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Payment for Living Donor (Vendor) Kidneys: A Cost-Effectiveness Analysis

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The supply of kidneys does not meet the demand. As a consequence, the waiting time for a cadaver kidney continues to lengthen, and there is renewed debate about payment for living donors. To facilitate this debate, we studied what amount of payment would be cost-effective for society, i.e. what costs would be saved (if any) by removing a patient from the waiting list using a paid (living unrelated: LURD) donor-vendor. A Markov model was developed to calculate the expected average cost and outcome benefits of increasing the organ supply and reducing waiting times by adding paid LURD organs to the available pool.

We found that a LURD transplant saved $94 579 (US dollars, 2002), and 3.5 quality-adjusted life years (QALYs) were gained. Adding the value of QALYs, a LURD transplant saved $269 319, assuming society values additional QALYs from transplantation at the rate paid per QALY while on dialysis.

At a minimum, a vendor program would save society >$90 000 per transplant and provides QALYs for the ESRD population. Thus, society could break even while paying $90 000/kidney vendor.

Key words: Kidneys, living donor, payment

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The major clinical problem in kidney transplantation today is the shortage of donor organs. The significant improvement in transplant patient and graft survival in the last two decades (1) and the clear demonstration that long-term survival is better after a transplant (vs. dialysis) for patients with end-stage renal disease (ESRD) (2,3) have led an increasing number of patients with ESRD to opt for transplantation. In addition, acceptance of older patients as transplant candidates has markedly increased the potential number of recipients.

A kidney transplant can come from either a living or cadaver donor. In the United States during the last decade, despite numerous local and national educational attempts and media promotions, there has been little increase in the number of cadaver donors. With recognition of the excellent outcome with living unrelated donors (LURDs) and in response to the organ shortage, there has been some increase in the number of living donors (4).

The net result is that each year more patients join the waiting list than are transplanted. As a consequence, the waiting list and the resultant waiting time to transplantation have continued to increase (4). The Scientific Registry of Transplant Recipients (SRTR) database shows that between 1988 and June 2002, the number of patients on the waiting list for a kidney transplant increased from 13 943 to 52 766 (4). Currently, in most areas of the country, the average waiting time for a cadaver kidney is approaching or has exceeded 5 years. These long waits not only are expensive (dialysis costs approximately $50 000 per year) but also have a negative impact on post-transplant outcome; both patient survival and graft survival are inversely related to length of time on dialysis (5–7). In addition, the number of patients dying while on the kidney transplant waiting list has increased from 736 in 1988 to 2875 in 2000 (4).

Clearly, altruistic donation is not providing sufficient organs. One potential solution is to consider payment to donors or to donor families. Numerous authors have debated the ethics for and against paid donation (8–34); and a proposal has recently been made to consider a small payment to families of cadaver donors as an 'ethical incentive' (34). Herein, we do not debate the ethics, but we asked what payment our society could potentially 'afford' to provide for a living donor. Our answer helps establish the framework for the ethical debate.

We studied what amount of payment to a living donor (vendor) would be cost-effective for society, i.e. what costs would be saved by removing a patient from the waiting list using a paid LURD (vendor). We show, herein, that payment for living donor kidneys could be cost-effective for the US health care system. For our analysis, we have assumed the establishment of a government-regulated system where a fixed price is paid to the donor, and where the kidneys are allocated by a predefined algorithm similar to the extant UNOS point system. Of note, in the United

States, the government or private insurance pays the costs of long-term dialysis.

Analysis

Details of the economic and quality of life analyses and the structure of calculations that we used are found in Birkmeyer et al. (35), Whiting (36), and Schnitzler et al. (37).

The expected average cost and outcome benefits of increasing the organ supply and reducing waiting times were calculated for the addition of paid LURD organs to the available pool (38). Factors included in calculations were patient survival, cost on dialysis, graft survival, death with function, death after graft loss, cost of organ acquisition, cost of transplant, maintenance costs with graft function, and cost of return to dialysis for LURD transplantation. Our analysis was carried out from society's perspective (i.e. overall costs) and assumes a regulated system and a predefined allocation algorithm (36). Thus the first vendor kidneys would likely go to those candidates at or near the top of the waiting list who had already accumulated a long waiting time. We used the assumption that waiting time would only be minimally reduced for these first recipients. However, if vendor kidneys became a reality and a large number of vendors came forward, the waiting time (for a cadaver kidney) would be markedly reduced and, consequently, potential savings to the health care system would be increased.

A simplified tree diagram of the calculations is shown in Figure 1. A patient may receive a vendor kidney or continue to wait on the list for a cadaver transplant. Patients receiving a vendor kidney would end their first year post-transplant in one of three conditions: graft function, return to dialysis, or death. Each year, recipients beginning with a functioning graft would end in one of these three conditions. Patients who return to dialysis would end the following year in one of two conditions: survival on dialysis or death. Patients that end a year with death exit calculations at that point. The probability of ending a period in a given condition is dependent on the entry condition, the year, and the receipt of a LURD kidney, dialysis, or death. Similarly, the outcomes, quality-adjusted life years (QALYs), and cost associated with each condition are dependent on the entry state and the period. The possibility of retransplantation after return to dialysis was not modeled explicitly but was included in the estimates of return to dialysis probabilities and outcome.

Adding a vendor kidney to the system removes a patient from the waiting list who would have otherwise received a cadaver organ now available for another patient. The second patient would receive an organ now available for a third patient and so on. This pattern continues until a patient undergoes a transplant who would have otherwise died awaiting transplant. Therefore, the limiting factor to

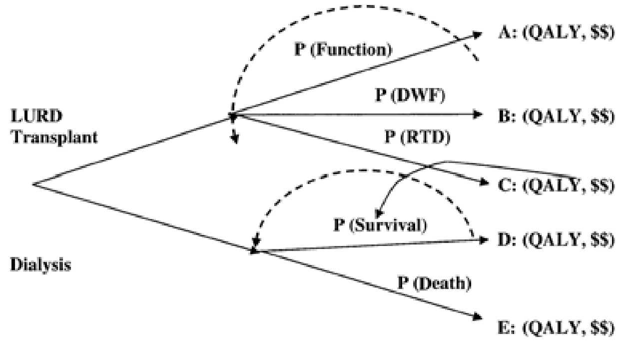

Figure 1: Tree diagram representation of possible outcomes for patients waiting vs. receiving a vendor kidney. In each period following transplantation, a patient and his or her allograft will survive to the next period, or the allograft will fail with the patient returning to dialysis (RTD), or the patient will die with graft function (DWF). An additional organ transplant from any source shortens the waits of a string of patients limited by the death rate while waiting. This averages to one expected lifetime on dialysis for a wait-listed patient. Therefore, outcomes for the reference patient are calculated for a lifetime on dialysis. Each period for this patient will end with continued dialysis or death. The probabilities of events and associated outcomes were estimated from the actual experiences of LURD kidney recipients and patients wait-listed for transplant as recorded in the USRDS database. Relisting and retransplantation outcomes were included in the estimates of outcomes associated with return to dialysis. Calculations were run through 20 years post-transplant. Each outcome is associated with a cost and an impact on quality-adjusted life years (QALYs).

the benefits of additional organs for transplant is the death rate while waiting, and the average effect of adding a vendor kidney is the removal of one lifetime of dialysis from the system. Thus, for reference, the outcomes and cost were compared for a patient receiving a hypothetical LURD vendor kidney vs. a hypothetical patient waiting a lifetime on dialysis. This patient waiting on dialysis will end the first year in one of two states: continuing dialysis or death.

The length of a calculation period was 1 year, with a 20-year timeframe. Within this time frame, the probabilities of all possible outcomes, with associated QALYs and costs, were calculated for receipt of a vendor kidney vs. remaining on dialysis. All monetary values and QALYs were discounted at a rate of 5% per year (36).

The primary measure of interest in the study is expected financial savings to the health care system (US dollars, 2002) of using a vendor kidney. We also calculated the expected change in QALYs with the use of a vendor kidney. From an accounting perspective, society would 'break even' if a kidney vendor were paid the amount saved by using a LURD kidney. From a cost-effectiveness perspective, society would 'break even' if a kidney vendor were paid an amount so that the cost of care and vendor payments per QALY were equivalent to a lifetime of dialysis.

Data

Patients were drawn from the US Renal Data System (USRDS). All patients wait-listed for a cadaver transplant or receiving a LURD transplant between 1995 and 1999 were included in the analysis. Patients were excluded from the analysis if Medicare was not their primary insurer. Transplant patient and graft survival, and dialysis patient survival, were estimated from the USRDS and calculated using Cox regression analysis for 2757 LURD recipients and 24 333 dialysis patients wait-listed for transplantation.

Direct measures of quality of life were not available in the USRDS database. Therefore, utility values for life on dialysis compared with transplant were drawn from the literature (39). These utility scores were used to adjust years of life to QALYs.

Organ procurement costs including evaluation, testing, surgery, and recovery are not directly measured by the USRDS database. These were estimated using cost-accounting figures from the University of Minnesota and Washington University transplant programs.

Statistics

Patient and graft survival rates were calculated using multivariate Cox regression analysis. Medicare costs were calculated using linear regression. Results were adjusted to mean patient characteristics for recipient age, race, gender, degree of immunologic sensitization, diabetes, and insulin dependence; for donor age and gender; and for cause of ESRD duration of pretransplant dialysis, HLA mismatches, and year of transplant. Wait-listed patient survival while on dialysis was calculated using methods described by Wolfe et al. (2) and adjusted to mean patient characteristics for age, race, gender, cause of ESRD, and blood type.

Table 1: Input values for calculations of costs and benefits for the model

Utility scores	
Dialysis	0.68
Transplantation	0.84
LURD donor and dialysis costs	
Initial cost (transplant hospitalization)	$29 201
Organ procurement cost	$15 000
Initial cost (first 12 months excluding transplant hospitalization)	$28 492
Total first year cost: transplantation	$72 693
Maintenance cost: transplantation (months 12–24)	$12 814
Cost first year post graft loss	$136 338
Excess cost of graft loss over dialysis	$94 508
Maintenance cost: dialysis: year before transplant	$41 830
Annual increase in dialysis maintenance costs	$268
Cost year before death on dialysis	$93 985
Excess cost of death on dialysis	$52 155
Cost year before death with function	$83 471
Excess cost of death with function	$70 657
Discounting and willingness to pay	
Discount factor for quality-adjusted life years	5.0%
Discount factor for costs	5.0%
Graft survival	
LURD graft survival at year 1	94.3%
LURD graft survival at year 2	91.8%
LURD graft survival at year 3	89.1%
LURD graft survival at year 5 (not ECD)	82.0%
Long-term graft loss rate (calculated from year 3 through year 5)	4.1%
Other parameters	
Rate of graft failure from death with	42.5%
function	16.8%
Death risk after graft loss (within 1 year)	
Death risk after graft loss (through year 2)	24.6%
Death risk after graft loss (after 1 year)	7.8%
Wait list survival	
Four-year patient survival on the wait list given 2-year survival	87.1%
Long-term death rate on the wait list (calculated as rate from years 2 to 4)	6.7%

LURD = living unrelated donor.

Results

Input values

Input values for calculations obtained from the USRDS are seen in Table 1.

Calculation results

The estimated present value of medical care expenses through 20 years post-transplant was $277 600 for the recipient of a LURD kidney transplant. This is contrasted by the expected present value of medical care expenses for a dialysis patient at $372 179. The difference of $94 579, the expected average savings in medical care generated by a vendor-donor, would be the payment that could be made to vendor-donors without increasing the cost of ESRD care, or the financial break-even payment. However, there are additional expected benefits of LURD transplantation. The recipient of a LURD transplant can expect 8.9 discounted QALYs from the point of transplant compared with 5.4 QALYs had he or she remained on dialysis for life from that point, a gain of 3.5 QALYs from transplantation. In cost-effectiveness terms, the monetary value of this benefit is $174 740, if society values the gain in QALYs at the same rate paid per QALY on dialysis. Therefore, it would be cost-effective to add one vendor to the donor pool if the payment made to that vendor for donation was no more than $269 319.

Paying vendor-donors may make it necessary to pay all living donors. Figure 2 plots possible donor payments to all donors depending upon the number of vendor-donors that are obtained. Doubling the number of living donors would allow break-even and cost-effective payments of $47 290 and $134 659, respectively, while paying all living donors.

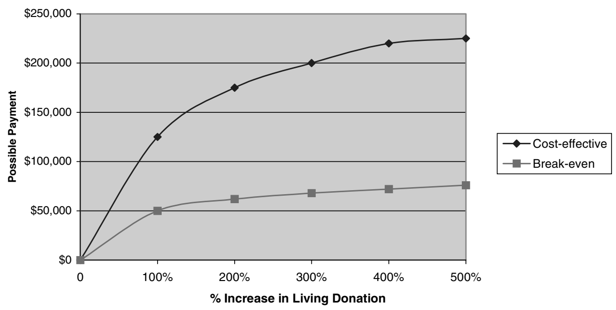

Figure 2: Break-even point to society if all vendors and all current donors were paid. Cost-effective point includes impact of a gain in QALYs.

Increasing the number of living donors by a factor of five would allow break-even and cost-effective payments of $78 816 and $224432, respectively.

The calculations showed limited sensitivity to variations in the majority of parameters using simulation methods based on estimated variances from the data, with the exception of the cost of maintenance dialysis. Our input figure for dialysis costs, $41 830, was estimated from the cost of care the year before transplant for patients on dialysis. The USRDS has estimated the cost of maintenance dialysis to be $67 506 for all dialysis patients (4). Break-even and cost-effective payment estimates jump to $258 615 and $433 355, respectively, using the USRDS figure. However, we believe our estimates of dialysis costs to be more appropriate to this analysis. At a minimum, our estimates are conservative estimates of what could be paid to living donors. The utility of dialysis and transplantation is perhaps the most speculative aspect of our calculations with limited literature to use as guidance. However, varying the utility benefit of transplantation over dialysis by as much as 50% had a limited effect on the cost-effective payment estimate, ranging from $231 202 to 307 436: high in either case. The cost-effective payment estimate remained high even if the utility benefit of transplantation over dialysis were set at zero ($193 085).

Discussion

Altruistic organ donors are true heroes! And nothing should diminish the quality of their wonderful acts. But, for more than 40 years, numerous attempts have been made to increase altruistic organ donation. National and local campaigns, advertisements, and educational efforts have resulted in a modest increase in donation, but the donation rate has been inadequate. Currently, in the United States, more than 50 000 people are on the waiting list for a cadaver kidney transplant (4).

Previous analyses, not including donor payment, have shown that, compared with dialysis, transplantation is a cost-effective treatment for patients with ESRD (40,41). Our analysis suggests that even with a significant payment, transplantation could remain cost-effective. Importantly, although our model incorporated a 20-year period, the calculated potential payment represents the value of the savings as an investment decision. The observed savings over time would be a larger figure, but a decision maker (the government or a payor) is concerned with the value to the stream of returns today.

Our model assumed only a short decrease in waiting time. If the use of vendor kidneys markedly reduced the waiting time, there would be additional savings to the health care system.

In the United States, payment for cadaver or living organ donation is illegal (42). Yet, because of the tremendous organ shortage and the resultant morbidity and mortality while waiting for a transplant, there has recently been renewed discussion about the possibilities of payment. Powerful and emotional arguments have been put forward by proponents and opponents. Our study provides a numeric figure that can help facilitate the debate. We believe that if a policy of payment for organs were developed, a significant payment would be reasonable. The donor has to go through a major operation associated with a risk of mortality, morbidity, and lost income from time out of work. The payment should be sufficient to balance the risks and inconvenience. Because living donation is associated with both the risks of dying and of perioperative complications, we believe the ‘payment’ should include a life insurance policy (e.g. an agreement to pay for term life insurance for 5 years) and a health insurance policy to cover treatment for any surgical complications (e.g. hernia). Because donors would be a selected low-risk population, these policies would be relatively inexpensive.

A debate of the merits of payment for organs needs to be framed correctly. First, payment for living and cadaver donor organs, although somewhat interrelated, needs to be considered separately. Second, payment in a regulated, government-controlled system cannot be confused with payment in an unregulated, uncontrolled system associated with variable donor payment. In addition, the numerous ethical and social ramifications need to be considered. For example, would payment for organs affect other altruistic programs such as blood or marrow donation? Would there be a way to eliminate organ sales by high-risk vendors, e.g. drug addicts? Could noncitizens be vendors (23)?

Finally, studies would need to be performed to determine if paying some donors might lead to a decrease in altruistic donation. In Iran, where a vendor system has been implemented, altruistic donation has continued, but there are concerns that the rate of altruistic donation has decreased (26). In 2002, there were 6235 living donor kidney transplants carried out in the United States in which the donors had no expectation of payment. We feel that if a payment system is implemented, it may need to be offered to all donors. A donor wishing to provide an altruistic donation would have the opportunity to refuse the offer. Of note, our model remains cost-effective, even with incorporating payment for the current number of unpaid donors.

If payment for organs were to be implemented, either nationally or as a pilot in a specific region, the impact on altruistic donation could be studied. Similarly, studies would need to be carried out to determine whether payment for living donation affects cadaver donation, and whether it might also be necessary to develop an incentive program for cadaver donation. One could argue that the cadaver donor does not have the same perioperative and long-term risks. Alternatively, cadaver donation provides numerous life-saving gifts not possible with living donation.

In summary, we have shown that if a vendor system were established for kidney donors, a significant payment could be made to the vendors without increasing the overall costs to the health care system. Further, cost-effective vendor payments of approximately $250 000 are possible. Large payments to all living donors are also possible if sufficient vendor donors come forward. This study is of importance, now that the debate about paid donation is being renewed.

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