



Published in final edited form as:

Transplant Proc. 1990 February ; 22(1): 47–49.

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

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.

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 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 blood bank, and dialysis were all at least twofold or greater for those receiving CyA compared with those receiving FK 506 (all $P < 0.04$). Similarly, the cost of all types of radiologic services, except the nuclear scans used to assess the effects of FK 506 on renal function, were greater in those receiving CyA opposed to those receiving FK 506 (Table 6).

DISCUSSION

Cost factors in liver transplantation include (1) the thoroughness of the preoperative medical evaluation, (2) the performance status of the patient just prior to surgery, (3) the number of abdominal surgical procedures performed on the patient prior to the transplant surgery, and (4) the length of time the patient remains in the hospital following the transplant procedure. Of these, the last is the easiest to determine and tends to be a function, at least in part, of each of the others. Unpredictable determinants of the length of hospitalization following transplant procedure are the frequency and intensity of the rejection episodes and the number and severity of any infections experienced.

For patients receiving primary liver grafts and matched for age, gender, liver disease diagnosis, and UNOS score, liver transplantation performed under CyA as opposed to FK 506 was nearly twice as expensive, costing an average of \$244,863.00, compared with \$134,169.00 ($P < 0.004$). This difference in total costs for liver transplantation between the two groups predominantly reflected differences in the duration of hospitalization and, presumably, the difficulties experienced in the immediate postoperative care of these two different patient groups. As a result, the cost differences are reflected rather uniformly across all hospital services: pharmacy, hematology and clinical chemistry, laboratories, radiology, and the blood bank. The costs accrued as a result of the use and monitoring of CyA did not account for the substantial differences between the two groups, as the

differences in expenses between the two groups persisted even when these costs were removed from the pharmacy and clinical chemistry charges (Tables 4 and 5).

This study underestimates the cost savings made possible by FK 506. The group receiving FK 506 had inflated total costs as a result of the additional liver biopsies and nuclear medicine scans assessing renal function, which were obtained on all patients receiving FK 506. These tests were obtained only as indicated clinically for those receiving CyA (Table 4).

In conclusion, these studies suggest that the cost of liver transplantation under FK 506, as opposed to CyA, will decline considerably, and may be reduced by as much as half or more. This reduction in costs is a direct consequence of a shorter period of hospitalization, and reflects global improvements in the postoperative course. As experience with FK 506 increases, even greater reductions in costs may be achieved.

Acknowledgments

Supported by research grants from the Veterans Administration, Project Grant No. DK 29961 from, the National Institutes of Health, Bethesda, MD, and NIDDK 32556.

References

1. Maddrey WC, Van Thiel DH. *Hepatology* 1988;8:948. [PubMed: 3292366]
2. Busuttil RW, Goldstein LI, Danovitch GM, et al. *Ann Intern Med* 1986;104:377. [PubMed: 3511823]
3. Pichlmayr R, Ringe B, Lauchart W, et al. *Transplant Proc* 1987;19:103. [PubMed: 3547807]
4. Scharschmidt BF. *Hepatology* 1984;4:95S. [PubMed: 6363266]
5. Starzl TE, Iwatsuki S, Van Thiel DH, et al. *Hepatology* 1982;2:614. [PubMed: 6749635]
6. Dindzans VJ, Schade RR, Van Thiel DH. *Gastroenterol Clin N Am* 1988;17:19.
7. Schenker S. *Hepatology* 1984;4:102S. [PubMed: 6363253]
8. Van Thiel DH, Tarter R, Gavalier JS, et al. *Gastroenterology* 1986;90:211. [PubMed: 3079595]
9. Millikan WJ, Henderson JM, Stewart MT, et al. *Ann Surg* 1989;209:513. [PubMed: 2650642]

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 ± SEM		40.2 ± 2.5		2.5 ± 0.2	40.1 ± 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	

Table 3

Increased Costs Related to the Use of FK 506

CyA	FK 506
Anatomic pathology protocol biopsies	
\$1,681 ± 262	\$2,391 ± 228
Nuclear medicine renal scans	
\$460 ± 218	\$2,068 ± 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 ± 3.5 d
FK 506	13.2 ± 1.3 d
Total days ($P < 0.02$)	
CyA	35.9 ± 5.2 d
FK 506	16.1 ± 1.3 d
Bed charges ($P < 0.02$)	
CyA	\$33,121 ± 8,387
FK 506	\$10,552 ± 1,340
Pharmacy charges ($P < 0.0007$)	
CyA	\$19,842 ± 3,381
FK 506	\$ 4,847 ± 1,371
Pharmacy minus CyA charges ($P < 0.002$)	
CyA	\$17,051 ± 3,087
FK 506	\$4,847 ± 1,371
Total charges ($P < 0.04$)	
CyA	\$244,863 ± 45,501
FK 506	\$134,169 ± 10,305

Table 5

Reduced Charges Associated With the Use of FK 506

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

Table 6

Decreased Radiologic Charges Associated With the Use of FK 506

Standard radiology ($P < 0.02$)	
CyA	\$6,631 ± 1,483
FK 506	\$2,663 ± 420
Computed tomography ($P < 0.007$)	
CyA	\$2,105 ± 511
FK 506	\$425 ± 164
US ($P < 0.001$)	
CyA	\$2,015 ± 292
FK 506	\$767 ± 176
