The Cost-Effectiveness of Using Payment to Increase Living Donor Kidneys for Transplantation

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Summary

Background and objectives For eligible candidates, transplantation is considered the optimal treatment compared with dialysis for patients with ESRD. The growing number of patients with ESRD requires new strategies to increase the pool of potential donors.

Design, setting, participants, & measurements Using decision analysis modeling, this study compared a strategy of paying living kidney donors to waitlisted recipients on dialysis with the current organ donation system. In the base case estimate, this study assumed that the number of donors would increase by 5% with a payment of $10,000. Quality of life estimates, resource use, and costs (2010 Canadian dollars) were based on the best available published data.

Results Compared with the current organ donation system, a strategy of increasing the number of kidneys for transplantation by 5% by paying living donors $10,000 has an incremental cost-savings of $340 and a gain of 0.11 quality-adjusted life years. Increasing the number of kidneys for transplantation by 10% and 20% would translate into incremental cost-savings of $1640 and $4030 and incremental quality-adjusted life years gain of 0.21 and 0.39, respectively.

Conclusion Although the impact is uncertain, this model suggests that a strategy of paying living donors to increase the number of kidneys available for transplantation could be cost-effective, even with a transplant rate increase of only 5%. Future work needs to examine the feasibility, legal policy, ethics, and public perception of a strategy to pay living donors.

Introduction

There are currently two broad treatments for people with ESRD: dialysis (including its various modalities) and transplantation (including deceased and living donor transplantation). For eligible candidates, transplantation is considered the optimal treatment given that it is far less resource-intensive and associated with improved survival and higher quality of life compared with dialysis (1,2). Although the prevalence of ESRD is increasing in Canada, the United States, and the world (3), transplantation rates have not kept pace (4,5), and new strategies to increase donation are urgently needed.

Currently, living kidney donation relies on donors stepping forward, with no form of compensation or incentive other than reimbursement for expenses related to the donation (in certain jurisdictions). Multiple strategies to increase living donation have been proposed, including limiting financial disincentives for living donors (6–9). Recently, we conducted a survey examining the acceptability of financial incentives to increase the number of kidneys for transplantation (10). Most respondents reported that financial incentives were an acceptable strategy to increase the number of living donor kidneys for transplantation, and nearly one half found monetary payment an acceptable form of financial incentive. Furthermore, over one half of respondents stated that they would be willing to consider donating one of their kidneys while alive to a relative or friend for $10,000.

Although kidney transplantation has been shown to improve outcomes and reduce health care costs compared with dialysis, there is limited information on the cost-effectiveness of additional investment into strategies that may potentially increase the rate of kidney transplantation (11–13). Because previous studies suggest that financial barriers exist to donating organs, providing financial incentives might be an effective strategy for increasing donation rates, which is further supported by our recent survey results. No studies have formally tested the impact of such a strategy. However, before conducting further studies, with their attendant costs and legal, pragmatic, and perception issues, it is logical to determine whether a strategy of financial incentives would be cost-effective. A previous cost-effectiveness study that examined this issue was limited by lack of an appropriate comparator; it compared the outcomes and cost for a patient receiving a hypothetical paid unrelated donor kidney with a patient waiting a lifetime on dialysis, and therefore, it did not consider the impact on the current donations in the system (12). Furthermore, this study is
now 10 years old. Given these limitations, we use contemporaneous information on the cost of dialysis and kidney transplantation along with decision analysis to estimate the cost-effectiveness of a paid living donor strategy compared with the current system of organ donation in waitlisted dialysis patients.

Materials and Methods

Overview

We compared the cost-effectiveness of a strategy of paying living donors to increase the number of kidneys available for transplantation with the current organ donation system, which has no monetary incentive or compensation for donors. Table 1 shows a high-level overview of the analysis.

We used the perspective of the publicly funded health care system. Outcomes included incremental costs, quality-adjusted life years (QALYs) gained over a lifetime, and incremental cost per QALY gained. Costs and benefits were discounted at 5% annually. All costs are reported in 2010 Canadian dollars and were inflated by using the Canadian general consumer price index. Ethics approval was obtained from the University of Calgary Conjoint Ethics and Research Board.

Intervention

We assumed that payment to living donors would occur through an independently monitored system that would act as a third party to remunerate all living donors with a payment of $10,000. We also assumed that the number of living donor transplantations would increase, thus removing recipients from the deceased donor waiting list and slightly lowering the wait time for people awaiting a deceased donor kidney. The same system of evaluation for recipients and living donors would be in place as the current system, and recipients would not be involved in the system of payment. Living donors would still be able to donate to a relative/friend or anonymously to the waiting list, and all living donors would receive payment. In the absence of data from high-quality studies examining the impact of financial incentives on living kidney donation rates, our estimates were based on a recent survey (10), which found that, of those who would not consider donating at baseline, 54% would consider donating to a relative for payment of $10,000 from a third party government payer on donation. Because this survey only measured intent to consider donation, we used a conservative estimate of an increase of 5% in transplants—representing five additional paid living donors in a 100 total transplant/yr program—if $10,000 were offered through a paid living donor strategy to all living donors in the base case analysis and considered a broad range of estimates in sensitivity analyses.

Modeling Strategy

We created a Markov decision model (14) to evaluate the impact of increasing the transplant rates on life expectancy, quality of life, and costs in a fixed cohort of waitlisted dialysis patients representative of a Canadian and US dialysis program. We used decision analysis software (TreeAge Pro 2011, Williamstown, MA) and followed accepted guidelines for economic evaluation (15). To account for the differences in survival and rates of transplantation for younger and older waitlisted patients, our analysis was age-stratified into two age categories (18–50 and 51–65 years). We considered several health states both before and after transplantation; Figure 1 represents a simplified overview of the model for patients on dialysis. Because only 3% of new kidney failure patients receive a preemptive transplant per year, we did not consider these transplants within our model (4).

Model Validity

Model validity was established in accordance with guidelines for best practice in economic modeling (16). Model structure and flow were tested by using null or extreme inputs. We established internal validity by examining model outputs at various time horizons using the current data. Finally, the internal validity of our model was determined by comparing model outcomes at 3 years with published data not used in our model and noting consistent results.

Data Inputs

We created a cohort of patients on dialysis waitlisted for a kidney transplant as of January 1, 2004 and followed them for 3 years using US Renal Data Service (USRDS) data (5). This cohort of patients was similar (based on observed baseline characteristics) to patients in Canada waiting for a transplant. After stratifying into two age categories (18–50 and 51–65 years), we determined annual probabilities of receiving a living or deceased donor kidney transplant, risk of dying while on the waitlist, probability of being removed from the waitlist because of ineligibility arising over time, and probability of returning to the waitlist after failed transplant (Table 2). Because the perspective of the study was taken from a publicly available database, we used the most recent data. In this model, patients on the waiting list were randomized to the current system of payment or to the proposed system with payment of $10,000. We assumed that the number of patients who would accept payment of $10,000 was 54%.

Table 1. Overview of Analysis

| We compared a strategy of paying all living kidney donors $10,000 with the current organ donation system in dialysis patients who are waitlisted for transplantation. |
| In the base case estimate, we assumed that the number of donors each year would increase by 5%—representing an additional five paid living donors in a hypothetical 100 transplant/yr program—if $10,000 was offered, but we also considered a wide range of estimates, acknowledging significant uncertainty in the true effectiveness of such a strategy. |
| Transplantation rates and survival on the waitlist were estimated from a large contemporary cohort of waitlisted dialysis patients, whereas patient and graft survival after transplantation were estimated from a national cohort of patients with ESRD. |
| The cost of dialysis and transplantation were taken from recently published Canadian data. This information was combined with decision analysis to examine the cost-effectiveness of a strategy of paying living donors. |
funded health care system, probabilities for graft failure and death for transplant patients came from Canada using the Canadian Organ Replacement Registry (4) and yearly age-specific risks. To estimate the probability of transplantation, we used data from the USRDS on transplant wait times (5), given that a Canadian source of data on waitlisted patients is not available. Quality of life estimates, expressed as utility scores (ranging from zero [the worst possible quality of life] to one [perfect health]) were taken from the work by Laupacis et al. (1) to value outcomes (Table 3).

Resource use and costs (2010 Canadian dollars) were based on the best available published data (Table 3) (17,18). Given the perspective of the publicly funded health care system, only direct costs to the health system were included, consistent with Canadian guidelines published by the Canadian Association for Drugs and Technology in Health (15). Costs for transplantation for the first and following years (assuming that year 2 costs are ongoing) included recipient and donor transplant surgeries; recipient transplant-related medications; recipient physician costs; recipient outpatient diagnostic imaging, laboratory tests, and outpatient services; and recipient inpatient stays. The cost of dialysis used in this study was calculated as a blend of in-center hemodialysis (79%) and peritoneal dialysis (21%), consistent with current dialysis modality usage in Canada (19). The annual cost of dialysis included dialysis equipment, overhead, supplies, salaries and wages, cost of all access, drugs, and any other resources related to dialysis, and it is detailed elsewhere (17).

The probability of receiving a kidney from a paid living donor was estimated by increasing the total number of transplants from both deceased and living donors by the assumed increase (5% at baseline). This increase would remove some recipients from the waitlist (who are now receiving a paid living donor transplant), thus reducing wait times for deceased donor kidneys for those individuals who did not receive paid living donor transplants. To estimate the magnitude of this reduction in wait times for deceased donor kidneys, we recalculated the probability of receiving a deceased donor transplant after removing people from the waitlist who had received paid living donor transplants.

### Sensitivity Analyses

We performed both univariate sensitivity analyses and scenario analyses for the model and individual parameters, including variables around which the greatest uncertainty was centered: the payment and the effectiveness of the strategy. Our model only included recipients already on the waitlist. Because we recognize that some patients receive living donor transplants without ever being placed on the waitlist (some of whom receive transplants preemptively) and because a payment system may also reimburse these donors, we performed a sensitivity analysis to also examine the impact of paying individuals who donate to recipients not on the waiting list. Although the standard way of expressing uncertainty in classic statistics is through the use of measures of variance, such as the 95% confidence interval around a mean for normally distributed variables, this approach is problematic in economic evaluation and has led to the use of probabilistic sensitivity analysis (20,21). Probabilistic sensitivity analysis enables a...
simultaneous sensitivity analysis of all uncertain variables by replacing estimates of probabilities, utilities, and costs with specific probability distributions, which are based on the reported means and variances of each variable (22). The analysis is then repeated 10,000 times, and different values are sampled from the appropriate distributions for each of the variables. In such a way, a statistical distribution is built up around the incremental cost-effectiveness ratio, giving a better reflection of the uncertainty inherent in the analysis, which is reflected in a cost-effectiveness scatter plot.

Results
Cost-Effectiveness of Paid Living Donor Strategy
Compared with the current organ donation system, a strategy that increases transplantation rates by 5% through paying living donors $10,000 both saves costs and improves
outcomes, with an incremental cost-savings of $340 and a gain of 0.11 QALYs over a patient lifetime (Table 4). If the paid living donor strategy increases the number of kidneys for transplantation by 10% and 20%, this increase would translate into an incremental cost-savings of $1640 and $4030 and an incremental QALY gain of 0.21 and 0.39, respectively.

### Variability of Cost-Effectiveness Strategy

The greatest uncertainty lay around two parameters: the amount of payment to a living donor and the increase in transplantation that this payment would elicit. We varied both the payment ($10,000–$50,000) and the increase in transplantation (1%–50%) simultaneously and found that the paid strategy was always more effective; however, with lower increases in transplantation (1% or 2%), the strategy is not cost-saving (Figure 2).

### Univariate Sensitivity Analyses

Figure 3 shows the results of univariate sensitivity analyses for select variables. In addition to varying the amount paid and the effectiveness of the paid living donor strategy (described above), the model was most sensitive to the cost of living donor transplantation and the annual costs of dialysis. Lowering dialysis costs to the lower bound of the 95% confidence intervals (Table 3) and increasing the cost of living donor transplantation to the upper bounds of the 95% confidence intervals (Table 3) made the paid living donor strategy more costly, with an overall cost per QALY gained of $2870 and $6400, respectively. The overall cost per QALY gained was not sensitive to plausible variations in the remaining estimates. Because our data were based strictly on waitlisted dialysis patients, our base case analysis did not consider payment to living donors who donated to recipients who were never on the waitlist. Assuming that, in any given transplant program, the number of living donors who donate to someone on the waiting list is equal to the number of living donors donating to someone not on the waiting list, the strategy of paying all living donors is no longer saving costs and results in an incremental cost per QALY gained of $5760.
Probabilistic Sensitivity Analysis

The results of the probabilistic sensitivity analysis are presented in Figure 4 using base case assumptions, including a payment of $10,000 and an increase in transplantation by 5%. When variation for the estimates was considered simultaneously for other variables, the paid living donor strategy was always more effective than the current system of organ donation; however, the cost varied from cost-saving to more costly.

Discussion

Because transplantation provides better health outcomes and is less costly than dialysis, potential strategies that may increase kidney transplantation need to be examined in the context of any possible incremental costs. Numerous attempts have been made to increase the pool of potential donors and include the introduction of deceased donor registries, national and local awareness campaigns, educational efforts, and paired exchange programs among others. However, transplantation rates have not increased over the last decade, and the deceased donor waiting list continues to grow, particularly in the United States. Our model showed that a strategy where living donors are paid $10,000, with a corresponding assumption that this strategy would increase the number of transplants performed among waitlisted dialysis patients by 5%, would be less costly and more effective than the current organ donation system. Even with a conservative estimate of a 1% increase in transplantations, the cost per QALY gained would be under $10,000, which falls well within proposed Canadian and international cost-effectiveness thresholds (23). Because our model was based on small incremental increases in transplantation, the results were small incremental increases in both cost and effectiveness. Our results differed from a previous cost-effectiveness study by Matas and Schnitzler (12) that showed that a strategy of paying living donors would be cost-effective with payments up to $100,000. Their comparator, however, was not the current organ donation system but patients who remain on dialysis; it did not take into account current transplantation rates, and overestimated the effectiveness of the payment system (12).

Determining the cost-effectiveness of strategies to increase kidneys for donation by paying living donors is challenging, because there are no trials definitively establishing the net impact that payment would have on living donor rates. We did, however, show that a paid living donor strategy is attractive from a cost-effectiveness perspective, even under conservative estimates of effectiveness. These estimates of effectiveness, although assumptions, were based on a survey where 54% of those individuals who previously would not consider donating while alive would consider donating a kidney to a relative for a payment of $10,000. The theory of planned behavior states that behavioral intention is a function of one’s attitude toward performing the behavior, their perception about the behavior, and their control over initiating the behavior (24,25). Although this theory cannot predict how many people are likely to pursue their action, their attitude to this behavior

Figure 2. | Two-way sensitivity analysis: cost per QALY gained for varying payments to living donor ($10,000–$50,000) and varying increases in transplantation.
Figure 3. Tornado diagram representing the incremental cost-effectiveness ratios of one-way sensitivity analyses under base case conditions.

Figure 4. Incremental cost-effectiveness scatter plot of a strategy of paying living donors compared with the current organ donation system.
was shown to be positive, and our estimate of 5% could be considered conservative. Furthermore, our analysis remains economically attractive if donation rates increased by only 2% (that is, an additional two paid living donors per year in a 100 total transplant/yr program).

We made several assumptions in our analysis. The first assumption is the choice of payment of $10,000; we justify this choice as our base case estimate, because our survey suggested that this payment may be sufficient to motivate additional potential donors. The second assumption is that, under base case conditions, living donors donating to recipients who are not waitlisted were not paid. We did, however, consider paying these donors in a sensitivity analysis and noted that a strategy of paying these living donors remained within acceptable cost-effectiveness ranges. The third assumption is that outcomes for paid living donors would be the same as outcomes for nonpaid living donors, which could be examined with additional work. Finally, the fourth assumption is that a strategy of paid living donors would result in a net gain of living donors with no impact on current deceased donation rates or living donation rates. This last assumption can only be tested in a controlled setting.

Our model has limitations. We did not incorporate any attendant costs of administering a strategy to pay living donors, because these costs are not known and may be significant. We used a health care payer perspective, thereby excluding costs such as time off work for dialysis, donation, and transplantation. However, out-of-pocket costs to patients, including donors, would not differ between the paid strategy and the current organ donation system. Although our source of inputs came from two different sources, both sources are large national datasets with comparable characteristics of patients and outcomes. This study cannot evaluate the merits or ethics of a strategy of paying living donors. The payment strategy examined here would be from a third party government payer and not the context of free market or organ trafficking, both of which we oppose. This study addresses one aspect of the uncertainty of implementing a strategy using financial incentives, namely cost-effectiveness, although there are a number of other important considerations with a strategy of paying living donors, including feasibility, legal policy, ethics, and public perception, which will need to be examined further with future work.

Currently, in Canada, there is no compensation or incentives for living donors, although reimbursement of expenses incurred by donors is permitted. Given the increasing waitlist, to address the shortage of organs, it is clear that new strategies need to be considered to increase the pool of potential donors. Preliminary survey data have suggested that financial incentives are acceptable to the Canadian public. This study shows that paying living donors may be considered attractive under a cost-effectiveness framework if transplant rates increase by only 5%, a conservative estimate. Future work should focus on addressing other important considerations and potential challenges related to the implementation of a strategy to pay living donors.

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Disclosures

None.

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