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Screening Admission CT Scans in Patients with AIDS

A Randomized Trial

OBJECTIVE. To determine if the length of hospital stay could be reduced for patients with AIDS by performing screening head and abdominal–pelvic computed tomography (CT) scans within 24 hours of admission, regardless of presenting signs and symptoms.

DESIGN. Randomized, prospective trial.

SETTING. Tertiary, academic medical center.

PATIENTS. On presentation to the emergency department, 42 patients with AIDS were identified as being eligible to participate in our study. Twenty-two patients consented to participate and were assigned to screening CT or control group.

INTERVENTION. Patients assigned to the screening CT group had head and abdominal–pelvic CT scans within 24 hours of admission, regardless of presenting signs or symptoms. The findings of the screening CT scans were immediately communicated to the patient's referring physician. Patients assigned to the control group had CT studies done solely at the discretion of their physician.

MAIN OUTCOME MEASURE. Length of stay for patients in the screening CT and control groups.

RESULTS. The average length of stay for patients in the screening CT group was 1.3 days longer than the average length of stay for patients in the control group (95% CI, 1.4 days shorter to 4 days longer). The study was terminated after 22 patients were enrolled.

CONCLUSION. Screening CT scans of the head and abdomen and pelvis at the time of hospital admission do not reduce the length of stay for patients with AIDS.

Over the past 4 years, we have reduced the interval between ordering and performing diagnostic computed tomography (CT) for inpatients, because any delay in performing these studies may increase the length of stay. This has been accomplished through changes in the process by which we deliver care (e.g., improved patient transport and more efficient scheduling of CT on nights and weekends). Having improved many of our original processes, we questioned whether we could be even more efficient by completely rethinking the basic assumptions of diagnostic testing.

Our objective was to attempt to reduce the length of stay by identifying patients who were likely to undergo CT scanning during their course of hospitalization and to perform the scans before development of signs or symptoms that would ordinari-

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ORIGINAL ARTICLE

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ly lead physicians to order a scan. At our institution, the cost of 1 day in the hospital exceeds the cost of a CT scan. Therefore, a reduction in the length of stay by 1 or more days would offset the incremental cost of performing these screening CT scans. (Although *screening* technically refers to application of a test to an asymptomatic population, for the purpose of this paper, we will use the term *screening CT* to refer to CT scans performed as a routine part of a patient's work-up at admission.)

Pilot Retrospective Study

To select a group of patients on which to test our hypothesis, we identified the diagnosis-related groups (DRGs) that generated the greatest CT charges in our department. From this list, we selected DRGs that met the following criteria: patients in the DRG are clearly identified on admission to the hospital, the prevalence of pathologic conditions detectable by CT studies performed on patients in the DRG is fairly high, and the range of pathologic conditions represented in the DRG is homogeneous. DRG 489—HIV with a major related condition—was the only DRG associated with high CT charges that met all three criteria.

Through a review of computerized medical records, we correlated the length of stay of patients with AIDS with the time during the hospital stay that head or abdominal–pelvic CT scanning was performed. We found that the average length of stay for patients who had a head CT scan within 24 hours of admission (8.9 days) was 4.5 days less than that for patients who had a head CT scan at least 24 hours after admission (13.4 days). The average length of stay for patients with AIDS who had an abdominal–pelvic CT scan within 48 hours of admission (11.6 days) was 1.7 days less than that for patients who had an abdominal–pelvic CT scan 48 or more hours after admission (13.3 days).

Subsequent Inquiry

The data from our retrospective study raised the following question: Did performing head and abdominal–pelvic CT scans within 24 to 48 hours of admission to the hospital reduce the length of stay, or were we simply observing a chance association, possibly related to confounding causes by differences in comorbid conditions? Also, we did not know if performing screening CT scans would uncover incidental findings that would necessitate further diagnostic studies and interventional procedures, thereby eliminating potential cost savings realized by a reduced length of stay.

The purpose of the study was to test, in a randomized trial, our hypothesis that performing head and abdominal–pelvic CT scans at the time of hospital admission could reduce the length of stay for patients with AIDS.

Methods

Overview

We estimated that 152 patients (76 in each group) would need to be studied to detect a reduction in the length of stay for patients undergoing screening CT similar to that seen in our retrospective study (i.e., a difference in average length of stay of 4.5 days, pooled standard deviation, 9.9 days, testing at a 5% level of significance with 80% power). After a preliminary review of our data, we decided to terminate the study because of concerns raised by our institution's Committee on Clinical Investigations about exposing patients to radiation and intravenous contrast medium in the absence of traditional indications for CT scanning. Thus, in this article we report on the 22 patients who entered the study before its termination.

Patient Selection

The patient selection process is depicted in **Figure 1**. Between August 1, 1995, and May 31, 1997, seventy-eight patients who were HIV positive were identified at hospital admission by the emergency department radiology resident. Forty-two of these 78 patients met the following requirements: HIV posi-

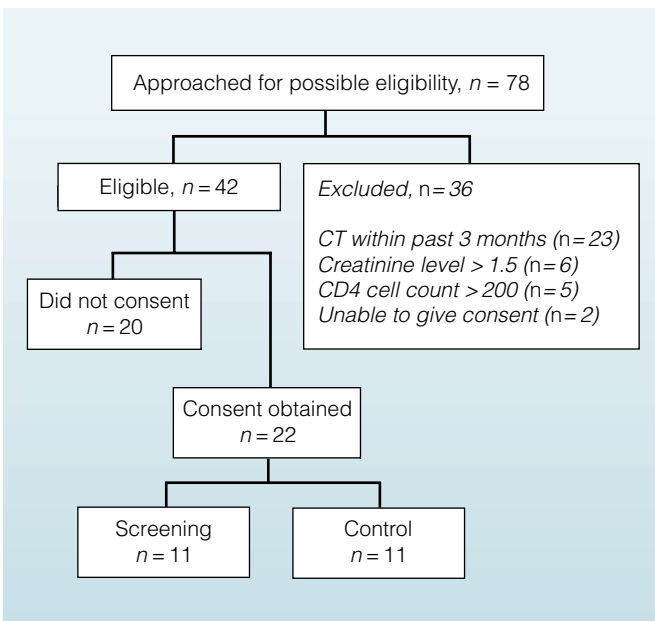

FIGURE 1. Patient selection process and inclusion–exclusion criteria. CT = computed tomography.

tive; CD4 count less than 200 or a history of opportunistic infection or opportunistic malignancy; not pregnant; no head or abdominal–pelvic CT scan within the past 3 months; able to give informed consent; serum creatinine level less than 1.5; and permission to contact the patient was provided by the referring physician. The reasons for exclusion of 36 patients are also shown in **Figure 1**.

Twenty-two of the 42 eligible patients consented to participate in the study, which had been approved by our institution's Committee on Clinical Investigations. Twenty patients refused; the most common reasons given were concern about an adverse reaction to intravenous contrast medium and concern about radiation dose.

Randomization

After written informed consent was obtained, patients were assigned to screening CT or control by using permuted block randomization.

Screening CT: Patients randomly assigned to the screening CT group had head and abdominal–pelvic CT within 24 hours of admission. Spiral scanning of the abdomen and pelvis was performed after routine oral preparation and injection of intravenous contrast medium by using the following parameters: 7-mm-thick collimation, pitch of 1.3, 120 KeV, 200 to 280 mA, and 20 to 40 field of view. After the abdominal and pelvic CT scans, a head CT scan was performed with 5-mm-thick collimation through the posterior fossa and 10-mm-thick collimation through the remainder of the brain. Additional intravenous contrast medium was not administered for the head CT.

The head and abdominal–pelvic CT scans were immediately interpreted by members of our neurology and abdominal CT sections, respectively, and the relevant findings were immediately communicated to the patient's referring physician. All referring physicians were asked whether the information obtained from the screening CT studies would alter their initial management decision.

The information obtained from the referring physician was subjective. Patient care plans and charts were not reviewed to confirm the physician's self-report. Assignment to the screening CT group did not preclude the patient's physician from ordering additional CT studies during the patient's hospitalization.

Control Group: Patients randomly assigned to the control CT group had CT studies done solely at the discretion of their physician.

Analysis

To detect potential selection bias among eligible patients who did not consent to participate in the study, the age and CD4 count of these patients were compared with the age and CD4 count of patients who did consent by using the Student *t*-test and Mann-Whitney test, respectively.

The medical records of patients in both groups were reviewed after discharge; age, sex, diagnosis on admission, length of stay, CD4 count, and number and type of CT studies performed during hospitalization were recorded. All subsequent admissions and CT studies performed at our hospital were recorded during a follow-up period (average follow-up, 5 months; range 1 to 12 months). Differences in the age, length of stay, and CD4 count of patients in the screening and control groups were compared by using a two-tailed Student *t*-test or Mann-Whitney test.

To assess potential confounding by severity of illness, we compared patient disease severity in the screening and control groups by using the system developed by Turner and coworkers.[1]

TABLE 1
Baseline Characteristics of Screening and Control Groups

CHARACTERISTIC	SCREENING (*n* = 11)	CONTROL (*n* = 11)	*P* VALUE
Age ± SD, *yr*	38 ± 10	41 ± 7	0.40
Male, *n*	10	9	1.00
CD4 count ± SD	24.7 ± 36.7	56.7 ± 108.3	0.39
Disease severity			
Stage 1, *n*	2	2	
Stage 2, *n*	7	9	
Stage 3, *n*	2	0	

Results

Twenty of the 42 patients who were eligible for our study refused to participate. Their mean age (36.8 years) was not significantly different from the mean age of the 22 patients who did participate (39.5 years). Mean CD4 count also did not differ significantly (43.1 vs. 41.5).

The baseline characteristics of the 22 patients who participated in the study are shown in **Table 1**. The disease of patients assigned to the screening group was slightly more severe than that of patients assigned to the control group. Two patients in the screening group were classified in the most severely ill stage (stage 3), whereas no patient in the control group was classified in stage 3.

Table 2 presents outcome data for each group. The average length of stay of patients in the screening CT group was 1.3 days longer than that of patients in the control group (95% CI, 1.4 days shorter to 4 days longer). The observed difference in the length of stay and hospital readmission rate was not statistically significant. **Table 3** provides detailed data for each of the 22 patients.

The screening CT findings for each of the 11 patients assigned to the screening group are provided in **Table 4**. Screening CT altered patient management in one patient, a 63-year-old man presenting with right upper-quadrant pain (patient 22) in whom multiple hepatic lesions were found. Subsequent biopsy documented large cell lymphoma, and palliative care was begun. Although the findings of the abdominal CT led to the diagnosis of lymphoma, it is likely that the diagnosis would have been made on the basis of physical findings (hepatomegaly) or clinical presentation (40-pound weight loss and night sweats). For all other patients, the findings on the screening CT scans were considered to be incidental (e.g., cerebral atrophy, retroperitoneal adenopathy, free pelvic fluid) and did not alter patient management or result in further diagnostic tests or interventional procedures (**Table 5**).

Discussion

This randomized study was generated by a retrospective observation that patients with AIDS who had head and abdominal–pelvic CT scans within 24 to 48 hours of hospital admission had a shorter length of stay than patients who had these scans later in the course of hospitalization. The logical question that followed this observation was, "Does the timing of the CT scan have a direct, causal effect on the patient's length of stay? Alternatively, was the observation of an increased length of stay for patients who had CT scans more than 48 hours into their hospitalization simply a result of confounding by severity of illness?" The findings of our study suggest that length of stay is not reduced by screening CT. A likely explanation of the results from the retrospective study is that patients who have CT scans more than 48 hours after admission have already had, by definition, a length of stay that has exceeded 2 days. In addition, patients with complications leading to the CT during the hospital stay are more likely to be included in the greater-than-48 hour group.

With regard to length of stay, the direction of the observed effect was the opposite of what we anticipated. The length of stay of patients in the screening group was 1.3 days *longer* than that in the control group. Despite randomization, it is still possible that

TABLE 2
Outcomes of Patients in Screening and Control Groups

OUTCOME	SCREENING	CONTROL	DIFFERENCE (SCREENING MINUS CONTROL)
Length of stay, *d*	6.1	4.8	1.3
Hospital readmission rate (per patient per month of follow-up)	0.31	0.28	0.03

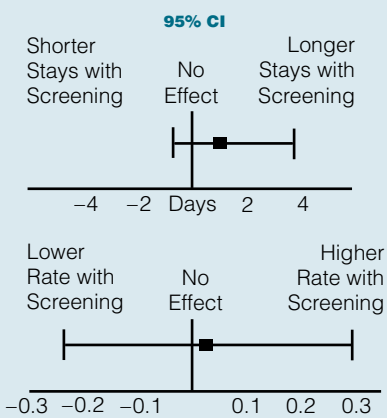

TABLE 3

Individual-Level Data for the 22 Study Patients*

PATIENT	AGE, *yr*	SEX	ADMITTING DIAGNOSIS	SEVERITY†	LENGTH OF STAY, *d*
SCREENING GROUP					
1	30	Male	PCP, SOB	2.5	5
3	41	Male	PCP	2.2	4
6	25	Male	SOB	3.1	9
11	35	Male	Pneumonia	2.5	4
12	33	Male	Fever	2.5	5
13	40	Male	Fever, abnormal results on LFT	2.5	10
14	37	Male	PCP, dyspnea	3.4	12
17	40	Male	Seizure, pneumonia	1.1	4
20	33	Male	Abdominal pain, fever	2.5	4
21	39	Female	Fever, pneumonia	2.1	6
22	63	Male	RUQ pain	1.5	4
CONTROL GROUP					
2	42	Male	Fever	2.5	4
4	48	Female	Dysphagia, SOB	2.3	7
5	35	Male	Hemoptysis, fever, SOB	2.5	7‡
7	38	Male	Pneumonia	2.5	5
8	39	Male	Fever, cough, pleuritic chest pain	1.5	1
9	31	Female	Possible tuberculosis	1.5	1
10	47	Male	Dehydration	2.5	9
15	47	Male	Fever	2.5	3
16	34	Male	Pneumonia	2.5	3
18	53	Male	SOB	2.4	9
19	37	Male	Fever, weakness, fatigue	2.3	6

**F/U = follow-up (months); LFT = liver function test; PCP = pneumocystic pneumonia; RUQ = right upper quadrant; SOB = shortness of breath.*

†International Classification of Diseases, ninth revision, codes from the patients' discharge summary are used to assign them to one of three stages (1, 2, or 3). Each stage is then divided into four to eight substages. These stages are ranked in increasing severity and in-hospital mortality rates (10% to 20% stage 1, 18% to 30% stage 2, and 35% to 60% stage 3).

‡Patient died on hospital day 7.

patients in the screening group were more sick than patients in the control group and that this could explain the longer length of stay. The average CD4 count of patients was lower in the screening group than in the control group, and the screening group had two patients with stage 3 disease, whereas the control group had none. Nevertheless, the finding of a longer length of stay persisted even if the two stage 3 patients in the screening group were excluded from the analysis.

Several factors led to termination of the study. In light of our findings among the initial 22 patients, we

TABLE 4

Findings of Screening Computed Tomography Scans for the 11 Patients Assigned to the Screening Group

PATIENT	FINDINGS	
	HEAD	ABDOMEN–PELVIS
1		Pulmonary nodules; hepatosplenomegaly; nonspecific ileal folds
3	Mild cerebral atrophy; mucus retention cyst	
6	Cerebral atrophy	Atelectasis; lung bases; pelvic free fluid
11	Cerebral atrophy	Pulmonary nodule; bilateral small pleural effusions; pleural thickening; pelvic free fluid
12		Splenomegaly; small para-aortic nodes
13	Cerebral atrophy; ethmoid mucosal thickening	Periportal fluid; gallbladder wall thickening; retroperitoneal adenopathy; pelvic free fluid
14	Cerebral atrophy; maxillary mucosal thickening	Consolidation at lung base
17	Ethmoid mucosal thickening	
20		Extensive para-aortic and aortacaval adenopathy
21		Para-aortic, aortacaval, and inguinal adenopathy; bilateral renal cysts; mild splenomegaly
22	Cerebral atrophy	Multiple hepatic lesions; portacaval adenopathy; hepatomegaly; pericholecystic fluid

TABLE 5

Type and Number of CT Scans Performed for Screening and Control Groups during Initial Hospital Admission*

TYPE	SCREENING	CONTROL
Head	11	1
Abdomen–pelvis	12	1
Other testing		
Chest CT	1	1
Other CT/MRI	0	3
Chest radiographs	19	20
Other imaging studies	0	2

**CT = computed tomography; MRI = magnetic resonance imaging.*

thought that it would be extremely unlikely to find a statistically significant or clinically meaningful reduction of length of stay with screening CT. In addition, approximately 50% of eligible patients did not consent. When we initially proposed our study, the hospital's internal review board voiced concern about the amount of radiation exposure that the patients would receive (approximately 5 rads). Most patients who declined to participate cited concern about potential adverse effect of intravenous x-ray contrast medium. Another factor that influenced our decision was the decreased hospital admission rate for patients with AIDS during the course of our study. This decrease probably resulted from the efficacy of protease inhibitors.

Despite the lack of statistical power, we believe that our study can shed some light on the potential (or lack thereof) of performing CT scans on patients who do not have signs or symptoms related to the organ system being imaged. Although our results may not be

generalizable to patients with other disease, the high prevalence of pathologic conditions among patients with AIDS suggests that if screening CT was not beneficial in our study, it is unlikely to be beneficial in patient populations in which the prevalence of abnormal CT findings is lower. Our findings are similar to those of Hubbell and colleagues[2] who studied the impact of routine admission chest radiographs and found that the results changed management in only 4% of patients and that almost all of the patients would have received similar care on the basis of other laboratory or clinical findings.

With the exception of patient 22, findings of the screening head and abdominal–pelvic CT scans (**Table 4**) were all nonspecific. For example, the most common findings on head CT were cerebral atrophy and thickening of the mucosa of the ethmoid or maxillary sinuses. Focal lesions commonly seen in patients with AIDS presenting with neurologic symptoms,[3] such as opportunistic infections, bacterial abscesses, or central nervous system lymphoma,[4] were not found in any of our patients. The most common findings of the abdominal–pelvic CT scans were ascites, adenopathy, splenomegaly, and hepatomegaly. These findings are the same as the most common ultrasonographic abnormalities detected among 399 patients with AIDS who had abdominal ultrasonography in a recent large series.[5] It is important to emphasize that these "incidental" findings did not lead to additional, unnecessary, or potentially risky procedures being performed on patients in the screening group, which was one of our major concerns before the study began.

Conclusion

Performing head and abdominal–pelvic CT scans in the absence of localizing signs or symptoms provided little significant diagnostic information, even when performed in a population of patients with AIDS in whom the prevalence of neurologic and abdominal pathologic conditions is high.

Take-Home Points

- **In a retrospective review of hospitalized patients with AIDS, we found that those who had a CT scan of the head within 24 hours of admission had a length of stay that was at least 4 days shorter than those who had a scan more than 24 hours after admission.**
- **Thus, we designed and implemented a randomized trial to determine if screening admission CT scans of the head and abdomen and pelvis could reduce the length of stay in patients with AIDS.**
- **Although the trial was stopped prematurely, length of stay was 1 day longer in patients assigned to screening admission CT scans.**
- **Retrospective studies of the effect of diagnostic testing on length of stay can be misleading.**

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Presentation

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