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Cadaveric Kidneys for Transplantation: Is There a Need for More?

Kidney transplantation is rapidly becoming the treatment of choice for end-stage renal disease [1,2]. Unfortunately, the paucity of donor kidneys has inhibited the more widespread application of this modality. A more than ample number of organs go to waste for various reasons.

Original successes with kidney transplantation were observed on transplants from living, related donors. With advances in tissue typing, organ preservation, and immunosuppression, more cadaver transplants have been performed. The 1971 figures from the pooled data of the Human Renal Transplant Registry [3] indicated that 65% of all reported transplants relied on cadaver donors. Of all the transplants performed in the United States before 1 Jan. 1972, 51.2% came from cadaver donors [4]. The early U.S. figures emphasize living, related donor transplants, but today's figures shift more towards cadaver donor transplants. From 1967 to 1971, the U.S. figures [5] rose from about 49% to 65%. In Europe [6] the trend is even stronger. Of all transplants, the current proportion of cadaver transplants has reached 79%.

Is There Really a Need for More Kidneys?

Many people in the medical profession allege an insufficient supply of cadaver kidneys for transplantation. Increasing this supply may be the major goal of kidney disease programs for the near future. Some will constantly point out the long waiting lists of potential recipients within most transplant centers, whereas some will dispute the need for more cadaver kidneys, at least in some geographical areas. In the Boston area, for example, the transplanting hospitals are organized within the Inter-Hospital Organ Bank, Inc. (IHOB). Within the IHOB, each hospital receives certain priorities on a weekly basis with respect to obtaining available cadaver kidneys. The Peter Bent Brigham Hospital (PBBH) has the lowest credit rating, but seems to be performing transplants to capacity.

How then can anyone claim a shortage in cadaver kidneys? Well, transplanting to capacity does not eliminate queues of potential recipients but simply suggests insufficient transplant capacity, or other than optimal allocation of patients among participating hospitals, or both conditions. Moreover, the PBBH accepts almost any recipient. Overall, a slack in available cadaver kidneys does exist. Many feel that a substantial future increase in cadaver kidney procurement will be a major breakthrough.

Dr. Paul Russel, head of the Massachusetts General Hospital transplant program, claims that, although not enough cadaver kidneys exist to meet demand and patients are

Received for publication 20 March 1975; revised manuscript received 6 May 1975; accepted for publication 13 May 1975.

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therefore denied transplantation, the real problems we face are rejection and compatibility. More incompatible kidneys do not assure more functioning transplants. An increase in the number of cadaver kidneys has vital importance if accompanied by a breakthrough in the rejection problem.

The Effect of Procuring More Cadaver Kidneys

We will agree on the need for more cadaver kidneys to meet demand. What effects will more cadaver kidneys have on the system? First, naturally, more transplants will take place. Since many believe that transplantation is the treatment of choice for uremic patients, more kidneys will therefore result in more patients receiving better treatment. However, we have to agree with Dr. Russel's conjecture that, in the absence of major advances in the rejection problem, we cannot really view transplantation as the treatment of choice on a large-scale basis. (This is due to the poorer survival of cadaver transplant recipients as compared to survival on dialysis.)

Second, if more patients overall receive transplants and there is a fixed rate of inflowing uremic patients, the waiting lists of potential recipients should diminish.

Third, and most important, more cadaver kidneys imply a larger kidney pool; from a larger pool, we should obtain better matched kidneys for individual patients. Perhaps we cannot really be sure today of what constitutes a better match. Some controversy surrounds this aspect. But, if we adopt for the moment the less controversial argument that a four-antigen match is superior (on the average) to other matches, then the larger the donor pool, the higher the probability of finding a four-antigen match for a given patient [7].

Fourth, more cadaver kidneys means reduction of the pretransplant dialysis period. The same number of potential recipients can share more kidneys. This reduction has medical and economic benefits. A shorter pretransplant dialysis period reduces somewhat the probability of becoming presensitized, increasing the chances for successful transplantation. Treatment costs also drop. The average post-transplantation costs are much lower than the average dialysis costs; therefore, the shorter the pretransplant dialysis period, the more we can (on the average) save in costs.

If patients are denied treatment through lack of facilities, an increase in the number of available cadaver kidneys should enable more patients to receive treatment. Therefore, we observe a positive effect not only on patients currently in the system but also on patients waiting to enter.

Some effects of a larger cadaver kidney pool on waiting times for transplantation, the size of the transplant pool, the number of back-up dialysis beds, and waiting times for retransplantation are expressed in functional form in a somewhat hypothetical model elsewhere [8]. This source also provides a real-world model which numerically demonstrates the effect of more cadaver kidneys on the size of the dialysis and transplant pools, and thereby the effect on the number of needed dialysis beds. For further comments regarding the value of an additional cadaver kidney, see Recommendations.

Current Needs and Availability

Supply and Demand

In the previous section, we agreed on a need to procure more cadaver kidneys. In this section, we shall look at the total kidney need, theoretical availability, and actual availability. We will mention some causes of the large discrepancy between actual supply and demand.

In 1966, Couch et al [9] reported that under ideal conditions the national demand for kidney and liver transplantation could be entirely supplied by cadaver donors. This estimate originated from a survey of national vital statistics and relied on age and cause of

death as the only determining factors in selection of donors and recipients. Couch also assumed that persons dying from subarachnoid hemorrhage make the optimum cadaver donors. A later retrospective study by Fox et al [10] in 1972 on a typical urban population (Milwaukee County) gave rise to the same conclusions. Of total deaths in 1966 (10 494), 0.6% (60) satisfied the rather strict criteria for kidney donors. (The criteria appear in the next section.)

Of individual causes of death, cerebral trauma (80% of deaths) was most apt to meet the donor criteria. The same population contained 56 potential kidney recipients; therefore, the supply of cadaver kidneys (coming from 60 donors) should meet the demand. Moreover, every kidney donor has two kidneys to donate, but for various reasons only an average of about 1.5 kidneys from every potential kidney donor are usable; therefore, in any case, the theoretical supply should easily exceed demand. An estimated 16 000 potentially transplantable kidneys become available every year [11] in the United States. The annual number of patients in need of a transplant is approximately 12 000 [12]. This figure agrees with the findings of Fox et al. However, only about 2 000 patients per year in fact receive transplants in the United States! Strikingly, *only one of eight potentially transplantable kidneys is used for transplantation*. This discrepancy and the obvious need for more cadaver kidneys motivated this paper. Not only lack of cadaver kidneys but also the related transplant capacity must expand. Many people feel that the primary cause for the recent substantial increase in the dialysis population has been the inability of renal transplant programs to proportionately (relative to dialysis programs) expand with demand.

Criteria for Cadaver Kidney Donors

The following criteria for acceptable cadaver kidney donors were established for the Milwaukee study:

- (1) death within a controllable environment (a hospital accredited by the Joint Commission on Accreditation of Hospitals);
 - (2) sufficient records for evaluation;
 - (3) no history or evidence of malignancy except primary central nervous system neoplasms;
 - (4) terminal course free from prolonged hypotension (less than 70 mm mercury for more than 30 min); prolonged hyperthermia (greater than 38.3°C for more than 12 h); sepsis; or severe metabolic, electrolyte, or acid-base imbalance;
 - (5) age at death—15 to 55 years inclusive;
 - (6) death due to central nervous system disorders;
 - (7) no history or evidence of renal disease, diabetes, arteriosclerosis, or hypertension;
- and
- (8) normal results from kidney function studies.

Difficulties in Obtaining Transplantable Kidneys

As mentioned in Supply and Demand, only one of every eight potentially usable kidneys ever ends up in transplantation. Many diverse factors bring about loss of the other seven kidneys. The causes are medical, logistical, ethical, moral, legal, social, theological, psychological, and economic. We will mention some very briefly because an extensive treatment might require many books. Miller [13], Porzio [14], Fried [15], and the Spring 1969 issue of *Daedalus* [16] provide more details and discuss the issues generally relating to transplantation and specifically affecting cadaver donors. Some of the issues are mentioned below.

Medical-anatomical—About 20 to 25% of potentially suitable kidneys cannot serve due to anatomical shortcomings [11]. Such kidneys have multiple arterial blood vessels (more than two) which greatly complicate their transplantation. This condition can only be detected by an arteriogram. Despite a potential donor's meeting all donor criteria, a case of multiple vessels usually forces the discarding of the kidney(s).

Logistical—Many kidneys are lost through referral problems: transportation and preservation, identification of a potential donor, and other issues. The IHOB, for example, has made extreme efforts to minimize the logistical problems. Their method of operation and procedures appear in "Procedures of the IHOB, Inc., Concerning Organ Procurement and Distribution."

Legal—Legal problems begin with the definition of death and the removal of the donor's kidneys, then include malpractice and securing consent for donation. The Uniform Anatomical Gift Act of 1968 attempts to minimize the legal problems and to protect the rights of the donor and his family, the recipient, the physicians, and the hospital. An extensive review of this Act is given by Porzio [14]. Some kidneys are lost when the donor becomes involved in a criminal act and the coroner refuses permission for kidney removal.

Theological—Approaches of the various religions vary from an extreme claim of no right to cut off life, even when only the slightest hope of survival remains for a few more seconds, to justification of speeding up a donor's death, when death is inevitable, if the transplant provides another human with valuable life. The major religions view the sacrifice of one's own life for another as the highest ethical act of man. Theological and legal problems mingle concerning control and ownership of corpses and organs in the dead.

Social—Social factors enter into the consent phase of organ transplantation. Many families will refuse consent for a variety of social reasons. Other social aspects may involve unwanted publicity. Severe problems arise with a potential donor's family who know that death is inevitable and that the donor is being maintained only for transplantation purposes.

Geographical—Such factors form a subset of logistical problems. Kidneys are lost simply because a certain geographical area does not have the facilities or physicians, or both, to identify and remove a transplantable kidney.

Physicians—Many kidneys are lost because physicians are reluctant to undertake the whole venture. They may posit logistical and economical reasons and the risk of criminal liability, civil malpractice, and sacrifice of a professional career. Many ethical and moral considerations affect the physician. Most importantly, the transplant physician cannot be involved with the donor in any way because this relationship may lead to a serious conflict of interests. For emotional reasons family physicians are sometimes reluctant to approach the family for consent, but concern for future practice is the predominant inhibition.

Ethical and Moral—Moral and ethical considerations and conflicts exert a heavy influence in the context of transplantation. One physician's desire to save a patient who has a greater chance at living must never violate the ethics of the other whose patient deserves the best medical care available. On the other hand, as Dr. Christian Barnard asks, "Is it not immoral to bury a heart when we have the ability to save a life?" Any further discussion of ethical and moral problems will only open the door to endless considerations. Therefore, the reader should refer to the previously mentioned references.

Economic—Economic considerations include the costs, usually sustained by the recipient, of procuring cadaver kidneys. Additional costs, such as those for artificially maintaining the potential donor, also appear.

The problems described above reflect only part of a spectrum. Most of these problems can be considered separately from the standpoints of (1) the recipient; (2) the donor and his family; (3) the physician, his team, and the hospital; and (4) society in terms of mores, laws, customs, conventions, and collective thought.

sent is necessary. This legislation eliminates many logistical, legal, and ethical problems of trying to reach the next of kin for their consent to donation.

So far, the Uniform Donor Cards have not really served their purpose. Too few people carry them. Ironically, sicker and older patients who die in hospitals carry donor cards, but do not meet the strict donor criteria. The donor cards have not paid off directly, but they have raised the level of appreciation, an important step in itself, and constitute a good campaigning tool for promoting organ donation.

Some activities to increase procurement have had a positive effect: centralization of efforts (to be discussed in the sequel) and, to some extent, publicity. In the Northwest Kidney Center in Seattle, Wash., publicity and campaigning have aimed both at the general public and at the medical profession [17]. This project included newspaper articles and displays, articles in medical journals, talks at local medical society meetings, and dispatch of part of the Center's team to regularly visit both administration and staff of area hospitals which might serve as good potential sources. As a result, the Northwest Kidney Center harvested 42 kidneys in 1971; they previously averaged about 10 kidneys a year. (In Seattle, authorities do claim that publicity with donor cards has been significant [17].)

We now turn to the problem of centralization and accommodating the smaller, non-transplanting community hospitals. We will consider the situation in New England, specifically in Massachusetts, where major transplanting hospitals have a joint transplant effort under the IHOB. This centralized effort utilizes the transplant capabilities and organ procurement of all cooperating hospitals in a manner that minimizes (to some degree) logistical problems and achieves some degree of efficiency in distribution of kidneys to potential recipients. The smaller community hospitals participate in the procurement effort; their patients receive transplants at a hospital of the IHOB. The IHOB procedures with regard to procurement and distribution of cadaver kidneys and other related logistics also appear in "Procedures of the IHOB, Inc., Concerning Organ Procurement and Distribution."

Coordinating the effort was a major accomplishment for the various transplanting hospitals but did not solve the problems for smaller community hospitals. For them, a separate venture combined with the IHOB was undertaken. A group of transplant physicians received additional salaries and carried the title of organ procurement physicians. Each had charge of several smaller hospitals in Massachusetts. Each attempted to engage those hospitals in an effort to obtain as many cadaver kidneys as possible for the IHOB. The only initial incentives lay in more persuasion regarding the importance of transplantation, accommodation of their patients if transplants became necessary, and some financial compensation for the physicians involved. This motivation may encourage the administration but not necessarily the staff and physicians in the local hospitals.

Participating physicians at the local hospitals were to receive \$200 (initially \$400) for obtaining the kidneys from one cadaver. However, this incentive was not strong enough. Many claimed that they would rather not participate because of the complex logistics and loss of time. Realizing that for the same salary some organ procurement physicians harvested more kidneys than others (although there may not have been any difference with respect to time and effort), the strategy of incentives has been changed. By the current procedure, the local physician is paid per procurement. A sum of \$500 goes to the harvesting physician for each cadaver. This procedure seems better for motivation and, one hopes, will more effectively involve the local hospitals in the general procurement effort. Hospitals contributing cadaver kidneys would have their patients who require transplantation receive certain priorities within the IHOB. This reward serves as an incentive for the hospital administration and staff. We still have insufficient evidence to observe the effect of the new procedures. However, the previous joint effort of campaigning and establishing organ procurement physicians increased the number of cadaver kidneys procured in Massachusetts from 78 in 1971 to 114 in 1972 [18]. We really need a statistical analysis to

identify the various effects more accurately. The section on Recommendations will deal more carefully with this issue. However, some hospitals flatly refuse to cooperate.

Some hospitals have ideological objections. Some neurosurgeons simply oppose switching the respirator off while the patient's heart is still beating. Some administrative problems also discourage hospitals from cooperating. For example, imagine a hopeless but stable patient for whom it must be decided whether to start the respirator for transplantation purposes only. If so, who will pay the high costs of two or three days of intensive care? Some administrations simply want to avoid such situations altogether and refuse to participate in the transplant effort. Some smaller hospitals may not be able to participate through lack of facilities, neurosurgeons, or both. These institutions may have extreme difficulty determining brain death.

So far we have discussed the surgeons' side of cadaver kidney procurement. Better motivation for identification and the prompt removal of kidneys have great importance but cannot take place without the proper consent. Some kidneys (about 20–25%) are not available because of multiple arterial vessels and some are lost due to legal considerations involving criminal acts. But what about the others? We cannot simply find a potential donor. We must secure his or the family's consent. Donor cards solve such problems but, unfortunately, have yet to pay off. About 50% [11] of "good" kidneys are lost through lack of consent. Another estimate [19] puts at 10% the number of families approached for donation who flatly refuse.

These figures create some gap, but the gap is explainable. The transplanting physician or even the surgeon who removes the donor kidneys cannot, and should not for ethical reasons, approach the next of kin for consent. The private or family physician must make that contact. Only then should the family meet with the transplant physician. The family physician's reluctance to approach the donor's family for consent is responsible for the gap. So far, appropriate incentives for family physicians have not been found. They fear losing private patients through what might seem rude and inconsiderate practice. Families who are approached but refuse consent do so for various reasons: (1) the family wants the patient buried whole; (2) they feel that the patient has already suffered enough and therefore oppose further "suffering"; (3) they have religious reasons; (4) the family is just too hysterical and does not want to consider the issue. Experience has shown that if the private physician asks the next of kin to speak with the transplant physician and the family agrees, then in most cases, consent for donation is given! We can see potential sources for more cadaver kidneys and must find the means for utilizing them. Some possibilities will be discussed in the next section.

Racial differences also play a role in organ procurement. In the University of Colorado Medical Center [20], 90% of the white population consent to donate an organ, while the rate of consent falls to 50 to 60% for the black population and 10 to 15% for the Hispano-American population.

Future Activities

Given the different causes for the shortage in cadaver kidneys, we have to plan our activities for the future. Donor cards have not paid off directly so far. However, since fatalities from road accidents are potentially excellent donors, Dr. Russel has mentioned a very appealing idea. Rather than issue donor cards, willingness to donate organs can perhaps be incorporated in driver's licenses. (This is already implemented in some states.) Upon renewal of a driver's license, the driver will have to indicate (in a special space) whether he is willing to donate organs if he dies in a car accident. By this procedure people will have to seriously think about consent and make a decision one way or the other.

While donor cards have so far reached only a fraction of the population simply because people do not have to make a decision, incorporating donation with the driver's

license forces people to decide and reaches a far larger segment of the total population. People who may not voluntarily sign a donor card may indicate consent on their driver's license for social reasons if for nothing else. Such an act should have positive effects with respect to Highway Safety Councils and the Registry of Motor Vehicles because people will associate driving with the death risks involved and will hopefully resort to better driving habits. The logistics of such an idea would be minimal. However, the effort should be accompanied by an appropriate campaign and education.

Although some may find this idea infeasible, in my opinion the strategy is both possible and likely to have a significant impact on cadaver kidney procurement. The above proposal aims at obtaining prior consent of the donor himself. This perhaps optimal form of consent minimizes logistical, legal, and emotional problems usually present if consent is sought after the donor's legal death.

Concerning steps in the legal field, unambiguous regulations regarding the removal of organs in cases of criminal action should be drawn. This legislation may save some kidneys lost through coroners' refusals. Many coroners view organ transplantation favorably and do not believe that organ removal hinders their investigation. Cooperation between the transplant physician and the coroner's pathologist is vital. Current figures regarding kidneys lost due to coroners' refusals vary greatly from area to area.

Some argue that the family physician's reluctance to involve the family is the major stumbling block to obtaining more kidneys, and some argue that the family's lack of consent predominates. Estimates for the percentage of kidneys lost through each of these obstacles are frequently ambiguous and contradictory. Appropriate data are simply not available. We shall not further investigate possible differences. Concerning activities to invoke the family physicians' cooperation, we cannot really say much. Resolution of some of the ethical dilemmas will take time and patience. Both potential families and family physicians should be educated about their future mutual relations. Paying the family physician for obtaining family consent seems highly unethical; therefore, incentives along this line should not be undertaken.

The fact that less traumatic events such as autopsy or removal of corneas for transplantation create fewer problems and yield more successes should boost hope for obtaining more cadaver kidneys. The general public and the medical profession should learn that no real ethical difference exists between cornea and kidney removal. Except for donor suitability and logistics, nothing should cause a different procurement percentage for corneas and kidneys. People seem to consent to autopsies because in this procedure they see benefits (fulfilling curiosity and learning more about the cause of death). Perhaps we should consider incentives that somehow, directly or indirectly, benefit the donor's family. The sequel will discuss this alternative.

We have mentioned steps to increase consent on the part of the donor himself, so we now turn to efforts to obtain consent from next of kin. At a time when the next of kin are in grief and perhaps shock, we should not expect them to volunteer the kidneys. Obtaining consent is difficult even if we approach them. Conventional reasoning, in many cases, does not appeal to relatives. Perhaps some incentives and rewards are necessary. We do not dare suggest direct monetary compensation for an organ donation. Such a totally immoral act would quickly lead to "traffic of human flesh" [1].

I can suggest participation in funeral arrangements, educational scholarships bearing the donor's name, or some formal recognition. All these strategies have pros and cons. Many will strongly argue against participation in funeral arrangements, which may seem equivalent to direct payment to the next of kin. Kidneys might become a commodity sold to the highest bidder. If carefully administered, however, this practice should not develop. The standard funeral participation will be offered by the hospital (transplanting hospital or the institution where harvesting took place) which, in turn, will be reimbursed by the recipient (or his insurance). Legalities must be carefully worked out to prevent poten-

tial recipients from bypassing the procedure and offering more for an available kidney. In my opinion, all the logistics can be successfully implemented. Before the donor's death, this incentive may not be strong because the next of kin do not realize the burden of a funeral until the donor is dead. As the only apparently weak point in such an arrangement, consent on the part of the family results in monetary savings to them. Therefore, they do possess purchasing powers. With proper attention this problem can be smoothed out.

If we consider the possibility of creating a scholarship, then the donor's family is not materially rewarded but does receive social and spiritual gain. This incentive may be quite strong and realizable even before the donor's death.

A similar spiritual incentive is public recognition. A community hall, library, playground, or sport event may acquire the name of the deceased. Newspapers and other media can give recognition. Some doubts exist about the effectiveness of such an incentive in light of experience showing that many donor families choose to remain anonymous. Calne [21] claims, "The privacy of bereaved relatives should not be abused by the press, radio, and television. The names, personal details, and photographs of donors and their families should not be made public even with the permission of those involved, since an effect of this publicity is to deter others from agreeing to be donors for fear of being similarly treated." Today, the medical profession is reluctant to let the donor and recipient families know each other, even if they mutually so desire. Unhealthy emotional relations may result.

Experimentation

We have discussed some incentives aimed at individual donors and their families. Indubitably, the procurement rate with such incentives as scholarships will at least equal that of today where no such incentives exist. We apparently can obtain more kidneys for a cost. We have discussed some benefits to society which result from an increase in cadaver kidney procurement. If desirous of benefits, we should be willing to pay. Additional costs involved not only go for the extra procured kidneys, but also for *all* procured cadaver kidneys. We cannot apply a certain policy discriminately. We cannot deny the donor's family some return even if they will donate the kidney despite any incentives. In a sense, a rather large opportunity loss occurs but the total cost (when determined) should be justified.

Although agreeing on some action, we face the problem of which incentive to adopt, if any, and how much money to spend. We will address only the first problem here. Judging one incentive over another probably requires an experiment. We do not need a clinical trial in the usual sense of the word but a trial applied to deceased patients and their families. The results of the trial affect other, for the moment unidentified, patients. The experiment does not really affect the (deceased) experimental subjects from a medical point of view. For each experimental subject there is a corresponding patient (the recipient), identified only after procurement of a kidney, that is, only upon realization of a success in the trial. Current patients, but not the direct experimental subjects, are affected by the experimental outcomes. Since direct experimental subjects do not experience medical effects from the experiment, moral and ethical problems raised by the experiment may not become so great.

We must decide how to set up an experiment. Despite the previously mentioned moral advantage, such an experiment is extremely difficult to set up. Far too many public policy issues and social problems would arise from various sectors of the public and the medical profession. Such an experiment, even on a local basis, would probably require federal action. This requirement poses serious ethical considerations; the secondary effects of such actions would be very wide and numerous. On the other hand, due to the

different approaches and procedures in different geographical areas and mainly because of the high degree of controversy, we cannot conduct such an experiment on a national basis. Many problems may crop up with the hospital trustees and administration, who would be very reluctant to entertain such an experiment, especially if they alone would be involved. We will have to carefully identify all the legal and social ramifications and secondary effects. Concerning the community, no problems should develop in setting up the logistics and response to directly related compensation.

Given a fixed sum of money, we could not determine in advance the number of trials required. The relevant costs apply only on a success in the trial (procuring the kidneys), not on failure. Money goes only for a donated kidney; therefore, the design of the experiment must allow for a variable sample size until all funds are exhausted. Of course, we could set a bond on the number of trials (total cost divided by the amount paid for each donation), but this approach could yield a small sample size for comparing alternatives. Even if the incentives doubled the number of procured kidneys, only two of eight kidneys would be harvested. Therefore, we may wind up having a sample size one fourth the size permitted by the funds. We wouldn't have to go to such an extreme to set a limit on the sample size. We could adjust the figure according to a prior distribution on the number of successes.

What kind of experiment should we conduct? The general design of the "two-armed-bandit" procedure [22-24] seems appropriate. In this case, we face the simpler dichotomous response situation. We should view the trials as affecting current patients, although at the time of the trial that patient (the potential recipient) is unidentified. Moreover, the trial itself does not medically affect the experimental subject. We have the fixed patient horizon case and can solve the problem as illustrated in Ref. 24. The "play-the-winner" rule [25] would be quite appropriate. We may not be able to continue experimenting with two or more incentives after exhausting the initial resources, but rather we may have to settle on one procedure from that point on.

Kidney Banks: A Problem of Morality

Naturally, future breakthroughs in kidney preservation and perfusion methods should permit the creation of kidney banks similar to today's blood banks. This innovation would eliminate the immediate necessity to find a compatible recipient or otherwise discard the kidney. We should also acquire better matching on a larger geographical scale. Ample time will exist for checking with the various regional transplant registries. This practice is already followed today with respect to four-antigen matches where a national list is scanned for the desired recipients. A kidney bank will allow a search for the best recipient on a more individual basis. Obviously, kidney banks, in the true sense of the word (not current banks, such as the IHOB, which just distribute but cannot preserve kidneys for more than a day or two) will assist efforts to operate on a nationally centralized basis where too many logistical problems currently interfere.

Having mentioned kidney banks, we can pose the controversial problem of allowing living donors to make use of such a bank in the same manner that living donors give blood to blood banks. Today, kidney donations from unrelated living donors are infrequently accepted because of the disbelief in a gift for its own sake alone. Moreover, unrelated living donor kidney transplants do not show better survival than cadaver kidney transplants; letting the donor undergo nephrectomy seems unjustified. The recipient can wait for a cadaver transplant. Living related donors do not need a kidney bank because the recipient is a priori identified and the time of donation can be adjusted for the time of transplantation.

Because of the need for more kidneys for transplantation, I have posed the question of

literally selling kidneys for transplantation purposes. This approach would be considered only in rare cases which I will discuss shortly. This proposal was immediately rejected by all to whom I had spoken on the grounds that the procedure would create a black market, a "traffic in human flesh" [11]. The Statement of the Committee on Morals and Ethics of the Transplantation Society [26] clearly notes that "the sale of organs by donors living or dead is indefensible under any circumstances." A black market can be avoided with appropriate legal and ethical guidelines. A person should not be able to simply pay another for his kidney, but kidneys should be sold directly to the bank for a fixed, predetermined sum of money without the donor and recipient ever knowing each other. Some might argue that such a plan is completely immoral and unnecessary due to the survival rate of unrelated living donors. These arguments are sound. I am posing this controversial idea in light of the following hypothetical case where not to allow selling a kidney may be immoral!

Suppose that four-antigen matched transplants do indeed show superior survival rates. Now, consider a potential recipient, A, waiting for a kidney. An anonymous person, B, whose tissue was typed, has four HL-A antigens matching those of A. B is willing to sell one kidney to a kidney bank, but the whole concept is rejected on ethical and moral grounds. Thus A is denied a four-antigen match transplant; his chances of receiving one from a cadaver donor in the future remain very small. To deny A the kidney that can give him a high probability of many more years of life—a kidney that B was willing to sacrifice for an appropriate monetary compensation—is less moral in my opinion. In such circumstances, B should be allowed to sell his kidney to the bank for the fixed, predetermined buying price. The virtual guarantee of success overrides counter arguments of immoral behavior.

In theory, kidney banks should be allowed to buy kidneys. Now, can we expect that for a given patient a located matching donor will actually agree to sacrifice a kidney? We cannot; but we should allow anyone interested in selling a kidney to register with the kidney bank, be typed, and agree that his kidney will be bought only if a recipient with four matching antigens turns up. Even given an appropriate recipient, the donor and recipient should be carefully evaluated (in complete confidentiality) and the kidney accepted only if the resulting transplant seems very promising. The recipient should not even know that a potential kidney seller has turned up. Such cases and perhaps other theoretical cases will be extremely rare.

We are referring to theoretical rather than practical aspects; the kidney banks will actually serve only cadaver kidneys. But should such cases arise, the life-saving capability of the living unrelated seller should be recognized and exploited. We should recall that donating a kidney does not entail a significant loss of longevity. Until the time this study was completed, only two known deaths attributed to donation were recorded among the many thousands of living donors. Recuperation from surgery is rather fast; the donor is back on his feet within 10 to 14 days. From a moral point of view, kidney banks should offer their services to potential sellers, but pay for a kidney only when morality necessitates. The probability of facing the preceding case is extremely small because, of all people who are four-antigen matched to a given recipient, very few, if any, among those would approach a kidney bank to sell a kidney. The principle of the idea, not its implementation, is important. Concerning people offering a kidney for sale, this approach is not at all unreasonable. Many people would gladly sacrifice a kidney for a sum like \$5000 to \$10 000. After all, selling blood is acceptable to society, so the moral and ethical blocks to selling a kidney should not be that great. (However, we have to remember that lost blood, unlike a lost kidney, is replaced by the body.) I have tried to clarify this disputed point and will argue no further. The author takes full responsibility for the content of this section.

Recommendations

We should concentrate our effort in all possible directions to achieve the goal of a higher procurement rate. After a while, we may drop some approaches if the effort seems in vain; but, initially, we should approach all aspects. Reaching larger segments of the public, perhaps through drivers' licenses, seems necessary and appropriate. More campaigning and education, both for the general public and the medical profession, should continue. Incentives for organ harvesting, such as those now employed in Massachusetts, should continue while they seem appropriate. New ideas along this same line should be sought and perhaps applied. The various legal and ethical stumbling blocks should be removed with appropriate legislation. Firm, unambiguous guidelines should become available to enforce the rights of the donor (and his family), recipient, physician, and hospital.

At present, an experiment of the type discussed in Experimentation seems too controversial. Even so, we should emphasize the collection of more and better data to better clarify the issues. This would perhaps enable us to conduct a more useful experiment if necessary. Every case where a potential donor has died should be carefully recorded. If he was lost before the appropriate staff could reach him, the precise reasons and obstacles, if any, should go on record. If he was approached but the family refused consent, the circumstances should go on record. Of greatest importance, we must identify in each case the exact reason for the loss of the kidney. We must focus on extreme detail, not on such broad categories as social or religious reasons. We should collect such data as, "How many times was a family in fact approached for consent?" All this information should give a clearer picture of the percentage of kidneys lost for various reasons.

A clearer picture will allow a better focus on specifics rather than broad areas. We may decide to abandon some targets altogether if their role proves unimportant compared with others. We may, for example, discover that an experiment of the type mentioned in Experimentation by no means seems justified because lack of family consent is responsible for very few lost kidneys. In cases where coroners' refusals are responsible for lost kidneys, the exact cases and all arguments should be recorded. This recording will foster better legislation and firmer guidelines.

We should also consider transplant capacity. Although many hospitals transplant to their bed and personnel capacity, a need for more kidneys still exists. Should more become available, the hospitals must be able to accommodate them. The current capacity can expand even without bringing in more surgeons and beds. A more cooperative and just patient distribution among cooperating hospitals should be established. Cadaver kidney transplants should be appropriately accommodated and scheduled relative to living related donor transplants.

As an example of insufficient transplant capacity, especially before centralization, we can refer to the New York-New Jersey Regional Transplant Program [27]. In 1971, about 60 transplants per year were performed in the New York City area. Experts have estimated that hospitals participating in kidney transplantation programs have a transplant capacity of 468 per year, nearly eight times the level of 1971. The limiting factors seem to be paucity of cadaver donors; lack of a central registry of transplant candidates; and absence of a formal, effective coordinating mechanism for linking donor with recipient. In many regional centers the latter causes have been accommodated, but transplantation capacity can still expand. An increase in cadaver kidney procurement will, one hopes, be followed by an increase in transplant capability.

We have previously mentioned the various activities to date concerning procurement of cadaver kidneys for transplantation by the IHOB in Boston. A joint campaign aimed at various sectors of the public and activities of organ procurement physicians led to an increase in procurement. However, we do not know which of the two policies had the

stronger and more significant impact on procurement. Statistical analysis could help break the total effect into individual contributions. Because the organ procurement program has been replaced by more direct, and seemingly more fair, payment to the harvesting surgeon, not much use would come from conducting this statistical analysis. We need to monitor the effect of this new incentive along with the effects of ongoing campaigns. We also want to appeal to the general public and medical profession.

To monitor the effects of various activities on procurement of cadaver kidneys, we have to obtain and record appropriate data carefully. We should try to identify the precise circumstances leading to harvesting of a kidney. If the recognition and action of the harvesting surgeon alone were most important, we should make a record of them; if the family's immediate consent dominated, then possible exposure of the family to any form of campaign should be investigated; if a donor card were present, we should make a record of it (and perhaps contact the witnesses to its signature to help identify why the bearer carried and signed a donor card). In any case, we should not naively assume only one underlying factor but should try to ferret out various causes. All cases where the kidneys were not harvested should also be categorized and recorded. Then, after some data has been accumulated, we can attempt an analysis, perhaps discriminant analysis or regression, to identify more precisely the relative effects of various factors.

We have not sufficiently covered one major aspect in this paper: the impact of procuring more cadaver kidneys. We find general agreement regarding the need for more kidneys, but the rather intuitive arguments usually fail to reveal explicit reasoning. We want to quantify the impact of an additional kidney on the whole system. We will not do so in this study but will suggest this problem as a future area for research. This problem has significance not only in the area of kidney transplantation but also for other problems where we seek an imputed value to the system of a variable.

The imputed value of an additional cadaver kidney can be measured in terms of longevity, quality of life, and monetary terms. We can ask such questions as "How many man-years of life does it add to the system?" Some feel that failure to supply an additional useful cadaver kidney results in withholding x man-years of life. At present, we have no final evidence that x is indeed positive! In light of the poorer average patient survival of cadaver transplant recipients relative to dialysis patients, we cannot at all be certain that man-years are gained by increasing the cadaver kidney pool. Even adjusting life-years for quality through an "objective eye" [9] may still not favor transplantation. However, if we judge patient attitude toward quality of life while on dialysis versus perception of quality with a cadaver transplant, transplantation may seem the better course. If we do believe that life-years are lost through insufficient supply of cadaver kidneys, we should quantify this loss.

Where an increase in cadaver kidneys adds longevity to the patient population, we have to reemphasize the two sides of the problem. Medical ethics focus primarily on one side of the problem but ignore the unethical practice of letting good cadaver kidneys go unused, thereby sacrificing life-years.

The problem just posed, in my opinion, offers excellent and challenging opportunities for future research and investigation. The problem also has ramifications for many other problems, not necessarily limited to the medical field.

Summary

The paper questions the need for more cadaveric kidneys for transplantation. After establishing such need, it points out the inability of current supply to meet demand. Theoretically, enough kidneys should be available to meet all demand, so the various reasons for discrepancies between theoretical supply and the lesser actual one are discussed. The medical profession is aware of the insufficient supply of kidneys, and several

avenues are currently being pursued to increase procurement. The paper reviews these activities and looks into possible future ones, mainly along the line of creating incentives, not necessarily financial, for more donations and procurement. Some experimentation may be necessary to identify more promising activities and to eliminate inefficient ones. Finally, the paper looks into the somewhat controversial problem of allowing living donors to participate in kidney banks. It argues that sometimes it may be immoral to prohibit a living donor from selling a kidney if this kidney has the prospect of offering excellent prognosis to a needy patient.

Acknowledgment

The author would like to thank Professor Howard Raiffa for suggesting the topic of this paper.

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