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ORIGINAL ARTICLE

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Attitudes toward xenotransplantation – patients waiting for transplantation versus the general public

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Abstract The aim of this study was to survey attitudes toward xenotransplantation and to investigate whether there is a difference in attitudes between patients awaiting a kidney transplantation and the general public. A questionnaire was sent to randomly selected members of the public aged 18–75 (n = 1000) and to all patients of the same age group waiting for kidney transplants in Sweden in 1998 (n = 460). Among the public, 60 % expressed a positive attitude toward receiving an animal kidney graft with the same degree of risk as a human kidney graft, compared with 66 % for the patients. The proportion in favour of receiving a heart remained 60 % for the public, but rose to 70 % for the patients. If a human heart was not available, 61 % of the public were for the use of an animal heart, compared with 73 % in the patient group. A majority of the respondents would accept a transplant from an animal, provided the result and risk of infection were the same as with a human transplant. A greater proportion of patients had a positive attitude to receiving a xenotransplant than did the general public. A life threatening situation marginally increased the positive proportions.

Keywords Xenotransplantation · Attitudes · Patients · The general public

Introduction

In the future we may be able to increase the supply of organs, tissue, and cells available for transplantation by means of xenotransplantation. During recent years, the conditions for this activity have been evaluated in several countries, for example the US [7], the United Kingdom [13, 17], the Netherlands [6] and Spain [14]. In Sweden, as in other countries, there exists no legislation covering xenotransplantation. Therefore, a committee was appointed by the Swedish government to evaluate the ethical, medical, legal, and animal protection aspects of the transplantation of organs, tissue, and cells from animals into human beings. This study was carried out to investigate the public attitude to xenotransplantation. The results have previously been presented in Swedish in a different form [2].

Studies on attitudes toward xenotransplantation have been performed in different contexts [1, 3, 4, 5, 8, 9, 10, 11, 12, 15, 16, 18, 19]. In some cases, questions were asked regarding a procedure, in others, regarding individual acceptance. The rate of acceptance of xenotransplantation ranges between 40 % and 75 %. Sanner performed a study in Sweden in 1996 among a random sample of 1500 inhabitants ranging from 18 to 70 years of age in the county of Uppsala [15]. The response rate was 71 %. The questionnaire included questions on transplantation and transfusion issues. When asked about their preferences regarding the receiving of material of different origins in their own bodies, the answers were: organs from living donors, 77 %; organs from deceased donors, 69 %; artificial organs, 63 %; and animal organs, 40 %. Another Swedish study by Lundin comprised patients who had received xenografts [9]. From

an ethnological perspective, eight diabetics were interviewed about their thoughts and feelings regarding the implantation of insulin-producing porcine islets. Lundin's experience is that the patients have a pragmatic view according to which "survival takes precedence over any ethical or existential doubts". In a telephone survey carried out on behalf of the US National Kidney Foundation (NKF) 1997, the attitude to xenotransplantation of several groups in society were investigated [1, 4, 12]. Among a random sample of the public (1200), 62% accepted the concept of xenotransplantation, and 75% would consider xenotransplantation for a loved one if the organ or tissue was not available from a human. There are also studies which focus on genetic technology, for example the Eurobarometer study from 1996, which was performed to survey European attitudes toward biotechnology [5]. Over 16 000 interviews were carried out with random samples of the public from 15 years of age in the member countries of the European Union. On the specific question about moral acceptance of genetic engineering related to transplants, 36% agreed or tended to agree that it was acceptable to introduce human genes into animals to produce organs for human transplants, e.g. into pigs to facilitate human heart transplants.

Several factors can influence attitudes, for example, the cultural context; whether one has experience of being chronically ill; if one needs life-sustaining treatment, or if one is waiting for a transplant. As xenotransplantation is a question of general interest for society, it is necessary to study the public opinion. However, healthy people may find it difficult to imagine being seriously ill and in need of an organ or tissue from an animal. The thought of having an animal organ in one's body might be strange to many people. Patients with end-stage renal disease on the waiting list for kidney transplantation all have the experience of being chronically ill, of being in need of life-sustaining treatment, and of waiting for an organ transplant. One would expect them to have the insight and understanding that makes it easier for them to relate to the concept of xenotransplantation. Furthermore, a negative attitude to xenotransplantation might be modified if there was no effective alternative treatment. With this in mind, our working hypotheses were:

- A greater proportion of patients with a life-threatening disease demonstrate a positive attitude toward receiving a xenotransplant than does the general public.
- The proportion in favour of xenotransplantation is larger if there is no acceptable alternative treatment when suffering a life-threatening disease.

The aim of this study was to survey attitudes toward xenotransplantation and to investigate whether attitudes differ between patients on the waiting list for kidney transplantation and the general public. This study was approved by the regional research ethics committee at Lund University.

Materials and methods

The study populations

A questionnaire was sent both to randomly selected members of the public in the age group 18–75 ($n = 1000$), and also to all patients with end-stage renal failure in the same age group, who were on a waiting list for kidney transplantation in Sweden in the spring of 1998 ($n = 460$). The sample size of the public was sufficient to determine a difference of five percentage points.

The general public group was randomly chosen from the general population register in Sweden. Information about the waiting lists was received from each transplant unit in Sweden (Gothenburg, Stockholm, Uppsala and Malmö). Consequently, the patient study population does not include all patients with end-stage renal disease, but those patients who were eligible for the waiting list from a medical point of view and who wished to receive a transplant.

Of the public group, 596 (60%) sent in processable questionnaires; 294 (49%) were male and 302 (51%) were female. These numbers correspond to the gender distribution in this age group in the country. The mean age was 45, similar to 44 in the same age group in Sweden. Regarding the educational level of the respondents, 193 (33%) had lower education, 249 (42%) had an average education and 150 (25%) had received higher education, which corresponds with the general public aged 16–74.

Of the patient group, 398 (87%) sent in processable questionnaires; 259 (65%) were male and 139 (35%) were female. The gender distribution on the waiting-list was 287 (62%) males and 173 (38%) females. Among the non-respondents in the patient-group 28 (45%) were male and 34 (55%) were female. The mean age of the respondents and all the patients on the waiting list was 50 years. In this group, 196 (50%) had lower education, 139 (35%) an average education, and 61 (15%) had higher received education. Sixty percent underwent dialysis in hospital, three per cent underwent home haemodialysis, and more than one third had continuous ambulatory peritoneal dialysis (CAPD). The median waiting time for undergoing transplantation was 5 five months (1–132).

The questionnaire

The questionnaire was designed to survey attitudes toward xenotransplantation in order to be able to reject or confirm the hypotheses. Questions were asked about the attitude toward xenotransplantation of organs, cells, and tissue. In connection with the questions, brief information was given. The information concerned the circumstances of dialysis and of allo-, and xenotransplantation. Information was also given on the uncertainty regarding the transmission of viruses when transplanting organs and tissues from animals to humans, and the lack of alternative treatment in the case of a heart transplantations. Diabetes and Parkinson's disease were described briefly. Information about the ongoing research aiming to overcome the medical difficulties related to xenotransplantation was also included. In the enclosed letter, the pig was mentioned as a potential source of animal organs, tissue or cells

for xenotransplantation. The questionnaire was slightly modified for the patient group, as they were already waiting for a kidney transplant and undergoing treatment. Most of the questions the respondents had to answer on a five-step scale ("very negative"-"rather negative"-"uncertain"-"rather positive"-"very positive"). At the end of the questionnaire, it was possible to make comments.

In a first trial, doctoral students at the Department of Medical Ethics of Lund University were asked to fill out a pilot questionnaire. The next pilot version was distributed to six patients who had received kidney transplants. In addition to this, 21 individuals from the general public were asked to answer the questionnaire. After a final revision of the questionnaire, it was mailed to all the members of each study group in April 1998. An enclosed letter explained the purpose of the study, stated total anonymity and voluntary participation. In the letter, brief information was given about xenotransplantation. A stamped, addressed envelope was included. Five weeks later, a reminder was sent out to all, since the study was performed under full anonymity.

Analysis

The results are presented in frequency and cross tables. The number of the non-respondents is stated in each table, but the percentages are based on the number of answers given. Due to rounding, the percentages do not always add up to exactly 100. The Mann-Whitney U-test was used for statistical analyses of differences between independent groups, i.e. those representing the public and patients. Paired or serial data on subjects was analysed using Wilcoxon's signed ranks test. Logistic regression analysis was used to compare groups by mathematical adjustment for differences between groups regarding age, sex and education. In this analysis, the group of people who were uncertain was analysed together with the group against the issue. Regarding the situation when a human heart was not available, the respondents who answered "Don't know" were excluded.

Results

Questions related to the first hypothesis

Attitudes toward kidney transplants from animals

Among the patients, 66% were for receiving a kidney graft from an animal, provided that the likely result and the risk of infection were the same as with a graft from a human donor. The corresponding number among the public was 60%. The patients were more often "very positive" and the public "rather positive". The differences between the two groups are statistically significant (Table 1).

When confronted with a higher degree of uncertainty regarding result and risk of infection, the obvious difference in attitude between the patients and the public disappeared. In both groups, the negative and uncertain proportions increased to approximately 45% and 39%, respectively. In both groups, 16% were for the issue (Table 2).

Table 1 What is your attitude toward receiving a kidney from an animal with *the same result and risk of infection* as with transplantation from a human? The operation can be planned and performed within 3 months

Attitude	Patients		Public	
	n	%	*n*	%
Very negative	27	7	51	9
Rather negative	20	5	46	8
Uncertain	89	22	142	24
Rather positive	114	29	211	36
Very positive	147	37	143	24
Missing answers	1		3	
Total	398	100	596	100

$P < 0.001$ (Mann-Whitney), *P*-value for test of difference in attitude

Table 2 What is your attitude toward receiving a kidney from an animal with a *larger uncertainty regarding the result and risk of infection* than with transplantation from a human? The operation can be planned and performed within 3 months

Attitude	Patients		Public	
	n	%	*n*	%
Very negative	105	27	127	22
Rather negative	74	19	134	23
Uncertain	152	38	236	40
Rather positive	44	11	73	12
Very positive	21	5	21	4
Missing answers	2		5	
Total	398	100	596	100

$P = 0.517$ (Mann-Whitney), *P*-value for test of difference in attitude

Table 3 What is your attitude toward receiving a heart from an animal with *the same result and risk of infection* as with transplantation from a human? The operation can be planned and performed within 3 months

Attitude	Patients		Public	
	n	%	*n*	%
Very negative	27	7	58	10
Rather negative	14	4	44	7
Uncertain	78	20	135	23
Rather positive	132	34	191	32
Very positive	140	36	163	28
Missing answers	7		5	
Total	398	100	596	100

$P < 0.001$ (Mann-Whitney), *P*-value for test of difference in attitude

Attitudes toward heart transplants from animals

The majority in both groups were in favour of a heart transplant from an animal if the outcome and risk of infection were the same as with a human transplant.

Table 4 What is your attitude toward receiving a heart from an animal with a *larger uncertainty regarding the result and risk of infection* than with transplantation from a human? The operation can be planned and performed within 3 months

Attitude	Patients		Public	
	n	%	*n*	%
Very negative	63	16	123	21
Rather negative	68	18	122	21
Uncertain	148	38	235	40
Rather positive	72	19	94	16
Very positive	35	9	17	3
Missing answers	12		5	
Total	398	100	596	100

$P = 0.001$ (Mann-Whitney), *P*-value for test of difference in attitude

Table 5 *An organ from a human is not available.* The only treatment is transplantation with a heart from an animal. Which of the following alternatives would you prefer?

Attitude	Patients		Public	
	n	%	*n*	%
Heart from animal, op within 3 months	281	73	356	61
Accept to die within 1 year	10	3	49	8
Don't know	96	25	178	31
Missing answers	11		13	
Total	398	100	596	100

$P = 0.001$ (Mann-Whitney), *P*-value for test of difference in attitude

Table 6 If you had diabetes and could be cured with cells from animals, what would be your attitude to such a measure?

Attitude	Patients		Public	
	n	%	*n*	%
Very negative	6	2	17	3
Rather negative	5	1	18	3
Uncertain	51	13	110	19
Rather positive	127	33	203	35
Very positive	198	51	238	41
Missing answers	11		10	
Total	398	100	596	100

$P < 0.001$ (Mann-Whitney), *P*-value for test of difference in attitude

The positive proportions were larger among the patients than among the public (70% versus 60%) (Table 3).

Attitudes toward animal hearts connected with a higher degree of uncertainty than human hearts were similar to those toward kidneys bearing a higher risk. In both groups, the number of uncertain and negatively biased individuals increased. Again, more patients than the public were in favour of an animal transplant under these circumstances (28% versus 19%) (Table 4). Also, when the alternative to receiving an animal transplant was to die of heart disease within one year, the proportion in favour of an animal graft was higher among the patients than among the public. (73% versus 61%) (Table 5).

Table 7 If you had Parkinson's disease and your condition could be improved using cells from animals, what would be your attitude to such a measure?

Attitude	Patients		Public	
	n	%	*n*	%
Very negative	5	1	18	3
Rather negative	7	2	21	4
Uncertain	58	15	122	21
Rather positive	129	33	185	32
Very positive	188	49	240	41
Missing answers	11		10	
Total	398	100	596	100

$P = 0.001$ (Mann-Whitney), *P*-value for test of difference in attitude

Table 8 For a long time, heart-valves from pigs have been used to replace diseased heart-valves in humans. If you were suffering from a coronary disease and could be cured using a heart-valve from a pig, what would be your attitude to such a measure?

Attitude	Patients		Public	
	n	%	*n*	%
Very negative	7	2	18	3
Rather negative	8	2	22	4
Uncertain	49	13	92	16
Rather positive	119	31	194	33
Very positive	206	53	260	44
Missing answers	9		10	
Total	398	100	596	100

$P = 0.003$ (Mann-Whitney), *P*-value for test of difference in attitude

Attitudes toward cell and tissue transplants from animals

Among the patients, more than 80% were in favour of transplantation with animal cells if they were to suffer from diabetes or Parkinson's disease, most of them were "very positive". The attitude toward the implantation of heart-valves from animals was similar. Among the public, 73%–77% were for animal cell transplantation or the implantation of heart -valves. The proportion who answered "very positive" was larger than the proportion who stated "rather positive". The differences in attitudes between the patients and the public are statistically significant (Tables 6–8).

Table 9 *The public's* attitude toward receiving a kidney or a heart respectively from an animal with the same result and risk of infection as with transplantation from a human

Public attitude	Kidney same risk		Heart same risk	
	n	%	*n*	%
Very negative	51	9	58	10
Rather negative	46	8	44	7
Uncertain	141	24	135	23
Rather positive	211	36	191	32
Very positive	142	24	163	28
Missing answers	5		5	
Total	596	100	596	100

$P = 0.486$ (Wilcoxon), *P*-value for test of difference in attitude

Table 10 *The public's* attitude toward receiving a kidney or a heart respectively from an animal with greater uncertainty regarding the result and risk of infection than with transplantation from a human

Public attitude	Kidney larger uncertainty		Heart larger uncertainty	
	n	%	*n*	%
Very negative	127	22	123	21
Rather negative	134	23	122	21
Uncertain	236	40	234	40
Rather positive	73	12	94	16
Very positive	20	3	17	3
Missing answers	6		6	
Total	596	100	596	100

$P = 0.040$ (Wilcoxon), *P*-value for test of difference in attitude

Table 11 *The public's* attitude toward receiving a kidney from an animal with the same result and risk of infection as with transplantation from a human donor and the attitude when a human heart is not available

Public attitude	Kidney same risk		Human heart not available	
	n	%	*n*	%
Negative/accept to die	95	16	49	8
Uncertain/don't know	139	24	178	31
Positive/prefer animal	349	60	356	61
Missing answers	13		13	
Total	596	100	596	100

$P < 0.001$ (Wilcoxon), *P*-value for test of difference in attitude

Table 12 *The patients'* attitudes toward receiving a kidney from an animal with the same result and risk of infection as with transplantation from a human and the attitude when a human heart is not available

Patients' attitudes	Kidney same risk		Human heart not available	
	n	%	*n*	%
Negative/accept to die	47	12	10	3
Uncertain/don't know	83	21	96	25
Positive/prefer animals	257	66	281	73
Missing answers	11		11	
Total	398	100	398	100

$P < 0.001$ (Wilcoxon), *P*-value for test of difference in attitude

Our first hypothesis was that a greater proportion of patients with a life-threatening disease would have a positive attitude toward receiving a xenotransplant than the general public would. The differences in attitude between the two study groups are shown in Tables 1–8. The largest difference between the positive proportions, 12%, was expressed when the respondents were asked about their preferences in cases when a human organ was not available. The patients often expressed their positive attitude as "very positive" both regarding organs and cells, in comparison with the public, who were "rather positive" concerning use of organs from animals but "very positive" regarding the use of cells and tissue. The differences in attitude between the two study groups were statistically significant except in the question of higher-risk kidney transplants.

Questions related to the second hypothesis

Our second hypothesis was that the proportions in favour of xenotransplantation would be greater if there is no acceptable alternative treatment when suffering from a life threatening disease. We compared the attitude to xenotransplantation in cases of a necessary heart transplantation where there is no acceptable alternative treatment, with the attitude toward kidney transplantation where there is the alternative of dialysis.

The public

Among the public, there was no obvious difference in acceptance of either a heart- or kidney xenograft (Tables 9–10). When the alternative of a heart transplantation from a human did not exist, the positive proportion was only one per cent higher. In addition, less respondents were against and more were uncertain. The differences are small but statistically significant (Table 11).

The patients

Among the patients, a larger proportion accepted xenotransplantation when the situation was carried to extremes and there was no option of a human heart transplant (Table 12). Under conditions of high uncertainty of outcome and risk of infection, the patient-group more readily accepted an animal heart graft than an animal kidney graft. (Table 13). Conversely, there was no

Table 13 *The patients'* attitude toward receiving a kidney or a heart respectively from an animal with greater uncertainty regarding the result and risk of infection than with transplantation from a human

Patients' attitude	Kidney larger uncertainty		Heart larger uncertainty	
	n	%	*n*	%
Very negative	105	27	63	16
Rather negative	73	19	68	18
Uncertain	144	37	148	38
Rather positive	43	11	72	19
Very positive	21	5	35	9
Missing answers	12		12	
Total	398	100	398	100

$P < 0.001$ (Wilcoxon), *P*-value for test of difference in attitude

Table 14 *The patients'* attitude toward receiving a kidney or a heart respectively from an animal with the same result and risk of infection as with transplantation from a human

Patients' attitude	Kidney same risk		Heart same risk	
	n	%	*n*	%
Very negative	27	7	27	7
Rather negative	20	5	14	4
Uncertain	85	22	78	20
Rather positive	113	29	132	34
Very positive	146	37	140	36
Missing answers	7		7	
Total	398	100	398	100

$P = 0.529$ (Wilcoxon), *P*-value for test of difference in attitude

statistically significant difference in attitude between transplanting an animal kidney graft or an animal heart graft under the same conditions regarding outcome and risk of infection as with transplantation from a human (Table 14).

Taking into account these three comparisons, the positive proportion can be considered larger if there is no acceptable alternative in a life threatening situation (heart versus kidney). Adjusting for differences in age, sex and education had no major effect and did not alter our interpretation of the findings.

Discussion

Attitudes toward xenotransplantation

Our first hypothesis was based on the assumption that it was difficult for a healthy person to judge the various possibilities of treatment in the event of suffering a life-threatening disease. Patients with end-stage renal disease have insight into- and experience of being chronically ill and of needing life-sustaining treatment. They also know what it is like to wait in uncertainty for a human graft. The result of this study shows that a greater proportion of patients waiting for a kidney graft has a positive attitude toward receiving a xenotransplant than does a random sample of the public. However, there was not always a big difference between the groups regarding all questions . The most apparent difference was in the attitude regarding heart transplantation in cases when a human organ was not available. Even if the majority accept xenotransplantation, provided that transplantation outcome and risk of infection were the same as with human grafts, there are still other ethical problems to be solved.

As far as we know, this is the first study comparing the attitudes of patients toward receiving a xenotransplant with those of the general the public, using the same set of questions. Other studies show different acceptance rates, but the study groups are sometimes different from ours, and the background information varies. The way questions are stated influences the answer. The Gallup Organization conducted a study for "The Partnership for Organ Donation, Boston" in the US 1993 [18]. The result of 6127 telephone interviews with the public aged 18 and above showed that 50% approved of transplanting organs from pigs or baboons into humans when suitable human organs were not available for transplantation. When the question was asked from the individual's perspective, the acceptance rate was the same. The attitudes of 1728 acute care nurses were presented in a "Letter" in Nature in 1995 by Mohacsi et al [10]. The nurses were asked to grade their feelings toward two statements on a seven-point Likert scale. The statements were: "I would accept an organ from a species closely related to man (for example, baboon or chimpanzee), and "I would accept an organ from a species distant to man (for example pig or sheep)". The responses to the questions were similar, approximately 66% disagreed, 19% agreed, and 15% were undecided. The author presented another study carried out in Australia and published in 1997 [11]. This time, 113 renal patients (potential or actual transplant recipients) were confronted with the same statements. Even in this case, the responses were similar to both statements: about 45% of the patients disagreed, 42% agreed and 12% were neutral. A British study published in 1997 presented quite different results. This was a survey of the attitudes of 850 dialysis patients known to the British Kidney Association [19]. The result indicated that 663 (78%) were willing to accept a pig's kidney, 144 (17%) were unwilling to receive a graft from a transgenic pig and 43 (5%) were unsure.

Life threatening situations and xenotransplantation

One could expect the approval to xenotransplantation to be much larger if there was no alternative treatment in a life threatening situation. This was the origin of

our second hypothesis. We tried to verify this by comparing attitudes toward receiving a kidney or a heart, respectively, in two scenarios. The first scenario granted the availability of a human heart as an alternative, the second did not. The difference in acceptance observed was not as large as we expected. The reason is unclear. One possibility is that individuals who are against xenotransplantation do not change their attitudes even under rising pressure. For some people, the heart has a special meaning, and consequently the result might have been different if a kidney transplantation had been set against a vitally important liver transplantation. Another explanation is that people find it difficult, on the whole, to imagine themselves in this situation. After all, it is a hypothetical situation and people might react differently if confronted with the possibility of death. Among the public, about 30% answered "Don't know" when asked if they would accept a heart from an animal or otherwise die within one year. The corresponding figure for the patients was 25%. The patient group expressed a more positive attitude, which might be explained by the fact that it is easier for them to identify with this situation.

If patients in need of a heart or liver would have been asked, the differences in attitude between them and the public might have been more obvious, since these patients are under even higher pressure than patients with renal failure. However, Schlitt et al [16] indicate in a German study published in 1999 that the type of organ required has only a minor impact on the acceptance rate of xenotransplantation. The aim of Schlitt's study was to evaluate attitudes toward the transplantation of xenogeneic organs. Questionnaires were sent to 1079 patients who had undergone transplantation (response rate 722, 67%) and 533 patients on waiting lists for organ transplantation (response rate 327, 61%). More than 50% of the entire study group showed readiness to accept a xenograft, providing the organ could be transplanted with the same success as a human graft. A worsening clinical condition added 25% to those ready to accept a xenograft, 14% were ambivalent, and 7% would not accept a xenograft under this condition. Patients who had undergone transplantation demonstrated a higher acceptance rate than those waiting for liver transplantation. Arundell and McKenzie presented an Australian study comprising 277 patients from the age of 18 and above awaiting kidney, heart, or heart-lung transplantation [3]. Among the 188 respondents, 48% would accept a xenograft for themselves, 42% were unsure, and 10% found a xenograft to be unacceptable. Corresponding numbers regarding xenograft treatment for a family member were 45%, 35%, and 17%. Patients were asked under which conditions a xenograft was acceptable. Fifty-five percent felt this to be the case when no human organs were available; 13%, when human organ transplants had failed; and 9%, if conventional medicine failed. The authors presume that some of the "unsure" patients would accept a xenograft if it was clear that no other treatment was available. A study performed on behalf of the French Transplant Agency and published in The Lancet in 1999 presented the acceptance of xenotransplantation among 91 physicians, 128 nurses, 85 technicians and 321 students [8]. The response rate was 97%. Among the physicians, nurses, and technicians, 39–47% were involved in transplantation activities. When asked about their acceptance of xenografts under any circumstances, the acceptance rate ranged from 34% among nurses to 55% among physicians. Under conditions of life or death, the range was from 61% among nurses to 72% among students. In summary, even if we could not show a large difference between attitudes toward xenotransplantation in situations allowing alternative treatment, compared to situations in which no alternative treatment was available, our result regarding attitudes toward the latter are in accordance with some other studies [16, 3, 8]. This applies to whole organs. At the same time, our study found an even larger proportion in favour of cell xenotransplantation, even in not directly life–threatening situations.

Validity of the results

Responses to a questionnaire do not always accurately reflect what one would do in a real life situation. Attitudes may change with new knowledge and experience. As one of the respondents in the public expresses it, "As long as one is healthy it is easy to reflect negatively about incorporating a part of an animal in one's body. But if one were to become severely ill, it is quite possible that one's attitude would change regarding this question. Life is worth so much that principles may have to be sacrificed".

In the random sample of the general public, the non-respondents represented 40%. A tentative conclusion is that the people engaged in the matter have an explicitly positive or negative attitude toward xenotransplantation and are more likely to assist the survey. This is supported by the fact that a larger proportion of the patients, who could be expected to be deeply committed, did answer the questionnaire than was the case among the general public. If all non-respondents among the public had a negative attitude, the proportion of those with a positive attitude would be reduced from 60% to 35%, concerning the attitude to a kidney or a heart from an animal. Corresponding numbers for the patient group would be 66% to 57% for kidney transplants and 70% to 59% for heart transplants. Regarding the attitude toward the transplantation of cells in cases of diabetes, the proportion of positive responses would be reduced from 75% to 44% among the public, and from 84% to 71% among the patients. However, it is not re-

alistic to assume that all non-respondents have a negative attitude. Regarding the variables we were able to control, i.e. gender, age, and education, we found that among the respondents of the random sample, the gender proportion, the mean age, and the level of education were similar to those of the general public. The patient population consisted of all patients between 18–75 years of age awaiting a kidney transplant in Sweden at a certain point in time. The non-respondents represented 13%, which suggests that the group was very motivated. The mean age among the respondents corresponded to the mean age of the waiting-list patients. The proportion of women was higher among the non-respondents than among the patients on the waiting list, but the numbers are small. Thus we consider the respondents from each study group to be representative of the populations studied.

The results presented here ought to be valid for the general public, bearing in mind that if everyone were to have answered the questionnaire, the proportion of uncertain individuals might have been larger. Regarding the patient group awaiting kidney transplantation, our opinion is that the results could be generalised to patients with a life-threatening disease where transplantation is a possible treatment, for example patients with heart and liver diseases. One might extend this discussion to patients with Parkinson's disease, since these patients are familiar with having a chronic disease, even if it is not life threatening in the same way as it is for the patients waiting for a kidney transplant. If transplantation were a possible treatment for patients with Parkinson's disease, they might have displayed an attitude similar to that of the patients studied here.

The two study groups differ regarding age, gender, and level of education. Among the patients, a majority were men because the majority of persons with end-stage renal disease are men. The mean age was somewhat higher among the patients than among the public. This might be due to the fact that patients with kidney disease fall ill later in life, and that younger patients often have a living donor, which makes waiting for an organ unnecessary. Finally, the level of education was higher among the public than among the patients. These differences between the two groups do not appear to affect the relation between the attitudes among the public and the patients.

Conclusions

- A majority of the patients awaiting kidney transplantation and the general public would accept an animal graft provided that the result and risk of infection was the same as with a human graft.
- A greater proportion of patients waiting for a kidney graft demonstrated a positive attitude toward receiving a xenograft than the general public did.
- Concerning the transplantation of whole organs, the proportion in favour of xenotransplantation among the public was not obviously larger if no acceptable alternative was available in a life threatening situation. However, among the patients there was a clear tendency for a larger proportion to be in favour of xenotransplantation in a life-threatening situation.

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