

# Costs and Length of Hospitalizations Following Kidney Transplantation

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**Keywords.** hospitalization, kidney transplantation, health care costs

**Introduction.** We assessed the costs of hospital admissions and length of hospital stay in kidney allograft recipients admitted to our center, in order to rank hospitalization causes in terms of costly and prolonged admissions, to bring to light the respective correlates of costly and prolonged admissions, and to investigate the relationship between costs and length of rehospitalizations.

**Materials and Methods.** In a retrospective study at Baqiyatallah Hospital, in Tehran, records of 358 posttransplant hospitalizations were reviewed for the costs and duration of hospital stay. The causes of rehospitalizations, relative frequency of prolonged stays in costly rehospitalizations, and also relative frequency of costly admissions in short and prolonged stays were evaluated.

**Results.** Among rehospitalizations, 83.3% of those due to cerebrovascular accident were costly and 51% of those with graft rejection resulted in prolonged hospital stays. Costly admissions had a high regularity in cases of patients older than 60 years, end-stage renal disease due to diabetes mellitus, graft loss, intensive care unit admission, and hospitalizations accompanied by in death. Prolonged stays were more common in those who were admitted to intensive care unit and those who ultimately died. The Costs showed a significant correlation with the length of rehospitalization ( $r = 0.626$ ,  $P = .001$ ).

**Conclusions.** The strong correlation between the length of hospitalization and posttransplant hospitalization costs means that the former should be curtailed by focusing on such correlates of high-cost admissions as high age and diabetes mellitus as the cause of kidney failure.

IJKD 2009;3:103-8  
www.ijkd.org

## INTRODUCTION

Kidney transplantation, albeit the most cost-effective treatment modality for patients with end-stage renal disease (ESRD), is a costly procedure, especially when rehospitalization comes into play.<sup>1</sup> A good understanding of the relationship between the length of hospitalization, cost of hospitalization, clinical outcome, and their correlates can pave the

way for efforts to not only trim down the overall costs of kidney transplantation,<sup>2</sup> but also streamline resource allocations even in some other diseases.<sup>3</sup> The correlation between the length and costs of hospitalization is considered as an axiom by many in the medical community and as a topic of research by numerous investigators.<sup>4</sup> Nevertheless, there are those who believe that the length of hospitalization

has a minimal impact on its costs in some instances, eg, the costly procedures of certain short hospital stays preclude a focus on the length of stay for cost minimization studies, laparoscopic surgery being a case in point.<sup>5-7</sup>

Previous research into the correlation between cost and length of posttransplant hospitalizations prompted us to secure funding for a large project in our transplantation center; the cost-analysis studies conducted to date on kidney transplantation have drawn upon data analysis as a tool for cost minimization and pointed the finger of blame on the total cost of transplantation itself, correlates of high costs, and prolonged hospital stays.<sup>8-10</sup> We sought to investigate admission causes of rehospitalization of kidney transplant recipients, uncover correlates of costly and prolonged admissions, and probe into the link between costs and length of rehospitalizations.

## MATERIALS AND METHODS

This retrospective study was conducted on 358 consecutive rehospitalizations of kidney recipients between 2000 and 2005 at Baqiyatallah Hospital, in Tehran, Iran. The admitted kidney transplant recipients were among transplanted patients at the same hospital, the first of whom had received a kidney allograft in 1992. Rehospitalization was defined as hospital admission occurring for any reason after discharge from the initial hospitalization for transplantation. Hospitalization costs were considered as the total costs that a patient would be charged for rehospitalization, consisting of accommodation, medications, surgical procedures, laboratory tests, and imaging studies, as well as other miscellaneous medical costs, but not indirect ones such as those related to productivity loss due to days off work. Since the costs of rehospitalizations were recorded in different years, it was necessary to adjust them for the inflation rates, so that comparing costs across different years would make sense. Considering 2006 as our adjustment reference year, the costs filed from 2000 to 2005 were inflated to those of the year 2006, assuming an annual inflation rate of 10%.<sup>11</sup> Rehospitalizations of more than 9 days (mean hospital stay in our study) were defined as being “prolonged,” and those with costs more than 3 879 733 Iranian Rials (US \$ 431; mean costs of rehospitalization in our study) were classified

as being “costly.”

The patients’ demographic data, transplant-related data (cause of ESRD and donor source), and rehospitalization data (admission cause, transplantation-to-admission interval, and patient and graft outcome) were extracted from the hospital records. The admission causes were classified into the following broad categories: malignancy, cerebrovascular accident, infection, graft rejection, urinary calculus, surgical complications, drug complications, and miscellaneous. A categorization of the admissions as “prolonged and costly,” “short but costly,” “prolonged but not costly,” and “short and not costly” made it possible to report these frequencies for each admission cause without resorting to statistical comparisons. In addition, the term “hospitalization length-cost compatible” was considered to encompass either “prolonged and costly” and “short and not costly” rehospitalizations. Similarly, the phrase “hospitalization length-cost incompatible” covered “short but costly” and “prolonged but not costly” rehospitalizations.

Data analysis was performed using the SPSS software (Statistical Package for the Social Sciences, version 13.0, SPSS Inc, Chicago, Ill, USA). The chi-square test was employed to make comparisons both between the costly and noncostly admissions and between the prolonged and short hospital stays. The Pearson correlation coefficient test was used to find the correlation between the length and costs of rehospitalizations. A *P* value less than .05 was considered significant.

## RESULTS

### Patients and Rehospitalizations

Table 1 outlines characteristics of the patients and information on rehospitalizations. Of 358 rehospitalized kidney transplant recipients, 327 patients (91.3%) were younger than 60 years old, and the remaining 31 (8.6%) were 60 years or older. Diabetes mellitus was responsible for ESRD in 73 (20.4%). Of the patients, 310 (86.6%) were discharged with a functioning graft and 48 (13.4%) lost their graft. Eighteen hospitalizations (5.0%) led to death.

### Costly Rehospitalizations

Based on the mean rehospitalization costs, 119 rehospitalizations (33.2%) were “costly” (higher than the mean costs). Costly admissions were more

**Table 1.** Characteristics of Patients and Rehospitalizations

Characteristics	Value
Number of patients	358
Sex	
Male	243 (68)
Female	115 (32)
Mean age, y	39.5 ± 31.8
Donor source	
Living unrelated	344 (95.5)
Living related	8 (2.5)
Cadaver	6 (2)
Transplant-rehospitalization interval, mo	
< 6	180 (50)
6 to 24	80 (22)
> 24	98 (28)
Cause of admission	
Infection	168 (39.8)
Graft rejection	152 (36)
Surgical complications	23 (5.4)
Drug side effects	17 (4)
Urinary calculus	14 (3.3)
Cerebrovascular accident	12 (2.8)
Cancer	10 (2.3)
Miscellaneous	26 (6.1)
Intensive care unit admission	18 (5)

frequent in patients older than 60 years ( $P = .003$ ) and those with ESRD due to diabetes mellitus ( $P = .02$ ). In addition, rehospitalization of patients with graft loss at the time of discharge ( $P = .05$ ), those admitted to intensive care unit ( $P = .001$ ), and those who died during hospital stay ( $P = .005$ ) were costly.

### Prolonged Rehospitalizations

A total of 146 rehospitalizations (40.8%) were longer than the mean length of hospital stays, namely “prolonged.” Prolonged rehospitalizations showed a significant correlation only with admissions to intensive care unit ( $P < .001$ ) and death during hospital stay ( $P = .001$ ).

### Association of Costs and length of Rehospitalizations

Eighty-six rehospitalizations (24.0%) were prolonged and costly, 33 (9.2%) were short but costly, 60 (16.8%) were prolonged but not costly, and 179 (50.0%) were short and not costly. Overall, 265 rehospitalizations (74.0%) were “hospitalization length-cost compatible” and 93 (26.0%) were “hospitalization length-cost incompatible.” The costs showed a significant direct correlation with the length of hospital stay ( $r = 0.626$ ,  $P = .001$ ).

### Causes of Rehospitalizations and Their Costs and length

Costly rehospitalizations were mostly due to cerebrovascular accident (83.3%), cancer (60.0%), and surgical complications (43.5%). Prolonged rehospitalizations were seen in 51.3% of those due to graft rejection and 50.0% of those due to infection. Cancer ranked first in the group of prolonged and costly rehospitalizations, with 40.0% of hospitalizations due to cancer falling into this group, followed by cerebrovascular accident (33.3%). Hospitalizations due to infection, graft rejection, and miscellaneous causes were mostly short and not costly (Table 2).

### DISCUSSION

Transplant centers are increasingly under pressure to identify the major determinants of costs and the ways and means of controlling them.<sup>12</sup> As a result, increasing efforts should be directed at controlling costs and resource utilization associated with kidney transplantation.<sup>13</sup> Some studies reported that in the case of kidney transplantation, the costs of rehospitalization and its duration sometimes equal or surpass transplantation surgery itself.<sup>8,14</sup>

Our retrospective study on the causes of hospitalizations after kidney transplant revealed that 83% of admissions due to cerebrovascular accident were costly and 51% of admissions due to graft rejection were prolonged. A review of the related literature illustrates a tie between the duration of hospital stay and the cause of admission; for instance, 4 days for nephrolithiasis or poisonings, 5 days for hip arthroplasty, 8 days for bacterial pneumonia and pulmonary embolism, 10 days for cytomegalovirus disease, and 11 days for fungal infections.<sup>8,15-20</sup>

In our study, age and ESRD due to diabetes mellitus were the correlates of costly admissions. The impact of age on the cause of admission is further underscored by research stating that more than half of the patients requiring renal replacement therapy are over 60 years of age,<sup>21</sup> and that as a global trend, kidney transplant recipients are growing older.<sup>22</sup>

Almost three quarters of all the posttransplant admissions in our study were “hospitalization length-cost compatible.” The fact that there was a strong correlation between the length and costs of rehospitalization in our investigation chimes

**Table 2.** Frequency of Prolonged and Costly Rehospitalization in Kidney Allograft Recipients\*

Parameters	Prolonged and Costly (n = 86)	Short but Costly (n = 33)	Prolonged but not Costly (n = 60)	Short and not Costly (n = 179)
Cause of admission				
Cancer (n = 10)	4 (40.0)	2 (20.0)	0	4 (40.0)
CVA (n = 12)	4 (33.3)	6 (50.0)	0	2 (16.7)
Infection (n = 168)	53 (31.5)	10 (5.9)	31 (18.5)	74 (44.1)
Graft rejection (n = 152)	48 (31.6)	13 (8.5)	30 (19.7)	61 (40.1)
Surgical complication (n = 23)	7 (30.4)	3 (13.0)	4 (17.4)	9 (39.1)
Urinary calculus (n = 14)	2 (14.3)	4 (28.6)	2 (14.3)	6 (42.9)
Drug complication (n = 17)	3 (17.6)	1 (5.9)	3 (17.6)	10 (58.8)
Miscellaneous (n = 26)	2 (7.7)	4 (15.4)	2 (7.7)	18 (69.2)
Time after transplantation, mo				
< 6 (n = 180)	54 (30.0)	12 (6.7)	34 (18.9)	80 (44.4)
6 to 24 (n = 80)	18 (22.5)	11 (13.8)	15 (18.8)	36 (45.0)
> 24 (n = 98)	14 (14.3)	10 (10.2)	11 (11.2)	63 (64.3)
Age at transplantation				
< 60 (n = 327)	75 (22.9)	28 (8.6)	54 (16.5)	170 (52.0)
≥ 60 (n = 31)	11 (35.5)	5 (16.1)	6 (19.3)	9 (29.0)
Cause of ESRD				
Diabetes mellitus (n = 73)	27 (37)	10 (14)	10 (14)	26 (35)
Others (n = 285)	59 (28)	23 (3)	50 (15)	153 (54)
Graft status at discharge				
Lost (n = 48)	22 (48)	7 (10)	6 (8)	11 (34)
Functioning (n = 310)	64 (32)	26 (11)	54 (28)	168 (29)
Patient status at discharge				
Death (n = 18)	8 (45)	4 (22)	0	6 (33)
Alive (n = 340)	78 (26)	29 (7)	60 (20)	173 (47)
ICU admission				
Yes (n = 18)	10 (55)	5 (30)	0	3 (25)
No (n = 340)	76 (24)	28 (8)	60 (18)	176 (50)

\*CVA indicates cerebrovascular accident; ESRD, end-stage renal disease; and ICU, intensive care unit.

in with previous reports introducing the length of hospitalization as the major contributor to the costs of posttransplant care.<sup>23</sup> As previously stated, despite some investigators' inclination to disagree,<sup>5,6</sup> there seems to be a consensus that the length of rehospitalization is the main determinant of the costs.<sup>3</sup> The conclusion that follows from this assumption is that shortening the length of hospital stay in kidney transplant patients can bring about a reduction in costs.<sup>24</sup>

Our findings are strong indications of the fact that prevention of rehospitalization should be given pride of place on any agenda set to lower costs. We found infection and graft rejection to be the main culprits for rehospitalization of kidney transplant recipients; therefore, a closer follow-up of patients with a higher age and diabetes mellitus (the main risk factors of infection),<sup>25</sup> and keeping a watchful eye on some viral diseases and any nonadherence to immunosuppression therapies (the major risk factors of graft rejection),<sup>26</sup> could be effective

preventive measures. Involving the physicians in cost-reduction programs by trainings in hospital charges and providing practice guidelines and feedback to them can also be beneficial.<sup>27,28</sup> Finding the right time for hospital discharge and implementation of appropriate early discharge programs, while maintaining the quality of patient outcomes, are some other practical solutions.<sup>29,30</sup> These approaches may also result in a reduction in nosocomial infections, as well. Home-based rehabilitation and patients' education, community-based multidisciplinary programs focused on the improvement of outpatient care, and using the benefits of new approaches for treatment (such as laparoscopic surgeries) may also be useful.<sup>29,31-33</sup>

## CONCLUSIONS

The results of the present study demonstrated that age above 60 years, diabetes mellitus as the cause of ESRD, admission to intensive care unit, and graft loss or death during admission correlated

with costly admissions. On the other hand, admission to intensive care unit and death were the correlates of prolonged stays. Our findings, in line with previous research on diabetics and the elderly, put more emphasis on the importance of proper preventive measures. In kidney allograft recipients, the strong correlation between the length of rehospitalization and costs of rehospitalization suggests that efforts should be made in order to shorten their hospital stay.

### FINANCIAL SUPPORT

This study was fully supported and funded by the Nephrology and Urology Research Center of Baqiyatallah University of Medical Sciences.

### CONFLICT OF INTEREST

None declared.

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Received July 2008  
Revised September 2008  
Accepted October 2008

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