.

DIMACS Technical Report 2005-10
March 2005

MENTAL ILLNESS AND LENGTH OF HOSPITAL STAY FOR MEDICAID INPATIENTS INFECTED WITH HIV

Donald R. Hoover, Usha Sambamoorthi, James T Walkup Stephen Crystal[1]
Institute for Health, Health Care Policy and Aging Research
Rutgers University, 30
College Avenue, New Brunswick, NJ 08901.

1. Partially supported by National Institute of Health grants R01 MH60831, P30 MH43450, P20 HS11825, R03 HS09566-0, and R03 AG15166-01 and National Science Foundation Grant EIA 02-05116

ABSTRACT

OBJECTIVE: Study associations of length of inpatient stay (LOS) for HIV-infected Medicaid recipients with; Severe Mental Illness History (SMI-H), Other (Less Severe) Mental Illness History (OMI-H), and diagnosis with Acute Mental Illness (AMI) during the inpatient visit. **DATA SOURCE & COLLECTION / STUDY SETTING:** Merged 1992-98 Medicaid claims and HIV/AIDS surveillance data obtained from the State of New Jersey for adults with $\geq$1 inpatient stay after an HIV/AIDS diagnosis from 1992-1996. **STUDY DESIGN:** Observational study of 8,186 HIV patients with 31,515 inpatient visits. SMI-H, OMI-H and Primary/Secondary AMI diagnosis at visits were ascertained from ICD–9-CM Codes; 11% of visits had an AMI diagnosis while 25% and 29% of visits, respectively, were from patients with SMI-H and OMI-H histories. **PRINCIPAL FINDINGS:** HIV patient-stays with Primary or Secondary AMI diagnoses each had mean LOS=11.0 days and stays of patients with SMI-H and OMI-H had mean LOS of 10.4 and 11.8 days, respectively compared to a mean LOS=12.7 days for stays of patients with no history of mental illness. But after adjusting for measures of HIV disease severity and health care access in multivariate models, patients presenting with primary and secondary AMI diagnoses had ~32% and ~13% longer LOS, respectively, than did similar patients without AMI ($P<0.001$). In the absence of a diagnosed AMI, SMI-H and OMI-H alone were not related to LOS in adjusted models. However, in adjusted models, SMI-H was associated with ~20% shorter time to readmission for a new visit. **CONCLUSIONS:** This study concurs with previous findings of greater (adjusted) LOS for HIV patients that have mental cormibidity. But the patterns seen here suggest that the increase may be mediated by extra time required to treat acute mental illnesses occurring at the visit rather than from mental illness interfering with treatment and discharge of HIV conditions.

KEYWORDS: HIV Disease, Hospitalization, Length of Stay, Mental Illness

.

MENTAL ILLNESS AND LENGTH OF INPATIENT STAY FOR HIV-INFECTED MEDICAID RECIPIENTS

INTRODUCTION

Minimizing length of stay (LOS) for hospitalized patients infected with the human immunodeficiency virus (HIV) without reducing quality of care is desirable. Besides being expensive [1], days spent in hospitals tie up resources, put HIV patients at risk for nosocomial infections, and disrupt their economic and social life. Thus patients, providers, and payers welcome approaches for warranted reduction of length of hospital stay. Most studies found substantial reductions in hospital LOS for HIV patients have occurred since the middle 1980s. For example, mean LOS in New York State decreased by 2-4 days from 1984-87 [2, 3] and from 16 days to 8 days at a hospital in Spain 1992-1997 [4]. A two-day reduction in median length of stay (from 10 to 8 days) was observed following introduction of highly active antiretroviral therapies (HAART) in 1996 [5]. Not surprisingly, many studies find greater severity of HIV/AIDS was strongly associated with longer LOS [4, 6-8].

Recently, several studies suggest that psychiatric comorbidities may substantially increase the time required to treat HIV conditions and discharge HIV patients [9-11] with corresponding economic implications. Uldall and others [9, 10] found from 1990-92 that almost 30% of AIDS inpatient hospital admissions involved patients with psychiatric (including substance abuse) problems and that these patients had mean LOS 2-6 days longer than did patients without psychiatric illness. Cheng et. al. [11] found psychosocial diagnoses were associated with increased risk of >90 days hospitalization for patients

with advanced HIV disease. These authors [9-11] proposed that psychiatric comorbidity could increase time needed to treat HIV conditions through: 1) difficulty finding appropriate discharge facilities for patients that would potentially need psychiatric treatment, 2) reduced ability of patients with underlying psychiatric conditions to follow HIV treatment regimens; and 3) negative effects of depression on immune function. The first of these mechanisms is supported by evidence that among HIV/AIDS patients, barriers to finding an appropriate place of discharge are associated with increased LOS [4, 12].

Unfortunately, ascertainment of any associations between psychiatric illnesses and LOS in HIV patients and the underlying mechanisms for causal effect is complicated by the multifactorial determinants of length of stay and various potential roles that psychiatric illness could play as depicted in the Figure. From a clinical standpoint, the lowest pathways of the Figure (pathways 3A and 3B) have the greatest concern. Psychiatric illness may increase hospital utilization for HIV conditions by hindering treatment or discharge (pathway 3A) or increasing frequency for which HIV related care is sought (pathway 3B). More frequent readmission to hospitals could also result if mental illness caused HIV patients to have an inappropriately short LOS at a previous visit [10].

As Pathway 2 of the Figure notes, HIV patients with mental comorbidities are treated for their mental illnesses while those without mental illness do not need treatment for such conditions. If so, increased hospital utilization and greater LOS to treat (non-HIV) mental disorders would not be surprising for persons with acute mental illnesses.

Differential LOS between HIV persons with and without mental illness for this reason would not be so alarming or unexpected.

Finally, pathway 1 of the Figure notes that confounding factors, such as access to care and stages of HIV disease, may differ between persons with and without mental illness. If so, these differences, rather than any direct interaction of a patient's mental illness with HIV treatment and discharge, may influence LOS. For example, being under treatment for a mental illness may facilitate earlier recognition of HIV [13] resulting in hospitalized HIV persons with mental illness tending to have mild HIV conditions that require shorter LOS. Persons who are diagnosed with mental illness may be of different ethnic groups, have different insurance coverage, etc and thus have different access to medical care which could influence LOS and make it appear mental illness was related to LOS in unadjusted analyses. Since, as noted earlier, LOS for HIV hospitalization is decreasing with calendar time, any changes in mental illness prevalence over time could create artifactual associations between mental illness and LOS for HIV patients.

Injection drug use (IDU) and other substance abuse further complicate direct measurement of the impact of mental illness on LOS inasmuch as IDU diseases including tuberculosis [14] and hepatitis C viral infection [15], could influence hospital costs and utilization. Compared to non-IDUs with HIV, IDU HIV patients have been found to have more frequent and longer hospitalizations, as well as, greater levels of mental illness [7, 16, 17]. In some studies, injection drug users were more likely to be seen in earlier stage of HIV disease than non drug users and thus to have shorter stays for HIV conditions [7].

.

Substance abuse (SA) is associated with many mental disorders and has been shown to be costly and disabling [18-20]. Substance abuse has also been shown to influence length and frequency of hospitalizations due to overdose and other acute SA related conditions [4, 16, 17]. Other potential confounders are gender, insurance coverage, social economic status and even season, all of which have been found associated with underlying and/or diagnosed psychiatric illness [21 – 29]. Among these characteristics of HIV/AIDS patients, some studies have found: neurological disorders caused by HIV [26] and insurance coverage [27] were associated with increased length of stay; women received fewer hospital resources [28]; non-White patients had longer lengths of stay [6, 8]; and admissions in the spring and summer had shorter LOS [3]. In some settings longer LOS may causally increase the chance for a patient to be diagnosed with a psychiatric comorbidity as a secondary diagnosis [11, 30].

Within this framework, both the severity of underlying mental conditions and whether these conditions are acutely manifesting at the visit must also be considered. For example, a person diagnosed with an acute mental illness (AMI) at a hospitalization could have increased LOS either due to the additional need to treat that illness or to the AMI interfering with treatment of HIV conditions or discharge, whereas a person with a history of mental illness but no acute mental illness symptoms at a hospitalization might not have a comparable increase in LOS. Another consideration would be severity of underlying mental illnesses. The impact of more severe mental illnesses (typically considered to be schizophrenia, bipolar disorder and major depression [31]) on LOS could be greater than that of other less severe mental disorders.

In order to understand more fully the associations (and potential causal patterns) between psychiatric illness and length of stay, we analyzed 31,515 hospital visits among 8,186 HIV patients hospitalized at least once between 1992 and 1998. In order to account for the potential confounding biases noted in Pathway 1 of the Figure, we consider a large number of (potentially confounding) covariates. To help separate the effects of mental illness on LOS caused by treating acute mental illnesses in the patient (Pathway 2 of Figure 1) from effects caused by interactions of underlying mental illness with treatment of HIV conditions (pathway 3 of Figure 1) we incorporated variables denoting whether a mental illness was a primary or secondary diagnosis (i.e. AMI) of the specific hospital visit and whether the patient had a history of severe mental Illness (SMI-H) or other (less severe) mental illness history (OMI-H) (irrespective of whether the person had an acute mental morbidity diagnoses at the given hospital visit).

METHODS

Study Population

The patient population for this study was derived from a file matching between New Jersey Medicaid eligibility files and the State's AIDS/HIV Registry through March 1996 under a cooperative agreement with the New Jersey Department of Health and Senior Services (DHSS) and Division of Medical Assistance and Health Services (DMAHS). This paper includes 8,168 adult ($\geq$ 18 years old) Medicaid recipients identified through the match who were diagnosed with HIV in New Jersey by March 1996 and hospitalized at least once (after diagnosis of HIV/AIDS) from 1992-1998.

.

Measures

Length of Stay and Time to Readmission Outcomes:

Length of Stay (LOS). Length of stay was calculated as the number of days from the date of admission to the date of discharge. Because same day visits are usually clinic visits, they were excluded from the analyses (but the findings are essentially unaltered with same day visits included). For patients readmitted to a hospital on the same day as discharged, (or transferred to another hospital) the two visits were combined into one visit.

Time to Readmission. Time to Readmission (TR) was calculated as number of days from the date of discharge to the date of admission for a subsequent visit. It should be noted that some problems exist from censoring due to the date of analysis, December 1998. While the technical issues are complicated, we believe the impact is minor as most patients have numerous readmissions and the study covers 6 years. Nor is there any evidence that such censoring would bias comparisons between persons with and without mental illness.

Mental and Neurological Illness:

Mental Illness History (SMI-H, OMI-H) Based on data available from all inpatient and outpatient hospital records, patient histories of mental illness were identified through the *International Classification of Diseases, 9th Revision, Clinical Modification* (ICD-9-CM) diagnoses codes. If a person had one inpatient and/or two outpatient visits from 1992-98 with recorded diagnoses of ICD-9-CM codes 295-98, 300-02, 306-14, 316 and/or 780 then he/she was considered to have an identified history of mental illness. If schizophrenia (ICD-CM code 295), bipolar disorder (ICD-9-CM codes: 2964, 2965,

2966,2967 or 2968), and/or major depressive disorder (ICD-9-CM codes 29624 or 29634) were recorded for two outpatient and/or one inpatient visit, this person was considered to have an identified severe mental illness history (SMI-H). Patients who were identified with a mental illness history but not a severe mental illness history (as described above) were considered to have other (less severe) mental illness history (OMI-H). We are limited to diagnoses available in the Medicaid data set, which means that patients diagnosed with SMI-H or OMI-H elsewhere were not identified.

Acute Mental Illness (AMI). Mental illness is a chronic condition and a patient with SMI-H or OMI-H does not necessarily exhibit mental illness symptoms at each hospital visit. Thus, for each visit, based on presence of ICD-9-CM codes 295-98, 300-02, 306-14, 316 and/or 780, we classified acute mental illness (AMI) as: Primary-AMI, an acute mental illness was the primary diagnosis of the admission; Secondary AMI, an AMI was diagnosed at the visit, but was not the primary diagnosis; and no-AMI was diagnosed.

HIV Dementia. HIV dementia is a neurological condition and therefore was not included in mental illness. However, at each visit, ICD-9-CM codes 2901, 3109, 3238, 3239, 3319, 3418, 3438, and 3488 were used to create an indicator variable for diagnosis of HIV dementia.

Other Illnesses/Conditions:

Acute Substance Abuse (ASA). Based on presence of ICD-9-CM codes 291, 292 and 303-305 we classified each visit into three substance abuse diagnosis categories. If a substance abuse event was the primary diagnosis for the admission, the visit was classified as Primary-ASA. If a substance abuse diagnosis was recorded for the visit, but

was not the primary diagnosis, the visit was classified as secondary ASA. If no substance abuse diagnosis was recorded for the visit, the visit was classified no-ASA.

Severity of HIV Illness:

Opportunistic Infections (OI) Since HIV is a chronic condition with varying severity and recovery, diagnosis of an OI at the current visit was used to indicate severity of illness. AIDS defining opportunistic conditions were evaluated based on diagnostic codes conforming to the ICD-9-CM contained in administrative Medicaid claims data. A complete list of the opportunistic infections included is available on request. Most Severe HIV Disease Diagnosis (AIDS / HIV Without AIDS) A diagnosis of AIDS at or before the current visit was used as an additional indicator of severity of illness. Death During the Hospital Visit (yes, no) was also included as a further indicator of HIV disease severity.

Timing of Visit Admission:

To control for changes in treatment practices over time Year of Admission was considered as a categorical variable with 1992 as the reference category for multivaraiate analysis. Season of Admission (Spring/Summer = 1) (Fall / Winter = 0) was also considered.

Other Patient Characteristics:

Demographic characteristics (i.e., gender, race, county of residence at diagnosis of HIV), HIV exposure category and date of AIDS diagnosis were obtained from the surveillance data. Race/ethnicity was characterized as White, African American, and Latino. In multivariate analyses, White was the reference category. Age at Diagnosis was categorized as: 18-29 years, 30-39 years, 40-49 years, and 50 and older (reference

category). Year of Diagnosis of HIV infection was categorized as 1995-96, 93-94, 90-92 and before 1990 (reference category). Residents living in the Highest HIV Prevalence counties, those nearest to New York City and Philadelphia, were compared to residents living elsewhere in New Jersey. Risk Group was based on information on injection drug use history from the AIDS Registry and patients were classified as either IDU or non-IDU. This information was missing for a substantial number of patients whom were classified as "Missing". Some participants in Medicaid were eligible for Medicare Coverage. Dual Medicare coverage (yes/no) was assessed based on claim type recorded in paid Medicaid claims data. Some of the New Jersey Medicaid population is enrolled in a waiver program, ACCAP, an HIV-specific Medicaid home and community-based care waiver program, which offers case management and private duty nursing, among other services. Participation in the Waiver Program was determined from procedure codes in Medicaid claims for waivered services. As an indicator of HAART therapy, from National Drug Codes recorded in pharmacy claims, we identified the use of Protease Inhibitor/ Non-Nucleoside Reverse Transcriptase Inhibitor (PI/NNRTI) and the first date that an individual Used a PI or NNRTI. We used this as an intent-to-treat variable; the patient was considered to be on PI/NNRTI for all visits after the initiation date.

Analytic Procedures

Descriptive statistics based on patients and all patient-visits are reported. Both univariate (one predictor) and multivariate (all predictors) linear models for LOS and TR were fit based on each patient-visit as the observation. Since repeated visits from the same persons were used, we applied robust covariance methods [32] to account for

intraindividual collinearity with SUDAAN. Due to skewed distributions, for the adjusted and unadjusted analyses of Table 2, LOS and TR were log (base e) transformed to improve symmetry and other statistical properties. Exponentiated values of differences in logs (which can be roughly interpreted as ratios) are reported.

RESULTS

Of the 8,168 patients (data not tabled), 56% were male; 61% were African American, 17% Latino, and 21% non-Latino white. A majority (74%) were aged 30-49 years at diagnosis of HIV. IDU was the largest HIV risk group (61%). Seventy-one percent of the study cohort lived in high HIV prevalence urban areas (near New York City or Philadelphia) at time of initial HIV diagnosis. A minority, (21%) were enrolled in the ACCAP waiver program, and 27% received Medicare after diagnosis of HIV disease. A majority (76%) of the patients were diagnosed with AIDS by March 1996. Forty-four percent of the study population was alive as of December 1998. Nearly 17% (1362) were identified with severe mental illness (SMI-H); 577 with schizophrenia, 191 with bipolar disorder (but not schizophrenia) and 594 with major depressive disorder (but not schizophrenia or bipolar disorder); 2134 (26%) other patients had identified admissions for less severe mental illnesses (OMI-H).

Table 1 displays (post HIV diagnosis) inpatient stays of HIV-infected Medicaid recipients along with mean LOS and time to readmission to the next visit (TR) by Mental Illness and other patient and patient-visit characteristics. The distribution of age, gender, ethnicity, exposure group, residence and insurance coverage among all patient-visits was similar to the distribution by patients reported in the previous paragraph. However, while only 17%

of patients had SMI-H, these patients contributed 25% of the hospital visits. The 26% of patients with OMI-H contributed 29% of these visits while the 57% of patients with no identified history of mental illness contributed only 46% of the visits. On average, persons with SMI-H and OMI-H, respectively, had 82% more ($P<0.001$) and 38% more ($P<0.001$) visits, respectively, than did a person without mental illness history.

Overall, compared to the mean LOS for those with no history of mental illness (12.7 days), the mean LOS was significantly shorter for persons with SMI-H (10.4 days $p<0.001$) and with OMI-H (11.8 days, $p<0.001$). But mean months to readmission did not differ significantly between those with SMI-H (5.0 months), OMI-H (5.2 days) and no mental illness (MI) history (5.0 months). Overall, visits both with diagnosed primary and with diagnosed secondary AMI had (non-statistically) shorter mean LOS (11.0 days each) than did visits with no AMI (12.0 days). Mean months to readmission (TR) did not vary dramatically (or statistically) by diagnosis of Primary AMI , (5.3 months) Secondary AMI (5.4 months) or no AMI (5.0 months) at a visit.

The following indicators of HIV illness severity and underlying health were associated with substantially higher (5-10 days) unadjusted mean LOS ($P<0.001$ for all) and to a lesser degree shorter TR; older age, current or prior diagnosis of AIDS, and diagnosis of an OI at the current visit. Year of admission had a mean LOS reduction of 4 days from 1992-1998 ($P <0.001$) and a quadrupling of mean months to readmission from 2.2 to 8.6 ($P<0.001$). Use of PI/NNRTI was associated with ~ 3.5 days mean reduction in LOS ($P<0.001$) and ~2.5 months greater mean TR ($P<0.001$). Those enrolled in Medicare had

substantially longer mean times to readmission than did others; 6.7 months versus 4.5 months P<0.001. Finally, while overall the mean LOS and TR did not differ by injection drug use history, patients with a primary diagnosis of substance abuse (SA) had a mean LOS of 5.6 days versus 13.2 days for those with no SA diagnosis (P<0.001); with mean TR also longer for patients diagnosed with substance abuse.

Table 2 presents unadjusted and adjusted logistic regression models for log transformed LOS and TR comparing the row category to the baseline category of that variable. In unadjusted models only the categorized row variable (versus its baseline value) is in the model. In the adjusted models all variables in Table 2 are included. The point estimates of the coefficients for log transformed comparisons and 95% confidence limits are exponentiated to obtain approximate point estimates and confidence limits of ratios for mean LOS and TR. For example, the upper left entry of 1.06 (1.00, 1.13) in Table 3 for the unadjusted comparison indicates that, overall, patient-visits with Primary AMI diagnoses tend to have LOS 106% as long as did those with no AMI diagnosis, with a 95% confidence limit of 100% - 113% for ratio of LOS. This differs somewhat from direct comparison of mean LOS in Table 1 (11.0 for visits with primary AMI versus 12.0 for those with no AMI diagnosis) as the transformation to the log scale in Table 2 does somewhat alter the relative central tendencies of the data.

In the adjusted model for LOS of visits with Primary AMI versus visits with no AMI (the upper entry in the second column of Table 2) the entry is 1.32 (1.25,1.40). This means that if all other characteristics in Table 2 are the same (i.e., age at diagnosis,

severity of HIV disease, etc.), then the LOS for a visit with a Primary AMI diagnosis tends to be ~132% as long as the LOS of a visit with No AMI diagnosis, with a 95% confidence limit of 125% - 140% as long. The change from 1.06 (~106% as long) in the unadjusted model to 1.32 (132% as long) in the adjusted model reflects adjustment for the fact that visits with Primary AMI tend to be from persons at earlier stage HIV disease, from younger persons, and with other characteristics that are independently associated with shorter LOS (data not shown). For most variables, the unadjusted ratios for LOS and TR in Table 2 are similar to the patterns reflected by mean LOS and TR in Table 1 so we focus on adjusted ratios. As noted earlier, the mostly minor differences between the patterns of Table 1 and unadjusted ratios of Table 2 occur because mathematically means of log transformed variable do not have to correspond ordinally to means of untransformed variables.

After adjusting for other variables in Table 2 (including diagnosis of AMI and access to health care / severity of HIV disease measures), LOS of admissions did not differ by whether the person had a history of SMI-H or OMI-H. This means persons without an AMI diagnosis who had comparable severity of HIV disease and access to care had similar LOS irrespective of a history of SMI-H or OMI-H. However, as noted earlier, person-visits with Primary AMI tended to have stays that were 32% longer ($P<0.001$) and those with Secondary MI had visits that were 13% longer ($P<0.001$) than did similar person-visits without an acute mental illness diagnosis. While a diagnosis of HIV Dementia was associated with a longer adjusted LOS, ratio=1.26 (95% CI: 1.09-1.45),

this increase was less than the adjusted ratio for diagnoses of other end stage HIV diseases (Opportunistic infections) ratio = 1.45 (95% CI: 1.41-1.49).

In adjusted models, Time to Readmission (TR) did not differ according to a diagnosis of a Primary or Secondary AMI or HIV dementia. But adjusted TR was ~20% shorter (0.79 times as long, P<0.001) following inpatient stays of persons with SMI-H than for those with no MI history. Adjusted TR was only 0.95 times as long (not statistically different) for visits of persons with OMI-H than for persons with no MI history.

Almost all of the other (non-mental health) variables considered remained significantly (and often very strongly) associated with LOS and/or TR in the adjusted models of Table 2. Indicators of more severe HIV disease (i.e., current or prior diagnosis of AIDS, death in hospital) or worse underlying health of patient (i.e., older age) were associated with longer LOS and shorter TR in adjusted models. Medicare enrollment continued to remain associated with (almost 2 times) longer TR; and from 1993 to 1998 (versus 1992), LOS systematically reduced to a ratio of 0.79 while TR ratio increased to 3.35; all significant at (P <0.001) in adjusted models. Those diagnosed with Primary and Secondary substance abuse each continued to have shorter adjusted LOS (ratios 0.63, 95% CI: 0.60-0.65 and 0.90, 95% CI: 0.87-0.92, respectively) and longer times to readmission (ratios 1.49, 95% CI: 1.36-1.63 and 1.16, 95% CI: 1.11-1.22, respectively).

DISCUSSION

This paper set out to explore associations between acute mental illness episodes and underlying mental illness history with inpatient length of stay (LOS) and time to

readmission (TR) among a large subgroup of HIV patients insured by Medicaid. Of particular interest was whether mental illness comorbidities increased the time taken to treat and/or discharge HIV conditions. In this large study with 8,186 patients and 31,515 visits from 1992-98, treatment of mental illness was common; 11% of visits involved an acute mental illness diagnoses. Persons with a history of severe mental illness contributed 25% of the hospital stays while persons with less severe "other" mental illness history contributed 29% of the stays (although not all of these stays had an acute mental illness diagnosed). While HIV patients with identified OMI-H and SMI-H Histories had on average 38-82% more visits as did those without identified MI history, many of these excess stayss may have involved treating the mental illness itself. For example, AMI was the primary diagnosis for 25%, and a secondary diagnosis for 14% of all visits or persons with SMI-H. Also, as others have noted, [13] HIV may be diagnosed earlier in patients being treated for mental illnesses which would also cause more post HIV diagnosis treatment visits in these persons.

In Table 1, admissions with AMI (either as a Primary or Secondary diagnoses) had "unadjusted" mean LOS of 11 days or 1 day shorter than the mean LOS for HIV patients not diagnosed with an acute mental illness at the visit. Similiarly, the "unadjusted" mean LOS of visits for patients with OMI-H and SMI-H were 1-2 days shorter than visits of patients with no MI history. This compares to LOS being 2-6 days longer for admissions with psychiatric comorbidity among Washington State AIDS patients [9, 10]. But the different findings of these studies could reflect differences in study population

characteristics (e.g. proportion with more advanced HIV disease) rather than different effects of mental illness.

However due to many characteristics which were strongly associated with LOS and mental illness including severity of HIV disease and access to health care, unadjusted comparisons did not provided much insight into causal associations between mental illness and LOS. After adjusting for the large number of patient and patient-visit characteristics in Table 2, we observed that the LOS for hospital stays from persons who presented with Primary and Secondary AMI diagnoses, respectively, were ~32% and ~13% longer, respectively, than were LOS of stays of similar persons with no AMI diagnosed. This supports previous findings [9-11] of positive association between mental illness and LOS. But the substantially greater increase in adjusted LOS for a Primary AMI diagnosis than for a Secondary AMI Diagnosis suggests, that in this population, treating the mental illness itself rather than interaction of mental comorbidities with treating and discharging HIV conditions may be more responsible for increased LOS. Furthermore, the adjusted comparisons in Table 2 suggest that in the absence of an acute mental illness, history of severe mental illness (SMI-H) or less severe mental illness, (OMI-H) were not associated with greater LOS or thus time required to treat HIV related conditions in this population.

The adjusted models in Table 2 also suggest that HIV patients with severe mental illnesses (SMI-H) have (~20%) shorter times between admissions than other patients with similar characteristics, perhaps directly due to need to treat the mental illness itself in

addition to treating HIV disease. However, OMI-H history and the presence of an acute mental illness at a visit were not independently related to TR. Uldall et al [10] (in unadjusted analysis) also found that persons "ever diagnosed with a psychiatric morbidity" had shorter times to hospital readmission than did persons not diagnosed with psychiatric morbidity.

The associations between indicators of severity of disease and access to health care, and between LOS and TR observed in this study are mostly expected and consistent with prior findings [4, 6-8, 25]. While HIV dementia was associated with a 26% longer LOS in adjusted models, this may be more related to HIV dementia occurring in late stage HIV disease rather than from interactions of dementia with treating other HIV conditions. For example, diagnosis of an opportunistic illness at the visit was associated with a 45% increase in LOS. By comparison with these increases, the 32% increase in LOS associated with a primary diagnosis of acute mental illness in these adjusted models indicates that treating mental illness episodes among persons with HIV may have important economic importance relative to treating conditions of advanced HIV related diseases.

The most notable associations with LOS and TR observed in this study are for calendar trends from 1992-98 with mean LOS declining 4 days and TR increasing 6 months. These findings are consistent with similar reductions in length of stay from 1992-97 [4] reported in the literature. While some of the calendar changes in LOS and TR observed here may be due to PI/NNRTI (or HAART), after adjusting for year of visit, our variable

for use of PI/NNRTI by the patient had minimal association with LOS and no association with TR. However, we incorporated PI/NNRTI as an intent-to-treat variable (once started always considered using PI/NNRTI) to eliminate well- known self-selection biases (sickest patients may not being able to tolerate treatment [30]). Thus, since patients began increasingly using PI/NNRTI after 1996, our ability to separate the effect of PI/NNRTI from other changes over calendar time may be limited.

Some potential study limitations should be noted. We studied New Jersey Medicaid patients and it cannot be ruled out that association between mental illness and hospital LOS for HIV patients differs between countries and by insurance coverage in the United States. The data available in Medicaid claims limit our ability to utilize criteria of duration and severity to define subgroups of interest. As our measures of chronic mental illness were based on number of contacts with the medical system, there is some bias towards identification of Mental Illness History in patients who had had longer contact with the medical system. However, as all patients had been diagnosed with HIV by 1996 and data were collected until the end of 1998, we believe this bias was small. The complicated potential causal and confounding relationships between mental illness and length of stay impede development and interpretation of predictive models given that so many other factors had strong associations with LOS and TR in our hospitalized HIV patients. Even with the large number of variables used here to adjust for stage of disease, access to health care and other patient-visit characteristics, it is possible that collectively these variables were still not comprehensive enough to remove all potential confounding with mental illness.

.

In conclusion, the adjusted analyses of this study of 31,515 hospital visits from 8,186 patients tends to confirm associations seen elsewhere [9-11] of mental illness with longer inpatient stays for hospitalized HIV patients, but raises questions about the causal reasons. The greater (adjusted) increase of LOS for a Primary (~32%) than for a Secondary (~13%) Acute Mental Illness diagnosis suggests that treatment of the mental illness itself, rather than complications of the mental illness interfering with treating HIV conditions, may be most responsible for increased length of stay. Since mental illness history alone (i.e., in the absence of an acute mental illness at that visit) was not associated with LOS in adjusted models, underlying mental illness may not affect length of stay unless the patient experiences an acute mental illness at that visit. Given the association patterns observed here, to better understand causal relationships between mental illness and hospital LOS among HIV patients, it may be important for future studies to distinguish between severe and less severe mental illnesses and to consider primary (and secondary) diagnoses of acute mental illnesses at a visit separately from underlying patient history of mental illness. Finally, given the large number of factors, such as calendar time, indicators of HIV disease severity and access to health care, that have strong associations with LOS in this population, these characteristics may also need to be considered in future studies of associations between mental illness and LOS of HIV patients.

TABLE 1
Breakdown of 1992-98 Inpatient Admissions, LOS and Time to Readmission Among HIV-Infected NJ Medicaid Recipients by Visit and Patient Characteristics

Characteristic	Number of Admissions	Percentage of Admissions	Mean Length of Stay in Days	Mean Months to Readmission
TOTAL				
	31,515	**100.0**	**11.9**	**5.1**
MENTAL AND NEUROLOGICAL ILLNESS				
Mental Illness Episode Diagnosed at Visit				
Primary AMI	1,931	6.1	11.0	5.3
Secondary AMI	1,638	5.2	11.0	5.4
No AMI	27,946	88.7	12.0	5.0
Most Severe Mental Illness History at Current/Other Visits				
SMI-H	7,895	25.1%	10.4	5.0
OMI-H	9,238	29.3%	11.8	5.2
No MI History	14,382	45.6%	12.7	5.0
HIV Dementia at or Before Visit				
Yes	173	0.5	15.9	4.2
No	31,342	99.5	11.9	5.1
OTHER PATIENT-VISIT CHARACTERISTICS				
Opportunistic Infection at Visit				
Yes	10,032	31.8	15.5	4.3
No	21,483	68.2	10.2	5.5
Died in Hospital at Visit				
Yes	1,803	5.7	20.9	NA
No	29,712	94.3	11.3	NA
Substance Abuse Diagnosed at Visit				
Primary S. Abuse	2,807	8.9	5.6	6.9
Secondary S. Abuse	8,372	26.6	10.9	5.5
No S. Abuse	20,336	64.5	13.2	4.7
Season of Admission for Visit				
Fall/Winter	15,579	49.4	12.1	5.2
Spring/Summer	15,936	50.6	11.7	5.0
Year of Admission for Visit				
1992	1,979	6.3	12.8	2.2
1993	5,352	17.0	13.8	3.3
1994	7,004	22.2	13.4	4.0
1995	6,987	22.2	12.3	4.4
1996	4,687	14.9	10.1	5.8
1997	3,080	9.7	9.2	7.5
1998	2,426	7.7	8.6	8.6

TABLE 1

Breakdown of 1992-98 Inpatient Admissions, LOS and Time to Readmission Among HIV-Infected NJ Medicaid Recipients by Visit and Patient Characteristics

Characteristic	Number of Admissions	Percentage of Admissions	Mean Length of Stay in Days	Mean Months to Readmission
Age at Visit				
18-29 Years	6,993	20.3	10.0	5.0
30-39 Years	16,077	51.0	11.9	5.0
40-49 years	7,297	23.2	12.8	5.3
50 and Older	1,748	5.5	15.3	5.5
Most Severe HIV Diagnosis at or Before Visit				
AIDS	24,975	79.2	12.8	4.6
HIV w/o AIDS	6,540	20.8	8.6	7.1
PI/NNRTI Use at or Before Visit				
Yes	4,535	14.4	8.9	7.2
No	26,980	85.6	12.4	4.6
OTHER PATIENT CHARACTERISTICS				
Gender				
Female	14,693	46.6	11.4	5.1
Male	16,822	53.4	12.4	5.1
Race/Ethnicity				
White	5,948	18.9	10.7	5.5
African American	19,947	63.3	12.4	5.1
Latino	5,480	17.4	11.5	4.5
Risk Group				
Missing	3,308	10.5	11.5	5.5
IDU	20,839	66.1	11.8	5.0
Non-IDU	7,368	23.4	12.2	5.2
County of Residence at Visit of HIV Diagnosis				
High Prevalence	23,304	73.9	12.2	5.0
Elsewhere	8,211	26.1	10.9	5.3
Waiver Participation at Visit of HIV Diagnosis				
ACCAP	7,326	23.1	12.9	4.3
Non-ACCAP	24,189	76.9	11.6	5.3
Medicare Enrollment at Visit of HIV Diagnosis				
No Medicare	23,326	74.0	12.0	4.5
Medicare	8,189	26.0	11.4	6.7
Year of Initial HIV Disease Diagnosis				
Before 1990	2,280	7.2	11.5	5.9
1990-1992	10,967	34.8	11.7	5.4
1993-1994	14,754	46.8	12.2	4.8
1995-1996	3,514	11.1	11.2	4.4

Note: Based on HIV-Diagnosed persons 18 years and older, receiving Medicaid with at least one inpatient stay from 1992-1998. AIDS: Acquired Immune Deficiency Syndrome. Values may not add up to 100% due to rounding.

ABBREVIATIONS: AIDS: Acquired Immune Deficiency Syndrome. PI/NNRTI: Protease Inhibitor or Non-Nucleoside Reverse Transcriptase Inhibitors; MI: Mental Illness; SMI: Severe Mental Illness; IDU: Injection Drug User; ACCAP: AIDS Community Care Alternatives Care Program; S.Abuse: Substance Abuse

TABLE 2
Robust Least Squares Regression on Log Length of Stay (in Days) and Log Time (in Months) to Readmission Adjusted and Unadjusted Ratios (e^{β}) (With 95% Confidence Intervals)

	Length of Stay Ratio		Time to Readmission Ratio	
	Unadjusted Effect	**Adjusted Effect**	**Unadjusted Effect**	**Adjusted Effect**
MENTAL AND NEUROLOGICAL ILLNESS				
Mental Illness Episode Diagnosed at Visit				
Primary AMI	1.06 (1.00, 1.13)	1.32 (1.25, 1.40)***	1.03 (0.90,1.19)	1.02 (0.89,1.17)
Secondary AMI	0.97 (0.91, 1.03)	1.13 (1.08, 1.19)***	0.99 (0.90,1.09)	1.00 (0.82,1.21)
No AMI	…	…	…	…
Most Severe Mental Illness History at Current/Other Visits				
SMI-H	0.87 (0.84, 0.90)***	0.99 (0.96,1.02)	0.96 (0.89,1.04)	0.79 (0.74,0.86)***
OMI-H	0.94 (0.90, 0.98)***	0.99 (0.95, 1.03)	1.01 (0.95,1.07)	0.95 (0.82,1.06)
No MI History	…	…	…	…
HIV Dementia at or Prior to Visit				
Yes	1.43 (1.22, 1.68)***	1.26 (1.09, 1.45)**	0.81 (0.63, 1.05)	0.96 (0.76,1.21)
No	…	…	…	…
OTHER PATIENT-VISIT CHARACTERISTICS				
Opportunistic Infection Diagnoses at Visit				
Yes	1.60 (1.57, 1.63***	1.45 (1.41, 1.49)***	0.81 (0.78, 0.84)***	0.96 (0.92,1.00)
No	…	…	…	…
Died in Hospital at Visit				
Yes	1.54 (1.45, 1.63)***	1.28 (1.21, 1.36)***	NA	NA
No	…	…	…	…
Substance Abuse Diagnosis at Visit				
Primary S. Abuse	0.51 (0.49, 0.53)***	0.63 (0.60,0.65)***	1.51 (1.36, 1.67)***	1.49 (1.36,1.63)***
Secondary S. Abuse	0.87 (0.85, 0.96)***	0.90 (0.87,0.92)***	1.16 (1.09, 1.23)***	1.16 (1.11,1.22)***
No S. Abuse	…	…	…	…
PI/NNRTI Use at or Before Visit				
Yes	0.77 (0.74, 0.80)***	0.90 (0.85,0.94)***	1.49 (1.38, 1.62)***	0.99 (0.91,1.07)
No	…	…	…	…
Season of Admission for Visit				
Fall/Winter	1.04 (1.02, 1.06)**	1.04 (1.02, 1.06)***	1.06 (1.02, 1.11)**	1.08 (1.04,1.12)***
Spring/Summer	…	…	…	…
Year of Admission of Visit				
1998	0.70 (0.66, 0.74)***	0.79 (0.73,0.85)***	2.83 (2.46, 3.25)***	3.35 (2.84,3.96)***
1997	0.72 (0.68, 0.67)***	0.78 (0.73,0.83)***	2.59 (2.25, 2.97)***	3.06 (2.63,3.57)***
1996	0.80 (0.76, 0.85)***	0.80 (0.76,0.85)***	2.03 (1.80, 2.29)***	2.53 (2.22,2.89)***
1995	0.92 (0.87, 0.98)**	0.85 (0.81,0.90)***	1.62 (1.43, 1.82)***	2.05 (1.82,2.32)***
1994	0.99 (0.93, 1.05)	0.90 (0.86,0.95)***	1.58 (1.43, 1.75)***	1.88 (1.68,2.10)***
1993	1.04 (0.98, 1.11)	0.97 (0.92,1.03)	1.38 (1.25, 1.52)***	1.55 (1.39,1.73)***
1992	…	…	…	…
Most Severe Diagnosis of HIV Disease at or Prior to Visit				
AIDS	1.46 (1.40, 1.52)***	1.10 (1.14,1.23)***	0.68 (0.61, 0.75)***	0.80 (0.73,0.88)***
HIV W/O AIDS	…	…	…	…
OTHER PATIENT CHARACTERISTICS				
Gender				
Female	0.95 (0.91 – 0.98)***	1.01 (0.95,1.07)	1.00 (0.94 – 1.06)	1.10 (1.04,1.17)***
Age at Initial Diagnosis of HIV Disease				
18-29 years	0.67 (0.62, 0.73)***	0.71 (0.67,0.76)***	0.83 (0.72, 0.96)**	0.84 (0.74,0.96)*

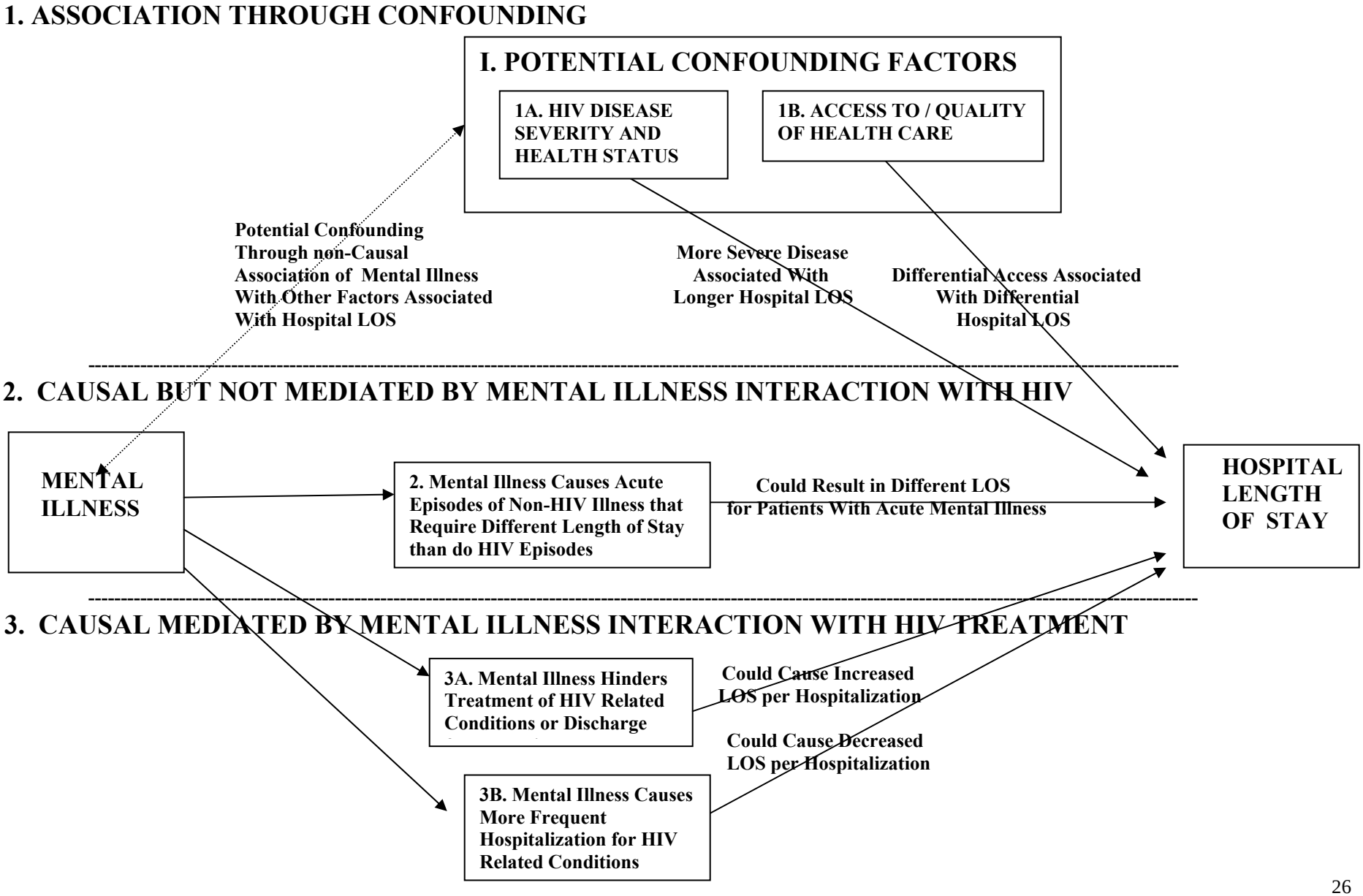
TABLE 2
Robust Least Squares Regression on Log Length of Stay (in Days) and Log Time (in Months) to Readmission Adjusted and Unadjusted Ratios (e^{β}) (With 95% Confidence Intervals)

	Length of Stay Ratio		Time to Readmission Ratio	
	Unadjusted Effect	**Adjusted Effect**	**Unadjusted Effect**	**Adjusted Effect**
30-39 years	0.81 (0.76, 0.86) ***	0.82 (0.77,0.87) ***	0.86 (0.74, 0.99)*	0.90 (0.80,1.02)
40-49 years	0.86 (0.80, 0.93) ***	0.87 (0.82,0.92) ***	0.95 (0.83, 1.13)	0.98 (0.93,1.07)
50 years and older	…	…	…	…
Race/Ethnicity				
Latino	1.05 (0.99, 1.12)	1.04 (1.00,1.09)	0.79 (0.72, 0.88) ***	0.87 (0.79,0.95) **
African American	1.13 (1.08, 1.17) ***	1.13 (1.09,1.17) ***	0.90 (0.84, 0.98) *	0.94 (0.88,1.01)
White	…	…	…	…
Risk Group				
Missing	0.90 (0.85, 0.96) ***	1.01 (0.90,1.12)	1.04 (0.90, 1.19)	0.92 (0.84,1.00)*
IDU	0.97 (0.93, 1.01)	1.04 (1.01,1.08)*	0.96 (0.88, 1.04)	0.88 (0.82,0.94) ***
Non-IDU	…	…	…	…
County of Residence at Initial Diagnosis of HIV Disease				
High Prevalence	1.11 (1.06, 1.15) ***	1.12 (1.09,1.17) ***	0.95 (0.90, 1.01)	0.93 (0.87,0.99) *
Elsewhere	…	…	…	…
Waiver Participation at Initial Diagnosis of HIV Disease				
ACCAP	1.15 (1.11, 1.20) ***	1.06 (1.02,1.10) ***	0.88 (0.83, 0.93) ***	0.87 (0.82,0.92) ***
Non-ACCAP	…	…	…	…
Medicare Enrollment at Initial Diagnosis of HIV Disease				
Medicare	0.98 (0.94, 1.02)	0.99 (0.97,1.01)	1.88 (1.77, 1.99) ***	1.84 (1.73,1.96) ***
No Medicare	…	…	…	…
Year of Initial Diagnosis of HIV Disease				
1995-1996	0.91 (0.84, 0.99) *	0.94 (0.89,0.99) *	0.78 (0.68, 0.90)***	0.94 (0.85,1.04)
1993-1994	1.03 (0.97, 1.09)	0.96 (0.92,1.01)	0.81 (0.72, 0.91)***	0.74 (0.67,0.82) ***
1990-1992	1.01 (0.95, 1.07)	0.96 (0.90,1.02)	0.93 (0.83, 1.05)	0.57 (0.50,0.65) ***
Before 1990	…	…	…	…

Note: Based on HIV-Diagnosed persons aged 18 and older, receiving Medicaid with at least one inpatient stay between 1992 and 1998. Parameter estimates are based on robust ordinary least squares regression on log length of stay and log time in months to readmisison. The regressions include an intercept term. The asterisks denote significant effects relative to the reference group: *** $p < 0.001$; ** $p<0.01$; * $p < 0.05$.

ABBREVIATIONS: AIDS: Acquired Immune Deficiency Syndrome; PI/NNRTI: Protease Inhibitor or Non-Nucleoside Reverse Transcriptase Inhibitors; MI: Mental Illness; SMI : Severe Mental Illness; OI: Opportunistic Infection; IDU: Injection Drug User; ACCAP: AIDS Community Care Alternatives Care Program. NA: Not applicable; S. Abuse: Substance Abuse

FIGURE - POTENTIAL CAUSAL AND NON-CAUSAL ASSOCIATIONS BETWEEN MENTAL ILLNES AND HOSPITAL LENGTH OF STAY (LOS) IN HIV INFECTED PERSONS



REFERENCES

1. Van Haastrecht HJ, Bindels PJ, Sluijis TA, et al. 1996. "The impact of drug users on inpatient hospital care during the human immunodeficiency virus epidemic in Amsterdam." *Int J Epidemiol* 25(4):846-53.

2. Grabau JC, Kaufman GI, Han Y. 1991. "Characteristics of HIV-infected adults in acute care hospitals in New York state 1984-86." *NY State J Med* 389-93.

3. Markson LE, Turner BJ, Fanning TR. 1992. "Duration of Medicaid AIDS hospitalizations – variation by season, stage and year." *Am J Publ Hlth* 82:578-80.

4. Collazos J, Mayo J, Martinez E. 1998. "Hospitalization parameters in patients infected with HIV: an analysis of the period 1992-97." *AIDS Patient Care and STDs* 12(11):861-6.

5. Paul S, Gilbert HM, Ziecheck W, Jacobs J, Sepkowitz KA. 1999. "The impact of potent antiretroviral therapy on the characteristics of hospitalized patients with HIV infection." *AIDS* 13:415-18.

6. Kelly JV, Ball JK, Turner BJ. 1994. "Duration and costs of AIDS hospitalizations in New York." *Medical Care* 1989; 27:1085-98.

7. Stein MD. "Injected-drug use: complications and costs in the care of hospitalized HIV-infected patients. *JAIDS* 7:469-73.

8. Bonuck KA, Arno PS. 1997. Social and medical factors affecting hospital discharge of persons with HIV/AIDS." *J Com Hlth* 22(4):225-32.

9. Uldall KK, Koutsky LA, Bradshaw DH, et. al. 1994. "Psychiatric comorbidity and length of stay in hospitalized AIDS patients." *Am J Psychiatry* 151:1475-8.

10. Uldall KK, Koutsky LA, Bradshaw DH, Krone M. 1998. "Use of hospital services by patients with psychiatric illness." *Gen Hosp Psych* 20:292-301.

11. Cheng AC, Mijch AM, Hoy JF, Wesselingh SL, Fairley CK. 2001. "Psychological factors are associated with prolonged hospitalization in a population with advanced HIV". *Int J STD AIDS* 12(5):302-6

12. Uldall KK, Berghuis J. 1997. "Delirium in AIDS patients: recognition and medication factors." *AIDS Patient Care and STDs* 11(6):435-441.

13. Goulet JL, Molde S, Constantino J, Gaughan D, Selwyn PA. 2000. "Psychiatric comorbidity and the long-term care of people with AIDS." *J Urban Health* 77(2):213-21.

14. Gollub EL, Trino R, Salmon M, et al. 1997. “Co-occurrence of AIDS and tuberculosis: results of a database "match" and investigation.” *J Acquir Immune Defic Syndr Hum Retrovirol* 16(1):44-9.

15. Bodsworth NJ, Cunningham P, Kaldor J, Donovan B. 1996. “Hepatitis C virus infection in a large cohort of homosexually active men: independent associations with HIV infection and injecting drug use but not sexual behaviour.” *Genitourin Med* 72(2):118-22.

16. Seage GR 3rd, Hertz T, Stone VE, Epstein AM. 1993. “The effects of intravenous drug use and gender on the cost of hospitalization for patients with AIDS.” *J Acquir Immune Defic Syndr*. 6(7):831-9.

17. Johnston D, Smith K, Stall R. 1995. “A comparison of public health care utilization by gay men and intravenous drug users with AIDS in San Francisco.” *AIDS Care* 6, 304-316.

18. Solomon L, Frank R, Vlahov D, Astemborski J. 1991. “Utilization of health services in a cohort of intravenous drug users with known HIV serostatus.” *Am J Public Health* 81(10):1285-90.

19. Mor V, Fleishman JA, Dresser M, Piette J. 1992. “Variation in health service use among HIV-infected patients.” *Med Care*. 30(1):17-29.

20. Solomon L, Stein M, Flynn C, et al. 1998. “Health services use by urban women with or at risk for HIV infection: the HIV Epidemiology Research Study (HERS).” *J Acquir Immune Defic Syndr Hum Retrovirol* 17(3):253-61.

21. Eastwood M. Stiasny S. 1978. “Psychiatric disorder, hospital admission and season.” *Arch Gen Psych* 35 169-811.

22. Takei N, O’Callaghan E, Sham PC, Glover G et al. 1992. “Seasonality of admissions in the psychoses: effects of diagnosis, sex and age at onset.” *Brit J of Psych* 161, 506-511.

23. Sturm R, Wells K. 2000. “Health insurance may be improving--but not for individuals with mental illness.” *Health Serv Res* 35(1 Pt 2):253-62.

24. McAlpine DD, Mechanic D. 2000. “Utilization of specialty mental health care among persons with severe mental illness: the roles of demographics, need, insurance, and risk.” *Health Serv Res* 35(1 Pt 2):277-92.

25. Stoskopf CH, Kim YK, Glover SH. 2001. “Dual diagnosis: HIV and mental illness, a population-based study.” *Community Ment Health J* 37(6):469-79.

26. Dal Pan GJ, Skolasky RL, Moore RD. 1997. "The impact of neourologic disease on hospitalizations related to Human Immunodeficiency Virus in Maryland, 1991-1992." *Arch Neurol* 54:846-52.

27. Fleishman JA, Mor V. 1993. "Insurance status among people with AIDS: relationships with sociodemographic characteristics and service use." *Inquiry* 30:180-8.

28. Hellinger FJ. 1993. "The use of health services by women with HIV infection". *Health Services Research;* 28:543-61.

29. Federman EJ, Drebing CE, Boisvert C, et al. 2000. "Relationship between climate and psychiatric inpatient length of stay in Veterans Health Administration hospitals." *Am J Psychiatry* 157(10):1669-73.

30. Glesby MJ, Hoover DR**.** 1996. "Survivor treatment selection bias in observational studies: examples from the AlDS literature. *Ann Intern Med* 124:999-1005."

31. Shinnar A, Rothbard A, Kanter R, Jung Y. 1990. An empirical literature review of definitions of severe and persistent mental illness. *Am J Psychiarry*147:95-107.

32. Diggle P, Liang KY and Zeger S. 1994. *Analysis of Longitudinal Data.* Oxford and New York: Oxford University Press.