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Medical ICU Admission Diagnoses and Outcomes in Human Immunodeficiency Virus–Infected and Virus–Uninfected Veterans in the Combination Antiretroviral Era

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Abstract

Objectives—Human immunodeficiency virus (HIV)–infected (HIV+) patients on combination antiretroviral therapy are living longer but have increased risk for aging-associated disease which may lead to increasing critical care requirements. We compare medical ICU admission characteristics and outcomes among HIV infected and demographically similar uninfected patients (uninfected) and considered whether an index which combines routine clinical biomarkers (the Veterans Aging Cohort Study Index) predicts 30-day medical ICU mortality.

Design—Observational data analyses (Veterans Aging Cohort Study).

Setting—Eight Veterans Affairs medical centers nationwide.

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Patients—HIV infected and uninfected with a medical ICU admission between 2002 and 2010.

Intervention—None.

Measurements and Main Results—Medical ICU admission was determined using bedsection (Veterans Affairs) and revenue center codes (Medicare). For Veterans Affairs admissions, we used clinical data to calculate Veterans Aging Cohort Study Index scores and multivariable logistic regression to determine factors associated with 30-day mortality. Overall, 539 of 3,620 (15%) HIV infected and 375 of 3,639 (10%) uninfected had a medical ICU admission; 72% and 78%, respectively, were Veterans Affairs based. HIV+ patients were younger at admission ($p < 0.0001$). Although most HIV+ patients were on antiretroviral therapy (71%) with undetectable HIV-1 RNA (54%), compared with uninfected they were more commonly admitted with respiratory diagnoses or infections (21% vs. 12%), were more likely to require mechanical ventilation (17% vs. 9%; $p = 0.001$), and had a higher mortality rate (18.6% vs. 11.2%, $p = 0.003$). Cardiovascular diagnoses were less common among HIV infected (18% vs. 29%; $p < 0.0001$). In logistic regression (c-statistic 0.87), a 5-point increment in Veterans Aging Cohort Study Index was associated with an odds ratio of death of 1.22 (95% confidence interval 1.14–1.30) among HIV infected and of 1.50 (95% confidence interval 1.29–1.76) among uninfected; infection/sepsis and respiratory diagnoses were also associated with mortality.

Conclusions—Medical ICU admission was frequent, 30-day mortality higher, and mechanical ventilation more common in HIV infected compared with uninfected. The Veterans Aging Cohort Study Index calculated at medical ICU admission predicted 30-day mortality for HIV infected and uninfected. As more individuals age with HIV, their requirements for medical ICU care may be greater than demographically similar uninfected individuals.

Keywords

30-day mortality; comorbidity; human immunodeficiency virus; medical ICU; Veterans Aging Cohort Study Index

The average human immunodeficiency virus–infected person (HIV+) on combination antiretroviral therapy (ART) is expected to live into their seventh decade (1–4). Non-AIDS comorbid diseases associated with aging such as cardiovascular disease (CAD), non-AIDS cancer, chronic obstructive pulmonary disease (COPD), and cirrhosis are increasingly prevalent in HIV+ patients (5–12). These conditions occur more frequently among HIV+, often progress more rapidly compared with uninfected individuals (7, 9, 13–16), and may or may not be associated with traditional biomarkers of HIV infection (CD4 cell count and HIV-1 RNA) (3, 11).

Non-AIDS comorbidities account for the majority of hospitalizations and medical ICU (MICU) admissions for HIV+ in the current ART era (17–21). While hospitalization rates have been decreasing (19, 22), MICU admission rates for HIV+ have been relatively stable (19, 22, 23). Requirements for MICU care will likely also increase among the growing population of those aging with HIV infection (3, 11, 15, 18, 19, 22, 24–28). Whether conditions associated with MICU admission and mortality following MICU admission differ among those with HIV infection and demographically similar uninfected patients has not

been described. This information is needed to anticipate future health care requirements and to inform patient management.

In particular, our ability to predict which HIV+ patients are at greatest risk of poor outcomes after MICU admission may be limited despite the fact that several ICU scoring systems have been developed and validated to predict hospital mortality (29–31). These scoring systems frequently include age, physiologic, and laboratory variables at ICU admission and select comorbidities such as AIDS but were developed before ART transformed HIV into a manageable chronic disease (29–31). Furthermore, these scoring systems do not give points for HIV in the absence of symptomatic AIDS which is common in the current era. The Veterans Aging Cohort Study (VACS) Risk Index (VACS Index), which includes measures of HIV-specific and general organ injury, was developed to predict all-cause mortality in HIV+ (11). It incorporates age and eight routine clinical laboratories, namely CD4 cell count, HIV RNA, hemoglobin, creatinine, hepatitis C serologic status, and FIB-4 (a measure of likely liver fibrosis that includes age, aspartate aminotransferase (AST), alanine aminotransferase (ALT), and platelet count) (32, 33). Variables are weighted to produce a composite score for individuals (11, 34, 35) (Supplemental Table 1, Supplemental Digital Content 1, <http://links.lww.com/CCM/A607>). The VACS Index was developed and validated with a Veterans cohort and has been validated in European and North American cohorts as a strong predictor of all-cause mortality (11, 36). In addition, the VACS Index strongly correlates with inflammatory biomarkers including interleukin-6, D-dimer, and soluble CD14 (34). We have recently shown that the VACS Index predicts hospitalization and MICU admission in HIV+ (37). Whether the VACS Index at MICU admission can be used to predict 30-day mortality in HIV+ and uninfected patients has not been examined.

Using data from the VACS and including both Veterans Affairs (VA) and Medicare hospitalizations requiring MICU admission, we compared principal diagnoses between HIV + and uninfected patients admitted to the MICU and then, among those with a VA MICU admission, determined factors associated with 30-day mortality after VA MICU admission.

METHODS

Patients

The VACS has been described in detail elsewhere and is approved by all participating institutional review boards (38). VACS 8 is a prospective, observational cohort study conducted in infectious disease and general medicine clinics at eight VA Medical Centers located in Atlanta, Baltimore, the Bronx, Houston, Los Angeles, Manhattan/Brooklyn, Pittsburgh, and Washington, DC. In addition to database extracts from the VA electronic medical record, Medicare and Medicaid utilization data, and pharmacy fills, patients complete detailed questionnaires at enrollment and annual follow-up. Written informed consent is obtained from patients prior to enrollment, which began in 2002 and is ongoing. HIV+ are matched (1:1) by age, race, sex, and site-of-care to uninfected patients.

MICU Admission

Patients with a first MICU admission after VACS enrollment between 2002 and 2010 were included in this study. We restricted the cohort to patients with at least 1 year of VA medical care prior to their first MICU admission (Fig. 1). MICU admissions to both VA facilities and outside facilities reimbursed by Medicare were included. We could not include 29 Medicaid-reimbursed MICU admissions because the data elements available were inadequate for these analyses. VA MICU admission was identified by inpatient bedsection codes 12 and 13. Prior to 2008, bedsection code 12 included cardiac ICU (CICU) admissions. Starting in 2008 CICU was given a separate bedsection code (13) and was also included. For the purposes of this article, MICU admission refers to both MICU and CICU admissions unless otherwise specified. Medicare MICU admissions were identified using CMS Revenue Center Codes (0200, 0202, 0210, 0211, 0212) in MedPar data. VA data include the specific MICU admit and discharge date; Medicare data do not. Patients were excluded if they were discharged alive the same day as MICU admission, if their hospital length of stay exceeded 30 days, or they were transferred into or out of another acute care facility.

Admitting Diagnosis

We obtained principal and secondary *International Classification of Diseases*, 9th Revision (ICD-9), diagnoses codes assigned to the hospitalization. VA data also included a separate principal MICU diagnosis that was the same as the principal hospital diagnosis for 90% of VA admissions. Principal MICU diagnosis was not available for Medicare admissions. For the purposes of this article, the term MICU admission diagnosis is used interchangeably with principal hospital diagnosis. Principal diagnoses were grouped into the following mutually exclusive categories: respiratory, cardiovascular (primary cardiac diagnoses only), infection including sepsis and shock (ISS), gastrointestinal/liver, neurologic (including cerebrovascular diagnoses), endocrine, cancer, renal, and other (see Supplemental Table 2 for ICD-9 codes used for disease categories, Supplemental Digital Content 1, <http://links.lww.com/CCM/A607>). We found that HIV+ often had a principal diagnosis of simply HIV. Based on secondary diagnoses, we assigned HIV+ with respiratory failure (including *Pneumocystis jiroveci* pneumonia [PCP]) to respiratory diseases and those with sepsis to ISS. Opportunistic infections (OIs) as defined by Centers for Disease Control (39) were tabulated from principal and secondary diagnoses. ICD-9 procedure codes for mechanical ventilation were obtained from VA and Medicare data.

VACS Risk Index

The VACS Risk Index was calculated only in patients admitted to VA MICUs because the laboratory values needed to calculate the index were not available in the Medicare data. The VACS Index is a composite of age, CD4 cell count, HIV RNA, hemoglobin, eGFR estimated from serum creatinine, hepatitis C infection (ICD-9 code or serum laboratory antibody positive, respectively), and FIB-4 (a measure of liver cirrhosis that includes age, AST, ALT, and platelet count; Supplemental Table 1, Supplemental Digital Content 1, <http://links.lww.com/CCM/A607>) (11, 34). Components of the VACS Index were categorized and assigned point values via a previously established system and summed to calculate a score (34, 35). Lab values obtained the day before, day of, or day after MICU

admission were considered. The worst value for each lab in this interval was chosen, consistent with other ICU scoring systems (29, 30). Complete labs were available for 92% of HIV+ and 80% of uninfected patients.

Other Covariates

Comorbidities occurring up to 30 days prior to hospitalization were identified by at least one inpatient or two outpatient ICD-9 codes for the condition. This approach has been shown to improve the specificity of these codes (38). Patients were classified as having a history of pneumonia if they had one or more episode of prior pneumonia without restricting the definition to recurrent pneumonia within 12 months. Combination ART use, defined as receiving at least three antiretroviral medications for greater than 30 days within the 90 days prior to hospitalization, was determined from VA pharmacy databases. We chose a 90-day window because 90-day supplies of medications are frequently provided. This assured that HIV+ on ART should have received at least one refill within the 90 days prior to admission.

Smoking status was based on self-administered questionnaires completed closest to MICU admission (7, 40–42). Current smokers were those who smoked within 4 wk, and former smokers were those who quit smoking 4 or more weeks prior to questionnaire administration. Hazardous alcohol use was a composite variable defined by the presence of at least one of the following: ICD-9 code for alcohol abuse/dependence; self-administered questionnaires regarding binge drinking or hazardous drinking (Alcohol Use Disorders Identification Test score ≥ 4 on self-report from survey completion) (9, 38, 43).

Outcome

Our primary outcome was 30-day mortality from admission. Mortality was determined from the VA vital status file which is compiled from combined sources including inpatient mortality, social security data, and national death benefits data, a method previously shown to provide excellent mortality ascertainment (44). VACS recently obtained underlying cause of death (COD) from death certificates coded by the National Death Index according to ICD-10 codes and grouped into organ system categories comparable to those used for hospitalization ICD-9 diagnosis codes. COD data were available for deaths occurring by December 31, 2009, and was complete for 90% of decedents. COD was classified as HIV related or non-HIV related (including accidental and violent) or unknown (Supplemental Table 3, Supplemental Digital Content 1, <http://links.lww.com/CCM/A607>). HIV deaths were ICD-10 B20-B24. All other deaths with known cause were classified as non-HIV.

Statistical Analysis

We compared patient characteristics at MICU admission stratified by HIV status and VA vs. Medicare MICU admission using the *t* test or chi-square test as appropriate. Logistic regression models were used to determine adjusted odds ratio (OR) with 95% confidence interval (CI) for 30-day mortality in patients with a VA MICU admission. We evaluated VACS Index score at MICU admission after adjustment for gender, race/ethnicity, hypertension, diabetes, and diagnosis (cardiovascular, respiratory, ISS, and other). We first stratified by HIV status and then formally tested for an interaction between VACS Index score and HIV status using both an interaction term and the Likelihood ratio test. Because a

significant interaction was found, we created two composite variables: one equal to VACS Index score if HIV+, otherwise 0 and another equal to score if uninfected, otherwise 0. This approach provides directly interpretable ORs. Age was not included separately in the regression models because it was already represented in the VACS Index. The diagnosis categories chosen were the most common. CAD was used as the reference group because it had the lowest mortality. The final model included only significant variables: HIV status, VACS Index score at MICU admission (two variables), race/ethnicity, and diagnosis. Model fit was assessed with the Hosmer-Lemeshow goodness-of-fit test. In HIV+, we generated a calibration curve to determine the association between 30-day mortality and the VACS Index score at MICU admission. Observed mortality was superimposed on the plot to show agreement between observed and predicted mortality. We were unable to do this in the uninfected patients as there were only 20 deaths. Statistical analyses were performed using SAS 9.2 (SAS Institute, Cary, NC). Statistical significance was defined as a *p* value less than 0.05.

RESULTS

Characteristics of MICU Admissions

From 2002 to 2010, 631 of 3,620 (17%) HIV+ patients and 426 of 3,639 (12%) uninfected patients enrolled in VACS 8 had a first MICU admission after VACS enrollment. After applying exclusion criteria (Fig. 1), the final cohort included 539 (85%) HIV+ and 375 (88%) uninfected patients. Most MICU admissions were to VA MICUs: 386 of 539 (72%) among HIV+, compared with 292 of 375 (78%) in uninfected patients.

The study sample of patients with a MICU admission was overwhelmingly men; some patient characteristics varied by HIV status (Table 1). HIV+ patients admitted to the MICU were younger, more likely to be of non-white race/ethnicity, and current smokers. History of non-AIDS cancer, hepatitis B and hepatitis C, and history of pneumonia were more common in the HIV+ compared with uninfected patients. Hypertension, CAD, congestive heart failure, COPD, and diabetes mellitus were more common in uninfected patients. Among HIV+, 73% of VA admissions and 67% of Medicare admissions were on ART prior to MICU admission. Between 1 and 6 months prior to admission, median CD4 cell count was 277 (interquartile range [IQR] 114, 496) cells/ μ L for VA MICU admissions and 281 (IQR 165, 442) cells/ μ L for Medicare admissions; 53% and 57%, respectively, had an undetectable viral load prior to MICU admission.

Some admission-specific characteristics also varied by HIV (Table 1). Median length of hospital stay was longer in HIV+ (6 days [IQR 3, 12] for HIV+ compared with 5 days [IQR 3, 9] for uninfected patients). Mechanical ventilation was more frequent in HIV+ (17%) than in the uninfected (9%) (*p* = 0.001).

Respiratory diseases were the most common diagnosis in HIV+, whereas CAD was the most common in uninfected patients (Table 1). OIs were present in 13% of HIV+. PCP (6%) and mucocutaneous candidiasis (6%) were the most common OIs diagnoses identified during hospitalization. The majority of candidiasis cases were coded for oropharyngeal candidiasis.

Gastrointestinal/liver diagnoses and neurologic diagnoses were more common in uninfected patients.

Admission diagnosis also varied slightly between VA and Medicare MICU admissions. In patients with VA admissions, infection was more frequent in HIV+. CAD was more common in VA MICU admissions, whereas neurologic diseases were more common in Medicare MICU admission. OIs were more common in VA MICU admissions (15% compared with 9%, respectively).

In VA patients, VACS Index score at MICU admission was available for 356 (92%) of HIV+ and 232 (80%) of uninfected patients. Assuming CD4 cell count greater than 500 and undetectable viral load in uninfected patients, VACS Index scores at MICU admission were higher in HIV+ compared with uninfected patients. At MICU admission, median VACS Index scores with IQR were 76 (55, 96) in HIV+ and 42 (28, 60) in uninfected patients ($p < 0.001$) (Table 1). General organ dysfunction was greater in HIV+ compared with uninfected patients as determined by lower hemoglobin, lower eGFR, and higher FIB-4 (data not otherwise shown).

Outcome of MICU Admission

All-cause 30-day mortality was substantial, with 19% of HIV+ and 11% of uninfected patients dying ($p = 0.003$; Table 1). The most frequent underlying COD was infection for HIV+ and cardiovascular for uninfected patients (Table 2). HIV-related COD was reported for 65% of HIV+ patients.

In patients with a VA MICU admission, VACS Index scores at admission strongly predicted 30-day mortality in HIV+ and uninfected patients (Table 3). After adjusting for race/ethnicity and admission diagnosis, we found a 22% increased risk of 30-day mortality per 5-point increment of score (OR 1.22; 95% CI 1.14, 1.30; $p < 0.001$) in HIV+ and a 50% increased risk of mortality per 5 points (OR 1.50; 95% CI 1.29, 1.76; $p < 0.001$ in the uninfected). While CIs were borderline, the estimated OR for HIV infection suggested a substantial increased risk of mortality (OR 10.9; 95% CI 0.73, 163). Respiratory and infectious diagnoses were also risk factors for 30-day mortality compared with CAD (referent category). The c-statistic for the overall model was 0.87. The Hosmer-Lemeshow test showed adequate model fit ($p = 0.57$).

In HIV+, predicted 30-day mortality using the VACS Index score at MICU admission coincided with observed mortality at all levels of score (Fig. 2). In patients with VACS Index scores less than 35 (lowest 10% of scores among HIV+), 30-day mortality was less than 3%. Among patients with a VACS score at MICU admission greater than 110 (the highest 10% of scores among HIV+), 39% of patients died within 30 days of MICU admission. Because there were only 20 deaths within 30 days among the uninfected patients, we did not compute a calibration curve between VACS Index score and 30-day mortality among uninfected patients.

DISCUSSION

HIV+ patients were admitted more frequently to the MICU, particularly for respiratory and infection-related diagnoses, and experienced higher 30-day mortality compared with uninfected patients. COD was HIV related for the majority of HIV+. While the VACS Index was associated with 30-day mortality in both HIV+ and uninfected patients, risk of mortality associated with each 5-point increment in score differed for HIV+ and uninfected individuals. Admission diagnoses of respiratory and infectious conditions were strongly associated with increased 30-day mortality for both groups, although with only 20 VA MICU deaths among the HIV-uninfected group, conclusions about risk factors in these individuals may be limited. These results highlight the continued morbidity and mortality associated with HIV and with respiratory disease and infectious complications among HIV+.

As in prior studies, respiratory diagnoses continue to be the most common admission diagnoses for HIV+ with MICU admission, accounting for more than 20% of admission diagnoses (17, 19,20,22,23, 25, 27, 45–47). Respiratory diagnoses were encountered less frequently in uninfected patients, accounting for 12% of admission diagnoses. Similarly, mechanical ventilation among patients admitted to the MICU was twice as common in HIV+ compared with uninfected patients. Infectious admission diagnoses were also common in HIV+ and were more than twice as frequent in HIV+ compared with uninfected patients. However, a substantial proportion of these patients had HIV infection as their primary ICD-9 code associated with the hospitalization, suggesting that we may underestimate the prevalence of other complications that were not captured by ICD-9 codes. Cardiovascular diagnoses were also leading admission diagnoses in HIV+. Thus, MICU admission diagnoses vary substantially by HIV status and, despite ongoing HIV care and access to ART, respiratory failure and infections contribute to critical illness disproportionately among HIV+ in this cohort. The contribution of chronic pulmonary diseases and their management on the risk of respiratory failure in HIV+ require further investigation (48).

Despite being on ART and having suppressed viral loads, HIV+ had higher VACS Index scores at MICU admission and experienced higher 30-day mortality compared with uninfected patients. These results are important, because prior scoring systems to predict ICU mortality have only accounted for the presence of AIDS-defining conditions such as PCP and have not given separate weighting for HIV infection itself. In the ART era, AIDS-defining events are rare and most individuals with HIV have not yet crossed the threshold of symptomatic AIDS. While the VACS Index has been validated to predict all-cause mortality in HIV+, this is the first study reporting its use at MICU admission to predict 30-day mortality in both HIV+ and uninfected patients (11). It is important to highlight that we did not alter the scoring system. The VACS Index at MICU admission predicted 30-day mortality well in both groups and was associated with a greater proportionate increase in risk for each 5-point increment in score among the uninfected sample. This may reflect the fact that uninfected subjects had to have more extreme values for the components of the score relevant to their physiologic injury (hemoglobin, eGFR, Hepatitis C, and FIB-4) to achieve comparably high scores with those with HIV infection who might have an elevated score due in part to a low CD4 cell count or detectable viral load.

Future analyses with a larger sample of uninfected individuals will need to explore the appropriate calibration of the VACS Index among uninfected patients. Given the predictive value of the VACS Risk Index for 30-day mortality, future studies are warranted to determine whether the Index may be of use as an indicator for MICU admission and/or for discussions of prognosis among patients, their caregivers, and providers.

Our study has a number of strengths. We are the first to compare admission diagnoses and 30-day mortality after MICU admission in a multicenter longitudinal cohort of HIV+ with demographically and behaviorally similar uninfected patients in the current ART era. Prior studies of HIV+ patients admitted to the MICU have been largely single-center cohorts and without comparison with similar uninfected patients. We were able to make comparisons between HIV+ and uninfected patients using the VACS Index. Future analyses are required to determine how the VACS Index compares to other critical illness scoring systems in predicting mortality risk for general medical patients as well as those with HIV infection. Importantly, we were able to include Medicare MICU admissions to demonstrate that a majority of patients received MICU care within the VA. Medicare admissions appeared to be a bit more likely to be due to very high acuity and instability, such as acute respiratory failure requiring mechanical ventilation, hemodynamic instability from sepsis or septic shock, or acute stroke. In contrast, cardiovascular admission diagnoses were more common in VA MICUs. Overall comparisons by HIV status were similar across VA and Medicare admissions suggesting that our focus on VA admissions for the survival analysis is likely representative.

There are several limitations to this study. First, this study is not able to compare severity of illness at MICU admission in patients admitted to Medicare MICUs (25.8%) as we did not have access to laboratory data in this subset. We also recognize that MICU admission does not necessarily equate to critical illness and that noncritically ill patients may be admitted to the MICU for other reasons such as hospital policy or bed availability. However, 30-day mortality and hospital length of stay were substantial, thereby supporting that a significant proportion of patients included in this study were critically ill. The wide CIs for admission diagnoses as risk factors for mortality (Table 3) are additional limitations of this study. Finally, nearly all patients in VACS were men. MICU admission diagnoses, outcomes, and predictive utility of the VACS Index at MICU admission need to be evaluated in cohorts with a representative proportion of women. As the VACS Index has been shown to accurately predict all-cause mortality among women in other validation studies (36), we would expect that the association reported with mortality after MICU admission will generalize to women. Because of the uncertainty regarding its application to HIV-uninfected patients, its conjectured accuracy among women, and because the VACS Index was developed from the same cohort used in this study to test its predictive powers, the VACS Index requires external validation of its ability to predict 30-day mortality. Of note, the original development of the VACS Index fits the weights for each component using a sample of 4,932 HIV+ patients with 656 deaths. Our current analysis looks at HIV+ and HIV-uninfected patients with VA MICU admissions and deaths, overlapping with only 5% of deaths in the development cohort.

CONCLUSIONS

MICU admission is more common in HIV+ compared with uninfected patients and is associated with substantial mortality in both populations. Respiratory conditions, CAD, and infections account for the majority of MICU admissions in HIV+. The VACS Index calculated at MICU admission identifies HIV+ and uninfected patients at high risk of 30-day mortality. Aging HIV+ will likely require increasing care within MICU settings that may differ from demographically similar uninfected individuals. Future studies are needed to externally validate the VACS Index at MICU admission and to determine how best to use the VACS Index to inform critical care management of those aging with HIV infection.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.
Description of the cohort patients with VA or medical ICU (MICU) admission after Veterans Aging Cohort Study (VACS) enrollment.
HIV = human immunodeficiency virus. VA = Veterans Affairs.

Figure 2.

Calibration curve for Veterans Aging Cohort Study (VACS) Index score at medical ICU (MICU) admission and 30-day mortality in human immunodeficiency virus-infected patients only. Predicted mortality from logistic regression model using VACS Index score at MICU admission (*solid line*). Note that we did not generate a calibration curve for uninfected patients as there were only 20 deaths in this group. Observed 30-day mortality from MICU admission (*open circles*) and 95% confidence intervals for predicted mortality (*dashed lines*).

Table 1
 Characteristics and Outcomes for Patients with at least One Medical ICU Admission by Human Immunodeficiency Virus Status and Medical ICU Source
 (Veterans Affairs vs. Medicare Medical ICU) (*n* = 914)

Characteristic	HIV Infected			Uninfected		
	VA (<i>n</i> = 386)	Medi- care (<i>n</i> = 153)	Combined (<i>n</i> = 539)	VA (<i>n</i> = 292)	Medi- care (<i>n</i> = 83)	Combined (<i>n</i> = 375)
Age in years at MICU admission, median (IQR)	54 (48, 58)	56 (48, 65)	54 (48, 59)	56 (52, 62)	59 (53, 68)	57 (52, 64)
Male gender, <i>n</i> (%)	381 (99)	151 (99)	532 (99)	285 (98)	80 (96)	365 (97)
Race, <i>n</i> (%)						
White	56 (15)	43 (28)	99 (18)	68 (23)	21 (25)	89 (24)
Black	285 (74)	92 (60)	377 (70)	186 (64)	51 (61)	237 (63)
Hispanic	30 (8)	13 (9)	43 (8)	21 (7)	6 (7)	27 (7)
Other	15 (4)	5 (3)	20 (4)	17 (6)	5 (6)	22 (6)
HIV-specific variables						
CD4 cell count in cells/mm ³ , median (IQR)	277 (114, 496)	281 (165, 442)	278 (129, 481)	N/A	N/A	N/A
HIV RNA nondetectable (< 500 copies/mm ³), <i>n</i> (%) ^a	194 (53)	73 (57)	267 (54)	N/A	N/A	N/A
HIV RNA in log ¹⁰ copies/mL, median (IQR)	2.6 (1.9, 4.4)	2.6 (1.9, 3.9)	2.6 (1.9, 4.3)	N/A	N/A	N/A
Antiretroviral therapy use within 90 d of MICU admission, <i>n</i> (%)	282 (73)	103 (67)	385 (71)	N/A	N/A	N/A
Baseline comorbidities diagnosed prior to MICU admission						
Smoking status, <i>n</i> (%)						
Never	64 (17)	25 (16)	89 (17)	39 (13)	16 (19)	55 (15)
Current	220 (57)	79 (52)	299 (56)	150 (51)	29 (35)	179 (48)
Former	102 (26)	49 (32)	151 (28)	103 (35)	38 (46)	141 (38)
Hazardous alcohol use, <i>n</i> (%)	179 (46)	66 (43)	245 (46)	168 (58)	35 (42)	203 (54)
Hypertension, <i>n</i> (%)	218 (57)	93 (61)	311 (58)	232 (80)	68 (82)	300 (80)
Diabetes mellitus, <i>n</i> (%)	108 (28)	46 (30)	154 (29)	144 (49)	43 (52)	187 (50)
History of pneumonia, <i>n</i> (%)	87 (23)	31 (20)	118 (22)	22 (8)	10 (12)	32 (9)
Cardiovascular disease, <i>n</i> (%)	42 (11)	22 (14)	64 (12)	68 (23)	29 (35)	97 (26)

Characteristic	HIV Infected			Uninfected		
	VA (n = 386)	Medi- care (n = 153)	Combined (n = 539)	VA (n = 292)	Medi- care (n = 83)	Combined (n = 375)
Congestive heart failure, n (%)	22 (6)	16 (11)	38 (7)	39 (13)	15 (18)	54 (14)
Cancer history, n (%) ^b	69 (18)	30 (20)	99 (18)	43 (15)	9 (11)	52 (14)
Chronic obstructive pulmonary disease, n (%)	56 (15)	24 (16)	80 (15)	66 (23)	14 (17)	80 (21)
Hepatitis B coinfection, n (%)	41 (11)	13 (9)	54 (10)	12 (4)	1 (1)	13 (4)
Hepatitis C coinfection, n (%)	237 (61)	83 (54)	320 (59)	116 (40)	30 (36)	146 (39)
Opportunistic infections during hospitalization, n (%)	56 (15)	14 (9)	70 (13)	N/A	N/A	N/A
<i>Pneumocystis</i> pneumonia	28 (7)	5 (3)	33 (6)	N/A	N/A	N/A
Candidiasis	24 (6)	9 (6)	33 (6)	N/A	N/A	N/A
All other ^c	18 (5)	1 (1)	19 (4)	N/A	N/A	N/A
Veterans Aging Cohort Study Index score at MICU admission, median (IQR) ^d	76 (55, 96)	N/A	N/A	42 (28, 60)	N/A	N/A
Length of stay and mechanical ventilation						
MICU length of stay, median (IQR)	2 (1, 4)	N/A	N/A	2 (1, 3)	N/A	N/A
Hospital length of stay, median (IQR)	6.5 (3, 12)	6 (3, 12)	6 (3, 12)	4 (2, 8)	6 (3, 10)	5 (3, 9)
Mechanical ventilation, n (%)	49 (13)	42 (28)	91 (17)	16 (6)	19 (23)	35 (9)
Reason for hospitalization (%) ^e						
Respiratory	81 (21)	30 (20)	111 (21)	35 (12)	10 (12)	45 (12)
Infection	35 (9)	20 (13)	55 (10)	7 (2)	7 (8)	14 (4)
HIV	45 (12)	30 (20)	75 (14)	N/A	N/A	N/A
Cardiovascular	77 (20)	22 (14)	99 (18)	87 (30)	21 (25)	108 (29)
Gastrointestinal and liver	39 (9)	10 (7)	46 (9)	35 (12)	6 (7)	41 (11)
Endocrine	22 (6)	9 (6)	31 (6)	26 (9)	5 (6)	31 (8)
Neurologic	10 (3)	9 (6)	19 (4)	20 (7)	11 (13)	31 (8)
Renal	22 (6)	5 (3)	27 (5)	5 (2)	3 (4)	8 (2)
Non-AIDS cancer ^b	14 (4)	5 (3)	19 (4)	10 (3)	3 (4)	13 (4)
Other	89 (23)	43 (28)	132 (25)	67 (23)	17 (21)	84 (22)

Characteristic	HIV Infected			Uninfected		
	VA (n = 386)	Medi- care (n = 153)	Combined (n = 539)	VA (n = 292)	Medi- care (n = 83)	Combined (n = 375)
30-d mortality, n (%)	69 (18)	31 (20)	100 (19)	27 (9)	15 (18)	42 (11)

MICU = medical ICU; HIV = human immunodeficiency virus; VA = Veterans Affairs; IQR = interquartile range; N/A = not applicable except for MICU and hospital length of stay where N/A = not available for Medicare MICU admission.

^a Among those with HIV viral load within 6 mo prior to MICU admission.

^b Excludes *International Classification of Diseases*, 9th Revision, codes for Kaposi sarcoma, non-Hodgkin lymphoma, and squamous and basal cell carcinoma of the skin.

^c No more than five of any other opportunistic infections.

^d Veterans Aging Cohort Study Index scores calculated assuming normal CD4 cell counts and undetectable viral load. Available for 92% of HIV+ and 80% of uninfected patients admitted to VA MICUs.

^e MICU principal diagnosis with 90% agreement with hospital principal diagnosis.

IQR 25% and 75% quartiles included.

Table 2

Primary Cause of Death Less Than or Equal to 30 Days After Hospital Admission by Human Immunodeficiency Virus Status, $n = 142$ (16%)^a

Cause of Death by Organ System	HIV Infected ($n = 100$)	Uninfected ($n = 42$)
Respiratory	0	3 (7)
Infection	68 (68)	4 (10)
Cardiovascular	3 (3)	11 (26)
Gastrointestinal and liver	6 (6)	3 (7)
Endocrine	0	2 (5)
Neurologic	2 (2)	3 (7)
Renal	1 (1)	1 (2)
Cancer	8 (8)	6 (14)
Other	4 (4)	1 (2)
Unknown ^b	8 (8)	8 (19)
HIV vs. non-HIV cause of death		
HIV related	65 (65)	0 (0)
Non-HIV related	27 (27)	34 (81)
Unknown ^b	8 (8)	8 (19)

HIV = human immunodeficiency virus.

^aNinety-eight percent of patients who died by December 31, 2009, the end date for the cause of death data, had a cause of death available.

^bIncludes 13 deaths that occurred after December 31, 2009.

Table 3

Multivariable Analyses of 30-Day Mortality after Medical ICU Admission, 83 Deaths in 588 Patients with Veterans Affairs Medical ICU Admission^a

Variable	Odds Ratio (95% Confidence Interval)
HIV	10.9 (0.73, 163)
Veterans Aging Cohort Study Index on medical ICU admission/5 points in HIV+	1.22 (1.14, 1.30)
Veterans Aging Cohort Study Index on medical ICU admission/5 points in uninfected	1.50 (1.29, 1.76)
Non-Black race/ethnicity (reference Black)	1.55 (0.85, 2.83)
Hospital admission code (reference cardiovascular)	
Infection	26.8 (5.25, 137)
Respiratory	11.7 (2.46, 55.9)
Other ^b	6.59 (1.47, 29.5)

HIV = human immunodeficiency virus.

^aSignificant interaction identified between HIV and Veterans Aging Cohort Study Index score at medical ICU admission ($p = 0.01$); C-statistic = 0.87, with Hosmer-Lemeshow lack of fit $p = 0.57$.

^bOther diagnostic categories include cancer, gastrointestinal and liver, renal, endocrine, neurologic, and other.