Surgical Outcomes in Human Immunodeficiency Virus–Infected Patients in the Era of Highly Active Antiretroviral Therapy

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Hypothesis: Matched patients who test positive or negative for human immunodeficiency virus (HIV) who are undergoing comparable operations have similar complication rates and outcomes.

Design: A retrospective study of surgical outcomes in HIV-infected and matched HIV-noninfected patients. Baseline information including HIV-related laboratory results, complications, and mortality was collected from printed and electronic records through 12 postoperative months.

Setting: Kaiser Permanente Medical Care Program–Northern California, an integrated health organization with more than 3 million members, including more than 5000 HIV-infected members.

Patients: From July 1,1997, through June 30, 2002, HIV-infected members undergoing surgical procedures were matched 1:1 with HIV-noninfected patients undergoing surgical procedures by type, location, and year of surgery as well as by sex and age. Surgical procedures studied included appendectomy, arthrotomy or arthroscopy, bowel resection, cholecystectomy, cardiothoracic procedures, hernia repair, hysterectomy, hip or knee replacement, laparoscopy or laparotomy, and mammoplasty.

Main Outcome Measures: Complications and mortality through 12 postoperative months, comparisons between HIV-infected and HIV-noninfected patients using matched-pair analyses, and HIV-infected cohort data were analyzed using the Fisher exact test and logistic regression.

Results: Of 332 HIV-infected–HIV-noninfected pairs (mean age, 46.7 years; male sex, 91%), more than 95.0% were followed up through 12 postoperative months or until their deaths. Pairs had similar comorbidities, length of hospital stay, and number of postoperative surgical visits ($P>.05$, all variables). Among HIV-infected patients, the median years with HIV infection was 8.4 years; median CD4 T-cell count was 379/μL; 61.5% of these patients had an HIV RNA level less than 500 copies per milliliter; and 68% were receiving highly active antiretroviral therapy. Various complications were no more frequent among HIV-infected than in HIV-noninfected patients (11.1% vs 10.2%; $P=.79$), except for pneumonia ($P=.04$). There were more deaths within the 12 postoperative months in HIV-infected patients (10/332 vs 2/332; $P=.02$); 2 patients died 30 days or less after being operated on. Among HIV-infected patients, viral load of 30 000 copies per milliliter or more was associated with increased complications (adjusted odds ratio, 2.95; $P=.007$), but a CD4 cell count less than 200/μL was not associated with poorer outcomes.

Conclusions: The HIV-infected patients had more incidences of postoperative pneumonia and higher 12-month mortality, although other operative outcomes were comparable for HIV-infected and HIV-noninfected patients. Viral suppression to fewer than 30 000 copies per milliliter reduced surgical complications.

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HIGHLY ACTIVE ANTIRETROVIRAL therapy (HAART) has transformed infection with human immunodeficiency virus (HIV) from a disease leading to rapid decline and early death into a chronic, manageable condition. Successfully treated patients have higher CD4 cell counts and lower viral loads, permitting healthier lives and longer survival.[1-3] Consequently, many HIV-infected patients elect to undergo surgical procedures to correct physical ailments that would not have been treated previously, and undergo operative interventions in lieu of medical therapies for certain conditions.

Before HAART, series with HIV-infected patients undergoing operative procedures reported conflicting results. Human immunodeficiency virus–infected patients had more complications, including more perioperative infections, impaired wound healing, and greater mortality,[4,5] and these results were deemed justification to withhold surgery in certain circumstances.[6] Other

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studies disputed these findings, including in patients undergoing laparoscopic surgery,[7] anorectal surgery,[8] endoscopic sinus surgery,[9] and dental procedures.[10] These analyses reported successful outcomes without higher perioperative morbidity. However, small sample sizes and lack of HIV-noninfected comparison groups[11] limited the ability to provide definite conclusions.

Conflicting research has addressed morbidity and mortality in HIV-infected patients undergoing operative procedures since the advent of HAART. There are indications that use of HAART has resulted in better surgical outcomes. When HAART was used as part of a treatment regimen, improved complication rates were seen in women undergoing cesarean section,[12] gynecologic surgical procedures,[13] laser surgery to treat anal condyloma,[14] and cardiac valve replacement.[15] However, these studies included small samples, lacked HIV-noninfected control subjects, and dealt with specific operations, which limits their generalizability. Further, others found a higher rate of complications with cesarean section in HIV-infected patients compared with HIV-noninfected patients.[16] A lower CD4 cell count may be an independent predictor of worse surgical outcome.[17] Thus, the belief persists that HIV-infected patients generally do worse perioperatively, and some surgeons are still reluctant to perform surgery in these patients.[18]

We studied the effect of HIV immune status and HIV disease outcome measures on operative morbidity and mortality in HIV-infected patients compared with HIV-noninfected patients in the modern antiretroviral treatment era. We matched HIV-infected and HIV-noninfected patients with similar demographic data who were undergoing the same surgical procedures to ascertain whether HIV-infected patients have worse surgical outcomes. We examined the effect of HIV disease properties (CD4 cell count, HIV viral load, and use of antiretroviral treatment) on operative morbidity. With sufficient numbers and diversity of types of surgery, we ascertained a more definitive answer to the safety of surgery in HIV-infected patients.

METHODS

We performed an observational cohort analysis of surgical outcomes at Kaiser Permanente Medical Care Program–Northern California (KPNC) in HIV-infected patients undergoing surgery from July 1, 1997, through June 30, 2002, and compared surgical outcomes and morbidity with those in matched HIV-noninfected patients. Kaiser Permanente Medical Care Program–Northern California is an integrated health care system providing outpatient and inpatient care including surgical, medical, and ancillary care. Administrative (electronic) databases include diagnoses, laboratory values, procedures, hospitalizations, office visits, demographic data, and vital status (known to be alive or dead) for more than 3 million patients. Separately, since July 1, 1988, demographic data including age, sex, race/ethnicity, HIV risk behavior, and other HIV-specific data for more than 12 000 HIV-infected patients have been recorded in a registry that identifies more than 95% of the HIV-infected patients in the KPNC health system. Linking the HIV registry to other KPNC data systems, including membership, outpatient and inpatient diagnoses and visits, and laboratory and pharmacy databases, we can electronically track diagnoses (inpatient and outpatient), procedures (including surgery), laboratory values, radiologic findings, and other pertinent data.

From the registry, we identified all HIV-infected patients who underwent an operative procedure from July 1, 1997, through June 30, 2002. Administrative data systems were queried to find HIV-noninfected patients who matched these HIV-infected patients based on the following criteria: sex (exact), type of operation (exact), age at surgery (closest possible), medical center where the operation was performed, and year of operative procedure (closest possible). Data systems did not permit matching to specific surgeon or to race/ethnicity. Most frequent surgical procedures were selected for analysis, including appendectomy, cholecystectomy, hernia repair (inguinal, umbilical, and ventral), colon resection, arthroplasty (knee or hip), arthroscopy or arthrotomy, coronary artery bypass, cardiac valve replacement, mastectomy, laparoscopy or laparotomy, and hysterectomy (with or without oophorectomy). We excluded operations classified as minor procedures at KPNC.

Electronic databases were accessed to extract the following data: hemoglobin level; white blood cell count; CD4 count (cells per microliter); HIV viral load (Chiron branched DNA count per microliter); dates of surgery; demographic data, including HIV risk factor; and pharmacy dispensing of HAART (≥3 antiretroviral medications within 180 days) before surgery. We performed manual medical record reviews of all patients in the study to examine the surgical record and operative report. Manual reviews provided confirmation of the surgery as recorded in the administrative database; presence of comorbidities including diabetes mellitus, hypertension, cardiac disease, and congestive heart failure; smoking history; urgency of surgery, defined as the expectation before surgery that the patient would have imminent morbidity if surgery were not performed; preoperative diagnosis; use of prophylactic antibiotic agents; and presence of bacterial infection at surgery. Race/ethnicity data, collected at admission, were extracted electronically from hospital databases and manually from patient paper medical records. Manual review further identified and recorded any postoperative complications, including wound infection, dehiscence, cardiopulmonary events, additional operations performed to treat surgical complications, and surgical site infection, to 12 months from the date of surgery. We defined and created criteria for these potential complications before medical record review began, and all reviewers (M.A.H., D.B.K., S.E.F., J.A.F., G.M.G., and T.L.), while not blinded to the HIV serostatus of the patient, followed these criteria. Vital status to 12 postoperative months was determined, and, if applicable, cause of death was identified. Records revealed the number of office visits to the surgeon in the 3 postoperative months.

We assessed study patients for risk of morbidity and mortality using an adaptation of the previously validated Charlson Comorbidity Index (CCI).[19-21] The CCI is the most extensively studied comorbidity index for predicting mortality using electronic databases and *International Classification of Diseases, Ninth Revision* (*ICD-9*) codes[22,23] and is considered a valid and reliable method for measuring comorbidity and mortality risk in clinical research.[24] For each HIV-infected and HIV-noninfected patient, the CCI was applied to the *ICD-9*–based diagnosis codes for all inpatient and outpatient encounters in the 365 days before the admission date associated with the operative procedure, exclusive of those codes indicating an HIV or AIDS diagnosis (*ICD-9* code 042-044). These CCI scores provided a basis for comparing HIV-infected patients with HIV-noninfected patients for risk of subsequent morbidity or mortality, controlling for any such risk associated with a diagnosis of HIV or AIDS.

Data were entered into SAS databases (version 8; SAS Institute Inc, Cary, NC) for analysis by research staff. Primary

Table 1. Baseline Characteristics*

Characteristic	HIV-Infected Patients (n = 332)	HIV-Noninfected Patients (n = 332)	P Value
Sex			
Male	303 (91.3)	303 (91.3)	>.99†
Female	29 (8.7)	29 (8.7)	
Age at surgery, y			
18-29	14 (4.2)	13 (3.9)	.70†
30-39	77 (23.2)	83 (25.0)	
40-49	115 (34.6)	111 (33.4)	
50-59	82 (24.7)	80 (24.1)	
≥60	44 (13.3)	45 (13.6)	
Mean (median)	46.7 (46.0)	46.8 (46.0)	
Race/ethnicity			
White	227 (68.4)	220 (66.3)	<.001†
Hispanic	57 (17.2)	47 (14.2)	
African American	44 (13.3)	22 (6.6)	
Asian	4 (1.2)	38 (11.4)	
Other/unknown	0	5 (1.5)	
Year of surgery			
1997, July-December only	19 (5.7)	17 (5.1)	.26†
1998	56 (16.9)	60 (18.1)	
1999	77 (23.2)	88 (26.5)	
2000	75 (22.6)	65 (19.6)	
2001	64 (19.3)	75 (22.6)	
2002, January-June only	41 (12.3)	27 (8.1)	
Follow-up status known, through 52 wk or death	317 (95.5)	314 (94.6)	.71‡
Comorbidities present			
Any	160 (48.2)	160 (48.2)	>.99‡
Diabetes mellitus	26 (7.8)	26 (7.8)	>.99‡
Hypertension	51 (15.4)	76 (22.9)	.01‡
Congestive heart disease	28 (8.4)	24 (7.2)	.50‡
Congestive heart failure	3 (0.9)	9 (2.7)	.11‡
Smoking, ever	107 (32.2)	100 (30.1)	.59‡
Charlson Index Score	332	332	.13§
Without HIV diagnosis	0.44 (0.35-0.52)	0.35 (0.26-0.44)	
Surgery indicated as urgent	98 (29.5)	97 (29.2)	>.99‡
Antibiotic prophylaxis documented	216 (65.1)	213 (64.2)	.85‡

Abbreviation: HIV, human immunodeficiency virus.
*Data are given as number (percentage) unless otherwise indicated.
†Conditional logistic regression.
‡McNemar test.
§Paired *t* test.

analysis of complication discordance within matched pairs was done using the McNemar test. Differences in preoperative measurements and demographic data (HIV-infected patients vs HIV-noninfected patients) were assessed using the McNemar test, conditional logistic regression, and the paired *t* test. The within-pair differences in CCI scores were tested for significance using the paired *t* test.

We analyzed outcome differences (complications and perioperative measurements) between HIV-infected and HIV-noninfected pairs using the McNemar and paired *t* tests. We had 80% power ($\alpha = .05$) to detect a 5% difference in complication rates between HIV-infected and HIV-noninfected patients, assuming the complication rate in HIV-noninfected patients was 1.5%.[25,26] Analysis of the HIV-infected cohort was performed using the Fisher exact test and logistic regression. We performed all analyses using MVS, release 8 (SAS Institute) and STATA (version 8SE; StataCorp, College Station, Tex) statistical programs. Institutional review board approval for protection of human subjects was obtained before the start of data collection, with waiver of informed consent granted. All appropriate Health Insurance Portability and Accountability Act rules were followed.

RESULTS

We identified 352 HIV-infected patients and 352 matched HIV-noninfected patients who were operated on from July 1, 1997, through June 30, 2002. Twenty pairs were excluded because the chart for half of the pair was unavailable for review; thus, 332 HIV-infected–HIV-noninfected surgical pairs were available for analysis.

Matching results and patient characteristics are given in **Table 1**. There was 100% match for sex and operative procedure type. There was no statistically significant difference between HIV-infected and matched HIV-noninfected patients for age (63% matched within 12 months of age, 87% matched within 3 years of age, and 99% matched within 5 years of age), medical center (95% matched to the same medical center), and year of procedure (96% matched within 12 months). The HIV-infected and HIV-noninfected groups had statistically different laboratory values for hemoglobin level (13.6 g/dL; 95% confidence interval [CI], 13.4-13.8, vs 13.9 g/dL; 95% CI, 13.7-14.1; $P = .05$) and total white blood cell count ($6.9 \times 10^3/\mu L$; 95% CI, 6.4-7.6, vs $9.0 \times 10^3/\mu L$; 95% CI, 8.3-9.7; $P < .001$) measured within 30 days before surgery. These lower values are common in HIV-infected patients. The HIV-infected group included fewer Asian and more African American patients, and fewer patients with hypertension (all $P < .05$). Forty-three HIV-infected patients (13.0%) had 1 comorbidity or more, as did 54 HIV-noninfected patients (16.3%; $P = .22$).

The surgical procedures analyzed are listed in **Table 2**. Most (80.8%) were abdominal or pelvic procedures; 8.4% were cardiac or breast procedures; and 10.8% were orthopedic procedures; no neurosurgical, urologic, or otolaryngologic procedures were performed. No difference was found for urgency of need for surgery, and more than half were elective procedures. The mean CCI score for HIV-noninfected patients was 0.35 (95% CI, 0.26-0.44) compared with 0.44 (95% CI, 0.35-0.52) for the HIV-infected patients. The mean within-pair difference (HIV-infected patient score minus HIV-noninfected patient score) was +0.08 and was not statistically significant ($P = .13$, paired *t* test), implying that the matched pairs were comparable for surgical risk at the time of their operations, aside from any risk attributable to HIV or AIDS.

Among the HIV-infected patients (**Table 3**), median years known to be HIV-infected was 8.4 years, with 69.6% having an AIDS diagnosis before the operative procedure (24.7% with a previous opportunistic infection). In 225 patients (67.8%), HAART was dispensed within 180 days before surgery. Median CD4 cell count was 379/μL, with 61.5% of patients having viral loads of less than 500 copies per milliliter (c/mL) before the operation.

Outcome measures are given in **Table 4**. More bacterial infections were diagnosed just before or during the procedure in the HIV-infected patients (11.1% vs 6.9%; $P = .03$). However, most such infections in both groups were in the patients undergoing appendectomy. Forty-

Table 2. Surgical Procedures Analyzed

Surgical Procedure	No. (%) of Pairs
Appendectomy	56 (16.9)
Arthrotomy/arthroscopy	9 (2.7)
Bowel resection	8 (2.4)
Cholecystectomy	46 (13.9)
Coronary bypass/valve replacement	19 (5.7)
Hernia repair, various forms	147 (44.3)
Hysterectomy, including laparoscopy-assisted vaginal hysterectomy	4 (1.2)
Knee or hip replacement, total or partial	27 (8.1)
Laparoscopy/laparotomy	5 (1.5)
Mammoplasty, breast reduction/removal	9 (2.7)
Rectal surgery	2 (0.6)
Total	**332** (100.0)

Table 3. Characteristics of HIV-Infected Patients at Surgery*

Characteristic	Value
Years of HIV infection before surgery	
<1	18 (5.4)
1-4.9	74 (22.3)
5-9.9	120 (36.1)
≥10	120 (36.1)
Mean (median)	8.0 (8.4)
HIV risk factor	
Men having sex with men	218 (65.7)
Intravenous drug use	24 (7.2)
Heterosexual	18 (5.4)
Blood products	11 (3.3)
Undisclosed	61 (18.4)
Diagnosis of AIDS† before surgery	
Yes	231 (69.6)
No	101 (30.4)
Opportunistic infection	
Ever	82 (24.7)
Active	5 (1.5)
HAART dispensed within 180 days before surgery	225 (67.8)
Immune status, CD4 cell count, cells/μL‡	
<50	11 (3.6)
50-199	49 (16.2)
200-499	144 (47.7)
≥500	98 (32.5)
Mean (median)	418 (379)
HIV viral load, branched DNA copies/mL§	
0-499	185 (61.5)
500-999	15 (5.0)
1000-9999	43 (14.3)
10 000-29 999	26 (8.6)
≥30 000	32 (10.6)
Mean (median)	17 248 (<500)

Abbreviations: HAART, highly active antiviral therapy; HIV, human immunodeficiency virus.

*Data are given as number (percentage) unless otherwise indicated.

†1993 Centers for Disease Control and Prevention criteria.

‡Recorded if done within 180 days before or on day of surgery; 302 (91%) met criteria.

§Recorded if done within 90 days before or on day of surgery, 301 (91%) met criteria.

three percent of these infections were in HIV-infected patients undergoing appendectomy compared with 5% in patients not undergoing appendectomy ($P<.001$). Findings were similar in HIV-noninfected patients: 32% vs 2%, respectively; $P<.001$).

Table 4. Outcome Measures in 332 HIV-Infected–HIV-Noninfected Matched Surgical Pairs*

Outcome	HIV-Infected Pairs	HIV-Noninfected Pairs	*P* Value†
Bacterial infection at surgery	37 (11.1) [7.8-14.5]	23 (6.9) [4.2-9.6]	.03
Postoperative complication			
Any	37 (11.1) [7.8-14.5]	34 (10.2) [7.0-13.5]	.79
>1	5 (1.5) [0.2-2.8]	3 (0.9) [0-1.9]	.45
Type of surgery, by pairs			
Abdominal (n = 264)	32 (11.7) [7.9-15.5]	26 (9.5) [6.0-13.0]	.47
Gynecologic and breast (n = 13)	2 (15.4) [0-35.0]	2 (15.4) [0-35.0]	>.99
Orthopedic (n = 36)	2 (5.6) [0-13.0]	1 (2.8) [0-8.1]	.56
Cardiothoracic (n = 19)	1 (5.3) [0-15.3]	5 (26.3) [6.5-46.1]	.10
Wound infection	13 (3.9) [1.8-6.0]	16 (4.8) [2.5-7.1]	.70
Surgical site infection within 12 mo	10 (3.0) [1.2-4.9]	8 (2.4) [0.8-4.1]	.81
Dehiscence	4 (1.2) [.03-2.4]	3 (0.9) [0-1.9]	>.99
Pneumonia, non–*Pneumocystis carinii*	8 (2.4) [0.8-4.1]	1 (0.3) [0-0.9]	.04
Additional operations to treat surgical complications	10 (3.0) [1.2-4.9]	8 (2.4) [0.8-4.1]	.80
Length of stay, d			
Mean (median)	2.7 (1.0)	2.4 (1.0)	.20‡
Range	1-31	1-47	
Visits to surgeon in 3 mo after operation, where noted			
Mean (median)	1.5 (1.0)	1.5 (1.0)	.48‡
Range	0-13	0-9	
Dead at 12 mo	10 (3.0) [1.2-4.9]	2 (0.6) [0-1.4]	.04

*Data are given as number (percentage) [95% confidence interval] unless otherwise indicated.

†McNemar test unless otherwise indicated.

‡ Paired *t* test.

No significant difference in most complication rates existed between the 2 cohorts (composite odds ratio [OR], 1.11; 95% CI, 0.64-1.92; $P=.79$). Concordance between the matched pairs for occurrence (6 pairs) or no occurrence (267 pairs) of any complication existed for 82.2% of the pairs. In 31 pairs (9.3%), complications occurred in the HIV-infected patient but not the HIV-noninfected patient; this pattern was reversed in 28 pairs (8.4%). No statistically significant difference was found for delayed wound healing, surgical site infections, wound dehiscence, number of complications, length of hospital stay, number of follow-up visits to the surgeon, or need for further operative procedures to treat surgical complications.

The HIV-infected patients had more incidences of postoperative pneumonia (2.4% vs 0.3%; $P=.02$). All incidences of pneumonia in 8 HIV-infected patients and 1 HIV-noninfected patient were bacterial and resolved with antibiotic therapy, without apparent sequelae. One other HIV-infected patient developed *Pneumocystis jiroveci* pneumonia and died 43 days after the surgical procedure.

When the operations were grouped by anatomical location and type (abdominal, gynecologic, breast, orthopedic, or cardiothoracic), no group demonstrated a statistically significant difference in complication outcome

Table 5. Delineation of 12 Patient Deaths Discovered in the Study

Type of Operation	No. of Days to Death*	Cause of Death
HIV-Infected		
Bilateral inguinal hernia repair	165	Renal failure secondary to bladder carcinoma
Arthrotomy, right knee	43	*Pneumocystis carinii* pneumonia with history of same
Appendectomy	318	Fournier gangrene†
Incisional hernia repair	125	Gastrointestinal lymphoma, away from graft
Bilateral inguinal hernia repair	76	Central nervous system toxoplasmosis
Ventral hernia repair	162	Infected amputated leg, clean at time of hernia repair
Three-vessel coronary artery bypass graft	30	Sudden death; presumed arrhythmia, but no autopsy performed
Partial small-bowel resection secondary to perforation	41	Metastatic lymphoma; wound healing at death
Exploratory laparotomy	6	Multiple organ failure secondary to lymphoma
Right hip partial replacement	97	Metastatic rectal carcinoma discovered at operation
HIV-Noninfected		
Bowel resection secondary to rectal carcinoma	307	Hemorrhage at ostomy site secondary to coagulopathy
Partial colonic resection secondary to colon carcinoma	54	Rectal carcinoma

*Days from date of operation to death.
†Unlikely related because location different from surgical site.

Table 6. Complication Rates Among HIV-Infected Patients Stratified by HAART Use and Laboratory Parameters

Variable	No. of Patients in Range	No. of Patients With Any Postoperative Complication	No. (95% CI)
HAART use before surgery			
Yes	225	24	11.9 (7.8-18.2)
No	107	13	13.8 (7.7-24.7)
P = .69*			
CD4 cell count, cells/μL			
<50	11	4	36.4 (7.9-64.8)†
50-199	49	4	8.2 (.50-15.8)
200-499	144	17	11.8 (6.5-17.1)
≥500	98	8	8.2 (2.7-13.6)
Total‡	**302**	**33**	10.9
P = .50§			
HIV viral load, c/mL branched DNA			
<500	185	17	9.2 (5.0-13.4)
500-599	15	2	13.3 (0-30.5)
1000-9999	43	2	4.7 (0-10.9)
10 000-29 999	26	4	15.4 (1.5-29.2)
≥30 000	32	8	25.0 (10.0-40.0)‖
Total‡	**301**	**33**	11.0
P = .008¶			

Abbreviations: c/mL, copies per milliliter; HAART, highly active antiviral therapy; HIV, immunodeficiency virus.
*Fisher exact test.
†*P* = .006, Fisher exact test, comparing complication rates of CD4 cell counts less than 50/μL vs CD4 cell counts greater than 50/μL.
‡Total with laboratory in 180-day preoperative period (CD4 cell count) and 90-day preoperative period (HIV viral load).
§Fisher exact test, comparing complication rates of CD4 cell count less than 200/μL vs CD4 cell count greater than 200/μL.
‖*P* = .007, Fisher exact test, comparing complication rates of viral load of 30 000 c/mL or greater vs viral load less than 30 000 c/mL.
¶Fisher exact test, comparing viral load less than 10 000 c/mL vs viral load greater than 10 000 c/mL.

by paired analysis. However, the HIV-infected patients tended to have fewer complications in the cardiothoracic group (19 pairs) compared with HIV-noninfected patients (5.3% vs 26.3%; *P*=.07, χ^2 test).

The HIV-infected patients had greater cumulative mortality at 12 months (OR, 5.0; 95% CI, 1.1-46.9; *P*=.04). The absolute risk difference for death at 12 months was 2.4%. **Table 5** summarizes the 12 deaths. Mean days from operation to death in the 10 HIV-infected patients was 106 days (range, 6-318 days) and in the 2 HIV-noninfected patients was 180 days (range, 54-307 days). The causes of death varied. While none of the causes appeared to be a direct consequence of the operation, 2 deaths were within 30 days of the operation (multiple organ failure secondary to lymphoma, and sudden death presumed secondary to arrhythmia).

As summarized in **Table 6**, in HIV-infected patients, CD4 cell count less than 50/μL was associated with a statistically significant higher complication rate than was CD4 cell count greater than 50/μL (36.4%; 95% CI, 7.9-64.8, vs 10.0%; 95% CI, 6.5-13.4; *P*=.006). However, in those with CD4 cell counts greater than 50/μL, no trend to higher complication rates was found. Using a CD4 cell count of 200/μL as a cutoff point, CD4 less than 200/μL (13.3%; 95% CI, 4.7-21.9) was not associated with higher complication rates than a CD4 cell count greater than 200/μL (10.3%; 95% CI, 6.5-14.2; *P*=.50). In HIV-infected patients, viral loads greater than 10 000 c/mL were associated with a higher complication rate (20.7%; 95% CI, 10.3-31.1, vs 8.6%; 95% CI, 5.1-12.2; *P*=.008), with most of the increase in complications seen in patients with preoperative viral loads greater than 30 000 c/mL. Among patients with a CD4 cell count less than 200/μL, only 1 (3.6%) of 28 with a viral load less than 500 c/mL had any complication, but 11 (34.4%) of 32 with a viral load of 500 c/mL or more had any complication (*P*=.003). However, only 1 (8.3%) of 12 patients with a CD4 cell count greater than 500/μL and a viral load greater than 10 000 c/mL had any complication.

At logistic regression, the OR for any complication associated with HIV viral load greater than 30 000 c/mL was 2.96 (95% CI, 0.91-9.65; *P*=.07), controlling for CD4 cell count, sex, HAART use, HIV risk factor, and race/ethnicity. Using the same model, the OR for any complication associated with CD4 cell count less than 50/μL was 4.34 (95% CI, 0.81-23.4; $P=.09$), controlling for HIV viral load, sex, HAART use, HIV risk factor, and race/ethnicity. No other categories of CD4 cell count, HIV viral load, sex, HIV risk factor, or race/ethnicity approached significance.

Patients with a history of HAART use within 180 days before surgery had a similar complication rate (11.9% vs 13.8%; $P=.69$) as patients without a history of HAART use. Using the logistic regression model, the OR for any complication associated with 0 to 2 HIV medicines used in combination was 1.14 (95% CI, 0.47-2.77; $P=.78$), controlling for a CD4 cell count, HIV viral load, sex, HIV risk factor, and race/ethnicity.

COMMENT

To our knowledge, this study is the largest analysis of surgical outcomes for HIV-infected patients compared with matched HIV-noninfected patients in the modern HAART era. We did not find a statistically higher complication rate, except for incidences of postoperative pneumonia and potential 12-month mortality, between the 2 groups matched for sex, age, surgery type, year of operation, and medical center. The HIV-infected patients did have higher 12-month mortality, but the causes of 10 observed deaths were not thought to be surgically related. Among the HIV-infected patients, those with a CD4 cell count less than 50/µL had a higher complication rate, but above this level there was no association of a CD4 cell count with outcomes. Patients with HIV viral loads greater than 10 000 c/mL (primarily, >30 000 c/mL) also had higher complication rates than those with lower HIV viral loads. Use of HAART before the operative procedure resulted in no appreciable decrease in complications.

The study's significance relates to its size, varieties of common operations represented, and matching of HIV-infected patients with HIV-noninfected control patients. We had initially predicted a lower overall complication rate in the HIV-noninfected patients, but our results are consistent with the literature for HIV-noninfected patients undergoing similar surgical procedures.[27-33] While the HIV-infected patients had a higher prevalence of bacterial infection at surgery, this did not predict a higher postoperative infection rate (19 [5.7%] of 332; $P=.32$), nor did these patients have a higher surgical site infection rate up to 12 months ($P=.60$). Patients who were HIV positive did not have a greater need for further surgical interventions to manage first surgery complications. In both groups, most bacterial infections at surgery occurred in patients requiring appendectomy. This result is expected in HIV-infected patients because acute appendicitis in the presence of HIV infection is associated with less leukocytosis, often delaying diagnosis.[34]

The 2 cohorts had comparable CCI scores when HIV disease was not considered, implying greater comorbidities when HIV disease in the HIV-infected patients is further calculated in the risk index. Thus, the HIV-infected patients would consistently have a higher CCI score than the HIV-noninfected patients if we had included that disease factor in the calculations. Usually, higher risk stratification scores lead to greater postoperation complications[24]; we did not note this phenomenon. In this study, the matched pairs had similar rates of complications for most outcomes studied.

Type of surgery (abdominal, gynecologic, breast, orthopedic, or cardiothoracic) did not produce statistically significantly different rates of complications between the matched HIV-infected and HIV-noninfected patients. This finding is those of similar to previous studies with far fewer HIV-infected patients.[13-16] However, there was a trend toward more complications in the HIV-noninfected patients undergoing cardiothoracic surgery; potential selection bias of the HIV-infected patients undergoing these operations cannot be excluded.

Concerns have been raised that HIV-infected patients have longer hospital stays and greater follow-up, affecting outcomes.[35,36] We found nearly identical numbers of hospital days and surgical follow-up visits in HIV-infected and HIV-noninfected patients.

Mortality at 12 months was different in the HIV-infected patients compared with the HIV-noninfected patients, both when matched ($P=.04$) and unmatched ($P=.02$). However, at review of the cause of death in these patients (Table 5), no cause could reasonably be attributed to the surgery itself. Two HIV-infected patients died within 30 days of their operation, and these would be included in operative mortality statistics. The overall mortality rate was small for either group (3.0% vs 0.6%). Of the 10 HIV-infected patients who died within 12 months after the operation, 8 had CD4 cell counts less than 200/µL, with a median CD4 cell count of 101/µL.

The HIV-infected patients with HIV viral loads less than 30 000 c/mL and those with CD4 cell counts greater than 50/µL had fewer adverse outcomes, and previous studies have indicated this dichotomy.[16,17] Treatment with HAART has been indicated as being protective against opportunistic and other infections in patients not undergoing surgery.[37,38] We did not find a protective effect; our results indicate that a history of HAART use 180 days before surgery did not lead to a lower rate of postoperative complications compared with no history of HAART use, even when analyzed with multivariate logistic regression. Our results indicate that a higher HIV viral load seems to be a greater predictor of surgically related complications than either the CD4 cell count or the presence or absence of HAART use.

There are limitations to our study. Inasmuch as this was an observational cohort analysis, we cannot preclude any selection bias in the HIV-infected patients. To the extent that these procedures were elective, sicker patients may have been less likely to undergo surgery. Our data systems would not capture such occurrences. Further, HIV-infected patients with postoperative complications may have been brought to the medical centers more frequently than HIV-noninfected patients with similar complications, leading to higher incidence reporting of such complications (eg, pneumonia) in the HIV-infected group. Medical record review precluded blinding the reviewer to the patients' HIV status. While thought to be few, operations performed outside of KPNC could not be evaluated. The KPNC does not record socioeconomic status or level of educational achievement, and these potential covariates were not available for analysis.

Twenty pairs were not available for analysis, and some HIV-infected patients did not have CD4 cell counts (9%) and HIV viral loads (9%) measured in the period before surgery that was evaluated. Further, we had fewer patients with lower CD4 cell counts, resulting in wide CIs for the proportion with any complication and the OR from the logistic regression model. Thirteen (4%) of the HIV-infected patients and 20 (6%) of the HIV-noninfected patients were lost to follow-up before 12 months. In a sensitivity analysis, if all of these missing patients died, the mortality differential at 12 months loses its statistical significance (*P* value increasing to .75).

CONCLUSIONS

We found a higher incidence of postoperative pneumonia and potential 12-month mortality in HIV-infected patients undergoing surgical procedures compared with HIV-noninfected patients undergoing similar procedures, but we did not discover a higher incidence of other complications between the 2 groups. The HIV-infected patients with CD4 cell counts less than 50/µL or with HIV viral loads greater than 30 000 c/mL had higher ORs of complications compared with HIV-infected patients with CD4 cell counts greater than 50/µL or with HIV viral loads less than 10 000 c/mL. Patients with HIV are living longer and regaining a substantial amount of immune function. Many HIV-infected patients will require surgical attention because of a variety of disorders. In many cases, HIV serostatus should not be a criterion when determining the need for surgery if patients have adequate viral control.

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Author Contributions: Dr Horberg had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. *Study concept and design:* Horberg, Klein, Flamm, and Green. *Acquisition of data:* Horberg, Follansbee, Flamm, Green, and Luu. *Analysis and interpretation of data:* Horberg, Hurley, Follansbee, Queensberry, and Green. *Drafting of the manuscript:* Horberg and Hurley. *Critical revision of the manuscript for important intellectual content*: Horberg, Hurley, Klein, Follansbee, Queensberry, Flamm, Green, and Luu. *Statistical analysis:* Horberg, Hurley, Klein, and Queensberry. *Obtained funding:* Horberg and Flamm. *Administrative, technical, and material support:* Horberg, Hurley, Klein, and Luu. *Study supervision:* Horberg.
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Correction

Numerical Error in Text. In the Original Article by Litvak and Arora titled, "Treatment of Elderly Breast Cancer Patients in a Community Hospital Setting," published in the October issue of the ARCHIVES (2006;141:985-990), the first paragraph in the second column on page 986 contained an incorrect percentage. The fourth sentence should have read as follows: More importantly, mammography was largely used as an adjunct to the physical examination; mammography detected occult disease in only 54% of all patients and 38% of patients aged 80 years and older (*P*<.001).