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A Cost Comparison of Liver Transplantation With FK 506 or CyA as the Primary Immunosuppressive Agent

S. Staschak, S. Wagner, G. Block, D.H. Van Thiel, A. Jain, J. Fung, S. Todo, and T.E. Starzl

LIVER transplantation is a form of therapy that provides a new life to patients with advanced and otherwise lethal liver disease.¹⁻⁷ Like all advanced technologies, it is expensive.^{8,9} Costs vary considerably and reflect the effects of a wide range of variables. A major factor in terms of cost, however, is the length of hospitalization required following the initial surgical procedure. This variable can be easily measured. In an effort to determine the effect of the type of immunosuppression used on liver transplant costs, the following study was performed.

METHODS

Subjects

Twenty patients who received a primary liver graft at the Presbyterian-University Hospital under FK 506 immunotherapy were matched with 20 patients who received a primary liver graft at the same institution within the preceding 2 years under CyA immunotherapy. Each patient who underwent transplantation and received FK 506 therapy was matched for age, gender, primary liver disease, and United Network for Organ Sharing (UNOS) score with one of the patients who received CyA as the primary immunosuppressant.

Cost Analysis

The hospital charges accrued by each patient from time of transplantation to initial discharge were compared. These were further segregated into costs for types of individual services to determine where differences between groups might have occurred.

Statistical Analysis

All data are reported as mean values \pm SEM. Statistical analysis was performed using a two-tailed Student's *t* test. $P < 0.05$ was considered to be significant.

From the Department of Surgery, University Health Center of Pittsburgh, University of Pittsburgh; and the Veterans Administration Medical Center, Pittsburgh, PA.

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Address reprint requests to S. Staschak, RN, Department of Surgery, 3601 Fifth Avenue, Falk Clinic 4 West, Pittsburgh, PA 15213.

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Table 1. Characteristics of the Two Groups of Subjects Studied

FK 506-Treated Patients	Sex	Age	Liver Disease Diagnosis	UNOS Score	Age of CyA-Treated Patients
1	M	31	PSC	2	35
2	M	18	Alagille's syndrome	1	18
3	M	38	PNC-NANB	3	35
4	M	19	PSC	3	28
5	M	43	PNC-C	1	45
6	M	38	PNC-NANB	4	43
7	M	42	PNC-ETOH	1	46
8	M	39	PNC-ETOH	4	40
9	F	41	PNC-B	2	36
10	F	49	Budd-Chiari syndrome	4	25
11	M	49	PSC	2	45
12	M	28	Caroli's disease	2	24
13	F	41	PBC	2	44
14	F	55	PBC	2	55
15	F	37	PNC-ETOH	3	33
16	M	55	PNC-ETOH	3	58
17	M	41	PNC-ETOH	3	44
18	F	33	PBC	1	42
19	F	64	PNC-C	2	64
20	F	43	PNC-ETOH	2	41
Mean \pm SEM		40.2 \pm 2.5		2.5 \pm 0.2	40.1 \pm 2.6

Abbreviations: PSC, primary sclerosing cholangitis; PNC-NANB, post-necrotic cirrhosis due to putative NANB; PNC-C, cryptogenic post-necrotic cirrhosis; PNC-ETOH, alcoholic cirrhosis; PNC-B, post-necrotic cirrhosis due to hepatitis B virus; PBC, primary biliary cirrhosis.

Table 2. No Difference in Costs Between CyA and FK 506 Cases

Variables	
Intensive care unit days	Electrocardiogram
Intensive care unit laboratory	Immunopathology
Operating room charges	Respiratory therapy
Liver acquisition charges	Intravenous solutions
Chemistry minus CyA level costs	

RESULTS

The 20 subjects in each group consisted of 8 women and 12 men with a wide variety of chronic liver disease, including chronic cholestatic diseases such as Alagille's syndrome, primary biliary cirrhosis, and primary sclerosing cholangitis, and a wide variety of chronic hepatocellular diseases including both alcoholic and viral liver disease. In addition, a case of Caroli's disease and a case with the Budd-Chiari syndrome were present in each group. The two groups were similar in age (FK 506 group, 40.2 ± 2.5 years; CyA group, 40.1 ± 2.6 years) and had an identical mean UNOS score of 2.5 ± 0.2 (Table 1).

No differences in costs between those treated with FK 506 and CyA were noted for nine variables (Table 2). These factors include the direct costs of organ procurement, total operating room charges, and the duration and intensity of the immediate posttransplantation intensive care provided each.

For two variables, the costs were increased in those receiving FK 506 compared with CyA (Table 3). These included the costs accrued as a result of the serial liver biopsies obtained to monitor the postoperative course of the patients receiving FK 506 and the nuclear scans used to assess the effect of FK 506 on renal blood flow and various other renal functional assessments. As a fraction of the total charges, however, neither of these two costs accounted for much, either in terms of total cost dollars or in the difference in costs between the two groups.

The major factor accounting for the difference in total costs between these two groups of patients was the duration of hospitalization following transplantation and the charges relating to this time interval, including the daily bed and pharmacy charges, which are shown in Table 4. Patients receiving CyA tended to stay in the hospital almost twice as long ($P < 0.02$) and accrued total bed charges almost three times as great ($P < 0.02$). Moreover, as a direct result of a longer hospital stay, total pharmacy charges were increased almost fivefold ($P < 0.0007$) and

Table 3. Increased Costs Related to the Use of FK 506

CyA	FK 506
Anatomic pathology protocol biopsies \$1,681 \pm 262	\$2,391 \pm 228
Nuclear medicine renal scans \$460 \pm 218	\$2,068 \pm 288

 $P < 0.005$ **Table 4. Reduced Costs Associated With the Use of FK 506**

Non-intensive care unit days ($P < 0.01$)	
CyA	23.6 \pm 3.5 d
FK 506	13.2 \pm 1.3 d
Total days ($P < 0.02$)	
CyA	35.9 \pm 5.2 d
FK 506	16.1 \pm 1.3 d
Bed charges ($P < 0.02$)	
CyA	\$33,121 \pm 8,387
FK 506	\$10,552 \pm 1,340
Pharmacy charges ($P < 0.0007$)	
CyA	\$19,842 \pm 3,381
FK 506	\$ 4,847 \pm 1,371
Pharmacy minus CyA charges ($P < 0.002$)	
CyA	\$17,051 \pm 3,087
FK 506	\$ 4,847 \pm 1,371
Total charges ($P < 0.04$)	
CyA	\$244,863 \pm 45,501
FK 506	\$134,169 \pm 10,305

were increased independent of the cost of CyA. When the costs for CyA were deleted from the total pharmacy charges, the pharmacy costs were still threefold greater ($P < 0.002$) for the patients receiving CyA compared with those receiving FK 506.

A direct extension of the costs accrued as a consequence of the duration of hospitalization, whatever its reasons, was the costs of various laboratory services provided each group of patients. Table 5 shows that the costs for hematology, clinical chemistry, microbiology, the

Table 5. Reduced Charges Associated With the Use of FK 506

Chemistry ($P < 0.005$)	
CyA	\$24,482 \pm 4,611
FK 506	\$14,026 \pm 1,806
Chemistry, minus CyA monitoring charges ($P < 0.13$)	
CyA	\$21,249 \pm 4,171
FK 506	\$14,026 \pm 1,807
Hematology ($P < 0.0005$)	
CyA	\$7,739 \pm 1,019
FK 506	\$4,219 \pm 304
Microbiology ($P < 0.04$)	
CyA	\$5,145 \pm 1,096
FK 506	\$2,533 \pm 418
Blood bank ($P < 0.04$)	
CyA	\$26,205 \pm 5,300
FK 506	\$13,467 \pm 2,020
Dialysis ($P < 0.04$)	
CyA	\$2,032 \pm 924
FK 506	0