Introducing Incentives in the Market for Live and Cadaveric Organ Donations

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Organ transplants began in 1954 with a kidney transplant performed at Brigham & Women's hospital in Boston. But such procedures only began to take off with the development in the 1970s of immunosuppressive drugs that could prevent the rejection of transplanted organs. Since then, the number of kidney, liver, heart, and other organ transplants has grown rapidly, but not nearly as rapidly as the growth in the number of persons with defective organs who desire transplants. The result has been longer and longer queues to receive organs. Seriously ill individuals often die while waiting for transplants.

When an economist sees a persistent gap between demand and supply—as in the demand for and supply of organs for transplants—the next step is usually to look for obstacles to equilibrating that market. Such obstacles are obvious in the market for transplants since very few countries—with the exceptions of India in the 1980s and the early 1990s and Iran starting in 1988—allow monetary incentives to acquire organs either from living individuals or from cadavers. This paper argues that monetary incentives could increase the supply of organs for transplant sufficiently to eliminate the large queues in the organ market, and it would do so while increasing the overall cost of transplant surgery by no more than about 12 percent.

The few papers that have discussed using monetary incentives have concentrated on increasing the supply of organs from cadavers (for example, Cohen, 1989; Becker, 1997; Kaserman and Barnett, 2002; Epstein, 1993). We instead stress the potential from using incentives to elicit more live donations, although we also

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consider the use of monetary incentives to obtain cadaver donations. Live transplants already account for almost half the kidney transplants in the United States and for almost 8 percent of liver transplants.

We begin by discussing some salient empirical features of the supply and demand for organ transplants in the United States with a few comparative statistics for other nations. The emphasis is on the growing list of persons in need of transplant surgery. We then consider characteristics of living donors and estimate how much it would cost to increase the supply of organs for live transplants sufficiently to eliminate any significant waiting for organs. We contrast the issues involved in paying to get organs from cadavers with those involved in getting live donors and argue that in several respects live donations are less subject to abuse and corruption. Interestingly, our analysis indicates that the market equilibrium price for kidneys, and perhaps also for livers, will be determined by live donations— even though most organs would come from cadavers. Finally, we consider various objections, on moral and other grounds, to paying for organs.

The Market for Organs for Transplant Surgery

The number of kidney transplants has increased slowly in recent years, from about 10,000 in 1990 to over 13,700 in 2005, as shown in Figure 1.[1] Most of these additional kidneys came from an increase in the number of live donors, so that by the early 2000s, almost half of all kidney transplants used live donors. Part of this increase can be attributed to the growing use of laparoscopic nephrectomy (the name for the surgical procedure of removing a kidney), a minimally-invasive procedure with equivalent recipient outcomes and lower donor morbidity relative to traditional open nephrectomy.

However, this modest increase in kidney transplants has not been remotely close to the surge in demand. Almost 17,000 persons were waiting for a kidney transplant in 1990. But this number grew rapidly, so that about 65,000 persons were on this waiting list by the beginning of 2006. Part of the increase can be attributed to technological progress that reduced the cost of organ transplants and made them safer during the past 15 years. A larger part can be attributed to the sustained increase in waiting times to receive an organ due to the inability of the current system to procure enough organs.

A rough way to estimate waiting times for a kidney transplant is to divide the total number on the waiting list for a kidney by the annual number of transplants, which suggests a waiting time of about five years. However, the median wait turns out to be shorter than this estimate because not everyone on the waiting list

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[1] The data and analyses reported in the 2005 Annual Report of the U.S. Organ Procurement and Transplantation Network (OPTN) and the Scientific Registry of Transplant Recipients (SRTR) have been supplied by the United Network for Organ Sharing (UNOS) and the University Renal Research and Education Association (URREA) under contract with the U.S. Department for Health and Human Services (HHS). The authors alone are responsible for the reporting and interpretation of these data.

Figure 1

Kidney Transplants: Total Number of Transplants, Living Transplants, and Total Number of Persons on the Waiting List in the United States: 1990–2005
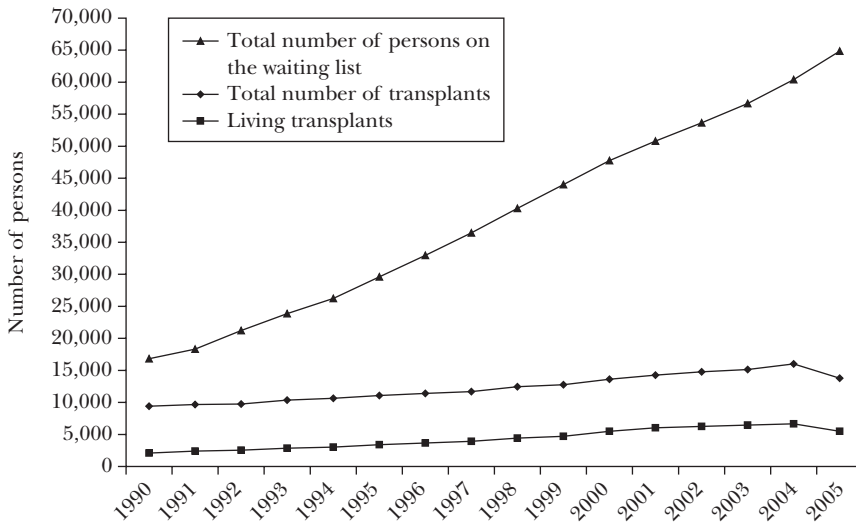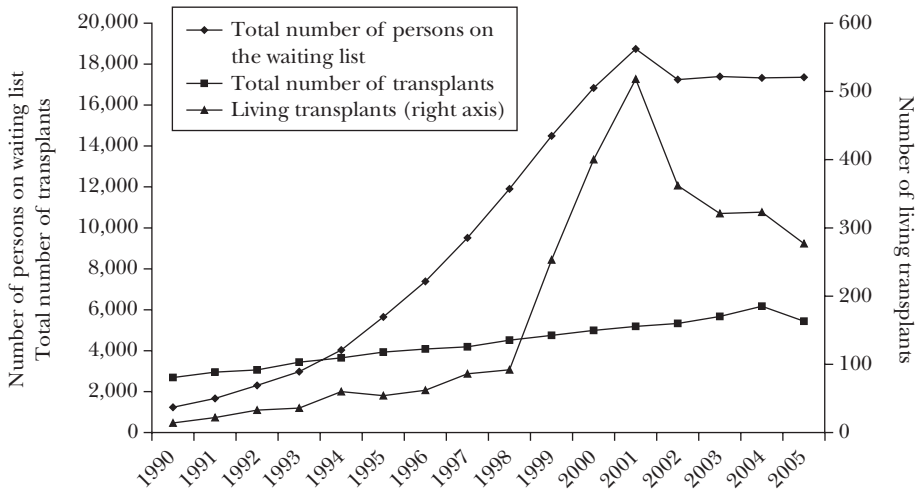

Source: United Network for Organ Sharing.

eventually receives a kidney. Some die. Some become too sick to go through transplant surgery. Some go abroad to get a transplant. Some decide to remain on kidney dialysis. Still, both waiting times and the number waiting for a kidney transplant increased sharply since 1990, and both statistics indicate that persons who need a kidney transplant must wait a long time before they get one.

Liver transplants have followed a roughly similar pattern, as shown in Figure 2. Over the 1990–2001 period, the number of liver transplants almost doubled to reach about 5,000 by 2001. But the waiting list grew much faster. It increased from about 1,200 persons in 1990 to over 18,700 by 2001, or to about three and half times the annual number of liver transplants.

In 2002, however, the number of persons on the waiting list for liver transplants declined to 17,200 and remains very stable through the end of the data. This sharp decrease in the number persons on the waiting list can be attributed to the introduction of the Model for End-stage Liver Disease and Pediatric End-stage Liver Disease (MELD/PELD) allocation system in 2002. Most of the decrease can be accounted for by noting the increase in the number of removals from the waiting list for "other" reasons (607 persons compared to 28 persons in 2001); "condition improved" (567 compared with 23 in 2001); and "too sick to go to transplant" (198 compared to 14 in 2001). These unusual changes in removals from the waiting list occurred because "when centers were required to re-examine wait-listed patients when the MELD/PELD system was first implemented, they may have then found patients who were not appropriate candidates for transplantation" under the previous system (United Network for Organ Sharing, 2003).

Figure 2

Liver Transplants: Total Number of Transplants, Living Transplants, and Total Number of Persons on the Waiting List in the United States: 1990–2005

Source: United Network for Organ Sharing.

Liver transplants with live donors were pioneered by Dr. Christoph Broelsch and others starting in the late 1980s. Only 14 such transplants took place in 1990. They grew at a rapid rate over the succeeding decade to peak at 518 in 2001. But live liver transplants are still less than 10 percent of all liver transplants. The main reason is the shortage of donors, not the risks of the surgery. As we show later, the safety of live liver transplant surgery has considerably improved and now poses only a small, although real, risk to donors.

The median waiting time to get a liver transplant increased from under 50 days in 1990 to about 670 days in 2001. In 2002, with the introduction of the MELD/PELD allocation system, waiting time declined to 430 days. When waiting times declined after 2002, living donations also fell by over 30 percent, which suggests that living donations respond to family pressures. Median waiting times to get a liver transplant are considerably less than the waiting time estimated from the ratio of the number on the queue to the number of liver transplants. The reason is that a larger fraction of people who need liver transplants die or become too sick to endure transplant surgery while waiting for livers than while waiting for kidneys: specifically, 13 percent for livers versus 7 percent for kidneys in 2005. Many persons in need of a kidney transplant can remain on dialysis while waiting—although prolonged use of dialysis often leads to diabetes and other diseases. However, persons in need of a liver transplant usually have no good temporary alternative available.

People suffer and die while waiting for organ transplants. With regard to kidney transplants, 1,000 people died in 1990 while waiting for a kidney transplant; from 2003 to 2005, between 3,500 and 4,000 died each year. With regard to liver

Table 1

Kidney Transplants in 2005: Total Number of Transplants, Living Transplants, and Number of Persons on the Waiting List
(***per million of population***)

	Total number of transplants	*Living transplants*	*Number of persons on the waiting list*
Germany	30.5	6.3	104.5
Spain	50.3	1.9	96.4
United Kingdom	29.1	9.1	94.9
United States	46.2	18.4	217.4

Source: Own calculations using data from Eurotransplant; Organizacion Nacional de Transplantes; UK Transplant; United Network for Organ Sharing; and the Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat.

transplants, about 315 died in 1990 while on the waiting list for a transplant; since 1999, between 1,500 and 2,000 have died each year. In 2000, over 80 percent of the patients who died while waiting for an organ belonged to the group with the *least* urgent degree of severity of liver disease according to the status code of medical urgency in the Organ Procurement and Transplantation Network (OPTN) classification. Even though death rates for patients in the least urgent groups are lower than in the most urgent group, they apply to a larger fraction of the total number of patients who die while waiting, because there are more people in the least urgent categories than in the most urgent categories.

One way to measure the gap between demand and supply for organ transplants is to compare the annual number of transplants with the annual number who join the queue in need of a transplant. This gap equals the annual growth in the waiting list plus the number who leave the list because of death and other reasons. We estimate the gap between demand and supply from the growth in the waiting list in any year plus the number who died while waiting for a transplant over the year. By this measure, excess demand equaled 2,500 persons in the kidney market and under 1,000 persons in the liver market in 1991. The gap grew in virtually every year, and by the year 2000, reached almost 7,000 for kidney transplants and over 4,000 persons for liver transplants. In addition, in 2005 over 1,070 persons left the kidney waiting list (1.6 percent of the waiting list) and about 600 left the liver waiting list (3 percent of the waiting list) because they became too sick to undergo transplant surgery.

Long queues for transplants are not unique to the United States, but are found in other nations as well. Table 1 lists, for several nations, the total number of kidney transplants in 2005, the number of live transplants, and the size of the waiting list per million of population. These numbers are generally smaller per million of population than numbers under the American program.

Moreover, live donors constitute a much smaller fraction of all transplants in other nations relative to the United States. The average waiting time in other nations, including Germany, Spain, and the United Kingdom, is large, but smaller than in

Figure 3
The Market for Kidney Transplants and Payments to Live Donors
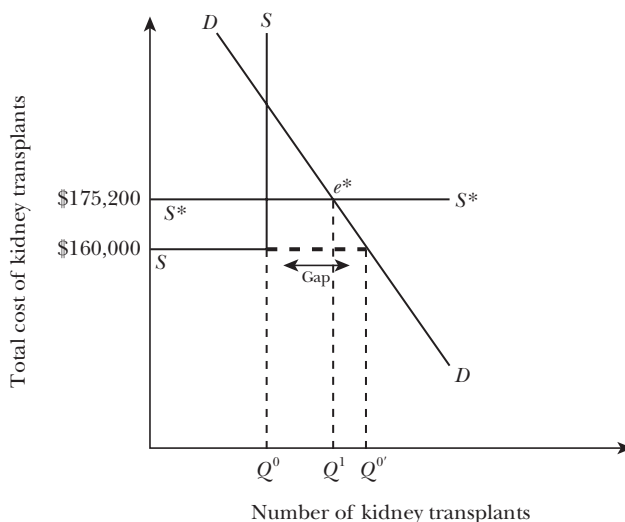
Note: SS is the supply curve if there are no payments to donors. *S*S** is the supply curve with payments to donors. We assume the cost of a kidney transplant is $160,000; monetary payments to donors of $15,200 increase total cost to $175,200.

America—estimated from the ratio of the waiting list to the annual number of kidney transplants at about two years for Spain and over three years for Germany and the United Kingdom. This may be because governments and private insurance companies in these nations impose harsher eligibility conditions for publicly subsidized or insurance-paid transplant surgery, so the waiting list for such surgery is shorter.

Monetary Incentives and Economic Analysis

The present legal market for kidney transplants can be represented by the supply curve *SS* and the demand curve *DD* in Figure 3, where the horizontal axis measures the number of kidney transplants, and the vertical axis the total cost of a typical kidney transplant. In most nations, the cost of transplant surgery is mainly borne either by governments or by private health insurance companies. Their willingness to qualify individuals for this expensive surgery increases as its cost declines. This is the main reason why the effective quantity demanded, given by the curve *DD*, increases as costs fall.

Demand by wealthy individuals who finance much of their own transplant costs clearly also tends to be negatively related to costs. Under the present system, it appears that some use the black market in other places, such as in some South Asian and African countries, to pay either for live donors or for organs from cadavers to reduce their waiting times.

When donors or their heirs receive no compensation for their organs, one

would not expect the supply of organs to depend much on the price above the cost of the surgery. This is why the supply curve for either live or cadaver legal transplants is a backward *L*-shape. The horizontal segment corresponds to the average cost of kidney transplants, and the supply curve becomes vertical, or independent of price, at the number of total altruistic donors Q^0.

We assume in Figure 3 that the average cost of a kidney transplant is $160,000. At that price, the quantity demanded of kidneys (given that government or private insurance is paying most of the cost) exceeds the quantity supplied, and a waiting list develops. The gap would be smaller at higher costs because quantity demanded is reduced by a rise in cost. Thus, the technological progress that reduced the cost of organ transplants and made them safer during the past 15 years raised excess demand and waiting lists by encouraging greater demand.

Monetary payments to donors or their heirs would increase the total cost of transplants, since costs would include such payments. But since higher payments would also elicit a larger number of organs, they would rotate the vertical part of the supply curve clockwise, so that the supply curve would shift from *SS* to *S*S**. If government subsidies or private insurance covers payments to donors, a legal market would affect the location of demand functions by redistributing some demand from the black market to the legal sector and by encouraging more patients in need of organs to apply since the wait would be sharply reduced. But still, monetary incentives would help close the gap between quantity supplied and quantity demanded both by increasing the number of organs available and by raising the total cost of transplant surgery.

In fact, monetary incentives should change the supply of organs from being completely inelastic with respect to costs to being highly elastic. The reason is that the number of potential useable organs from live donors and cadavers, especially live donors, is very large compared to the number of transplants. But the present system blocks almost all of this potential supply by disallowing payments for organs. We provide rough estimates of what it would cost to use financial incentives to attract enough live donors to close the gap between supply and demand.

The Price of an Organ

Donating an organ for transplantation may affect an individual's quality of life, risk of mortality, and ability to perform market and nonmarket activities for some period of time after the surgery. How much pay is required to induce an individual to sell an organ? We estimate the value or price of an organ from living donors by computing how much additional income or market consumption an individual will require to be indifferent between selling an organ or not. Specifically, we assume that the reservation price of an organ has three main additive components: a monetary compensation for the risk of death, a monetary compensation for the time lost during recovery, and a monetary compensation for the risk of reduced quality of life.

The monetary compensation required by an organ seller to face the risk of dying as a result of the transplant, the first component of the reservation price, will be given by the risk of dying multiplied by the money premium required to bear a

small increase in the probability of death. This last factor, referred to as the value of a statistical life, has been estimated empirically in many studies from risky market activities that involve tradeoffs between money and fatality risks. Based on these studies, the average value of a statistical life of a young person in the United States, expressed in 2005 dollars, is between about $1.5 million and $10 million per statistical life; this is for someone with an average annual income of approximately $35,000 (Viscusi and Aldy, 2003).

The risk of a donor dying as a result of a kidney transplant can be estimated based on three large American surveys covering nearly 10,000 operations, as well as from single center reports (Bia et al., 1995; Johnson, Najarian, and Matas, 1997; Bay and Herbert, 1987; Kasiske, Ravenschraft, Ramos, Gaston, Bia, and Danovitch, 1996). In this data, the reported death rates range from 0.03 to 0.06 percent. According to the Maria Lea Johnson Richards Transplantation Center at the New York University School of Medicine, the risk of death from the surgery is estimated to be less than 1/100 of 1 percent. Even these estimates probably overstate the risk of death for young, healthy donors because a number of the current live donors, such as parents, are not young. We will conservatively estimate that the risk of death from donating a kidney is 0.1 percent. Assuming a value of a statistical life of $5 million, as in Murphy and Topel (2003), this means that a 1/1000 increase in the probability of dying to a young kidney donor would be valued at $5 million x 0.1 percent, or at $5,000.

The monetary compensation for the time lost during recovery, the second component of the reservation price, will be given by forgone earnings. One of the main determinants of the value of statistical life is the level of income of individuals. As mentioned before, a value of life of $5 million is for a person with an average annual earnings of $35,000 approximately. Such a person would suffer $2,700 in foregone earnings as a result of not working four weeks due to the surgery.

The monetary compensation required by an organ seller to face the risk of a reduced quality of life, the third component, will be given by the expected change in the quality of life multiplied by the money premium required to bear a small decrease in the quality of life. We do not have good way to value the effects of donating a kidney on the quality of life.[2] A few studies suggest that persons who donate one kidney can live normal lives, except if they are athletes or engage in other activities with considerable physical contact that can damage their remaining kidney. Some studies report that living donors may have a greater chance of developing high blood pressure. For now, we arbitrarily add a generous $7,500 to

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[2] Many studies have documented the excellent results of living organ donation in developed countries. Johnson et al. (1999) sent a questionnaire to 979 who had donated a kidney between August 1, 1984, and December 31, 1996. Of the 60 percent who responded, the vast majority had an excellent quality of life. As a group, they scored higher than the national norm on a standardized quality-of-life health questionnaire. While 4 percent were dissatisfied and regretted the decision to donate, an overwhelming 96 percent would donate again. Jacobs, Johnson, Anderson, Gillingham, and Matas (1998) studied 524 donors, who had a higher quality of life than the general population, and 96 percent would donate again. For the 55 kidney donors evaluated by Corley, Elswick, Sargeant, and Scott (2000) all quality-of-life scores were high. Of the 167 donors in the study by Schover, Streem, Boparai, Duriak, Novick, and Litwin (1997), 90 percent would make the same choice again, and 83 percent would strongly encourage others to donate.

Table 2
Price of Kidney: International Evidence

Country	Year	Price of a kidney in local currency	Price of a kidney in 2005 U.S. $[h]	Equivalent cost of kidney in U.S., in 2005 U.S. $[i]
Iran[a]	1997	10 millions rials	$1,480	$8,536
Iran[b]	1996	3.5 millions rials	$518	$2,989
India[c]	1985–1999		$1,177[d]	$17,655
England[e]	1990	2,500–3,360 pounds	$6,260–$8,413	$9,077–$12,199
India[f]	1984–1988	40,000–50,000 Indian rupees	$4,281–$5,434	$64,218–$81,510
India[g]	1997	35,000 Indian rupees	$1,139	$17,078

[a,b]Zargooshi (2001a).
[c]Goyal, Mehta, Schneiderman, and Sehgal (2002).
[d]Range $450–$2,660. The persons that sold the kidney during the 1980s, when it was legal, received $1,603 compared with $975 for persons who sold the kidney during the 1990s, when it was illegal.
[e]In 1990, a Harley Street physician was struck off the medical profession after arranging transplant operations in which four Turks were paid between 2,500 and 3,360 pounds.
[f]Salahudeen et al. (1990).
[g]Casual evidence from *Frontline: India's National Magazine,* 1997. Based on two cases of kidney vendors.
[h]Computed using data on exchange rates and price index from IMF.
[i]Own calculations using data on income per capita from World Development Indicators Database, 2002, World Bank.

measure the quality-of-life component of the price. In the next section, we return to the problem of measuring this component of the price and perform a sensitivity analysis to see how the results that follow might change.

Adding these components gives a total expected cost to donors of $15,200. Relative to the number of persons who need a kidney transplant, a very large supply of live kidney donors would be available at about $15,200 per donor.

To check our numbers, we present, in Table 2, some estimates of the price paid for kidneys in various international settings. Payment to live kidney donors was sometimes legal in India during the 1980s and early 1990s, and payment was common even when it was officially illegal. The average price paid per kidney in India (row 3 of Table 2) was $1,177 in 2005 dollars. This estimate was computed by Goyal, Mehta, Schneiderman, and Sehgal (2002) from a cross-sectional survey conducted in 2001 among 305 individuals who had sold a kidney in India an average of six years before the survey.

Indian real per capita income is about 1/15 of that in the United States when purchasing power parity is used to adjust for cost-of-living differences between India and the United States. If, therefore, the Indian payment is multiplied by 15, the data imply a cost of a kidney from a live donor in the United States of about $17,000, a figure close to our estimate. (We ignore the figure listed in row 5, an obvious outlier.) Multiplying by 15 assumes a unitary elasticity of the value of life with respect to income, which is plausible based on existing empirical studies.[3]

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[3] Estimates of the income elasticity of the value of a statistical life, reviewed in Viscusi and Aldy (2003), vary in a wide range from 0.5 to 2.3. Using numerous studies of the value of a statistical life in United

Table 2 also presents data on payments to live kidney donors in Iran in 1996. In Iran, payment to live donors of organs is legal, but the Iranian government outlaws the use of organs from cadavers for transplants on the grounds that it violates the Koran. The implied values in U.S. dollars of these Iranian payments are less than $15,200.

A sizeable fraction of Indians (48 percent of the sample) who were paid for providing a kidney reported bad health experiences afterwards, and so did a considerable fraction (60 percent) of Iranians. Perhaps as a result of this, many (79 percent) asserted that if they could do it over, they would not have sold their kidneys (Goyal, Mehta, Schneiderman, and Sehgal, 2002; Zargooshi, 2001b). Some critics of buying organs have used this evidence to support their opposition to paying for organs (Rothman, 2002). However, the experience in these two low-income nations is hardly comparable to what would happen in the United States or in other advanced nations that began to pay for organs. The quality of the surgery would be far superior, as would be both the pre- and post-care, especially as some of the Indian cases occurred during periods when paying for organs was illegal and occurred in the underground medical economy. The subsequent health of kidney donors in the U.S. health care system has been high.

The cost of organ transplant surgeries varies greatly, not only with the type of transplant, but with the transplant center where the procedure is being done. Ortner (2005) estimates an average direct cost of kidney and liver transplant in the United States in 2005 of $160,000 and $335,000, respectively. These estimates are based on first-year billed charges per transplant and do not include organ procurement costs, which are in the order of $50,000 and $57,000 for kidney and liver, respectively, according to the same source. Since in a market system, procurement costs are expected to be low, we do not include these services in the total cost. In fact the total cost of transplants (i.e. after including the price of organs) may go down because procurement costs should be greatly reduced in a market system.

If the direct cost of a live kidney transplant in the United States is about $160,000, notice that payments to donors have a rather small effect on the total cost of live kidney transplants, but they have an enormous effect on the elasticity of supply. Payments to donors convert supply from being inelastic to being completely elastic at a price that is 9.5 percent above the price without payments—compare *SS* with the horizontal *S*S** in Figure 3.

S*S* intersects the demand function *DD* at the market-clearing point *e**. With payments to donors, the number of kidney transplants would increase, although the quantity demanded may decline from the levels that are producing the current waiting list because the total cost is a little higher. Unless the demand function is highly elastic—which is unlikely—the 9.5 percent increase in total cost due to

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States and international evidence, Viscusi and Aldy (2003) estimate an income elasticity of the value of a statistical life from about 0.5 to 0.6. However, when we recalculate their estimations excluding the three studies about India, which yield unrealistically large values of statistical life, the income elasticity of the value of a statistical life increases to 1.15.

payments to donors would not have a large negative effect on the effective demand for transplants.

The equilibrium number of transplants under the incentives system can be estimated in this framework. Actual quantity demanded at the current market price consists of the actual number of transplants plus the gap of those waiting for transplants. From this total, subtract the change in actual demand due to the change in price. For example, if the demand elasticity is –1, a 9.5 percent increase in price would lower effective demand by about 9.5 percent. With about 13,500 kidney transplants in 2005, and a gap of those waiting for transplants of about 8,000, quantity demanded is 21,500 transplants. So a 9.5 percent decline in quantity demanded is a decline of about 2,040 transplants to 19,460, all of which would be supplied. So after payments to donors, kidney transplants would increase from 13,500 to 19,460, or by 44 percent.

With regard to liver transplants, the risk of a donor dying as a result of a liver transplant seems to be about 1 in 300 at the major transplant centers. More than 2,000 living donor liver transplantations have been performed worldwide, with four donor deaths (Emre, 2001). According to the University of Colorado Hospital, the risk of dying from donating a portion of the liver is estimated to be 1 in 500. According to the Maria Lea Johnson Richards Transplantation Center School of Medicine at New York University, the risk of death from the surgery is estimated to be between 1/100 and 1/500. At a value of life equal to $5 million, a young person would need about $16,700 to compensate for the risk of dying from donating part of a liver.

We assume that liver donors lose nine weeks of work at a total value of about $6,000. We add another $15,000 as a guess about the value of the effect of donating parts of one's liver on the quality of remaining life. Thus, our rough estimate of the total cost of paying the donor is $37,600. The average cost of a liver transplant is about $335,000 in the United States (Ortner, 2005). So our estimated required compensation for live liver donors would add 11.2 percent to total cost.

The demand elasticity for livers is probably less than that for kidneys, since persons with defective kidneys have dialysis as an option. If we assume a demand elasticity of –0.5, then an increase of 11.2 percent in the cost of liver transplants would reduce demand by 5.6 percent. Since total quantity demanded for a liver transplant in 2001, before the new restrictions on demand through the MELD/PELD system were imposed, was about 9,200 (5,200 transplants per year plus a gap equal to about 4,000), a 5.6 percent reduction in demand is a reduction of about 515 persons. Thus, a parallel calculation to the one above for kidney transplants suggests liver transplants would increase by about 3,485—from 5,200 to 8,685—or by 67 percent.

Sensitivity Analysis

The effect on the total number of organ transplantations of introducing monetary incentives computed in the previous section depends on two main factors: 1) the share of the price of organs on the total cost of organ transplantation; and 2) the price elasticity of the demand for organ transplantations. In this

section, we explore the sensitivity of our results to variations in the values of the key parameters of the model.

The estimates for the price of a kidney at $15,200 and of a liver at $37,600 may seem low. Yet these estimates are a direct result of the following four factors: the $5,000,000 value of life drawn from economic research on individuals' willingness to take on risk; the low mortality risk of kidney and liver donations; the expected change in quality of life; and the short recovery period.

Table 3 presents estimates of the price of an organ and its effect on the total number of transplants for different values of a statistical life. The first column shows different values of a statistical life in a range from $2 million to $10 million. The second column calculates the corresponding price of the risk of death, assuming a risk of death of 0.1 percent for kidneys and 0.33 percent for livers.

The third column, the quality-of-life component, is the most difficult to estimate. This component is a combination of the risk of a poor outcome for the quality of life and the severity of that poor outcome. The risk of nonfatal risk injury is assumed to be 1 percent and 2 percent for kidneys and livers respectively, which is a conservative estimate based on the data. We assume that the value of a donor's year of life in the bad state is slightly less, but comparable, to that experienced by an amputee or someone who becomes blind. Using self-reported data on health status, Cutler and Richardson (1997) estimate "quality-adjusted life year" (QALY) weights for an amputee in 1990 of 0.89, and 0.87 for blindness. We assign a QALY weight of 0.85 to a bad outcome from being a kidney or liver donor and a QALY weight of 1 to a good outcome (in this analysis, there are two health states). Thus, the quality-of-life component is calculated as the product of the expected change in quality of life and the value of a statistical life.

Column 4 presents the foregone earnings component, which is constant since we assume the same annual income, $35,000, across estimates. This assumption implies that doubling the value of life will less than double the estimates of the price of an organ.

Adding these components, the price of a kidney will be in a range of $7,600–$27,700 and the price of a liver will be in the range of $18,700–$69,300, as shown in the next column. With a price elasticity of demand for transplants of –1 for kidneys and –0.5 for livers, the implied percentage increase in the total number of transplants lies in a range of 52 to 32 percent for kidneys and 72 to 59 percent for livers (see last column in Table 3). Even with a high, and possibly unrealistic, value of statistical life for potential donors and estimates of the risks that are deliberately high, the effects on the total number of transplants are large.

Gains of Reduced Waiting Time for Transplants

Reducing the waiting times for transplants leads to a substantial gain in terms of health and quality of life. We offer some relevant discussion for kidney transplants, which is by far the most common transplanted organ.

Waiting time is a sizeable risk factor in organ transplantation. The risk of death increases as time passes, and the health and quality of life of patients waiting for transplants deteriorates. Indeed, many patients die while waiting for transplants.

Table 3

Estimation of the Price of Organs for Transplantation and the Impact on the Total Number of Kidney and Liver Transplants under Different Assumptions about the Value of a Statistical Life

Value of a Statistical Life	Risk of Death Component[a]	Quality-of-life Component	Value of Time[b]	Total Price of Organ	% Change in Price[c]	% Change in Total Number of Transplants[d]
Kidneys						
$2,000,000	$2,000	$2,997	$2,692	$7,689	4.8%	52%
$3,000,000	$3,000	$4,496	$2,692	$10,188	6.4%	49%
$5,000,000	$5,000	$7,493	$2,692	$15,185	9.5%	44%
$7,000,000	$7,000	$10,490	$2,692	$20,182	12.6%	39%
$10,000,000	$10,000	$14,985	$2,692	$27,677	17.3%	32%
Livers						
$2,000,000	$6,667	$5,980	$6,058	$18,705	5.6%	72%
$3,000,000	$10,000	$8,970	$6,058	$25,028	7.5%	70%
$5,000,000	$16,667	$14,950	$6,058	$37,675	11.2%	67%
$7,000,000	$23,333	$20,930	$6,058	$50,321	15.0%	64%
$10,000,000	$33,333	$29,900	$6,058	$69,291	20.7%	59%

Note: The Quality-of-life Component is computed as the product of the expected change in the quality of life and the value of statistical life. We assume a risk of nonfatal injury of 1% and 2% for kidneys and livers, respectively, and that quality of life, as measured on a scale from 0 to 1, decreases 0.15 in case of a bad outcome from being a kidney or liver donor.
[a] Risk of Death Component = Risk of Death * Value of a Statistical Life. We assume a risk of death of 0.1% for kidneys and 0.33% for livers.
[b] Value of Time = Annual Income * Time for Recovery in years. Value of Time for Kidney Transplants = $35,000 * 4 weeks/52 weeks. Value of Time for Liver Transplants = $35,000 * 9 weeks/52 weeks.
[c] % Change in Price of Transplant = (Price of the Organ/Cost of Surgery) * 100. We assume a Cost of Surgery of $160,000 and $335,000 for kidney and liver transplants respectively.
[d] % Change in Total Number of Transplants = {[(Gap + Actual Number of Transplants) * (1 − price elasticity of demand for transplants * % Change in Price of Transplant/100)]/Actual Number of Transplants − 1} * 100.

The benefits of getting immediate access to a transplant are significant. Longer waiting times on dialysis negatively impact the success rate of transplantation and patient survival. Long-term mortality rates are between 50 to 80 percent lower among transplant recipients than among patients on the waiting list (Wolfe et al., 1999; Edwards, Bennett, and Cecka, 1997). Average time to graft failure increases by about one year if the patient receives a transplant immediately instead of waiting three to four years before transplant (Meier-Kriesche et al., 2000).

Perhaps the most egregious effect of the organ shortage on those people who wait is the suffering and the deterioration in the quality of life while waiting for an organ. Most people waiting for transplant are unable to work. The difference in employment rates among people on the kidney waiting list and those who have received a kidney transplant is at least 15 percentage points. Quality of life as measured by a score that ranges from 0 to 1 increases between 0.15 and 0.35 after a successful transplantation as compared to remaining on dialysis (for example, Laupacis et al., 1996; Russell, Beecroft, Ludwin, and Churchill, 1992).

Held and Port (2003) estimate the End Stage Renal Disease patients' willingness to pay to get immediate access to kidney transplantation by computing the increase in the value of life, including medical costs. They estimate the social cost per patient of the prolonged waiting to be $122,700 and the total social cost of the list to be $1.3 billion. We believe, however, that even these large values significantly underestimate the total value of gaining immediate access to a kidney transplant, partly because these authors assume only one transplant per person over their lifetimes.

Live Versus Cadaver Organ Markets

The small literature advocating payments for organs has concentrated on the cadaver market. This focus is not surprising, considering that most organ transplants use cadavers. In contrast, we have focused on the potential for paying live donors. In fact, transplants using live donors have become a larger proportion of both kidney and liver transplants, especially kidney transplants. When live transplants are possible, paying live donors can in some ways raise less thorny issues than paying heirs for organs from deceased individuals. Although our discussion mainly focuses on payment to live donors, we also support payment for organs from cadavers.

One reason why some critics have opposed payment for organs from cadavers is a fear that totalitarian governments and others might kill prisoners or other individuals to get their organs to sell. Although we believe that risk is exaggerated, it would be absent when the payment goes to live donors for their own organs.

Heirs often refuse to allow organs from deceased loved ones to be used for transplant, even if the deceased gave approval. Payment to the heirs would ameliorate this issue. Some nations have tried to overcome the objections of heirs by enacting into law the principle of "presumed consent," which holds that organs from cadavers can be used for transplant unless individuals prior to death expressly indicated that they did not want their organs harvested. We believe that presumed consent is a dangerous principle, and that in the absence of clear directive from the decedent, heirs should control the remains of loved ones. But setting aside this ethical argument, the "presumed consent" organ procurement approach will not eliminate the long queues for transplants. Gay's (2006) theoretical and empirical study indicates that presumed consent systems may reduce rather than raise the number of organs donated, compared to systems of explicit consent (since under a system of presumed consent families may decide not to give organs of deceased who did not register because they wanted to give their organs for transplant use).

The long-term outcome of medical transplantation depends on the quality of the match between organs of donors and recipients, and the "timing" of surgical interventions. Factors like blood type and tissue type determine match quality, and a good match raises the chance that an organ will help a recipient. One shortcoming of cadaver markets is that organs harvested must be transferred immediately to organ transplant surgery. Harvested organs remain viable for transplant for 48 to 72 hours for kidneys, and 24 to 48 hours for livers. These time constraints make it

harder to get an excellent match between organ donors and recipients and lead to more wasting of organs than would happen in a live organ market.

In addition, live transplants give much greater flexibility on timing of transplants than with cadaver organ transplants, so transplant surgery with live donors can take place when both the donor and recipient are in the best possible condition. In particular, live transplants can occur when recipients are in relatively good health.

Partly for reasons of match and timing, the long-term success rate of live organ transplants is generally greater than for cadaver organ transplants. The renal graft survival rates at one year are 89 percent for cadaveric donor transplants and 95 percent for living donor transplants, while the renal graft survival rates at ten years are 35.8 percent for cadaveric donor transplants and 55.8 percent for living donor transplants. For livers, the graft survival rates at one year are 82 percent for cadaveric donor transplants and 82.7 percent for living donor transplants, but the graft survival rates at ten years are 43.7 percent for cadaveric donors and 53.3 percent for live transplants.[4]

Perhaps most crucially, the present gap between demand and supply of kidneys could not be fully met from cadavers, even with full payments for cadaver organs. For their organs to be usable, cadaver donors must have had healthy, well-functioning organs and been free of infections at the time of their death. The majority of cadaveric organs come from accident or stroke victims who have been declared brain dead. In 2000, stroke victims accounted for over 40 percent of all cadaveric donors.

Table 4 presents various estimates from different studies of the maximum potential supply of cadaveric organs. The geographical area and the year considered in the studies are reported in the second and third column respectively. The fourth column of the table reports the estimates of the potential cadaveric donors rates in per million of population. In the last column, we estimate the maximum potential supply of cadaveric donors for the United States by taking the rates of potential donors reported in column four and scaling up to the 2006 U.S. population.

Taking into account the need to have healthy organs, these estimates suggest that between 10,000 and 16,000 of those dying annually are considered medically suitable for organ donation. Since all organs are not always useable from any single cadaver, the number of organs available for transplantation per cadaveric organ donor is limited even further. In 2000, the average number of kidneys and livers recovered per cadaveric organ donor was 1.82 and 0.83, respectively. The average number of kidneys and livers recovered and actually transplanted per cadaveric organ donor are much lower. In 2000 it was 1.57 for kidneys and 0.76 for livers.

These numbers and the number of useable cadavers indicate that the most reasonable estimates of the supply of cadaveric kidneys—in row 6 of Table 4 (the

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[4] See United Network for Organ Sharing (2001, 2003, 2005). The cohorts used to compute the survival rate are 2002 and 2004 for the graft survival rate at one year, and 1989 and 1990 for the graft survival rate at ten years.

Table 4
Estimates of Supply of Potential Cadaver Donors

Study	Population	Year	Donors per million of population	Estimated number of donors in 2006[a]
Bart et al. (1981)	Georgia	1975	43	12,839
		1976–1979	55	16,422
Bart, Macon, Whittier, Baldwin, and Blount (1981)	Georgia, Kansas, Missouri	1975	55[b]	16,422
			116[b]	34,636
National Task Force on Organ Transplantation (see Evans, 1990)	United States	1986	68[c]	20,304
			104[c]	31,053
Nathan et al. (1991)	Pennsylvania	1987	38.7[d]	11,555
			55.2[d]	16,482
Richardson (1990)	Kentucky	1989	48	14,332
Evans, Orians, and Ascher (1992)	United States	1991	28.5[e]	8,510
			43.7[e]	13,048
Gortmaker et al. (1996)	California, Kentucky, Minnesota, and Washington, D.C.	1990	55	16,422
AOPO[g] Death Record Review Study (see Conrad, 2002)	35 Organ procurement organizations in 27 states	1997–1999	40–50[f]	11,900–15,000

[a] Based upon a U.S. population of 298,590,500 in April 2006 (est.).
[b,c,d,e] The two estimates, within a single study, correspond to different definitions of potential cadaver organ donor.
[f] Own calculations using the range of estimates on the numbers of donors from the study and estimates of the United States population in 1999.
[g] Association of Organ Procurement Organizations.

Evans et al. study)—imply a maximum number of cadaveric kidneys harvested between 15,500 and 24,000 (8,510 times 1.82 and 13,048 times 1.82). This overlaps the actual demand for kidneys transplants in 2005 at 21,500. Yet only a fraction of all these potentially useable cadaveric kidneys are likely to be offered for sale, or to be useable even if offered since they may not be matched with any of the potential recipients.

Moreover, once a market for organs is in place, the actual demand would surpass present demand, since currently kidney transplants are only offered to people who have irreversible kidney failure. Other medical or surgical treatments for kidney problems are usually tried before consideration of a kidney transplant. Thus, it is highly unlikely that the full demand for kidney transplants could be met with organs of deceased persons.

This insight is illustrated in Figure 4, which plots the supply curve of kidney organs in a market with kidneys from both cadavers and live donors. This figure assumes a market with a single price for kidneys, no matter what the source, although our analysis suggests that organs from live donors are more valuable to recipients. For simplicity, the demand curve is taken to be the same as that in Figure 3.

Figure 4

Market for Kidney Transplants with Kidneys from both Cadavers and Live Donors
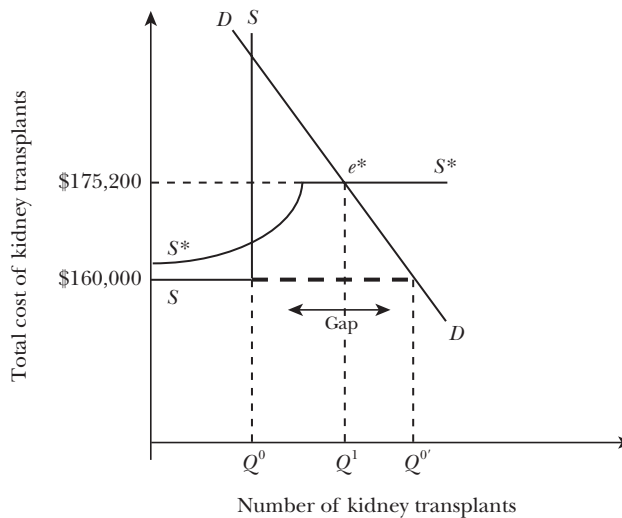
Note: SS is the kidney transplant supply curve with no payments to donors. *S*S** is the supply curve with payments to donors. We assume the cost of a kidney transplant is $160,000; monetary payments of $15,200 to donors increase total cost to $175,200. This figure assumes a market with a single price for kidneys, live or cadaveric.

The supply curve in this market would start just slightly above the cost of surgery, since some cadaver organs would be made available at low or no cost. A rise in price would induce more cadaver organs to be offered, and perhaps even a few from live donors. Eventually, the available organs from cadavers would run out, and the supply price would rise sharply to reach the main market for live donors. At that point the supply elasticity rises sharply because the potential live donor market is huge relative to demand.

If the cadaver market is insufficient to meet the demand for kidney transplants, the supply and demand curves in Figure 4 would intersect where supply is elastic, and where the marginal suppliers are live donors. Donors of organs from cadavers would receive a substantial surplus over the price they would be willing to accept because the market is too big to be supplied entirely by cadavers. The equilibrium price for organs would be similar to the price in Figure 3 which considers only live donors, because live donors would be the marginal donors in a full market equilibrium. Even if most organs were from cadavers, the market clearing price would be determined by the supply of live donors. Consequently, under the assumptions of this section about the number of cadaver organs available, the cost of buying organs to satisfy the demand for kidney transplants is not appreciably affected by integrating into the analysis the significant potential organ supply from cadavers.

The estimates in Table 4 (again using row 6, the Evans et al. study) suggest that the maximum number of livers that could be harvested is between about 7,000 and 11,000 (8,510 times 0.83 and 13,048 times 0.83, with 0.83 being the average number

of livers recovered per cadaveric organ). Since the estimated total demand for liver transplants is 9,200, again it is possible that cadavers could supply all the needed livers if payments were allowed. But if only a quarter of the useable cadaveric livers were not offered for sale, market equilibrium would require live donors. In that case, the equilibrium price would be determined by the cost of livers from live donors. So also in the market for liver transplants, most organs would come from cadavers, but the equilibrium price would likely be determined by the cost of livers from live donors.

Encouraging Living Donors?

In 2004, about 80 percent of living donors and recipients in the United States were related, either as parents, children, siblings, spouses, or other relatives. The first live liver transplant in the United States involved a mother who donated part of her liver to her young daughter. A professional basketball player who earned millions of dollars per year, Gregg Ostertag of the Utah Jazz, donated a kidney to his sister. It is not surprising that family members motivated by caring or altruism supply the overwhelming number of live organ donations when payment to donors is illegal. However, those individuals in need of transplants who do not have sufficiently altruistic relations or who do not belong to a numerous family are largely out of luck under the present system. They must wait years until they become eligible for a useable organ from a cadaver.

Of course, some live donors may not feel very altruistic, but may be under strong family pressure to donate their organs to save the life of sibling or parent. Conversely, some nonrelatives who are sufficiently altruistic to donate their organs are prevented from donating because of suspicions that the donors are being paid under the table.

Most organ procurement efforts in the United States have been directed toward increasing the pool of altruistic donors, whether from cadavers or live sources. An example of this approach is the New England Program for Kidney Exchange, which attempts to increase the number of transplants using a barter system and is limited to altruistic donors. Under this system, kidneys are exchanged between incompatible patient–donor pairs. To reduce the risk that a payment is made in the time between one surgery and another, all surgeries in an exchange are performed simultaneously, which requires coordination of multiple operating rooms and surgical teams. There are 2,300 persons waiting for a kidney transplant in the New England region, and this kidney exchange system has yielded only a couple of dozen transplants so far. The small number of kidney exchanges is not surprising, given the limitations that only kidneys from relatives can be used and the exchange must happen at the same time. This kind of program will only provide a limited increase in the number of transplants.

In addition, the most vulnerable patients are less likely to benefit from these exchanges, because the timing constraints make it harder for them to be able to participate in a simultaneous two-way kidney exchange. Clearly an outcome that is

superior, or at least as good, can be achieved with independent surgeries. This approach would be hard to enforce in an exchange system, since people might refuse the surgery that happens later in time. A market does not require such a barter arrangement, with all its defects.

Criticisms and Evaluation of Monetary Incentives

Proposals to pay for organs, even from cadavers, have been sharply criticized on several grounds. One common criticism is that payment is "immoral" because it involves the "commodification" of body parts. But if women can be paid to host the eggs of other women and bear their children—as they can in the United States— why cannot men and women get paid for selling their organs to save the lives of others? Surely, the moral considerations supporting pay for organs that save lives are no weaker, and for many persons would be stronger, than those supporting pay for the use of wombs to create lives.

In considering the arguments against payment for organ donors, it's illuminating to compare them with the arguments about paying market wages to attract a voluntary army. For example, a first argument against monetary payments for organs is that such payment is undesirable because it involves commodification of body parts. But the voluntary army used by the United States and many other nations allows the commodification of the whole body, since volunteers expose themselves to injury and death if they are sent into conflict. In general, our workplace lets many workers take on jobs that involve higher pay as compensation for some physical risk.

The sale of organs has also been opposed because poor individuals probably would be the main ones who would sell their organs. The argument was also made that a voluntary army would become an army of the poor. This argument is disputable on ethical grounds: Should poor individuals be deprived of revenue that could be highly useful to them, especially when their organs might save the lives of persons who desperately need to replace their defective organs? In addition, the voluntary army did not become an army of the poorest Americans. The very poorest often cannot qualify for the armed forces because they have insufficient education, low test scores, may use drugs, and so forth. Similarly, the organs of low-income individuals who use drugs or have AIDS, hepatitis, or other serious illnesses would be rejected. So probably the healthy poor and middle classes would actually provide most of the organs for live transplants under a market incentive system.

It is also claimed that payment for organ donations from living individuals would encourage impulsive and reckless provision of organs, because donors would not be able to calculate the risks involved. We would require that donors be informed fully in writing and in person of the risks during surgery, the length of the recovery period, and other possible risks. If impulsive donations were a problem, a few weeks cooling off period could be required to give donors sufficient time to change their minds. In fact, some evidence suggests that persons engaging in risky activities often overestimate rather than underestimate the risks, especially when

the risks get much publicity, such as the health risks of smoking (Viscusi, 1990). Similar arguments about impulsive military enlistments and underestimation of military risks were used in discussing the voluntary army, although these do not seem to have been a major problem. True, an enlistment decision is more reversible than the donation of an organ, so a longer cooling off period might be justified for organ donations.

Yet another argument raised against paying for organs is that it might reduce the supply of organs for altruistic reasons. Similarly, critics of the volunteer army claimed that it would be difficult to get volunteer soldiers at a reasonable price, because paying for volunteers would crowd out persons who would otherwise volunteer for patriotic motives. In fact, people have enlisted under a voluntary army for a variety of motives, including patriotism. Similarly, we expect that payment for organs will encourage donors who are somewhat altruistic—but for whom altruism alone is not enough. Remember, altruism alone clearly has been an insufficient motive to fill the demand for donated organs under the present system.

But above all, the most effective answer to the critics of paying for organs is that the present system imposes an intolerable burden on thousands of very ill individuals who suffer and sometimes die while waiting years until suitable organs become available. Increasing supply through payment would largely eliminate their wait.

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