Liver Transplantation for Biliary Atresia

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Introduction

Liver transplantation in humans has been performed since 1963 for the surgical correction of a variety of advanced medically intractable hepatobiliary diseases (1-3). The beneficiaries of such heroic surgery have been both adults and children (4-11). As experience with the procedure has increased, it has been observed that the results achieved in children have been better than the results achieved in adults (4-11). Moreover, the long-term benefits achieved in children who are given a new chance to live as a result of successful surgery are obvious to all, including parents, physicians and surgeons.

Among the many hepatobiliary disorders of children which are amenable to hepatic transplantation, the most frequent indication has been biliary atresia (3-8,10). The purpose of this report is to describe the results and the costs of hepatic transplantation in children with biliary atresia as obtained at the three largest programs presently in existence within North America.

Methods

The three centers with the largest experience with orthotopic liver transplantation in North America were each contacted and asked to provide the following information: (1) the number of children with biliary atresia evaluated; (2) the number of children evaluated

for such surgery but who have died prior to the identification of an appropriate organ; (3) the number of children with biliary atresia actually operated upon; (4) the survival statistics for these children; (5) the cost of the procedure for children with biliary atresia at their institution in terms of hospital days, special care unit days, and blood product utilization. This approach to estimating the cost of the procedure at each center was used to allow for a direct between center analysis of the costs that would be independent of local pricing factors. If the costs per day in a hospital or special care unit at a given locality are known, the data presented will allow for a calculation of the cost of the procedure at the locality in question.

When sufficient data were available, mean values and the SEM for each item evaluated were calculated.

Results

The three units from which the data were obtained were the University of Tennessee, the University of Minnesota, and the University of Pittsburgh. Table 1 demonstrates the number of children with biliary atresia evaluated and operated upon at each center sampled between January, 1981 and December, 1983. This time period was selected for analysis because it represents either the entire experience of the center or the experience under which cyclosporine-steroid

immunotherapy was utilized at each institution sampled. As can be seen from Table 1, the bulk of experience emanates from a single center with the other 2 centers accounting for 7 and 24% of the total accumulated experience respectively.

The short-term survival data and the number of children accepted as transplant candidates, but who have died prior to the performance of the surgery at each center sampled are shown in Table 2. As can be seen, the short-term survival figures range from a low of 50% to a high of 89%. These figures probably do not reflect real differences between the 3 institutions in terms of performance of the procedure because of the small n involved for two of the three centers sampled. Thus a statistical analysis of the data could not be applied to the data.

When the cost of the procedure in children with biliary atresia is calculated in terms of total hospital days and blood products used, no difference between the centers studied is noted (Figures 1 and 2 and Table 3). However, significant differences were noted between the 3 centers in the utilization of special care unit beds (Figure 1). This difference probably reflects the availability of such beds at a given institution more than anything else, as the survival figures, total blood product consumption, and total hospital days utilized at each institution per case, do not differ statistically (Figure 1, Tables 2 and 3). These data suggest

therefore that the center with the most experience is using fewer special care unit days per patient operated upon and has therby reduced the cost per procedure by the difference obtained when subtracting the cost of a standard care unit bed from that of a special care unit bed at a given institution.

Discussion

The data presented demonstrate that orthotopic liver transplantation can be applied successfully to the problem of biliary atresia. Moreover, they demonstrate that the short-term survival rate varies between 50-89% with the most active center having the best results. Two observations relative to the interpretation of these survival statistics, however, need to be made. First, because of the small numbers involved in the data obtained from two of the three centers sampled, the data may be mathematically unreliable and reflect the results of their one or two most recent cases, rather than providing a true measure of what can be expected; second, despite the short-term nature of the statistic, if one recalls that 70-80% of the post-transplant mortality occurs within the first 3 months in essentially everyone's published experience, the arbitrary use of a three-month survival figure may well be equivalent, and nearly identical to, the 1 year survival figure experienced at that center.

The data demonstrate that although the cost of the procedrue in terms of total hospital days required per surviving patient does not differ between centers, major statistically significant differences do exist between centers sampled in their use of special care unit beds (Figure 1) and the use of blood and blood products (Figure 2 and Table 3). The differences observed between the sampled centers in their use of special care unit beds per surviving cases may reflect the availability of such beds at a given center rather than a real difference between institutions. The evidence for this latter statement is that 1) the center with the most experience, and therefore with the greatest total need for such beds, uses them fewer days per patient than do the other two centers (Figure 1); and 2) this pertains, despite the fact that the patients operated upon at the most active center sampled require the largest number of blood units per patient (Figure 2 and Table 3) suggesting that their patients may be the sickest. Taken together, these two dichotomous observations suggest that the availability of such special care unit beds determines their use rather than their absolute necessity, per se. Clearly, as the number of cases increases within a given institution with a stable number of such special care unit beds, the number of days a given patient can occupy such a bed must decline.

In summary, the data presently available suggest that:

1. orthotopic liver transplantation can be applied successfully to the problem of biliary atresia;
2. the cost of the procedure at each of the centers sampled in terms of total days in hospital are quite similar;
3. the use of special care unit beds differs substantially between centers and affects the dollar cost of each procedure but that as the volume of cases increases, the use of these beds and therefore the dollar cost per procedure, by necessity, declines.

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Table 1

Number of Children Evaluated and Operated upon
at Each Institution Sampled from January 1981 to December 1983

	Evaluated	Operated On
University of Tennessee	12	3
University of Minnesota	25	10
University of Pittsburgh	62	29

Table 2

Short-term* Survival Figures for Liver Transplantation Performed for Biliary Atresia and the Number of Children Who Have Been Accepted for Surgery but Who Have Died Prior to Finding an Appropriate Donor Organ at the Three Centers Sampled

	Survival Rate	Death Prior to Surgery
University of Tennessee	67%	7
University of Minnesota	50%	6
University of Pittsburgh	89%	13

*Short-term survival = survival for at least 3 months following the procedure or less if performed less than 3 months ago.

Table 3

Total Blood Products Utilized* per Operation
Actually Performed at Each Center Sampled

University of Tennessee	2917 ± 1310
University of Minnesota	4946 ± 919
University of Pittsburgh	5230 ± 796

*Mean ± SEM

LEGENDS

Figure 1. Cost of liver transplantation for biliary atresia in terms of total days in hospital and days in a special care unit (ICU). The bars represent mean values; the brackets represent the SEM.

Figure 2. Cost of liver transplantation in terms of blood products used: RBC = red blood cells; FFP = fresh frozen plasma. Bars represent mean values; brackets represent the SEM.

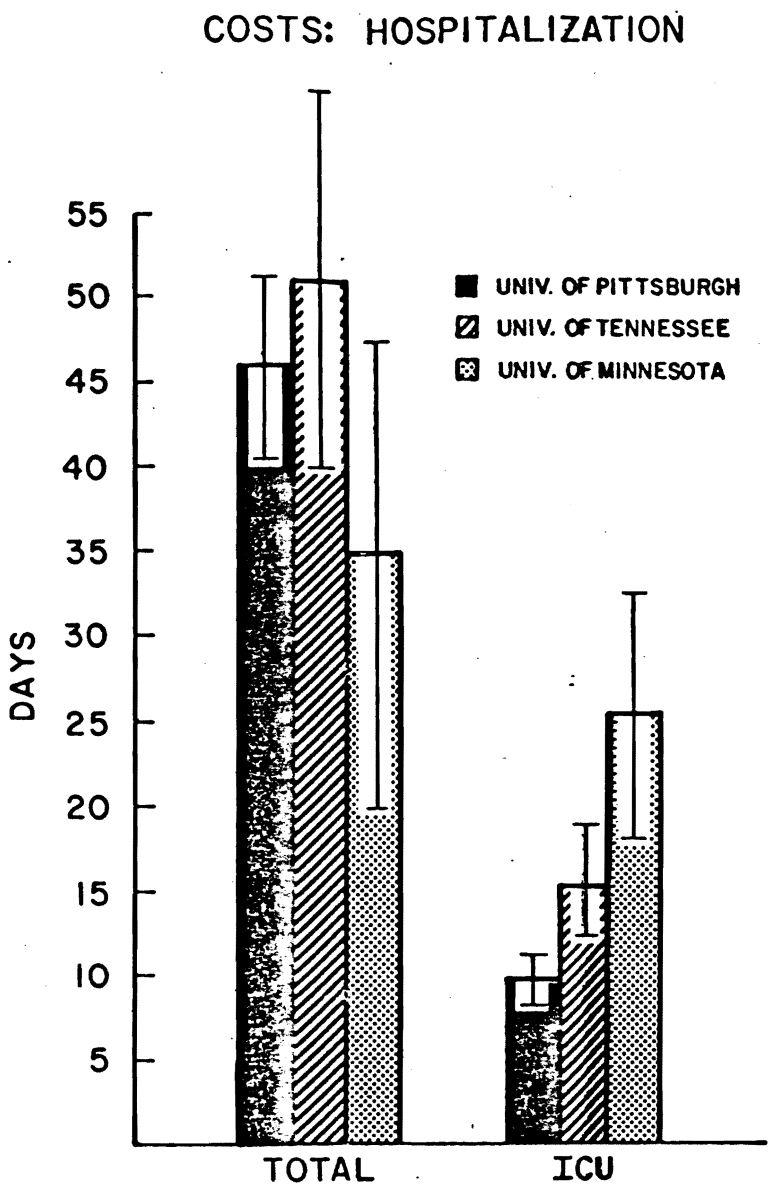
COSTS: HOSPITALIZATION
55
50
45
40
35
30
25
20
15
10
5
DAYS
UNIV. OF PITTSBURGH
UNIV. OF TENNESSEE
UNIV. OF MINNESOTA
TOTAL
ICU

Fig 1

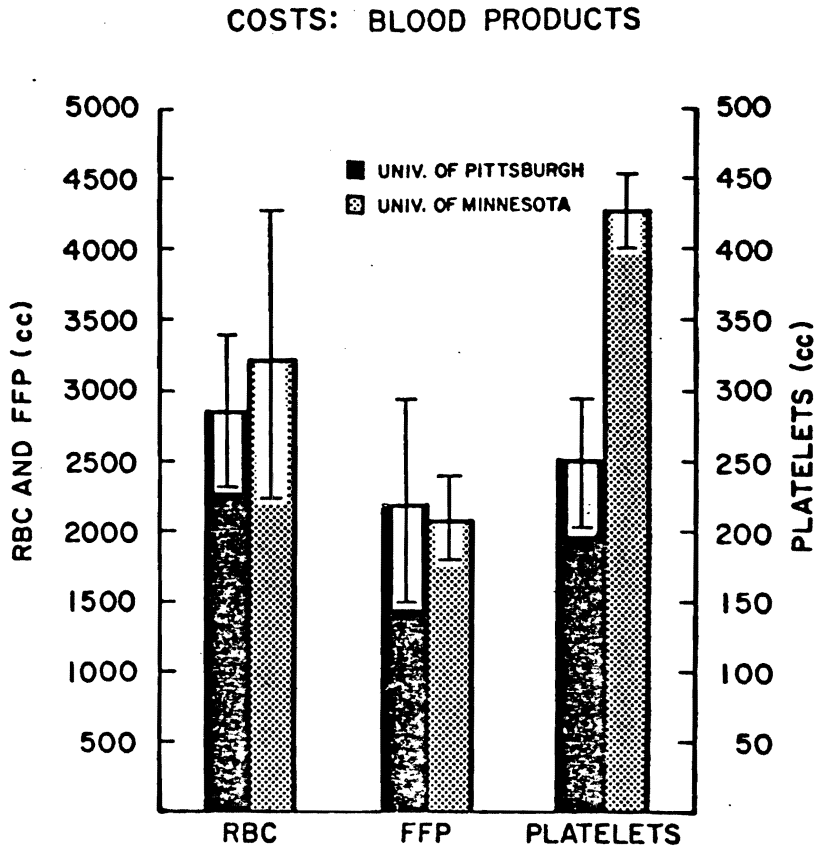
COSTS: BLOOD PRODUCTS
UNIV. OF PITTSBURGH
UNIV. OF MINNESOTA
RBC AND FFP (cc)
PLATELETS (cc)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
500
450
400
350
300
250
200
150
100
50
RBC
FFP
PLATELETS

Fig 2