

THE COST OF LIVER TRANSPLANTATION AT A UNIVERSITY HOSPITAL IN BRAZIL

MILENA PONTES PORTELA,¹ EUGENIE DESIREE RABELO NERI,² MARTA MARIA FRANCE FONTELES,³ JOSÉ HUYGENS PARENTE GARCIA,⁴ MARIA ENEIDA PORTO FERNANDES⁵

Study conducted at the Walter Cantídio Hospital/ Universidade Federal do Ceará, Fortaleza, CE, Brazil

ABSTRACT

OBJECTIVE. To investigate whether the liver transplants undertaken at a University Hospital in Ceará are cost-effective.

METHODS. The medical records of 62 liver transplant patients operated in 2007 were analyzed from the day of admission for transplantation up to hospital discharge or death in hospital. Indicators were analyzed, including the number of days in hospital and the wards occupied, the quantities of materials and medications employed and supplementary tests and procedures carried out.

RESULTS. The majority of this population were male and lived in the Northeast administrative region of Brazil. Mean age was 45 years. The mean cost of liver transplantation was US\$ 20,605.01. The most expensive cost item was the fees paid to the professional team involved in organ harvesting and transplantation; followed by daily rates, surgical and inpatient medications; and products (materials and medications) used in organ harvesting. The Brazilian National Health Service (Sistema Único de Saúde, SUS) paid the HUWC US\$1,322.97 for each organ harvesting, US\$ 3,223.56 for professionals' fees and US\$ 32,235.68 for the liver transplantation "package" that covers the surgical procedure and the first 7 days in hospital.

CONCLUSIONS. The figures observed were similar to those described for other Brazilian transplantation centers. Liver transplantation in Ceará is an economically viable procedure on the basis of the rates paid by the SUS.

KEY WORDS: Liver transplantation. Costs and cost analysis. Brazilian National Health Service, Sistema Único de Saúde.

*Correspondence:

Rua Júlio Gaspar, 775
Parangaba
Fortaleza – Ceará, Brazil
CEP: 60710-090
milenaortela@yahoo.
com.br

INTRODUCTION

Healthcare costs have been receiving special attention, in particular the resources expended on public health all over the world. Specifically in Brazil, this attention has been prompted by the constant and ever-growing lack of financial resources earmarked for health and by their misuse.⁹ In this situation, high cost procedures with little population coverage, such as liver transplantation, are constantly questioned.^{16,21}

Epidemiological data on liver transplantations in Brazil show that 997 transplantations were performed in 2007, 153 of which were in the North-East administrative region. None of these transplantations were performed in the North or Midwest regions because there are no liver transplant centres in those parts of the country.

When liver transplantation was introduced as a technique new to medical practice, the focus was on the technique's safety and efficacy, but questions related to its cost and economic

viability are now being raised. Indeed, modern medicine has been taking greater and greater interest in economics due to the increasing financial pressure affecting issues such as the balance between increased demand and scarcity of available resources.^{3,17}

Concerns about the financial impact of liver transplantation has limited its indication in many developing countries, despite the fact that the benefits have been widely documented. The extremely high costs involved do not only reflect the complexity of the procedure, but also the fact that transplantation is, in general, performed on critically ill patients with advanced liver disease.⁷ Etiology and the condition of the patient at the time of hospital admission are both factors that have a great influence on the cost.^{2,16}

Developments in liver preservation, surgical techniques, prophylaxis and treatment of secondary infections and improved control of rejection have contributed to positive liver transplantation

1. Especialização em Farmácia Hospitalar – Farmacêutica do Hospital Universitário Walter Cantídio/ Universidade Federal do Ceará, Fortaleza, CE

2. Mestre em Ciências Farmacêuticas – Farmacêutica do Hospital Universitário Walter Cantídio/ Universidade Federal do Ceará, Fortaleza, CE

3. Pós-Doutora - Professora universitária do Hospital Universitário Walter Cantídio/ Universidade Federal do Ceará, Fortaleza, CE

4. Doutor em Farmacologia - Médico/ Professor universitário do Hospital Universitário Walter Cantídio/ Universidade Federal do Ceará, Fortaleza, CE

5. Mestre em Saúde Pública - Professora universitária do Hospital Universitário Walter Cantídio/ Universidade Federal do Ceará, Fortaleza, CE

results and to widespread international acceptance.^{6,8}

In 2003, Lacerda et al.¹⁵ concluded that it is possible to conduct liver transplants in public hospitals in areas that are deprived in terms of healthcare with good results as long as a well-trained multidisciplinary team is in place and the minimum physical infrastructure is available. It is also important to control the costs of all procedures that involve sources of revenue and to study the surplus margin, i.e. the profit needed to recover the capital invested.¹¹

It is against this background that the objective of this study was to determine the cost of liver transplantation at a teaching hospital in the city of Fortaleza, Ceará, Brazil, and to compare the figure arrived at with the prices paid by the Brazilian National Health Service (SUS - *Sistema Único de Saúde*), thereby analyzing the financial viability of liver transplantation at this institution.

METHODS

Between May of 2002 and June of 2008, 256 liver transplants were performed with cadaveric donors at the Walter Cantídio Hospital at the *Universidade Federal do Ceará* (HUWC/ UFC), the only liver transplantation center in the state of Ceará. Sixty-two of these transplants took place during 2007 and these were used to assess the cost of the procedure in this study.

Following the method developed by Coelho,^{1997,8} the data on these patients' medical records were assessed from the day they were admitted for transplantation until the date of hospital discharge or death in hospital, in order to determine the number of days in hospital, the wards they stayed in, the quantities of materials and medications employed and the supplementary tests and procedures carried out.

Direct hospital costs were calculated using the average prices given by the HUWC's computerised management system in July of 2008. The prices were converted into United States' currency according to the price of the dollar on the 10th of July of 2008 (US\$ 1.00 = R\$ 1.61).

The cost of usage of equipment and its depreciation, indirect costs for water, electricity, gas, telephones, food, laundry, cleaning, maintenance, administration and security and also the costs of human resources (physicians, nurses, auxiliaries and others) were estimated and included in an operating theater usage rate and in a daily rate for beds in the Intensive care unit (ICU) postoperative ward and general wards. These rates were provided by the accounts department at the HUWC. Costs related to preoperative assessments conducted before admission or with possible postoperative complications after hospital discharge were not included. The prices of blood products were obtained from a private blood bank because this information was not available at the HUWC.

The costs of supplementary tests and procedures were provided by the accounts department at the HUWC, while the medical team's fees used for analysis were the actual figures paid out, provided by the accounts and finance department at the HUWC. Data were input on Excel® in order to calculate the final costs. For some variables, such as diagnoses and comorbidities, some patients had more than one parameter. Data are expressed in mean plus or minus the standard deviation.

The mean cost of transplantation was then compared with

the prices on the SUS Table of Procedures that had been in force in July of 2008. This information was provided by the hospital's affiliations department, who explained that there was a liver transplantation "package" paying R\$ 51,899.46 for costs incurred performing the transplantation itself, plus R\$ 5,189.94 to pay the medical team's fees and R\$ 2,130.00 to cover the costs of organ harvesting).

Comparative analysis of the results was performed on two levels. A local comparison was made against an earlier study conducted at the HUWC by Garcia et al. in 2005. A national comparison was made against studies conducted in Brazil and published on the subject during the last 10 years and indexed on Medline or Scielo. It should be mentioned that there are no conflicts of interest related to this study, it has been conducted in accordance with the standards demanded by the Helsinki Declaration and it was approved by the Research Ethics Committee at the HUWC.

RESULTS

Analysis of the medical records of the 62 patients who received transplants in 2007 showed that the principal indications for liver transplantation were: alcoholic liver disease (24.67%; n=19), hepatitis C (16.88%; n=13), hepatocarcinoma (11.68%; n=9), hepatitis B (11.68%; n=9) and autoimmune hepatitis (9.09%; n=7). No patients received retransplantation during 2007.

The sociodemographic profile was as follows. The patients' ages varied from 7 to 67 years, with a mean of 45 ± 15 years. Only three patients were less than 14 years old. Fourteen patients were female. In terms of origin, 79.03% (n=49) of the patients were from the Northeast region, 11.29% (n=7) from the North region, 8.06% (n=5) from the Midwest and 1.61% (n=1) from the Southeast. Of the northeastern patients, 35 (56.45%) were from Ceará and 14 (22.58%) were from other states in the Northeast. Forty-five patients were married, 15 were single and two were divorced.

With relation to occupation, 33 patients were working before they were admitted for transplantation, 11 were retired, 10 were students and the medical records for eight patients did not record anything about occupation. Five patients were illiterate, 12 had attended primary education, 12 had attended secondary education; eight had a higher education qualification and 25 medical records did not mention educational level. No records of patient income were found in the medical records analyzed. Twenty-six patients (41.94%) were ex-alcoholics and 16 (25.81%) were smokers. Reports of illicit drug use were identified on four (6.45%) medical records. Evidence of allergies was found in 42 medical records (67.74%).

Comorbidities were identified in 24 medical records, with a total of 37 comorbidities, of which the most common were: arterial hypertension (29.72%; n=11), diabetes (18.91%; n=7), heart failure (8.10%; n=3) and asthma (8.10%; n=3).

The total quantity of medications prescribed per patient during their hospital stays, from admission to discharge, varied from 10 to 112 items, with a mean of 53 ± 16 items. The medications most prescribed were: methylprednisolone, tacrolimus and nystatin for 100% (n=62) of the patients and insulin, dipyrone and vitamin K for 98.39% (n=61). The most expensive medications, according to the average price in July of 2008,

were: organ preservation solution (US\$ 869.56), anti-hepatitis B gammaglobulin (US\$ 381.98), sevoflurane (US\$ 337.68), human albumin (US\$ 68.94) and isoflurane (US\$ 53.37). Potentially dangerous medications were prescribed to 100% of the patients, including anesthetic (100%; n=62), insulin (100%; n=62) and potassium chloride (74.19%; n=46). The total length of hospital stay varied from zero to 128 days, with a mean of 18 ± 19 days, while time spent in the ICU varied from zero to 46 days, with a mean of 6 ± 9 days. The operating theater time varied from five to 13 hours with a mean of eight ± 1.4 hours.

Forty-one of the 62 transplant patients (66.13%) were given transfusions and 39 of them (95.12%) were given a mean of 5.21 ± 3.97 units of concentrated red blood cells, 26 (63.41%) were given a mean of 2.31 ± 3.21 units of fresh plasma, 10 (24.39%) were given a mean of 1.48 ± 4.70 units of concentrated platelets and one patient was given 11 units of cryoprecipitate. Among those who were given concentrated red blood cells, the mean volume was 5.21 ± 3.97 units. It was found that 20.97% (n=13) of the patients died between transplantation and discharge, while 79.03% (n=49) were discharged and described as improved, i.e. they had got through postoperative recovery and were being followed in outpatients. All of the 13 patients who died had suffered from complications, with the principal cause of death being cardiorespiratory arrest (61.54%). The day of death varied from zero to 46 days after admission with a mean of 18 ± 15.6 days. A total of 83 complications affected 32 patients and the most prevalent were as follows respiratory failure, acute renal failure and cardiorespiratory arrest; each accounting for 9.64% of complications, followed by metabolic acidosis and ascites; both accounting for 4.82% and then sepsis, oliguria, pleural hemorrhage, convulsions and hemorrhagic shock; each accounting for 3.61% of the complications. Twenty-two of the 62 patients given transplants in 2007 (35.48%) had private health insurance.

With reference to the funding provided by the SUS, according to the table in force in July of 2008, the HUWC was paid US\$1,322.97 for organ harvesting, US\$ 3,223.56 for professionals' fees and US\$ 32,235.68 for the liver transplantation package, including up to 7 days' in hospital (irrespective of whether in an ICU or other ward) and the entire surgical procedure. The amounts paid to the *Centro do Transplante de Fígado do Ceará* to pay for the team involved in organ harvesting and liver transplantation at the HUWC was US\$ 726.70 for each organ harvesting and US\$ 6,211.18, for each liver transplantation.

The total cost of liver transplantation varied from US\$ 11,384.30 to US\$ 54,698.34, with a mean of US\$ 20,605.01. This cost varied depending on postoperative complications, number of days in hospital and the quantity of blood products transfused. Of all the components analyzed, the cost item that had the greatest effect on increasing the costs was the amount paid to the professionals involved in organ harvesting and transplantation, followed by the daily rates, surgical and inpatient medications, hospital admission and products (materials and medications) used in organ harvesting.

DISCUSSION

Liver transplantation is a highly complex procedure conducted in few institutions in Brazil, in addition to being the only treatment available for end-stage liver disease.^{13,17}

Analysis of the transplant patients' medical records was difficult because of the volume of data and records. Information such as socioeconomic data and patients' addictions could not be obtained from the records, which prevented a more detailed epidemiological description of these patients.

The results found suggest that the HUWC is the reference for liver transplant in the North-Northeast, since around a fifth of the patients treated were from the North and Midwest regions. The transplant department also treated patients from other regions in Brazil.

The principal indications for liver transplantation were alcoholic liver disease and cirrhosis caused by hepatitis C, which are similar to the results published by Garcia et al. in 2005,⁹ from a study conducted at the same institution. In 2000, Coelho et al.⁵ found liver disease caused by hepatitis C and cryptogenic cirrhosis as principal indications.

The profile of the patients remained very similar to the results found by Garcia et al.,¹⁰ where age varied from 15 years to 62 years, with a mean of 42.5 years, and the majority were male. The profiles in both studies characterized a population at risk from alcohol consumption, confirmed by the presence of alcoholic liver disease as one of the principal diagnoses. However, according to GM/MS directive number 541 of 14th March of 2002,¹⁸ patients with a history of alcoholism can only be registered on the liver transplantation waiting list if they have been free from alcohol for at least 6 months.

Other similarities with the study by Garcia et al., 2005,¹⁰ were mean surgery duration, which was 8 hours in both studies and mean hospital stay, which was 18 days. The mean transfusion volume was five units of concentrated red blood cells, in contrast with the 1.9 units observed in 2005. These data are compatible with a study by Cacciarelli et al., conducted in 1999,⁴ which suggested there was an inverse relationship between the quantity of blood given and survival after liver transplantation.

The survival rate identified in this study was 79.03%, with follow-up until hospital discharge, whereas in 2005 Garcia et al.¹⁰ found a 94.7% survival rate, with 15-month follow-up. The reduction in survival may be the result of GM/MS directive number 1,160 of 29th May of 2006,¹⁹ which modified the criteria for allocating livers from cadaveric donors, including the criterion of the severity of the patient's clinical status. The patients receiving transplants in 2007 were possibly in a more severe condition than those treated in 2005.

O'Grady conducted a review in 1997,¹⁶ reporting survival of 60 to 75% for transplants with cadaveric donors, which is in line with the results observed at the HUWC. This type of transplant is faced with the risk that patient cases will be more complicated because the transplant cannot be planned for when patients are stable. This is in contrast with countries such as Japan, where the majority of liver transplants are from live donors.¹⁴

The great variety of medications prescribed to patients while in hospital demand precautions in all areas of patient care, since many of these medications are new and must be monitored for

possible adverse effects. Anesthetic and insulin usage meant that 100% of the patients given a liver transplant were exposed to potentially dangerous medications (medications with increased of patient harm if errors occur), according to a list published in 2008 by the Institute for Safe Medication Practices,¹² and require intense clinical and pharmacotherapeutic monitoring.

When the costs that were calculated were analyzed, it was observed that the results were comparable with other transplant centers in Brazil. A study conducted by Coelho et al. in 1997,⁸ found that the total mean liver transplantation cost in Paraná was US\$ 21,505.53, varying from US\$ 6,359.84 to 75,434.18. In this study, undertaken in Ceará, we found a variation of US\$ 11,384.30 to 54,698.34 and a mean of US\$ 20,605.01. Neither study was able to compare the costs of adult and child transplants because of the sample sizes. These very high figures do not only reflect the level of complexity, but also the fact that transplants are generally performed on critically ill patients, with advanced liver disease.

In 2005, Coelho et al.⁷ found that medications were the largest cost item in transplantation. In our study, the largest cost item was the professional team, followed by the daily rates and, in third place, the medications. The routine use of expensive medications, including some imported items, contributes to increasing the cost of transplantation.⁸ The most expensive items are the liver preservation solution, the broad-spectrum antibiotics and the immunosuppressants.

In a study conducted in 2002, Ferraz et al.⁹ calculated a lower liver transplantation cost, when performed in Pernambuco, where the mean cost was R\$22,184.40. Ferraz et al.⁹ found that the most expensive cost item was disposable materials; in the study in Ceará, this item was in seventh place on the list of costs. Although the two situations are similar, since both are university hospitals in the Northeast of Brazil, the differences in transplantation costs are significant.

Transplants are 100% paid for by the SUS, in compliance with the constitutional directive that "health is everyone's right and the State's duty". However, in this study we found that around one third of these patients had private healthcare plans, which leads us to ask whether their plans should not reimburse the public purse for these procedures?

In agreement with what was written by Staven et al. in 1998,²² the costs identified in this study varied from patient to patient, being highest for patients who suffered postoperative complications. Those patients spent longer in hospital, with increased daily costs and expenditure on medications. This was also reported by a study published by Ammori et al. in 2008,¹ which found that postoperative complications are common after liver transplantation and demand significant financial resources.

CONCLUSION

On the basis of the cost analysis of liver transplantation at the HUWC, it can be stated that the procedure is economically viable on the basis of the current price paid for the procedure by the Brazilian National Health Service.

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