarction, n (%)	50,725	(18.9%)	18,911	(18.0%)	5,943	(15.6%)	631	(11.9%)	76,210	(18.3%)
Cerebrovascular disease, n (%)	21,349	(8.0%)	6,036	(5.7%)	2,066	(5.4%)	218	(4.1%)	29,669	(7.1%)
Rheumatoid Arthritis, n (%)	24,540	(9.2%)	10,139	(9.7%)	3,478	(9.2%)	236	(4.5%)	38,393	(9.2%)
Ulcer disease, n (%)	12,582	(4.7%)	4,900	(4.7%)	1,845	(4.9%)	259	(4.9%)	19,586	(4.7%)
Uncomplicated diabetes, n (%)	128,333	(47.9%)	43,073	(41.0%)	11,655	(30.7%)	1,426	(26.9%)	184,487	(44.3%)
Valvular disease, n (%)	61,759	(23.1%)	25,969	(24.7%)	9,293	(24.5%)	703	(13.3%)	97,724	(23.5%)
Paralysis, n (%)	14,024	(5.2%)	3,759	(3.6%)	1,206	(3.2%)	143	(2.7%)	19,132	(4.6%)
Hypothyroidism, n (%)	49,834	(18.6%)	17,736	(16.9%)	5,902	(15.5%)	518	(9.8%)	73,990	(17.8%)

Obesity, n (%)	41,895	(15.6%)	17,267	(16.4%)	4,695	(12.4%)	757	(14.3%)	64,614	(15.5%)
Blood loss anemia, n (%)	9,353	(3.5%)	3,543	(3.4%)	1,330	(3.5%)	160	(3.0%)	14,386	(3.5%)
Drug use disorders, n (%)	4,423	(1.7%)	1,688	(1.6%)	783	(2.1%)	578	(10.9%)	7,472	(1.8%)
Depression, n (%)	14,349	(5.4%)	4,640	(4.4%)	1,591	(4.2%)	361	(6.8%)	20,941	(5.0%)
Neurodegenerative disorders, n (%)	70,142	(26.2%)	20,780	(19.8%)	7,185	(18.9%)	1,047	(19.8%)	99,154	(23.8%)

Appendix 3. Adjusted Mean Hospital Days and ED Visits, Across AUDIT-C Groups

	Nondrinker (n=267,746)		Low-risk Drinking (n=105,023)		Moderate-Risk Drinking (n=37,981)		High-Risk Drinking (n=5,300)	
	Estimate	**(95% CI)**	**Estimate**	**(95% CI)**	**Estimate**	**(95% CI)**	**Estimate**	**(95% CI)**
Total 30-Day Readmission Days								
Adjusted for Comorbidity and Prior Use[a]								
Probability of Any Readmission	**0.16**	**(0.16 , 0.16)**	0.14	(0.14 , 0.14)	0.14	(0.14 , 0.15)	**0.15**	**(0.14 , 0.16)**
Mean Readmission Days if Any Readmission	8.03	(7.95 , 8.11)	8.00	(7.85 , 8.14)	7.78	(7.55 , 8.00)	7.74	(7.22 , 8.27)
Mean Readmission Days in Total Sample	**1.30**	**(1.29 , 1.32)**	1.19	(1.16 , 1.21)	1.16	(1.12 , 1.21)	1.23	(1.12 , 1.35)
Adjusted for SES and Social Support[b]								
Probability of Any Readmission	**0.16**	**(0.15 , 0.16)**	0.14	(0.14 , 0.14)	0.14	(0.14 , 0.15)	0.15	(0.14 , 0.16)
Mean Readmission Days if Any Readmission	8.01	(7.93 , 8.09)	7.99	(7.84 , 8.13)	7.77	(7.55 , 8.00)	7.72	(7.20 , 8.24)
Mean Readmission Days in Total Sample	**1.30**	**(1.28 , 1.32)**	1.20	(1.17 , 1.22)	1.18	(1.13 , 1.22)	1.23	(1.11 , 1.34)
Total 30-day ED Visits								
Adjusted for Comorbidity and Prior Use[a]								
Probability of Any ED Visit	**0.12**	**(0.12 , 0.13)**	0.11	(0.11 , 0.11)	0.11	(0.11 , 0.11)	0.11	(0.10 , 0.12)
Mean ED Visits if Any ED Visit	1.22	(1.20 , 1.24)	1.22	(1.19 , 1.25)	1.22	(1.19 , 1.25)	1.21	(1.16 , 1.27)
Mean ED Days in Total Sample	**0.17**	**(0.15 , 0.19)**	0.16	(0.13 , 0.18)	0.16	(0.13 , 0.18)	0.15	(0.13 , 0.18)
Adjusted for SES and Social Support[b]								
Probability of Any ED Visit	**0.12**	**(0.12 , 0.12)**	0.11	(0.11 , 0.12)	0.11	(0.11 , 0.12)	0.11	(0.10 , 0.12)
Mean ED Visits if Any ED Visit	1.22	(1.19 , 1.24)	1.22	(1.19 , 1.24)	1.22	(1.19 , 1.24)	1.21	(1.16 , 1.27)
Mean ED Visits in Total Sample	0.17	(0.15 , 0.19)	0.16	(0.14 , 0.18)	0.16	(0.14 , 0.18)	0.15	(0.13 , 0.17)
Total 30-day Acute Care Days								
Adjusted for Comorbidity and Prior Use[a]								
Probability of Any Acute Care Use	**0.25**	**(0.25 , 0.26)**	0.23	(0.23 , 0.23)	0.23	(0.22 , 0.23)	0.24	(0.23 , 0.25)
Mean Acute Days if Any Acute Care Use	5.61	(5.56 , 5.67)	5.51	(5.41 , 5.60)	5.41	(5.25 , 5.56)	5.69	(5.30 , 6.09)
Mean Acute Days in Total Sample	**1.47**	**(1.46 , 1.49)**	1.29	(1.27 , 1.32)	1.26	(1.21 , 1.30)	1.42	(1.30 , 1.54)
Adjusted for SES and Social Support[b]								
Probability of Any Acute Care Use	**0.25**	**(0.25 , 0.25)**	0.23	(0.23 , 0.24)	0.23	(0.23 , 0.24)	0.24	(0.23 , 0.25)
Mean Acute Days if Any Acute Care Use	5.50	(5.45 , 5.56)	5.44	(5.35 , 5.54)	5.34	(5.19 , 5.50)	5.50	(5.11 , 5.88)
Mean Acute Days in Total Sample	**1.45**	**(1.43 , 1.47)**	1.35	(1.32 , 1.38)	1.34	(1.29 , 1.39)	1.39	(1.27 , 1.50)

Note: Bolded estimates indicate adjusted difference in mean from referent group (low-risk drinking) is significantly different from zero ($p<0.05$).

[a]Adjusted for age, gender, race, year of discharge, past-year tobacco diagnosis, past-year PTSD diagnosis, comorbid condition indicators, days from AUDIT-C screen to index stay, past-year inpatient/ED Visits, past-year discharge AMA, index LOS

[b]Adjusted for age, gender, race, year of discharge, past-year tobacco diagnosis, past-year PTSD diagnosis, comorbid condition indicators, days from AUDIT-C screen to index stay, past-year inpatient/ED Visits, past-year discharge AMA, index LOS, VA copay exempt status, marital status

Appendix 4. Adjusted Differences in Acute Care Utilization Relative to Low-Risk Drinking

	Nondrinker (n=267,746)		Low-risk Drinking (n=105,023)		Moderate-Risk Drinking (n=37,981)		High-Risk Drinking (n=5,300)	
	Difference	**(95% CI)**	**Difference**	**(95% CI)**	**Difference**	**(95% CI)**	**Difference**	**(95% CI)**
Total 30-Day Readmission Hospital Days								
Adjusted for Demographics[a]	**0.22**	**(0.19 , 0.25)**	--	-- --	-0.02	(-0.06 , 0.03)	**0.29**	**(0.16 , 0.42)**
Adjusted for Comorbidity and Prior Use[b]	**0.12**	**(0.09 , 0.15)**	--	-- --	-0.02	(-0.08 , 0.03)	0.04	(-0.08 , 0.16)
Adjusted for SES and Social Support[c]	**0.10**	**(0.07 , 0.14)**	--	-- --	-0.02	(-0.07 , 0.04)	0.03	(-0.09 , 0.15)
Total 30-day ED Visits								
Adjusted for Demographics[a]	**0.03**	**(0.02 , 0.03)**	--	-- --	0.00	(-0.01 , 0.00)	**0.03**	**(0.01 , 0.04)**
Adjusted for Comorbidity and Prior Use[b]	**0.01**	**(0.01 , 0.02)**	--	-- --	0.00	(-0.01 , 0.00)	0.00	(-0.02 , 0.01)
Adjusted for SES and Social Support[c]	**0.01**	**(0.01 , 0.01)**	--	-- --	0.00	(-0.01 , 0.01)	-0.01	(-0.02 , 0.01)
Total 30-day Acute Care Days								
Adjusted for Demographics[a]	**0.25**	**(0.21 , 0.28)**	--	-- --	-0.02	(-0.07 , 0.03)	**0.32**	**(0.18 , 0.45)**
Adjusted for Comorbidity and Prior Use[b]	**0.18**	**(0.15 , 0.21)**	--	-- --	-0.04	(-0.09 , 0.01)	0.12	(-0.01 , 0.25)
Adjusted for SES and Social Support[c]	**0.10**	**(0.06 , 0.13)**	--	-- --	-0.01	(-0.07 , 0.04)	0.03	(-0.08 , 0.15)

Note: Bolded estimates indicate adjusted difference in mean from referent group (low-risk drinking) is significantly different from zero ($p<0.05$).
[a]Adjusted for age, gender, race, year of discharge
[b]Adjusted for age, gender, race, year of discharge, past-year tobacco diagnosis, past-year PTSD diagnosis, comorbid condition indicators, days from AUDIT-C screen to index stay, past-year inpatient/ED Visits, past-year discharge AMA, index LOS
[c]Adjusted for age, gender, race, year of discharge, past-year tobacco diagnosis, past-year PTSD diagnosis, comorbid condition indicators, days from AUDIT-C screen to index stay, past-year inpatient/ED Visits, past-year discharge AMA, index LOS, VA copay exempt status, marital status

Appendix 5. Adjusted Mean Expenditures, Across AUDIT-C Groups

	Nondrinker (n=267,746)		Low-risk Drinking (n=105,023)		Moderate-Risk Drinking (n=37,981)		High-Risk Drinking (n=5,300)	
	Estimate	**(95% CI)**	**Estimate**	**(95% CI)**	**Estimate**	**(95% CI)**	**Estimate**	**(95% CI)**
Total 30-Day Readmission Expenditures								
Adjusted for Comorbidity and Prior Use[a]								
Mean Expenditures if Any Readmission	$16286	($16054, $16518)	$16818	($16438, $17198)	$16516	($15953, $17079)	**$14582**	**($13373, $15792)**
Mean Expenditures in Total Sample	**$2600**	**($2556, $2644)**	$2434	($2367, $2501)	$2400	($2297, $2503)	$2275	($2043, $2509)
Adjusted for SES and Social Support[b]								
Mean Expenditures if Any Readmission	$16220	($15990, $16450)	$16809	($16429, $17189)	$16543	($15981, $17105)	**$14528**	**($13330, $15726)**
Mean Expenditures in Total Sample	**$2584**	**($2541, $2628)**	$2456	($2388, $2524)	$2441	($2337, $2545)	$2268	($2037, $2499)
Total 30-day ED Expenditures								
Adjusted for Comorbidity and Prior Use[a]								
Mean Expenditures if Any ED Visit	$888	($804 $971)	$893	($807, $980)	$861	($774, $947)	$902	($783, $1020)
Mean Expenditures in Total Sample	$146	($62, $230)	$136	($52, $221)	$130	($49, $212)	$135	($49, $222)
Adjusted for SES and Social Support[b]								
Mean Expenditures if Any ED Visit	$895	($798, $992)	$899	($799, $999)	$865	($766, $964)	$908	($778, $1038)
Mean Expenditures in Total Sample	$151	($53, $249)	$143	($45, $241)	$137	($42, $232)	$141	($40, $242)
Total 30-day Acute Care Expenditures								
Adjusted for Comorbidity and Prior Use[a]								
Mean Expenditures if Any Acute Care Use	$10201	($10049, $10352)	$10520	($10269, $10771)	$10432	($10046, $10818)	$9639	($8755, $10522)
Mean Expenditures in Total Sample	**$2721**	**($2676, $2766)**	$2544	($2475, $2614)	$2504	($2399, $2610)	$2403	($2157, $2649)
Adjusted for SES and Social Support[b]								
Mean Expenditures if Any Acute Care Use	$10188	($10036, $10340)	$10505	($10254, $10756)	$10425	($10040, $10811)	$9610	($8734, $10486)
Mean Expenditures in Total Sample	**$2705**	**($2660, $2749)**	$2567	($2498, $2638)	$2548	($2441, $2655)	$2396	($2151, $2639)

Note: Bolded estimates indicate adjusted difference in mean from referent group (low-risk drinking) is significantly different from zero ($p<0.05$).

[a]Adjusted for age, gender, race, year of discharge, past-year tobacco diagnosis, past-year PTSD diagnosis, comorbid condition indicators, days from AUDIT-C screen to index stay, past-year inpatient/ER expenditures, past-year discharge AMA, index LOS

[b]Adjusted for age, gender, race, year of discharge, past-year tobacco diagnosis, past-year PTSD diagnosis, comorbid condition indicators, days from AUDIT-C screen to index stay, past-year inpatient/ER expenditures, past-year discharge AMA, index LOS, VA copay exempt status, marital status

Appendix 6. Adjusted Differences* in Average expenditures Relative to Low-Risk Drinking Group

	Nondrinker (n=267,746)			Low-risk Drinking (n=105,023)			Moderate-Risk Drinking (n=37,981)			High-Risk Drinking (n=5,300)		
	Diff	**(95% CI)**		**Diff**	**(95% CI)**		**Diff**	**(95% CI)**		**Diff**	**(95% CI)**	
Total 30-Day Readmission Hospital Days												
Adjusted for Demographics[a]	**$325.11**	**($246.59**	**, 403.62)**	--	--	--	-$25.87	(-$147.91	, 96.17)	$168.09	($96.70	, 432.88)
Adjusted for Comorbidity and Prior Use[b]	**$165.70**	**($87.25**	**, 244.16)**	--	--	--	-$33.90	(-$155.97	, 88.17)	-$158.96	(-$404.13	, 86.21)
Adjusted for SES and Social Support[c]	**$128.30**	**($50.35**	**, 206.25)**	--	--	--	-$15.42	(-$140.27	, 109.42)	-$188.24	(-$436.92	, 60.45)
Total 30-day ED Visits												
Adjusted for Demographics[a]	**$19.03**	**($15.95**	**, 22.11)**	--	--	--	-$4.69	(-$9.30	-, 0.09)	**$15.85**	**($3.05**	**, 28.64)**
Adjusted for Comorbidity and Prior Use[b]	**$9.59**	**($5.67**	**, 13.52)**	--	--	--	-$6.12	(-$13.02	, 0.79)	-$1.13	(-$15.96	, 13.71)
Adjusted for SES and Social Support[c]	**$7.99**	**($3.86**	**, 12.13)**	--	--	--	-$5.73	(-$12.95	, 1.49)	-$2.22	(-$17.15	, 12.71)
Total 30-day Acute Care Days												
Adjusted for Demographics[a]	**$345.45**	**($266.34**	**, 424.56)**	--	--	--	-$36.55	(-$156.94	, 83.85)	$183.68	(-$77.69	, 445.05)
Adjusted for Comorbidity and Prior Use[b]	**$176.47**	**($94.55**	**, 258.39)**	--	--	--	-$39.94	(-$167.06	, 87.18)	-$141.42	(-$404.36	, 121.51)
Adjusted for SES and Social Support[c]	**$136.86**	**($55.63**	**, 218.08)**	--	--	--	-$19.98	(-$148.71	, 108.75)	-$172.44	(-$435.26	, 90.37)

Note: Bolded estimates indicate adjusted difference in mean from referent group (low-risk drinking) is significantly different from zero ($p<0.05$).

[a]Adjusted for age, gender, race, year of discharge

[b]Adjusted for age, gender, race, year of discharge, past-year tobacco diagnosis, past-year PTSD diagnosis, comorbid condition indicators, days from AUDIT-C screen to index stay, past-year inpatient/ER expenditures, past-year discharge AMA, index LOS

[c]Adjusted for age, gender, race, year of discharge, past-year tobacco diagnosis, past-year PTSD diagnosis, comorbid condition indicators, days from AUDIT-C screen to index stay, past-year inpatient/ER expenditures, past-year discharge AMA, index LOS, VA copay exempt status, marital status

Title: Preference Weights for the Spectrum of

Alcohol Use in the U.S. Population

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Abstract

Background. Little is known about the cost-utility of population-based alcohol interventions. One barrier to research has been the lack of preference weights needed to calculate Quality Adjusted Life Years (QALYs) for the full spectrum of alcohol use. Preference weights can be estimated from measures of health-related quality of life (HRQOL).

Methods This cross-sectional study included participants in both the National Health Interview Survey (NHIS; 1999-2002) and the Medical Expenditure Panel Survey (MEPS; 2000-2003). The AUDIT-C alcohol screen was derived from NHIS with scores categorized into 6 groups (0,1-3, 4-5, 6-7, 8-9, 10-12 points), ranging from nondrinking (0) to very severe unhealthy alcohol use (10-12). AUDIT-C scores were mapped to EQ-5D and SF-6D preference weights using the linked datasets and analyses adjusted for demographics.

Results. Among 17,440 eligible participants, the EQ-5D and SF-6D preference weights were 0.82 (95% CI 0.82-0.83) and 0.79 (95% CI 0.79-0.80), respectively. Adjusted EQ-5D preference weights for nondrinking (0.80; 95% CI 0.79-0.81) and moderate unhealthy drinking (0.85; 95% CI 0.84-0.86) were significantly different from low-risk drinking (0.83; 95% CI 0.83-0.84), but no other significant differences were observed. Results for the SF-6D were similar.

Conclusions This study provides EQ-5D and SF-6D preference weights for a range of alcohol use categories in a representative U.S. adult sample. However, neither measure suggested meaningful differences in HRQOL based on AUDIT-C categories. Self-reported alcohol consumption may not be associated with preference weights or generic instruments may not be sensitive to differences in HRQOL based on consumption, as measured by the AUDIT-C.

1. Introduction

Unhealthy alcohol use, which ranges from drinking above recommended limits to meeting criteria for alcohol use disorders (AUD) [1], is a leading preventable cause of morbidity and mortality [2,3]. The societal costs of unhealthy alcohol use were estimated at over $200 billion in the U.S. in 2006, due to the toll of alcohol use on lost productivity, health care costs, and criminal justice costs [4]. Routine screening for alcohol misuse in general medical settings and repeated brief alcohol counseling for patients who screen positive is effective for reducing drinking [5,6]. However, it is difficult to determine how to prioritize investment in alcohol prevention efforts compared to other prevention priorities.

Cost utility analyses (CUA) allow comparison of the cost-effectiveness of interventions for different conditions with a common metric—the quality adjusted life year (QALY). QALYs are calculated by multiplying a preference weight for a particular health state by time spent living in that health state. Preference weights incorporate a health state's desirability into the QALY and range from 0 for health states valued equal to "death," to 1 for "perfect health" [7]. Preference weights can be obtained from generic multi-attribute health-related quality of life (HRQOL) measures, such as the EuroQoL (EQ)-5D and Short Form (SF)-6D. These generic measures can be collected on large, population-based surveys and preference weights can be indirectly assigned to health states using published algorithms. The use of generic systems for classifying health states was recommended by the U.S. Panel on Cost Effectiveness because it yields generic QALYs that are more comparable across health conditions [7].

The EQ-5D and SF-6D are among the most widely used generic HRQOL measures and have been used extensively to derive preference weights for physical and mental health conditions [8,9]. Yet, few population-based studies have used these measures to report preference

weights for differing levels of alcohol consumption. EQ-5D preference weights have been reported for various alcohol use categories among study samples from rural Australia [10], England [11], and Finland [12]. In these studies, associations between EQ-5D preference weights and alcohol use have been mixed—one study found high-risk drinking was associated with lower preference weights [10], while others did not [11,12]. However, no study has examined the associations of the EQ-5D or SF-6D preference weights with alcohol consumption in the U.S. general population. It remains unclear whether these generic HRQOL measures vary across differing levels of alcohol consumption in a population-based sample.

The present study utilized data from two nationally representative surveys in the U.S. to estimate mean preference weights for the spectrum of alcohol use—from no alcohol use to severe unhealthy alcohol use—using the EQ-5D and SF-6D. In addition, mean preference weights were estimated for the frequency of binge drinking among past-year drinkers and analyses evaluated evidence of differences in associations by age and gender.

2. Methods

2.1 Data Sources and Sample

This study utilized the National Health Interview Survey (NHIS) (1999-2002), linked to the Medical Expenditure Panel Survey (MEPS) (2000-2003). Alcohol consumption measures were obtained from NHIS and HRQOL measures from MEPS. The NHIS is a nationally representative survey of the civilian, non-institutionalized, U.S. population conducted by the National Center for Health Statistics annually. One adult from each sampled household is randomly selected to complete the adult questionnaire, which includes questions on health behaviors including alcohol use, health status, and health care services used. The NHIS provides a sampling frame for the subsequent year's MEPS; approximately three-eighths of NHIS

respondents are made available for MEPS recruitment. MEPS response rates averaged approximately 65%.

Respondents were eligible for the present study if they were age 18 or older, completed the adult questionnaire on NHIS and MEPS the subsequent year. Adults were included in the study sample if they completed measures of alcohol use on NHIS, HRQOL on MEPS, and other covariates. Among 127,545 adults who responded to the NHIS adult questionnaire over the study period, 19,364 participated in MEPS and 17,440 of MEPS participants (90.1%) completed all measures needed. The University of Washington Institutional Review Board considered this study exempt from human subjects review because data were publicly available and de-identified.

2.2 Measures

2.2.1 Alcohol Use Categories. Individuals' alcohol consumption was based on a derived AUDIT-C score, which was grouped into 6 categories. The AUDIT-C is a widely used alcohol screen, and derived AUDIT-C scores reflect average alcohol consumption and the probability of AUD [13,14]. Following methods validated previously [13], AUDIT-C scores were generated based on individuals' responses to three NHIS alcohol consumption questions: 1) frequency of past-year drinking, 2) usual quantity of drinking on drinking days, and 3) frequency of binge drinking (≥5 drinks per day). Consistent with Dawson et al., AUDIT-C scoring conventions were followed to assign 0-4 points to each item based on quantity/frequency, yielding a total score of 0-12 points (Appendix 1). Derived AUDIT-C scores were assigned to 1 of 6 groups to reflect increasing severity of unhealthy alcohol use: 0 (*nondrinking*), 1-3 (*low-risk drinking*), 4-5 (*mild unhealthy alcohol use*), 6-7 (*moderate unhealthy alcohol use*), 8-9 (*severe unhealthy alcohol use*), and 10-12 (*very severe unhealthy alcohol use*)[15,16].

2.2.2 Binge Drinking. A measure of binge drinking was based on the scoring algorithm of the third AUDIT-C question. Responses were categorized as no binge drinking, less than monthly, monthly, weekly, and daily or almost daily.

2.2.3 EQ-5D. The EQ-5D was available in MEPS and captures HRQOL in five dimensions: mobility, self-care, usual activities, pain/discomfort and anxiety/depression. Respondents reported how much of a problem they experience in each domain with 3 options: no problem, mild problem, extreme problem (referred to as the EQ-5D-3 Level). EQ-5D response combinations identify 243 different health states [17]. A scoring algorithm can be applied to yield a preference weight that takes into account community preferences for health states [18]. EQ-5D preference weights generally range from 0-1, but allow for some negative values indicating states rated "worse than death." The mean minimally important difference for EQ-5D preference weights was 0.074 in a prior literature review [19].

2.2.4 SF-6D. The SF-12 [20] was available in the MEPS and assesses HRQOL with 12 items. Seven of the 12 items are used for the SF-6D, a preference-based measure of health that captures HRQOL across 6 domains: physical functioning, role limitation, social functioning, pain, mental health, and vitality [21]. Brazier et al.'s scoring algorithm was applied to the SF-6D from MEPS to obtain a preference weight (0-1) for each respondent. The mean minimally important difference for the SF-6D in a prior study was 0.041 [19]. Over the study period, the SF-12 on MEPS changed from version 1 (2000-2002) to version 2 (2003). In order to derive the SF-6D, which utilizes SF-12 version 1, version 2 responses were first converted to version 1.

2.2.5 Covariates. Several characteristics may confound the association between alcohol use and HRQOL and are included as covariates. Individual age, gender, race/ethnicity, education, income level, marital status, and smoking are associated with alcohol consumption

and HRQOL [22,23] [24,25]. U.S. region (Northeast, Midwest, South, West) was also included to account for regional differences in alcohol consumption and HRQOL [22,23].

2.3 Analysis

Descriptive statistics described sample demographics and results are presented across alcohol use categories. Primary analyses estimated mean EQ-5D and SF-6D preference weights for each consumption category. Additional analyses estimated mean preference weights for differing levels of binge drinking among a subsample of past-year drinkers. Generalized linear models (GLM) with a log-link and Gaussian distribution were used to examine the association of the EQ-5D and SF-6D preference weights and AUDIT-C categories, adjusting for covariates. These models demonstrated adequate model fit for both EQ-5D and SF-6D preference weights based on Pearson correlation coefficients between y-scale residuals and predicted mean values ($p>0.05$), modified Hosmer-Lemeshow test (F-statistic $p>0.05$), and for the SF-6D, Pregobin's link test (t-statistic $p>0.05$). The method of recycled predictions was used to obtain average adjusted mean preference weights by holding all model covariates constant and allowing alcohol use category to vary [26]. Analyses took into account complex survey design. Because many NHIS respondents who did not complete MEPS were excluded, survey weights were adjusted to account for non-participation in MEPS. A propensity score for the predicted probability of response to MEPS was calculated using logistic regression and NHIS respondents were assigned to 1 of 100 groups based on propensity score [27]. Following Wun et al., an adjustment factor was calculated equal to the ratio of the total sum of survey weights within each group divided by the sum of the weights for all who responded to MEPS in the group. Secondary analyses further examined preference weights among nondrinkers. Main analyses were repeated after separating the original nondrinking group (AUDIT-C 0) into lifetime abstainers and former drinkers [28].

3. Results

Among 19,364 potentially eligible survey respondents, adults were excluded for missing alcohol consumption (n=627; 3.2%), EQ-5D (n=474; 2.5%), SF-6D (n=907; 4.7%), or other covariate measures (n=317; 1.6%). Relative to respondents with complete EQ-5D responses, a greater proportion of those missing items were poor (29.3% vs. 16.6%), unmarried (58.2% vs. 47.8%), had less than high school degrees (46.2% vs. 23.2%), and reported nondrinking (57.4% vs. 39.9%). Similar differences were observed for the SF-6D. Among 17,440 adults in the study sample, a higher proportion of respondents with very severe unhealthy alcohol use (AUDIT-C 10-12) was younger (age<50 years), male, nonwhite, had lower education, lower income, and were current smokers, relative to respondents with low-risk drinking (AUDIT-C 1-3) (Table 1). A higher proportion of participants reporting nondrinking was also nonwhite, had lower education and lower income, compared to those reporting low-risk drinking; but a higher proportion were older (age>50 years), female, and nonsmoking.

Individual EQ-5D and SF-6D domains differed across AUDIT-C groups to varying degrees (Figures 1 & 2). The EQ-5D self-care domain showed little variation across AUDIT-C score groups—the proportion of respondents reporting *no problems* with self-care ranged from 0.93 to 0.98. In contrast, the proportion reporting *no problems* with pain ranged from 0.49 to 0.63 and with anxiety/depression from 0.55 to 0.76 (Figure 1). The SF-6D mental health and vitality domains showed little variation across AUDIT-C groups for the first level of response options—the proportion of respondents reporting feeling downhearted *none of the time* ranged from 0.33 to 0.37 and reporting having energy *all of the time* from 0.08 to 0.10 (Figure 2). However, there was greater variation for reporting more severe problems in these domains—the

proportion of respondents reporting feeling downhearted *some* to *all of the time* ranged from 0.24 to 0.41 and reporting having energy *some* to *none of the time* from 0.38 to 0.48.

Overall, the EQ-5D and SF-6D preference weights were 0.82 (95% CI 0.82-0.83) and 0.79 (95% CI 0.79-0.80), respectively. Adjusted EQ-5D preference weights for nondrinking (0.80; 95% CI 0.79-0.81) and mild unhealthy alcohol use (0.85; 95% CI 0.84-0.86) were significantly different from the referent group, low-risk drinking (0.83; 95% CI 0.83-0.84) (Table 2). Adjusted differences in preference weights relative to low-risk drinking for different alcohol use categories were modest, ranging from 0.01 to 0.04 (Appendix). There was a significant age group by AUDIT-C group interaction for the EQ-5D ($p=0.03$) and significant differences in EQ-5D preference weights across AUDIT-C groups were limited to adults ≥35 years old (Appendix 2). Among past-year drinkers (n=10,362), respondents reporting binge drinking less than monthly had significantly higher adjusted EQ-5D preference weights relative to no binge drinking, 0.86 (95% CI 0.84-0.87) and 0.84 (95% CI 0.84-0.85), respectively (Appendix 3). No other significant differences in mean EQ-5D preference weights were observed for other frequencies of binge drinking.

The SF-6D preference weights followed a similar pattern as for the EQ-5D. Adjusted SF-6D preference weights for nondrinking (0.78; 95% CI 0.78-0.79) and mild unhealthy alcohol use (0.81; 95% CI 0.80-0.81) were significantly different than low-risk drinking (0.80; 95% CI 0.80-0.80) (Table 2). Adjusted differences in preference weights relative to low-risk drinking for different alcohol use categories were again modest, 0.01 to 0.02 (Appendix 4). There was a significant age group by AUDIT-C group interaction ($p<0.001$) and differences in SF-6D preference weights across AUDIT-C groups were again limited to adults ≥35 years old

(Appendix 2). Among past-year drinkers, no significant differences in mean SF-6D preference weights were observed for frequencies of binge drinking (Appendix 3).

In analyses separating lifetime abstainers (n= 4,355) and former drinkers (n=2,723), former drinkers had significantly lower EQ-5D (p=0.006) and SF-6D preference weights (p<0.001) relative to lifetime abstainers. For both the EQ-5D and SF-6D, adjusted preference weights were significantly lower for former drinkers and lifetime abstainers, than for low-risk drinking (Table 2).

4. Discussion

This study provides preference weights for alcohol use categories not previously reported for a representative U.S. adult sample. Preference weights were obtained through an indirect approach using two widely used generic measures of HRQOL—the SF-6D and EQ-5D—and provide values that could be compared with generic preference weights for other health conditions. These preference weights could be utilized in future CUAs using decision modeling or to compare values obtained in alcohol intervention study samples with U.S. population values. However, differences across alcohol use categories were modest, 0.01-0.04 for the EQ-5D and 0.01-0.02 for the SF-6D, and significant differences from low-risk drinking were not observed for most categories of alcohol use, with the exception of nondrinking and mild unhealthy alcohol use.

Preference weights for respondents with mild to very severe unhealthy alcohol use were greater than for those with low-risk drinking and may indicate that increased alcohol consumption based on a self-reported screening questionnaire is not associated with lower self-reported HRQOL in the general population. Evidence suggests that AUDs are associated lower quality of life [29], based on various measures of HRQOL or health status. However, while the

derived AUDIT-C screen performs well for identifying individuals at greater risk of AUD [13,14], it does not assess prior problems due to drinking. Many individuals with mild to very severe unhealthy alcohol use based on the AUDIT-C may not have developed symptoms of AUD that could result in lower HRQOL. A previous study among male Veterans similarly found only modest differences across AUDIT-C alcohol consumption categories in physical and mental functioning on the SF-36 [15]. It is possible that respondents in the present study did not have severe enough problems due to drinking to have been reflected in lower preference weights.

This study found lower preference weights for respondents reporting no alcohol consumption than for those with low-risk drinking and supports some previous research documenting differences in outcomes for lifetime abstainers and former drinkers. Nondrinkers have been shown to report lower HRQOL than current drinkers [12,15,28,30]. In the present study, these findings were evident in both the individual EQ-5D and SF-6D domains, as well as preference weights. Few studies have distinguished between nondrinkers who are lifetime abstainers and former drinkers when assessing HRQOL and results are conflicting. Two studies found that former drinkers reported significantly poorer physical and mental health functioning than lifetime abstainers [12,28], while others found no significant differences [30,31]. In the present study, former drinkers had significantly lower EQ-5D and SF-6D preference weights than both lifetime abstainers and current drinkers, which may support the idea that former drinkers abstain due to health problems. Moreover, significant differences between former drinkers and lifetime abstainers were limited to adults over 35 years.

Our findings may highlight limitations of using generic HRQOL measures. Previous research has suggested that generic measures may be insensitive for capturing the effect of some conditions on HRQOL, such as psychotic disorders [32], hearing loss [33], and psoriasis [34]. In the

present study, the lack of differences observed in the EQ-5D and SF-6D for differences in alcohol use could be due to their insensitivity, as some individual domains appeared more responsive than others. Greater variation across alcohol use patterns was observed for pain/discomfort and anxiety/depression on the EQ-5D, and for social functioning, role limitations, and pain on the SF-6D. Adding disease-specific questions to the EQ-5D has improved its responsiveness for conditions such as psoriasis [34]. Future research could evaluate whether important domains of HRQOL associated with alcohol consumption are inadequately captured on generic measures and whether changes could improve them. Though using disease-specific measures limits comparability across conditions, it may be justified when generic measures are not sensitive enough to capture HRQOL for a particular condition [7,35].

The preference weights for categories of alcohol use reported in this study differ from previous studies [10,36] and may reflect methodological differences. Mean EQ-5D preference weights were estimated in a rural study sample in Australia for several categories of unhealthy alcohol use, based on the AUDIT alcohol screen and a question assessing prior alcohol problems [10]. Compared to EQ-5D preference weights for lifetime abstainers in the present study (0.80), values were higher for abstainers without past problems (0.87) and lower for those with past problems (0.72) in this previous study. Petrie et al.'s ability to separate individuals based on prior alcohol problems suggests there may be additional heterogeneity of outcomes within abstainers based on prior alcohol problems not assessed in the present study. In another study (Kraemer et al., 2005), preference weights were derived using direct preference elicitation, as opposed to indirect methods used in the present study. Direct preference elicitation, using either a standard gamble or time-trade-off approach, provides descriptions of health states to research subjects and asks individuals to consider the probable risk of death they would be willing to

accept (standard gamble), or amount of time they would be willing to give up (time-trade-off), to avoid a health state [37]. Kraemer et al. provided research subjects with descriptions of alcohol-related problems (e.g. lost work productivity, social problems, or more severe alcohol dependence symptoms) for different levels of alcohol consumption. Compared to the present study, preference weights for low-risk drinking (0.93-0.97) and nondrinking (0.88-0.94) were higher. Differences between preference weights derived from direct elicitation and indirect methods are well known and in some cases and can be substantial [37]. However, the present study provides weights that are comparable across conditions and were derived among a representative U.S. adult sample.

There are several limitations to the present study. First, many characteristics that could act as confounders or effect modifiers were not available in study datasets, such as diagnoses of AUDs or mental health conditions. Second, alcohol use was self-reported and results may under-estimate the adverse effects of alcohol use on utility ratings due to under-reporting of alcohol consumption. For example, if individuals under-report alcohol use they may be misclassified as low-risk or nondrinkers potentially masking differences in HRQOL between low-risk and moderate to severe unhealthy alcohol use. Third, we were unable to examine the association of AUD with preference weights. Individuals with AUD have lower HRQOL [29], but may be less likely to respond to surveys [38] and may have been under-represented in our sample. Fourth, the preference weights assigned to EQ-5D and SF-6D health states were derived among representative community samples in the U.K. and some evidence suggests there are meaningful differences in health state valuations between U.S. and U.K. samples [39,40]. However, the U.S. valuation of SF-6D health states for the shortened SF-12 measure is not currently available and many U.S. studies utilize existing SF-6D preference weights [41,42].

5. Conclusions

In conclusion, this study provides preference weights for the spectrum of self-reported alcohol use—ranging from no use to very severe unhealthy alcohol use—in a representative U.S. adult sample. The EQ-5D and SF-6D preference weights showed small differences across AUDIT-C categories, which may not be clinically meaningful (0.01-0.02 for the SF-6D; 0.01-0.04 for the EQ-5D), suggesting that meaningful differences across self-reported alcohol use based on the AUDIT-C may not exist. It is also possible that generic HRQOL measures may not adequately capture differences associated with alcohol use, or that alcohol use primarily affects HRQOL among patients with AUDs, who may have been under-represented in our sample. Future research should evaluate whether the EQ-5D and SF-6D are responsive to changes in unhealthy alcohol use or whether modifications to these generic measures perform better.

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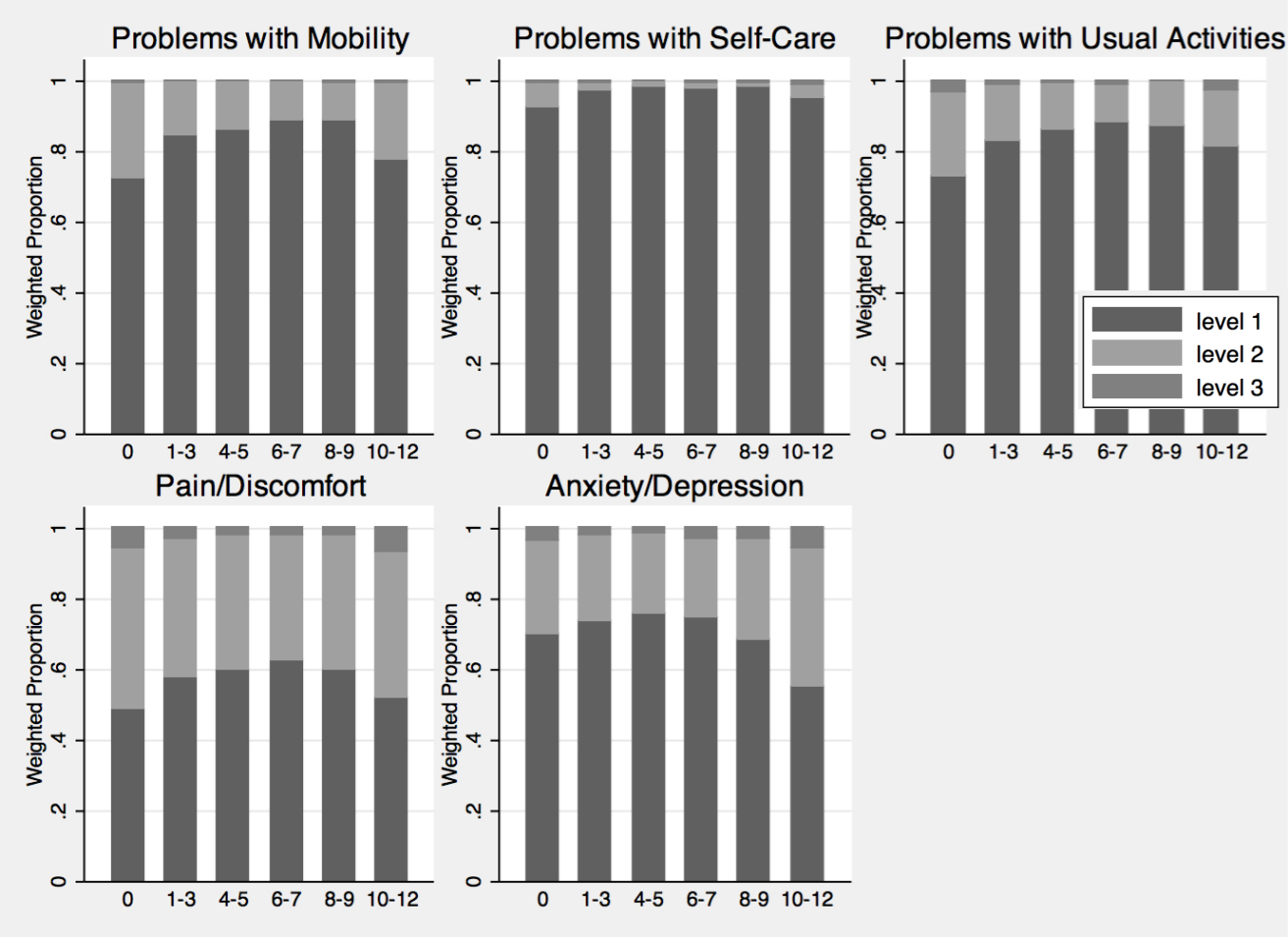
Table 1. Study Sample Characteristics Across AUDIT-C Score Groups

	AUDIT-C 0 *Nondrinking*	AUDIT-C 1-3 *Low-Risk Drinking*	AUDIT-C 4-5 *Mild Unhealthy Alcohol Use*	AUDIT-C 6-7 *Moderate Unhealthy Alcohol Use*	AUDIT-C 8-9 *Severe Unhealthy Alcohol Use*	AUDIT-C 10-12 *Very Severe Unhealthy Alcohol Use*	Total
	N=7,078	N=6,886	N=2,054	N=786	N=457	N=179	N=17,440
	%	%	%	%	%	%	%
Age Group							
18-34 yrs	28	31	34	47	52	39	32
35-49 yrs	26	35	32	34	34	41	31
50-64 yrs	21	22	20	14	12	14	21
65-85 yrs	24	12	14	4	3	6	16
Sex							
Male	38	44	64	77	87	89	48
Female	62	56	36	23	13	11	52
Race/ethnicity							
Hispanic	13	9	7	10	13	20	10
Non-Hispanic White	65	78	84	81	77	66	74
Non-Hispanic Black	16	9	6	7	9	11	11
Other	6	4	3	2	1	3	4
Marital Status							
married/partnered	61	68	66	57	53	52	64
Family Income as Percent of Poverty Line							
poor/near poor	21	11	9	11	16	26	14
low income	18	11	9	14	16	15	32
middle income	32	32	31	34	31	38	40
high income	29	46	50	41	37	21	15
Education							
<High School	26	11	10	14	21	33	17
High School	33	28	26	29	34	34	30
Some college	25	32	31	33	32	26	29
College or more	16	29	33	23	12	7	24
Smoking Status							
Daily	14	18	22	39	44	55	19
Some Days	2	4	8	9	9	10	4
Former	19	24	28	20	19	14	22
Never	66	54	42	32	28	22	55
Region							
Northeast	15	21	21	21	17	13	19
Midwest	21	27	28	30	28	20	25
South	46	32	28	30	39	42	37
West	18	19	22	19	16	25	19

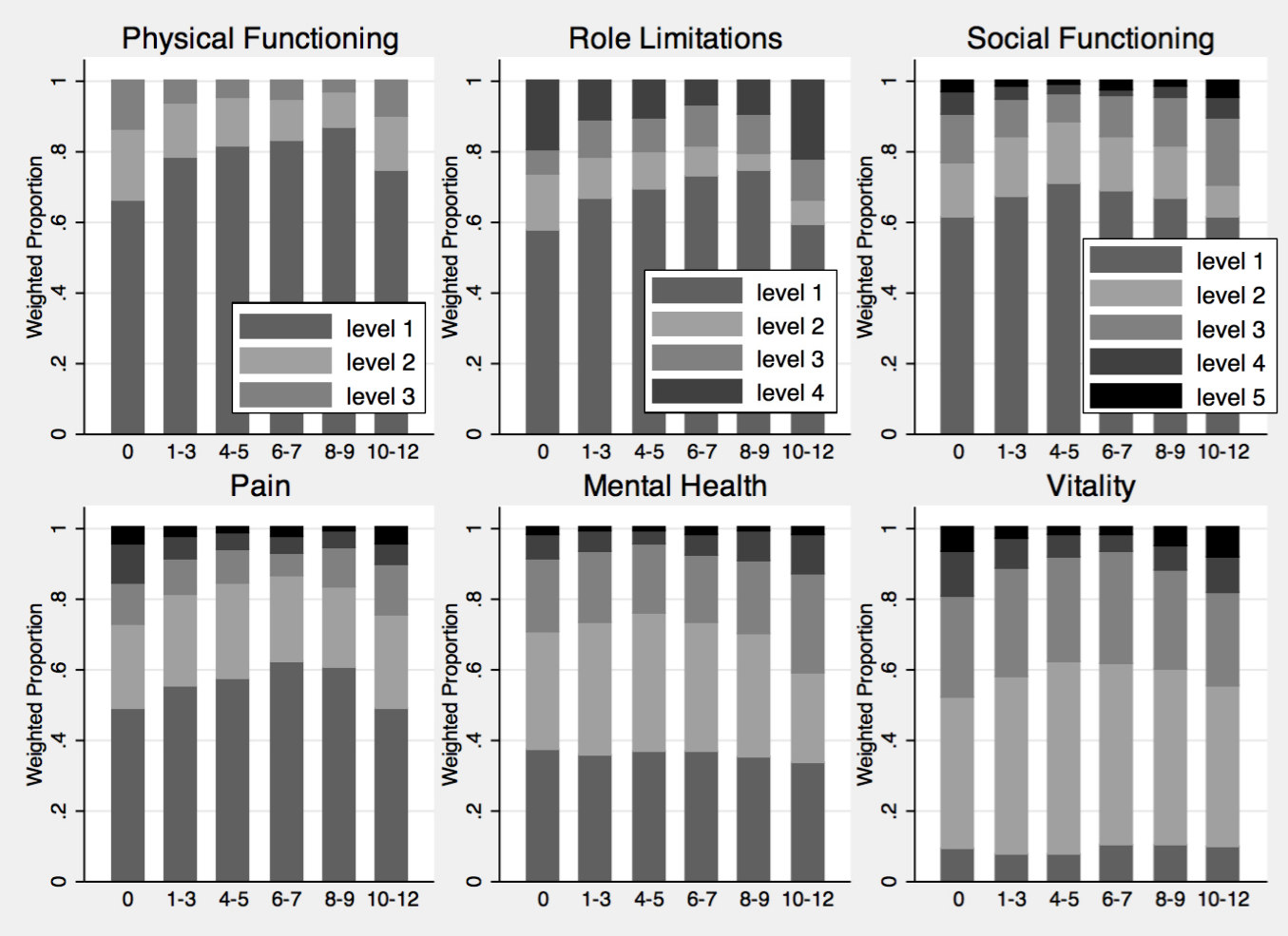
All percents are weighted to account for complex survey design

Figure 1. EQ-5D Domains Across AUDIT-C Score Groups



Notes: levels 1-3= *no problems, moderate problems, severe problems*

Figure 2. SF-6D Domains Across AUDIT-C Score Groups



Notes:

a. Physical Functioning (levels 1-3): *no limitations, limits a little, limits a lot,* (no levels 4-5)
b. Role Limitations (levels 1-4): *no limitations, limited because of physical health, limited because of emotional problems, limited because of both physical and emotional problems,* (no level 5)
c. Social Functioning (levels 1-5): limited *none of time, a little of time, some of time, most of time, all of time*
d. Pain (levels 1-5): interfered with work *not at all, a little bit, moderately, quite a bit, extremely*
e. Mental Health (levels 1-5): felt downhearted *none of time, a little of time, some of time, most of time, all of time*
f. Vitality (levels 1-5): have energy *all of time, most of time, some of time, a little of time, none of time.*

Table 2. Adjusted[a] EQ-5D and SF-6D Scores Across AUDIT-C Score Groups

	EQ-5D		SF-6D	
	Mean	(95% CI)	Mean	(95% CI)
Primary Analysis [b]				
AUDIT-C 0	0.80	(0.79-0.81) ***	0.78	(0.78-0.79) ***
AUDIT-C 1-3 [d]	0.83	(0.83-0.84)	0.80	(0.80-0.80)
AUDIT-C 4-5	0.85	(0.84-0.86) **	0.81	(0.80-0.81) *
AUDIT-C 6-7	0.85	(0.83-0.87)	0.80	(0.79-0.82)
AUDIT-C 8-9	0.84	(0.82-0.86)	0.80	(0.79-0.82)
AUDIT-C 10-12	0.80	(0.75-0.84)	0.78	(0.75-0.81)
Secondary Analysis[c]				
Lifetime Abstainer	0.81	(0.80-0.82) ***	0.79	(0.78-0.80) **
Former Drinker	0.79	(0.78-0.80) ***, †	0.77	(0.77-0.78) ***, ‡
AUDIT-C 1-3 [d]	0.83	(0.83-0.84)	0.80	(0.80-0.80)
AUDIT-C 4-5	0.85	(0.84-0.86) **	0.81	(0.80-0.81) *
AUDIT-C 6-7	0.85	(0.83-0.86)	0.80	(0.79-0.82)
AUDIT-C 8-9	0.84	(0.82-0.86)	0.80	(0.79-0.82)
AUDIT-C 10-12	0.79	(0.75-0.84)	0.78	(0.75-0.80)

[a] Adjusted for age, race/ethnicity, gender, smoking status, education, marital status, poverty, and region
[b] Primary Analysis Independent Variable of Interest was AUDIT-C categories (AUDIT-C 0, 1-3, 4-5, 6-7, 8-9, 10-12)
[c] Secondary Analysis Independent Variable of Interest was AUDIT-C categories taking into account lifetime use (Lifetime Abstainer, Former Drinker, AUDIT-C 1-3, 4-5, 6-7, 8-9, 10-12)
[d] Referent Group
Comparison to referent group,*p<0.05, ** p<0.01, *** p<0.001
Comparison of former drinker to lifetime abstainer, § p<0.05, † p<0.01, ‡ p<0.001

Appendix 1. Derived AUDIT-C Based on NHIS Alcohol Consumption Questions

	AUDIT-C Response Options	**AUDIT-C Score**	**NHIS Response Options**		
			Weekly	Monthly	Yearly
NHIS: In the PAST YEAR, how often did you drink any type of alcoholic beverage? AUDIT-C: How often did you have a drink containing alcohol in the past year	Never	0	0 *(Never)*	0 *(Never)*	0 *(Never)*
	Monthly or less	1	*NA*	1 time per mo	1-12 times per yr *13-18*
	2-4 times per Month	2	1 day per wk	2-4 times per mo *5-6*	*19-23* 24-48 times per yr *49-66*
	2-3 times per week	3	2-3 days per wk	*7* 8-12 times per mo *13-14*	*67-103* 104-156 times per yr *157-182*
	4+ times per week	4	4-7 days per wk	*15* 16-31 times per mo	*183-207* 208-365 times per yr
NHIS: In the PAST YEAR, on those days that you drank alcoholic beverages, on the average, how many drinks did you have? AUDIT-C: How many drinks did you have on a typical day when you were drinking in the past year?	1-2 drinks	0	*NA*	*NA*	*NA*
	3-4 drinks	1			
	5-6 drinks	2			
	7-9 drinks	3			
	10+ drinks	4			
NHIS: In the PAST YEAR, on how many DAYS did you have 5 or more drinks of any alcoholic beverage? AUDIT-C: How often did you have six or more drinks on one occasion during the past year?	Never	0	*0 (Never)*	*0 (Never)*	*0 (Never)*
	Less than monthly	1	*NA*	*NA*	1-11 times per yr
	Monthly	2	*NA*	1 time per mo *2*	12 times per yr *13-32*
	Weekly	3	1 day per wk *2-4*	*3* 4 times per mo *5-17*	*33-51* 52 times per yr *53-207*
	Daily or almost daily	4	*5-6* 7 days per wk	*18-19* 19-31 times per mo	*208-364* 365 times per yr

Appendix 2. Adjusted [a] EQ-5D and SF-6D scores stratified by age group, including Lifetime Use

	Age 18-34 years n=5,193		Age 35-49 years n=5,375		Age 50-64 years n=3,625		Age 65-85 years n=3,247	
	Mean	95% CI	Mean	95% CI	Mean	95% CI	Mean	95% CI
EQ-5D								
Lifetime								
Abstainer	0.89	(0.87-0.90)	0.83	(0.81-0.85)	0.74	(0.72-0.76) ***	0.74	(0.72-0.76) **
Former Drinker	0.87	(0.85-0.89)	0.78	(0.75-0.80) ***, ‡	0.74	(0.71-0.76) ***	0.72	(0.69-0.75) ***
AUDIT-C 1-3 [b]	0.88	(0.87-0.89)	0.83	(0.82-0.84)	0.80	(0.79-0.81)	0.78	(0.76-0.80)
AUDIT-C 4-5	0.89	(0.88-0.91)	0.85	(0.83-0.87)	0.82	(0.79-0.84)	0.79	(0.77-0.82)
AUDIT-C 6-7	0.90	(0.87-0.92)	0.84	(0.81-0.87)	0.82	(0.78-0.86)	0.77	(0.70-0.84)
AUDIT-C 8-9	0.88	(0.85-0.91)	0.85	(0.83-0.88)	0.80	(0.74-0.87)	0.75	(0.66-0.84)
AUDIT-C 10-12	0.87	(0.82-0.92)	0.79	(0.73-0.85)	0.71	(0.56-0.86)	0.84	(0.77-0.92)
SF-6D								
Lifetime								
Abstainer	0.83	(0.82-0.83)	0.79	(0.78-0.80)	0.76	(0.75-0.77) ***	0.75	(0.74-0.77) ***
Former Drinker	0.82	(0.80-0.83)	0.77	(0.76-0.79) ***	0.76	(0.74-0.77) ***	0.73	(0.72-0.75) ***
AUDIT-C 1-3 [b]	0.81	(0.81-0.82)	0.80	(0.79-0.81)	0.79	(0.78-0.80)	0.78	(0.77-0.79)
AUDIT-C 4-5	0.82	(0.81-0.83)	0.81	(0.80-0.82)	0.80	(0.79-0.82)	0.79	(0.77-0.80)
AUDIT-C 6-7	0.82	(0.81-0.84)	0.80	(0.78-0.82)	0.81	(0.78-0.84)	0.75	(0.69-0.81)
AUDIT-C 8-9	0.82	(0.80-0.83)	0.82	(0.80-0.85)	0.76	(0.72-0.81)	0.73	(0.65-0.81)
AUDIT-C 10-12	0.82	(0.78-0.86)	0.75	(0.70-0.79) *	0.77	(0.68-0.85)	0.79	(0.73-0.86)

[a] Adjusted for age, race/ethnicity, gender, smoking status, education, marital status, poverty, and region
[b] Referent Group
Comparison to referent group, * p<0.05, ** p<0.01, *** p<0.001
Comparison of former drinker to lifetime abstainer, § p<0.05, † p<0.01, ‡ p<0.001

Appendix 3. Adjusted[a] EQ-5D and SF-6D Scores for Frequency of Binge Drinking, Among Past-year Drinkers (n=10,362)

	EQ-5D		SF-6D	
	Mean	(95% CI)	Mean	(95% CI)
No Binge[b]	0.84	(0.84-0.85)	0.80	(0.80-0.81)
Less than monthly	0.86	(0.84-0.87)*	0.81	(0.80-0.82)
Monthly	0.86	(0.84-0.88)	0.81	(0.80-0.82)
Weekly	0.85	(0.84-0.87)	0.81	(0.80-0.82)
Daily or almost daily	0.83	(0.78-0.87)	0.79	(0.76-0.82)

[a] Adjusted for age, race/ethnicity, gender, smoking status, education, marital status, poverty, and region
[b] Referent Group
Comparison to referent group, *p<0.05, ** p<0.01, *** p<0.001

Appendix 4. Adjusted[a] EQ-5D and SF-6D Preference Weights and Differences in Preference Weights from Referent Group

	EQ-5D				SF-6D			
	Mean	(95% CI)	Difference from Referent[e]	(95% CI)	Mean	(95% CI)	Difference from Referent[e]	(95% CI)
Primary Analysis [b]								
AUDIT-C 0	0.80	(0.79-0.81)***	-0.03	(-0.04, -0.02)	0.78	(0.78-0.79)***	-0.02	(-0.02, -0.01)
AUDIT-C 1-3 [d]	0.83	(0.83-0.84)	--	--	0.80	(0.80-0.80)	--	--
AUDIT-C 4-5	0.85	(0.84-0.86)**	0.01	(0.00, 0.03)	0.81	(0.80-0.81)*	0.01	(0.00, 0.01)
AUDIT-C 6-7	0.85	(0.83-0.87)	0.01	(-0.01, 0.03)	0.80	(0.79-0.82)	0.00	(-0.01, 0.02)
AUDIT-C 8-9	0.84	(0.82-0.86)	0.01	(-0.02, 0.03)	0.80	(0.79-0.82)	0.00	(-0.01, 0.02)
AUDIT-C 10-12	0.79	(0.75-0.84)	-0.04	(-0.09, 0.01)	0.78	(0.75-0.81)	-0.02	(-0.05, 0.01)
Secondary Analysis[c]								
Lifetime Abstainer	0.81	(0.80-0.82)***	-0.02	(-0.04, -0.01)	0.79	(0.78-0.80)**	-0.01	(-0.02, 0.00)
Former Drinker	0.79	(0.78-0.80)***	-0.05	(-0.06, -0.03)	0.77	(0.77-0.78)***	-0.03	(-0.03, -0.02)
AUDIT-C 1-3 [d]	0.83	(0.83-0.84)	--	--	0.80	(0.80-0.80)	--	--
AUDIT-C 4-5	0.85	(0.84-0.86)**	0.01	(0.00, 0.02)	0.81	(0.80-0.81)*	0.01	(0.00, 0.01)
AUDIT-C 6-7	0.85	(0.83-0.86)	0.01	(-0.01, 0.03)	0.80	(0.79-0.82)	0.00	(-0.01, 0.02)
AUDIT-C 8-9	0.84	(0.82-0.86)	0.00	(-0.02, 0.03)	0.80	(0.79-0.82)	0.00	(-0.01, 0.02)
AUDIT-C 10-12	0.79	(0.75-0.84)	-0.04	(-0.09, 0.01)	0.78	(0.75-0.81)	-0.02	(-0.05, 0.00)

[a] Adjusted for age, race/ethnicity, gender, smoking status, education, marital status, poverty, and region

[b] Primary Analysis Independent Variable of Interest was AUDIT-C categories (AUDIT-C 0, 1-3, 4-5, 6-7, 8-9, 10-12)

[c] Secondary Analysis Independent Variable of Interest was AUDIT-C categories taking into account lifetime use (Lifetime Abstainer, Former Drinker, AUDIT-C 1-3, 4-5, 6-7, 8-9, 10-12)

[d] Referent Group

[e] Adjusted differences in this column may not equal differences in adjusted means from previous column due to rounding.

Conclusions

Summary of Findings

The present research found that older VA patients with high-risk drinking, based on routinely collected outpatient alcohol screening results, were at modestly increased risk for hospital readmissions (1%) within 30 days of hospital discharge. The association was limited to patients hospitalized for medical conditions during their index stay, of whom 15% were readmitted, but was no longer significant after adjusting for indicators of SES and social support, suggesting that drinking per se may not have been a significant contributor to the increased risk. Although patients with high-risk drinking had increased adjusted mean readmission hospital days and ED visits after hospital discharge, increased acute care utilization did not translate to increased acute care expenditures. However, patients who reported nondrinking were at increased risk of both readmissions (2%) and ED visits (1%) relative to low-risk drinking patients. These differences were observed among patients hospitalized for medical and surgical conditions, and remained significant after adjustment for indicators of SES and social support. In addition, nondrinking patients had increased adjusted mean readmission hospital days and mean ED visits; acute care expenditures were also higher among nondrinking patients ($345).

In a U.S. adult sample, preference weights based on the use of two widely used generic measures of health-related quality of life (HRQOL) (EQ-5D and SF-6D) for different categories of alcohol use did not differ significantly from low-risk drinking, with the exception of nondrinking (poorer HRQOL) and moderate-risk drinking (better HRQOL). Preference weights for respondents reporting nondrinking were significantly lower for both the EQ-5D and SF-6D, and were significantly higher for respondents with moderate-risk drinking. Former drinkers had lower preference weights than both low-risk drinkers and lifetime abstainers.

Implications

The results suggest that older adults with high-risk drinking may not have a greater cost burden for payers such as Medicare. These patients also made up the smallest proportion of hospital discharges, 1% of discharged patients had high-risk drinking compared to 62% who were nondrinking. Moreover, indicators of social risk,[1,2] such as lower SES and lack of social support, when available in data sources, may be more important than high-risk drinking for identifying discharged patients at greater risk of 30-day readmissions. However, the conditions that patients with high-risk drinking were readmitted for differed from that of other alcohol risk groups—the most common reason for readmission was congestive heart failure (CHF) for low-risk and nondrinking patients and alcohol-related conditions for high risk drinking. Further, 62% of patients with high-risk drinking had an AUD diagnosis at their index stay or in year prior suggesting that most patients with high-risk drinking were already recognized.

The present study found important differences between nondrinkers who were lifetime abstainers and those who were former drinkers, which has important implications for health systems implementing alcohol screening programs. These results are consistent with some previous studies that similarly found lower HRQOL among former drinkers than current drinkers or lifetime abstainers.[3,4] Widely used alcohol screening questionnaires such as the AUDIT-C do not assess lifetime drinking status. However, former drinkers had poorer HRQOL than respondents who were low-risk drinkers and lifetime abstainers. The heterogeneity in HRQOL for these different subgroups suggests that former drinkers and lifetime abstainers may also have differences in their post-discharge health care needs and expenditures. Lifetime drinking status may be important information for clinicians, but is not captured in routine screening that assesses current alcohol use.

In conclusion, health care systems that are targeting post-discharge interventions toward the patients with the greatest burden of post-discharge expenditures may not benefit from targeting patients with high-risk drinking based on alcohol screening results. Nevertheless, patients with high-risk drinking made up a small enough proportion of discharged patients for hospitals to feasibly target with post-discharge resources. Moreover, these patients may be more likely to be readmitted due to their drinking behaviors, and it remains unknown whether these readmissions are more preventable than readmissions for conditions such as CHF. Future research could evaluate whether hospitals should target patients with high-risk drinking due to the higher probability of readmissions, greater post-discharge acute care utilization, and potential delivery of post-discharge alcohol interventions that have been shown in some settings to reduce readmissions.[5] In addition, future research could evaluate whether modifications to generic measures of HRQOL are needed in order to capture differences associated with high-risk drinking behaviors, and whether such changes would translate to more meaningful differences in preference weights.

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