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## Blood use in liver transplantation

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During the first 5 years (1981-1985) of the liver transplantation program in Pittsburgh, a total (preoperative, intraoperative, and postoperative) of 18,668 packed red cell units, 23,627 fresh-frozen plasma units, 20,590 platelet units, and 4241 cryoprecipitate units was transfused for the procedures. This represents 3 to 9 percent of the total of blood products supplied by the Central Blood Bank to its 32 member hospitals. Six hundred thirty-six (636) transplants were performed on 485 patients in two hospitals: the Presbyterian University Hospital (564 beds) and Children's Hospital of Pittsburgh (236 beds). All of the blood components used in the operations were procured and released by the Central Blood Bank. This report describes some of these findings. **TRANSFUSION** 1987;27:222-225.

THE DEVELOPMENT of liver transplantation (LTx) programs in recent years has put new demands on blood banks and transfusion services, which must devise means of coping with this new challenge. The Central Blood Bank of Pittsburgh (CBB) provides blood product support for 32 member hospitals. Two of these hospitals, Presbyterian University Hospital (PUH, 564 beds) and Children's Hospital of Pittsburgh (CHP, 236 beds) began doing liver transplants in 1981. The results of this experiment are reported here.

### Study Results

Figure 1 divides the numbers of operations done in Pittsburgh by 1) the year of transplantation, 2) the hospital, and 3) the number of transplantations per patient. The numbers increased almost exponentially. Table 1 shows that, during the first 5 years, 290 adults and 195 children underwent 626 LTx. Of these, 61 adults and 54 children received two livers, and 15 adults and 11 children received three livers.

Table 2 shows the components used preoperatively, intraoperatively, and postoperatively. Most packed red cells (RBCs) (64%) and cryoprecipitate (86%) were used intraoperatively. Slightly more than one-half of the fresh-frozen plasma (FFP) and less than one-half of the platelets were

used in the operating room. Table 2 also compares the total number of components used for LTx with those distributed by CBB in the 5 years. The percentages ranged from 3 for RBC to 9.2 for FFP.

Table 3 shows the use of blood components in the two hospitals in 1985, the last year of this study. These high percentages of blood component use are even more striking if the total of 31,000 patient admissions to the two hospitals is considered. The patients who had LTx accounted for less than 0.01 percent of admissions, yet used approximately 25 percent of the blood.

Figure 2 shows the mean use of blood components in the operating room per patient per year. After 1982, there were sharp drops in the use of RBC and FFP in adults. The use of platelets and cryoprecipitate followed no pattern, and the

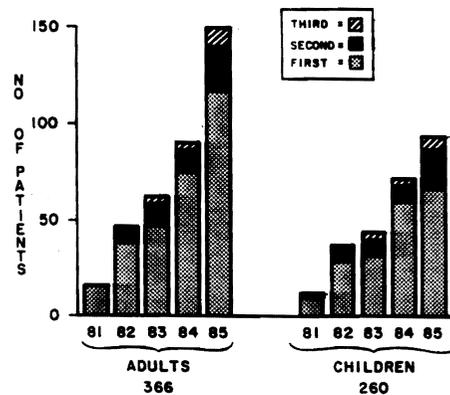


FIG. 1. Numbers of LTx per year, per hospital, and per repeat operation.

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Table 1. Numbers of liver transplantations

	PUH*				CHP*				Total
	1‡	2	3	Total	1‡	2	3	Total	
1981	16	1	0	17	9	2	1	12	29
1982	37	9	0	46	29	9	0	38	84
1983	47	12	2	61	32	10	2	44	105
1984	75	13	3	91	59	10	3	72	163
1985	115	26	10	151	66	23	5	94	245
Total	290	61	15	366	195	54	11	260	626

\* PUH = Presbyterian University Hospital.  
† CHP = Children's Hospital of Pittsburgh.  
‡ Number of liver LTx performed in reported patients.

Table 2. Total amounts of blood products (1981-1985) for adults and children

	RBC	FFP	Plat*	Cryo†
Preoperative	1546	2572	1098	96
Intraoperative	12,007	12,884	9420	3640
Postoperative	5315	8171	10,072	505
Total	18,868	23,627	20,590	4241
CBB total units	622,000	256,000	240,000	60,000
LTx use	3.0	9.2	8.6	7.1
(% of CBB total)				

\* Plat = Platelet units.  
† Cryo = Cryoprecipitate units.

pediatric operations showed no trend to less use of blood components.

Table 4 shows the decrease in blood use associated with second and third LTx procedures in adults. Blood component use in the first LTx was somewhat higher than that shown for all LTx. Figure 3 shows that, if the interval between first and second LTx in adults was 7 days or less, the blood use per patient was roughly one-half (RBC, 8 units; FFP, 10 units) that of the total for all second LTx. Negligible differences were noted in repeat procedures among children who had LTx.

Table 5 shows the mean use of "blood" (RBC plus FFP) in 229 patients who fell into four of the major diagnostic categories: postnecrotic cirrhosis (PNC), primary biliary cirrhosis (PBC), sclerosing cholangitis (SC), and carcinoma/neoplasia (CA). Because of the dependence on surgi-

cal technique and the changes observed by year of surgery, the relationship between original diagnosis and blood use is difficult to express. It is obvious that in 1985 the PNC group that showed the greatest number of coagulation abnormalities also used the greatest amount of blood, whereas the CA group that showed the most normal coagulation patterns used the least blood.

### Discussion

The preceding findings demonstrate the major demands on blood banks in centers where significant numbers of LTx are performed. Early studies from this laboratory<sup>1,2</sup> and the data shown in Table 5 suggest that blood use was at least to some extent dependent on the basic disease and the severity of preoperative coagulation defects. Improvements in surgical and anesthesiologic techniques, intraoperative coagulation monitoring, and therapy of intraoperative fibrinolysis<sup>3</sup> may have contributed to the substantial drop in blood use per adult patient over the period described. Future developments may result in further decreases in blood component usage. Due to the surgical demands for blood and blood components (liver transplantation, heart and heart-lung transplantation, etc.), CBB found it necessary to import from other blood banks about 25 percent of the blood components used. Autologous intraoperative recovery of blood supplied only a moderate por-

Table 3. Total blood products in units used in each hospital, total used for LTx, and percentage for LTx (1985)

	PUH			CHP		
	LTx	Percentage* of LTx	LTx	Percentage* of LTx	LTx	Percentage* of LTx
RBC	23152	19	4318	32	4142	26
FFP	15037	32	4759	21	3286	62
Plat†	23216	21	4788	52	4593	47
Cryo‡	2934	52	1526	16	1432	16

\* Percent of use of this component at the institution.  
† Plat = Platelet units.  
‡ Cryo = Cryoprecipitate units.

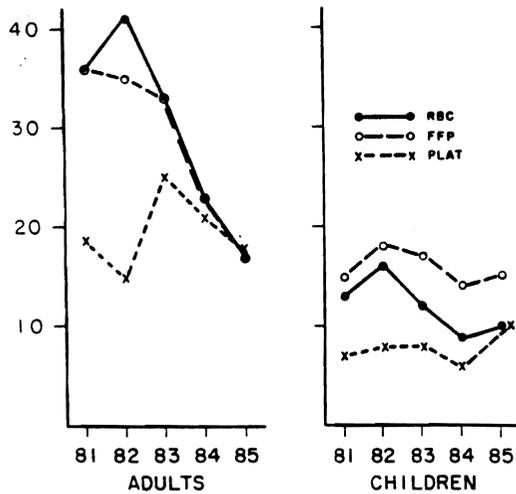


FIG. 2. Mean units of RBC, FFP, or platelets used per operation per year (including second and third LTx). Plat = platelets.

Table 4. Blood use in adults (mean units/patient/operation) in all procedures and in repeat transplantation

	Number of procedures	RBC	FFP	Plat*	Cryo†
All LTx	366	25	24	20	9
1st LTx only	290	27	26	20	10
2nd LTx only	61	18	18	19	8
3rd LTx only	15	17	18	21	9

\* Plat = Platelet units.

† Cryo = Cryoprecipitate units.

tion of the demand. For LTx, this may have been due in part to the presence of ascites or to the possible bacterial contamination of the operative area. Washed autologous red cells might have been satisfactory, but recovery was slow in the face of frequent large and immediate needs. A new pump capable of delivery of

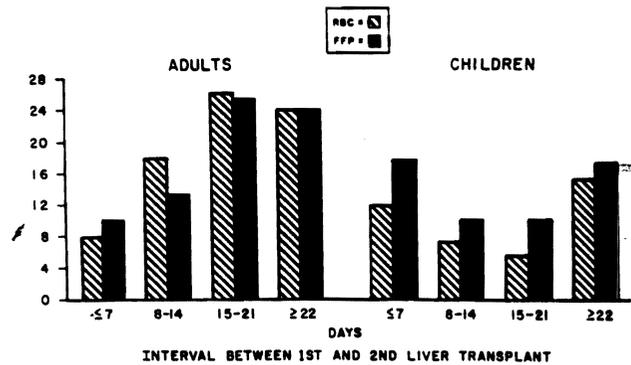


FIG. 3. Mean units of RBC and FFP in second LTx related to the interval between first and second LTx.

2 l per min<sup>4</sup> was life-saving for some patients who were near exsanguination.

Another concern was the possible introduction of infectious or viral agents due to the large numbers of donor exposures. In 1982, the mean number of exposures per patient was 173 units of blood components; in 1983, it was 201. In these years, all blood was tested for hepatitis B surface antigen but not for antibodies to human immune deficiency virus (HIV) or for non-A, non-B (NANB) hepatitis. If transmission of NANB hepatitis can occur from 5 percent<sup>5</sup> of donor units and HIV from 0.04 percent,<sup>6</sup> one would expect these transfusion-transmitted infections to be relatively common. Such was not observed, perhaps because new hepatitis was masked by the recurrence of old hepatitis. Drug-induced (cyclosporine) toxic effects on the new livers might also have obscured NANB effects. High-dose immunosuppressive therapy mimicked the symptoms of acquired immune deficiency syndrome (AIDS), and the two may not be able to be differentiated. In fact, the Centers for Disease Control does not recognize a diagnosis of AIDS in clinically immunosuppressed patients with opportunistic infections. CBB is currently recom-

Table 5. Mean "blood" (RBC + FFP) use in 229 adult patients\* divided by diagnostic category and year

	PNC†		PBC‡		SC§		CA	
	Number	Mean	Number	Mean	Number	Mean	Number	Mean
1981	8	78	1	37	1	16	3	31
1982	6	136	11	47	5	92	6	50
1983	15	90	11	49	7	86	7	60
1984	20	47	13	48	16	27	6	33
1985	40	37	43	30	6	30	4	23

\* Miscellaneous and fulminant omitted.

† PNC = Postnecrotic cirrhosis.

‡ PBC = Primary biliary cirrhosis.

§ SC = Sclerosing cholangitis.

|| CA = Carcinoma/neoplasia.

mending that modified whole blood (platelet-poor<sup>7</sup>) be substituted for the first 10 units of both RBC and FFP, for a significant decrease in infection exposure. In the early phases of the operation, platelets would not be added because of their possible thrombogenic effects. Coagulation factors in the reconstituted stored whole blood would be expected to be somewhat lower than in FFP.

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