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Linkage to primary care and survival after hospital discharge for HIV-infected adults in Tanzania: a prospective cohort study

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Abstract

Introduction—Little is known about outcomes after hospitalization for HIV-infected adults in sub-Saharan Africa. We determined 12-month, post-hospital mortality rates in HIV-infected vs. uninfected adults and predictors of mortality.

Methods—In this prospective cohort study, we enrolled adults admitted to the medical wards of a public hospital in northwestern Tanzania. We conducted standardized questionnaires, physical examinations, and basic laboratory analyses including HIV testing. Participants or proxies were called at one, three, six, and 12 months to determine outcomes. Predictors of in-hospital and post-hospital mortality were determined using logistic regression. Cox regression models were used to analyze mortality incidence and associated factors. To confirm our findings, we studied adults admitted to another government hospital.

Results—We enrolled 637 consecutive adult medical inpatients: 38/143 (26.6%) of the HIV-infected adults died in-hospital vs. 104/494 (21.1%) of the HIV-uninfected. Twelve-month outcomes were determined for 98/105 (93.3%) vs. 352/390 (90.3%) discharged adults, respectively. Post-hospital mortality was 53/105 (50.5%) for HIV-infected adults vs. 126/390 (32.3%) for HIV-uninfected (adjusted p=0.006). The 66/105 (62.9%) of HIV-infected who attended clinic within one month after discharge had significantly lower mortality than other HIV-infected adults (adjusted hazards ratio = 0.17 [0.07–0.39], p<0.001). Adults admitted to a nearby government hospital had similarly high rates of post-hospital mortality.

Conclusions—Post-hospital mortality is disturbingly high among HIV-infected adult inpatients in Tanzania. The post-hospital period may offer a window of opportunity to improve survival in

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this population. Interventions are urgently needed and should focus on increasing post-hospital linkage to primary HIV care.

Keywords

HIV; hospital; mortality; non-communicable diseases; Africa; Tanzania

INTRODUCTION

In sub-Saharan Africa, adults with HIV (and other chronic diseases) often remain undiagnosed and untreated until they are hospitalized.[1,2] Therefore, hospitals may offer an important window of opportunity to identify these conditions, initiate treatment and link to primary care.[3,4] Unfortunately, little is known about post-hospital outcomes for African adults. The few data that have been published regarding post-hospital outcomes in HIV-infected African adults have been limited by low rates of HIV testing in hospitals and low rates of post-hospital follow up after discharge.[2,5]

Studies from the US have demonstrated that the post-hospital period is a vulnerable period with a high risk of death,[6] but no published study has yet systematically examined predictors of post-hospital mortality for African adults. A thorough understanding of these predictors of post-hospital mortality will be essential to designing appropriate interventions to improve outcomes. Studies from the US have demonstrated that early linkage to primary care is one important predictor of post-hospital survival.[7–9] Primary care systems in sub-Saharan Africa are weak,[10,11] and this cause lower linkage to primary care and higher post-hospital mortality.

Therefore, we conducted a prospective cohort study of adults discharged from the general medical wards of a public hospital in northwestern Tanzania. Our study objectives were: 1) to determine post-hospital mortality rates for HIV and other disease categories; 2) to describe easily measurable predictors of post-hospital mortality; and 3) to determine if early clinic attendance predicts mortality. We hypothesized that post-hospital mortality rates would be higher among HIV-infected adults and that early linkage to primary HIV care predicts lower mortality.

METHODS

Study setting

In this prospective cohort study, we consecutively screened and enrolled adults hospitalized on the medical wards of Bugando Medical Centre (BMC). BMC is a public hospital that serves the Lake Victoria region of northwestern Tanzania (population: 13 million). BMC is located in the city of Mwanza, the second largest urban center in Tanzania and the capital of the Mwanza region. BMC has 100 adult medical beds and ~4000 medical hospitalizations per year. The HIV prevalence among adults in Mwanza region is ~6%.[12] According to national HIV guidelines at the time of the study, criteria for starting ART for HIV-infected adults include WHO clinical stage III or IV diseases or CD T-cell count <350 cells/mm^3.[13] Tuberculosis, schistosomiasis, malaria, and hepatitis B are also highly endemic. The

resources of BMC are similar to those available in other government hospitals in East Africa.[10,11]

Inclusion & exclusion criteria

Adults (≥18 years) hospitalized in the medical ward were eligible for enrollment. Potential study participants were provided with information regarding the study within 12 hours of hospitalization. All of those who provided informed consent were enrolled. Study participants with multiple hospitalizations to BMC during the study period were only enrolled during their first hospitalization.

Study procedures

On the day of enrollment, a pre-validated, adapted, translated version of the WHO STEPS questionnaire was administered in Kiswahili by a Tanzanian study investigator.[12,14,15] The WHO STEPS questionnaire includes questions regarding prior testing, diagnosis, and treatment for chronic diseases as well as standard protocols for physical examination.

After completing the questionnaire, we conducted a standardized physical examination. We measured weight to the nearest 0.1 kg using a digital weight measuring scale with participants wearing only light clothing and no shoes. Height was measured to the nearest 0.1 cm using a stadiometer. Waist and hip circumferences were measured to the nearest 0.1 cm using a measuring tape. For each of these measurements, the mean of two values was used. Blood pressures were measured by a registered nurse or doctor using a mercury sphygmomanometer according to the WHO STEPS protocol.[14]

Laboratory analysis

At the time of hospitalization, by hospital policy, all medical inpatients were offered voluntary counseling and testing for HIV and underwent measurement of glucose, creatinine, and urine dipstick testing. Serum creatinine levels were measured using a Cobas Integra 400 Plus Analyzer (Roche Diagnostic Limited, Basel, Switzerland). An estimated glomerular filtration rate (eGFR) was calculated using the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation (without ethnic factor) as recommended by international guidelines.[16] Random blood glucose was measured using a finger stick sample (Ascensia Glucometer, Bayer Healthcare, Germany). A urine dipstick was used to test for proteinuria, hematuria, and pyuria (Multistix 10SG, Siemens, USA).

Discharge diagnoses

Diagnoses were determined at the time of discharge. Since December 2008, our hospital has used a standard list of recommended discharge diagnoses.[1] These diagnoses were adapted from the WHO's International Classification of Diseases version 10 (ICD-10).[17] This standard list includes all of the diagnoses reported in this study, as in our prior work.

Follow-up of study participants

Three mobile phone numbers were obtained from all participants at discharge: one for the study participant and two additional numbers for relatives or close friends. Follow-up phone calls were made at one, three, six, and 12 months by the medical doctors who conducted

enrollment. During each call, a standard set of questions were asked in Kiswahili including: 1) vital status and 2) primary care clinic attendance. All potentially sensitive information was obtained from patients. If we were unable to reach the study participants immediately but reached a family member or friend instead, we first inquired about the vital status of the study subject. If the study subject had died, we recorded the date of death and offered condolences. If the study subject was alive, we asked to speak to the subject directly. If the subject was not nearby, friends or family members were asked for the best alternative time or phone number to contact the study subject. We were subsequently able to reach the study subject directly in all cases.

After we discovered high post-hospital mortality rates at our primary enrollment site, we decided to enroll study subjects from a second public hospital to assess whether these high post-hospital mortality rates were unique to our study site or were generalizable to other Tanzanian hospitals. For this purpose we chose the nearest government hospital, Sekou Toure Regional Hospital. Patients at Sekou Toure are similar to patients at BMC with regards to severity of illness, reasons for hospital admission and prevalence of HIV. We invited all consecutive adults admitted to the medical wards of Sekou Toure to be enrolled. Inclusion and exclusion criteria and patient follow-up were as above. We followed all study subjects at Sekou Toure until 3 months to determine post-hospital mortality rates.

Measures

The primary study outcome was mortality. Mortality was classified as in-hospital if it occurred during the index hospitalization and post-hospitalization if it occurred in the year that followed the index hospitalization. Linkage to primary care was a secondary outcome. Adults with HIV were also specifically asked about medication adherence to antiretroviral therapy at 1 month post-discharge.

Data analysis

Data were entered into Microsoft Excel (Microsoft, Redmond, Washington, USA) and analyzed using STATA version 11 (StataCorp, College Station, Texas, USA). Categorical variables were described as proportions (percentiles), and continuous variables were described as means (standard deviations). Non-missing data was included in all calculations. No explanatory variable was missing more than 7 patients except for the urine dipstick results, which were not performed in 23 patients due to a temporary shortage of supplies. A two-sided p-value of <0.05 was regarded as statistically significant in all analyses.

Logistic regression models were used to describe predictors of in-hospital and 12-month mortality because guidelines for international HIV reporting recommend the use of binary one and two-year outcomes. We also chose logistic regression because we wanted to explore which variables, among the variables commonly available to hospital clinicians in Africa, were the strongest independent predictors of in-hospital and 12-month post-hospital mortality in order to guide future efforts to build and validate predictive models for in-hospital and post-hospital mortality in Africa. For each mortality model, all continuous variables were assessed as linear, quadratic, ordinal quartiles, categorical quartiles, categorical, ordinal categorical, and binary transformations and the best transformation of

continuous variables was chosen as the transformation with the lowest Akaike Information Criteria (AIC). We used multivariable logistic regression with forward stepwise selection to determine the strongest independent predictors of mortality with a two sided p-value of $p<0.025$ used for both entry and exit from the models. After multivariable models were created, each additional variable was sequentially added back into the final model and considered for re-inclusion if it had a two sided p-value of <0.025. Collinearity testing was performed using variance inflation factors of greater than ten to indicate collinearity.

Kaplan-Meier survival curves were used to display incident mortality. Study participants who were lost-to-follow-up were censored at the last contact date. A log-rank test was used to determine if mortality incidence differed by diagnosis category. Multivariable Cox regression models were used to determine if mortality incidence significantly differed according to linkage to primary care before one month. Analysis for this outcome was limited to participants who survived for at least one month and were adjusted for all factors associated with post-hospital mortality.

Based on our prior studies,[1,18] we estimated that one-quarter of patients would be admitted into each diagnostic category, that in-hospital mortality rate would be ~20% and that linkage to primary HIV care would be ~50%. Given these assumptions, and allowing for 10% loss-to-follow-up, we calculated that enrolling 650 consecutive adults would give us >90% power to detect a 10% difference in 12-month, post-hospital mortality between HIV-infected adults and other diagnostic categories and >80% power to detect a 10% difference in mortality incidence between HIV-infected adults who did and did not link to primary care.

Ethical issues

Ethical approval was obtained from the ethics committee of BMC and the institutional review board of Weill Cornell Medical College. All study participants were informed about the study by a nurse or doctor fluent in Kiswahili and provided written informed consent before participation. Participants also consented to receiving phone calls at either their own mobile phone number or the mobile phone numbers that they provided for friends and relatives. They agreed that, if they were not available to receive the phone call, friends or relatives could provide information as to their vital status (alive or dead) and current phone number (if alive). Disease management was conducted by BMC physicians according to BMC and Tanzanian management protocols. All study procedures were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000.

RESULTS

Enrollment

Between 1st October and 30th December 2013, 660 adults were hospitalized in the medical wards of BMC. Of these 660 adults, 17 died within 12 hours of hospitalization (before enrollment could occur), and six refused participation. The remaining 637 adults (96.5%) were enrolled, and 142 died as inpatients: 38/143 (26.6%) of the HIV-infected adults vs. 104/494 (21.1%) of the HIV-uninfected.

Baseline characteristics

Baseline characteristics are summarized in Table 1. Of the 495 adult medical inpatients who were discharged, 105/495 (21.2%) had a primary discharge diagnosis of HIV and 390 (78.8%) had other diagnoses. The baseline characteristics of the two groups were broadly similar with a few exceptions such as age, history of hypertension and overweight/obesity, 47/105 (44.8%) of HIV-infected adults were male vs. 292/390 (49.2%) of the others. The mean ages were 38.1 (10.9) years and 48.2 (18.5) years, respectively. Only 11/105 (10.5%) vs. 69/390 (17.7%) had completed a secondary school education. A previous diagnosis of hypertension was reported in 7/105 (6.7%) of HIV-infected adults vs. 123/390 (31.2%) of the others. Shortness of breath was the most frequently symptom, reported in 21/105 (20.0%) vs. 131/390 (33.7%), respectively. Overweight or obese were present in 14/105 (13.3%) vs. 118/390 (30.4%). In the HIV-infected group, on laboratory investigations, 6/105 (5.7%) vs. 30/390 (7.7%) had an eGFR of <60mL/min/1.73 m^2.

Hospital clinicians denoted HIV as the primary discharge diagnosis in all HIV-infected adults. In the HIV-infected group, 84/105 (80.0%) had known that they were HIV-infected before hospital admission and 21/105 (20.0%) were newly diagnosed during the hospitalization. All 84 of those who knew they were HIV-infected before hospital admission reported taking ART at some time before hospital admission. All 105 HIV infected adults met criteria for starting or restarting ART due to having WHO clinical stage III or IV diseases.

The discharge diagnosis categories of these 495 study participants were as follows: 105 (21.2%) HIV, 85 (17.2%) hypertension-related diseases, 191 (38.6%) other NCDs, and 114 (23.0%) other infectious disease. All 105 HIV-infected patients' primary discharge diagnosis was HIV. Supplemental Table 1 lists the specific diagnoses made within each of these four categories.

Outcomes by diagnosis category

Of the 495 who were discharged from the hospital, mobile phone contact was made with, 467/495 (94.3%), 466/495 (94.1%), 450/495 (90.9%) at three, six and 12 months, respectively. For HIV-infected adults, 1/105 (1.0%), 1/105 (1.0%) and 7/105 (6.7%) could not be reached at three, six and 12 months vs. 27/390 (6.9%), 28/390 (7.2%) and 38/390 (9.7%) for HIV-uninfected adults.

Of the 495 participants discharged, 179 (36.2%) died within 12 months (see Table 2). The 12-month post-hospital mortality was 53/105 (50.5%) for participants with HIV, 28/85 (32.9%) for hypertension-related diseases, 65/191 (34.0%) for other NCDs, and 33/114 (28.9%) for other infectious diseases. Post-hospital mortality estimates varied significantly by the four disease categories (p=0.025 by log-rank test) but in-hospital mortality did not (p=0.73 by log-rank test) (see Figure 1).

Factors associated with mortality

Predictors of in-hospital differed from those of post-hospital mortality (see Table 3). HIV infection, for example, was significantly associated with post-hospital mortality but not in-

hospital mortality. AICs and complete univariable logic regression results are displayed in the appendix (Supplementary Tables 2 – 5). The best transformation of continuous variables differed according to the outcome. For eGFR, for example, a binary transformation (eGFR≥60 vs. eGFR <60 mL/min/1.73 m^2) was most predictive of in-hospital mortality whereas the original linear units were better a predictor of post-hospital mortality. Of note, longer hospital stay was associated with a lower odds of in-hospital mortality (OR=0.94 [0.90 – 0.98] per day, p=0.003) but a higher odds of post-hospital mortality (OR=1.07 [1.04 – 1.11] per day, p<0.001).

Multivariable models for predicting mortality

Table 4 lists the multivariable models for predictors of in-hospital and post-hospital mortality that were created by forward stepwise selection. The predictors with the strongest independent association with in-hospital mortality included lower oxygen saturation, systolic hypotension, lower Glasgow coma scale (GCS), proteinuria, absence of a history of diabetes, higher heart rate, current tobacco smoking, bilateral leg edema, and male gender. The predictors with the strongest independent association with 12-month, post-hospital mortality included less than primary level education, proteinuria, lower systolic blood pressure, bilateral leg edema, HIV, and lower oxygen saturation. After adjustment, HIV was associated with a 2-fold increased odds of post-hospital mortality (aOR=1.99 [1.22 to 3.24], p=0.006).

Association between clinic attendance within one month and mortality

Among all study participants discharged, 66/105 (62.9%) of the HIV-infected adults attended outpatient clinic within 1 month vs. 184/390 (47.1%) of HIV-uninfected adults; 31 HIV-infected adults who were alive and reachable by phone at 1 month had not followed up in clinic vs. 148 of the HIV-uninfected adults (see Table 1 for details). In HIV-infected adults, attending clinic within one month after discharge was associated with lower incident mortality (aHR=0.17 [0.07 – 0.39], p<0.001 vs. aHR 0.73 [0.48 – 1.13], p=0.16 in HIV-uninfected adults). Of note, all 66/66 (100.0%) of those who HIV-infected adults attended clinic within one month after discharge reported taking ART at one month vs. 0/31 (0.0%) of those who were alive and reachable but did not attend clinic within one month.

Validation at a second site

In the month of April of 2015, 124 consecutive adults were discharged at our confirmation site (Sekou Toure Regional Hospital) and enrolled in the validation study. Of these, 112/124 (90.3%) were reachable by mobile phone at 3 months. Among HIV-infected adults, 13/45 (28.9%) died within the first 3 months after discharge compared to 14/79 (17.7%) of HIV-negative adults. The 3-month post-hospital mortality rate for HIV-infected adults at the confirmation site was similar to that observed at the primary study site (28.9% vs. 31.4%).

DISCUSSIONS

Post-hospital mortality was strikingly high in HIV-infected Tanzanian medical patients. More than 1/2 of discharged adults died within 12 months, and nearly 1/3 died within the first three months. The odds of mortality were two-fold higher among HIV-infected adults

compared to other adults, even after adjusting for possible confounders (aOR=1.99 [1.22 to 3.24], p=0.006). This confirms and extends findings from prior studies. Similar results have been reported for HIV-infected adults in Uganda and South Africa where 6-month, post-hospital mortality rates were ~35%.[19,20]

Early linkage to primary HIV care was associated with a 75% lower incidence of post-hospital mortality for HIV-infected adults, even after adjusting for severity of illness. These data are consistent with studies from the US, where both medical[9] and surgical inpatients,[8] where early, post-hospital linkage to primary care was associated with better outcomes. In the US, HIV-infected adult outpatients with better linkage to primary HIV care have also been shown to have lower viral load and lower mortality.[21] The association between early linkage to HIV primary care and lower mortality was likely mediated by ART use, since all study subjects with early linkage to primary HIV care study started ART vs. none of those who did not attend HIV clinic in that time period. Initiation (or re-initiation) of ART for hospital inpatients may lead to even in-hospital and post-hospital outcomes. Our hospital has started a pilot to encourage in-hospital ART initiation or re-initiation for HIV-infected adults. So far, this strategy seems both feasible and beneficial in our setting.

Improving this critical transition from hospital to primary care is a major priority for health systems around the world,[7] and novel, cost-effective interventions are needed. Our results suggest that a successful intervention to improve post-hospital outcomes for HIV-infected adults in Africa would need to promote early linkage to primary HIV care while also addressing socioeconomic factors. One promising possibility is Antiretroviral Treatment and Access to Services (ARTAS). ARTAS is a CDC-recommended, time-limited, low-cost case management intervention designed to link persons with HIV to medical care. ARTAS has been validated in the United States to increase linkage to and retention in primary care for HIV-infected adults.[22,23] Due to the results of this study, we have already begun to adapt the ARTAS model to the Tanzanian context and to pilot it at our hospital.

Predictors of in-hospital and out-of-hospital mortality differed greatly. While in-hospital mortality was most strongly associated with markers of the severity of illness, post-hospital mortality was more strongly associated with educational status and diagnosis (such as HIV). This difference in predictors of in-hospital and post-hospital mortality argues that, unlike what has been in many prior studies from Africa,[2,24,25] predictors of these 2 outcomes should be analyzed separately. The predictors described in this study are good candidates for future work to build prediction rules for in-hospital and post-hospital mortality in sub-Saharan Africa.

Our study has limitations. Most of our results come from a single hospital. This hospital, though, is similar to other government hospitals in East Africa,[10,11] and our results at a second public hospital in Tanzania confirm similar mortality rates. In addition, our study design should be relatively simple to replicate since our study demonstrated that 99% of hospitalized adults had access to mobile phones, and we successfully contacted >90% of participants (or their proxies) 12 months after discharge. Our laboratory and radiologic investigations were limited by the resources of our hospital. We could not obtain CD4 T-cell counts, for example, because our hospitals CD4 counter was broken during the study period.

However, such constraints are typical of hospitals in Africa and enhance the applicability of this study to similarly resource-limited settings. We also acknowledge that some covariates included in our multi-variable logistic regression analysis may be mediators of other covariates, inducing potentially spurious associations. Additional longitudinal data are needed to determine the timing and relationship between theses covariates. Finally, for HIV-infected adults, we did not determine ART adherence. ART status was determined only at 1 month post-discharge by whether the study subject reported using ART or not.

In conclusion, we conducted a prospective, cohort study of >600 consecutive adults hospitalized on the general medical ward of a hospital in Tanzania and followed for 1 year after discharge. Post-hospital mortality rates were >50% among HIV-infected adults, significantly higher than HIV-negative adults even after adjusting for possible confounders. Failure to link to primary HIV care within one month after hospital discharge was a strong and independent predictor of post-hospital mortality. Clinical trials are urgently needed to assess novel strategies for reducing post-hospital mortality in this population. Strategies should focus on improving early linkage to primary HIV care, while also addressing socioeconomic issues, and the ARTAS case management model is one promising possibility.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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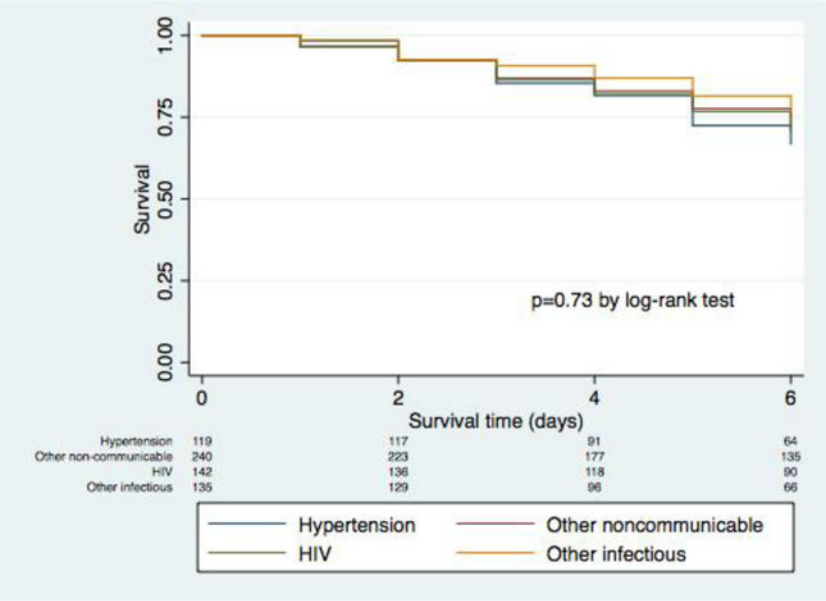
A



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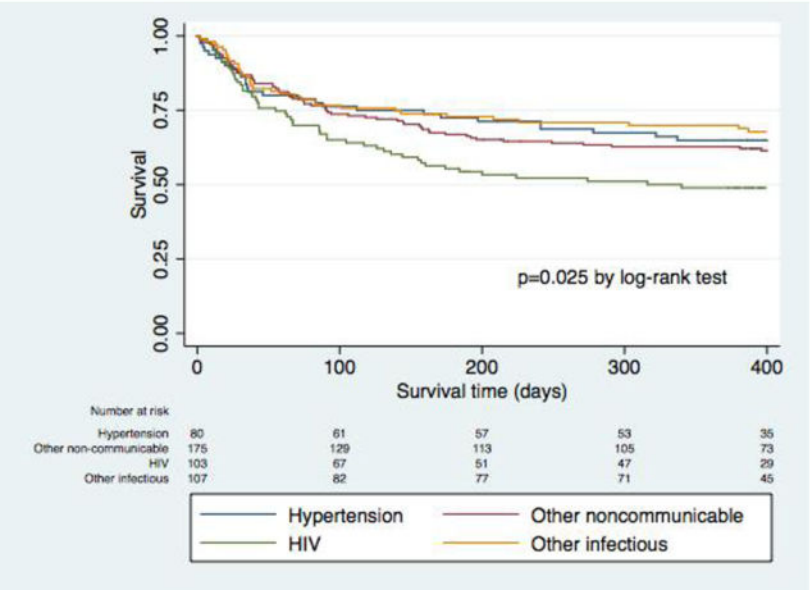

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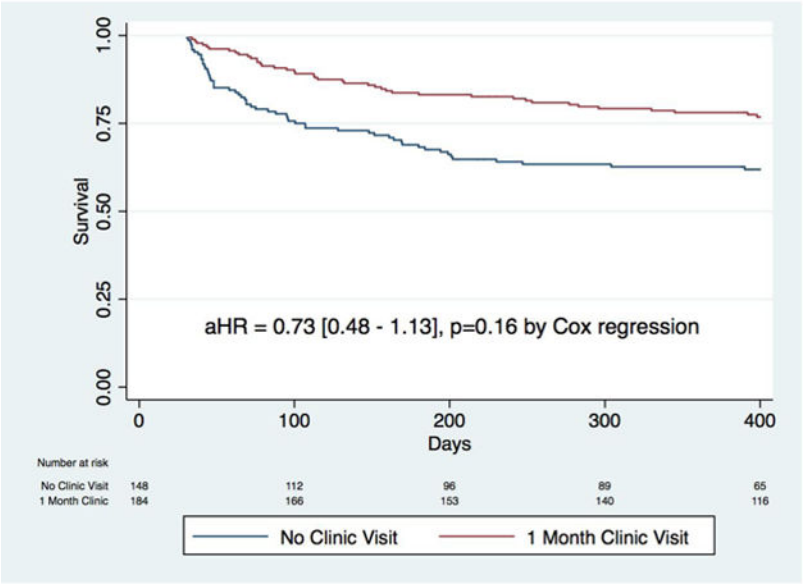

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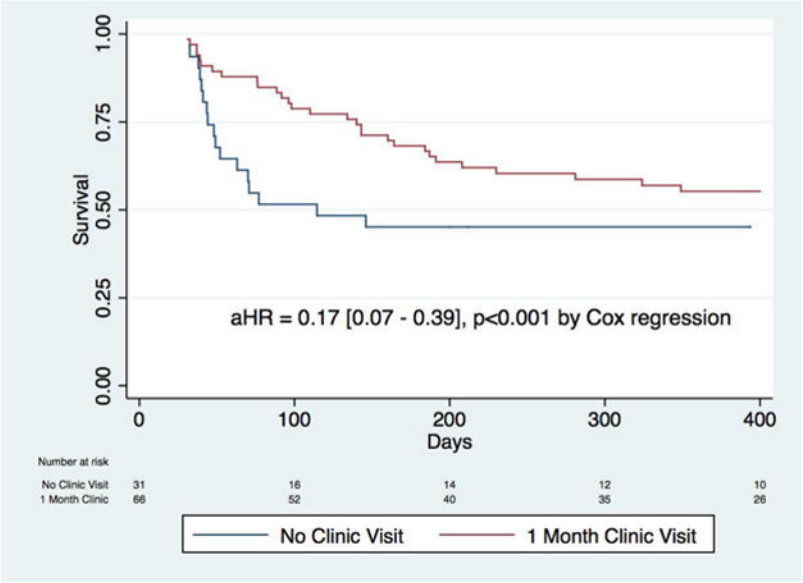

Figure 1.

Kaplan-Meier survival curves for (A) in-hospital mortality and (B) post-hospital mortality divided by the 4 diagnosis categories. Kaplan-Meier curves for post-hospital survival among HIV-infected study participants who survived until 1 month and were scheduled for a 1-month clinic visit for (C) all HIV-uninfected participants and (C) HIV-infected participants alone. Analyses are adjusted for the other factors significantly associated with post-hospital mortality (see Table 4).

(A) In-hospital mortality by diagnosis category

(B) Post-hospital mortality by diagnosis category

(C) Post-hospital mortality by clinic visit in 1st month after discharge (HIV-uninfected participants who survived until 1 month post-discharge)

(D) Post-hospital mortality by clinic visit in 1st month after discharge (HIV-infected adults who survived until 1 month post-discharge)

Table 1

Baseline characteristics of participants at time of admission.

Variable	Hospitalized (n=637)	Discharged (n=495)
HIV status		
HIV as primary diagnosis	143 (22.4%)	105 (21.2%)
Known HIV (prior to admission)	112 (17.6%)	84 (17.0%)
New diagnosis of HIV	31 (4.9%)	21 (4.2%)
Other primary diagnosis	494 (77.6%)	390 (78.8%)
Demographic characteristics		
Male	330 (51.8%)	239 (48.3%)
Age, years	47.3 (18.3%)	46.0 (17.6)
Education		
Did not complete primary education	232 (36.7%)	170 (34.4%)
Completed primary education	302 (47.7%)	244 (49.4%)
Completed secondary education or higher	99 (15.6%)	80 (16.2%)
Occupation		
Farmer	298 (47.1%)	233 (47.2%)
Petty trader	182 (28.8%)	138 (28.0%)
Civil servant, business, or professional	92 (14.5%)	70 (14.2%)
Unemployed, retired, or student	61 (9.6%)	53 (10.7%)
Medical History		
Current tobacco smoking	35 (5.5%)	19 (3.9%)
Current alcohol use	52 (8.2%)	34 (6.9%)
History of hypertension	162 (25.6%)	130 (26.5%)
History of kidney disease	26 (4.1%)	20 (4.1%)
History of heart failure	81 (12.8%)	59 (11.9%)
History of diabetes	46 (7.3%)	39 (7.9%)
Taking herbal or traditional medication	130 (20.5%)	95 (19.4%)
Symptoms on hospitalization		
Decreased urine output	77 (12.2%)	52 (10.5%)
Chest pain	89 (14.0%)	74 (15.0%)
Shortness of breath	213 (33.5%)	152 (30.8%)
Loss of consciousness	108 (17.0%)	58 (11.7%)
Signs on physical examination		
Heart rate (beats per minute)	92.9 (17.9)	91.7 (16.8)
Systolic blood pressure (mm Hg)	124.1 (27.8)	124.3 (26.0)

Variable	Hospitalized (n=637)	Discharged (n=495)
< 90	19 (3.0%)	6 (1.2%)
90–139	462 (72.9%)	368 (74.8%)
140–179	117 (18.5%)	95 (19.3%)
> 179	36 (5.7%)	23 (4.7%)
Diastolic blood pressure (mm Hg)	77.5 (17.2)	77.8 (16.1)
Severe hypertension (SBP≥180 or DBP≥110)	90 (14.1%)	65 (13.1%)
Oxygen saturation (%)	93.0 (7.8)	93.7 (7.4)
Abdominal obesity	408 (64.1%)	328 (66.3%)
Body mass index (kg/m^2)	23.4 (5.0)	23.5 (5.0)
< 18.5	80 (12.6%)	62 (12.6%)
18.5–24	386 (60.9%)	299 (60.7%)
25–29	100 (15.8%)	78 (15.8%)
≥ 30	68 (10.7%)	54 (11.0%)
Glasgow coma score		
< 13	49 (7.7%)	18 (3.7%)
13–14	39 (6.2%)	23 (4.7%)
15	546 (86.1%)	451 (91.7%)
Crackles on pulmonary exam	161 (25.4%)	109 (22.1%)
Bilateral lower extremity edema	149 (23.5%)	102 (20.7%)
Meets Framingham criteria for heart failure	145 (22.8%)	107 (21.6%)
Laboratory investigations		
Random blood glucose on hospitalization (mmol/L)	7.8 (4.6)	7.8 (4.7)
Estimated glomerular filtration rate (ml/min/1.73m^2)		
< 30	59 (9.3%)	36 (7.3%)
30–59	116 (18.3%)	77 (15.6%)
≥ 60	459 (72.4%)	380 (77.1%)
Proteinuria by urinalysis	175 (28.4%)	113 (23.6%)
Hematuria by urinalysis	76 (12.4%)	41 (8.6%)
Pyuria by urinalysis	65 (10.6%)	40 (8.4%)
Diagnosis category		
HIV	143 (22.5%)	105 (21.2%)
Hypertension	119 (18.7%)	85 (17.2%)
Other noncommunicable disease	240 (37.7%)	191 (38.6%)
Other infectious disease	135 (21.2%)	114 (23.0%)

Data are number of participants (%) or mean (SD), unless otherwise specified.

Non-missing data was included in all calculations. No category was missing more than 7 patients except for the urine dipstick results, which were not performed in 23 patients due to a temporary shortage of supplies.

Table 2

Post-hospital outcomes by disease category for 495 participants discharged alive.

Outcome	1 month	3 month	6 month	12 month
HIV (n=105)				
Mortality	7 (6.7%)	33 (31.4%)	45 (42.9%)	53 (50.5%)
Attended outpatient clinic	66 (62.9%)	75 (71.4%)	80 (76.2%)	80 (76.2%)
Not reachable by phone *	1 (1.0%)	1 (1.0%)	1 (1.0%)	7 (6.7%)
All HIV-uninfected adults (n=390)				
Mortality	31 (7.9%)	81 (20.8%)	108 (27.7%)	126 (32.3%)
Attended outpatient clinic	184 (47.1%)	230 (59.0%)	250 (64.1%)	258 (66.2%)
Not reachable by phone *	27 (6.9%)	27 (6.9%)	28 (7.2%)	38 (9.7%)
Hypertension (n=85)				
Mortality	9 (10.6%)	17 (20.0%)	22 (25.9%)	28 (32.9%)
Attended outpatient clinic	45 (52.9%)	58 (68.2%)	64 (75.3%)	64 (75.3%)
Not reachable by phone *	5 (5.9%)	5 (5.9%)	5 (5.9%)	6 (7.1%)
Other noncommunicable diseases (n=191)				
Mortality	13 (6.8%)	39 (20.4%)	57 (29.8%)	65 (34.0%)
Attended outpatient clinic	95 (49.7%)	116 (60.7%)	127 (66.5%)	130 (68.1%)
Not reachable by phone *	16 (8.4%)	16 (8.4%)	16 (8.4%)	21 (11.0%)
Other infectious diseases (n=114)				
Mortality	9 (7.9%)	25 (21.9%)	29 (25.4%)	33 (28.9%)
Attended outpatient clinic	44 (38.6%)	56 (49.1%)	59 (51.8%)	64 (56.1%)
Not reachable by phone *	6 (5.3%)	6 (5.3%)	7 (6.1%)	11 (9.6%)

*Attended outpatient clinic at least once.

**Neither the study subject nor their proxies were reachable by phone.

Table 3

Comparison of significant univariable predictors of in-hospital mortality and post-hospital mortality by logistic regression with best transformations.

	In-hospital mortality		Post-hospital mortality	
Variable	**OR**	***p-value***	**OR**	***p-value***
HIV status				
Confirmed negative	-----	-----	Ref.	<0.001
Known positive (prior to admission)			2.33	
New positive			1.93	
Refused testing			3.63	
Demographic characteristics				
Male	1.91	0.001	-----	-----
Education				
Did not complete primary education	-----	-----	2.38	<0.001
Medical history				
Current tobacco smoking	3.17	0.001	-----	-----
Current alcohol use	1.97	0.028	-----	-----
Taking herbal or traditional medication	-----	-----	1.66	0.027
Symptoms on hospitalization				
Decreased urine output	1.85	0.020	2.52	0.002
Shortness of breath	1.69	0.007	1.75	0.005
Loss of consciousness	4.09	<0.001	-----	-----
Signs on physical examination				
Heart rate (beats per minute)				
Linear	0.93	0.002 †	-----	-----
Quadratic	1.00			
Systolic blood pressure (mm Hg)				
Hypotensive (< 90)	8.48	<0.001 //	-----	-----
Normotensive (90 – 139)	Ref.			
Mildly hypertensive (140 – 179)	0.91			
Severely hypertensive (≥ 180)	2.21			
Diastolic blood pressure (mm Hg)				
Linear	0.91	<0.001 †	0.98	0.010 *
Quadratic	1.00			
Severe hypertension (SBP ≥ 180 or DBP ≥ 110)	2.14	0.011	-----	-----

	In-hospital mortality		Post-hospital mortality	
Variable	**OR**	***p-value***	**OR**	***p-value***
Oxygen saturation (%)				
Linear	1.62	<0.001 †	1.23	0.005 †
Quadratic	0.99		0.99	
Abdominal obesity	0.66	0.030	-----	-----
Lower Glasgow coma scale (<13, 13–14, 15)	0.34	<0.001 ¶	-----	-----
Crackles on pulmonary exam	2.06	<0.001	2.00	0.002
Bilateral edema	1.94	0.002	2.61	<0.001
Meets Framingham criteria for heart failure	-----	-----	2.00	0.002
Laboratory investigations				
Lower estimated glomerular filtration rate (mL/min/1.73m^2)	2.64	<0.001 Δ	0.99	0.001 *
Proteinuria by urinalysis	2.64	<0.001 Δ	1.60	<0.001 ¶
Hematuria by urinalysis	1.82	<0.001 ¶	2.29	0.012 Δ
Pyuria by urinalysis	2.44	0.001 Δ	-----	-----
Diagnosis category		0.0439		0.010
HIV	1.96	0.026	2.29	0.003
Hypertension	2.17	0.013	1.06	0.839
Other noncommunicable diseases	1.39	0.248	1.17	0.532
Other infectious diseases	Ref.	--	Ref.	--

Full analyses can be found in supplementary tables 3 and 5.

Analyses were performed on non-missing data.

----- = not significant

* linear

† quadratic

‡ ordinal quartiles

§ categorical quartiles

// categorical

¶ ordinal categories

Δ binary

Table 4

Multivariable logistic regression models for predictors of (A) in-hospital mortality and (B) post-hospital mortality. Predictors are listed by significance of association.

Variable	OR	95% CI	p-value
(A) Predictors of in-hospital mortality			
Oxygen saturation			
Linear	0.89	0.84 – 0.94	< 0.001
Quadratic	0.99	0.99 – 0.99	0.003
Systolic hypotension (binary: <90 mm Hg)	9.02	2.77 – 29.38	< 0.001
Glasgow coma scale (categorical: <13, 13–14, 15)	0.36	0.26 – 0.51	< 0.001
Proteinuria by urinalysis (binary)	2.26	1.41 – 3.63	0.001
History of diabetes	0.22	0.08 – 0.62	0.004
Heart rate (beats per minute)	1.02	1.00 – 1.02	0.008
Current tobacco smoking	3.03	1.30 – 7.09	0.010
Bilateral leg edema	1.92	1.15 – 3.21	0.012
Male gender	1.71	1.07 – 2.71	0.024
(B) Predictors of post-hospital mortality			
Less than primary level education	2.44	1.60 – 3.72	0.001
Proteinuria by urinalysis	1.51	1.17 – 1.94	0.001
Systolic blood pressure (mm Hg)	0.99	0.98 – 0.99	0.002
Bilateral leg edema	2.17	1.30 – 3.61	0.003
HIV	1.99	1.22 – 3.24	0.006
Oxygen saturation	0.96	0.93 – 0.99	0.013