

**To Kill/Save or Not to Save/Kill:
An Analysis of Increased Awareness on Teen Attitudes
Towards Xenotransplantation**

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Abstract

Globally, 139,024 solid organ transplants were done in humans in 2017, of which 37,447 these attempts resulted in the deaths of the patients. In the US alone, with only 5% of the world's population, 112,000 people wait on the organ recipient list, with 20 dying every day because they are not able to get an organ in time. This is why xenotransplantation that involves the grafting or transplanting of organs or tissues between humans and animals offers a way of closing the gap between organ donors and recipients. However, this practice of saving human lives entails inflicting cruelty and death on donor animals. This research study aimed to assess the impact of a deeper understanding of the process, trade-offs and the ethical dilemmas regarding xenotransplantation on the receptivity of teenagers towards it. Thirty-five teenagers in Haryana, India participated in an online survey, in which they rated their support for xenotransplantation before and after watching two video clips that address the pros and cons of xenotransplantation. Using a mixture of quantitative (paired T-test, regression) and qualitative (open ended questionnaire) approaches, the study showed that their increased understanding of xenotransplantation shaped their attitudes significantly. The teenagers showed great sympathy for the plight of animals too and there was an implicit ask that conditions and treatment of animals be more humane. Moreover, candidates suggested funding for future technological advancements be contingent on exploring usage of mechanical body parts instead of xeno-transplanted parts. The findings of this research study would be of value to institutions (hospitals and research institutes) and firms involved in the field of xenotransplantation and regulatory bodies, as these teens would most likely be coming of age when the field would have progressed sufficiently for this practice to be widely implemented.

Section A : Introduction and Context

A Introduction

An organ transplantation is inevitably a consequence of an injury or a replacement. Human to human transplantation normally happens from a living donor or one who is dead. Xeno-transplantation happens from a dead animal to the human subject. At this stage of technological development, the heart, intestine, kidney, liver, lung and pancreas are normally transplanted:

Globally, 139,024 solid organ transplants in humans were done in 2017, with 37,447 unsuccessful outcomes leading to the deaths of the patient (Global Observatory on Donation and Transplantation, 2019). The USA alone, with only 5% of the world's population, has 112,000 people waiting on the organ recipient list (organdonor.gov, n.d.), of which 20 patients die every day while awaiting a matching organ. Even though 16 transplants occur across the globe every hour, it is no match against the statistic of another person joining the transplant list in the USA alone every 10 minutes. There is no question that the demand for solid organ transplants outpaces the supply with the disparities widening year by year (see Figure 1).

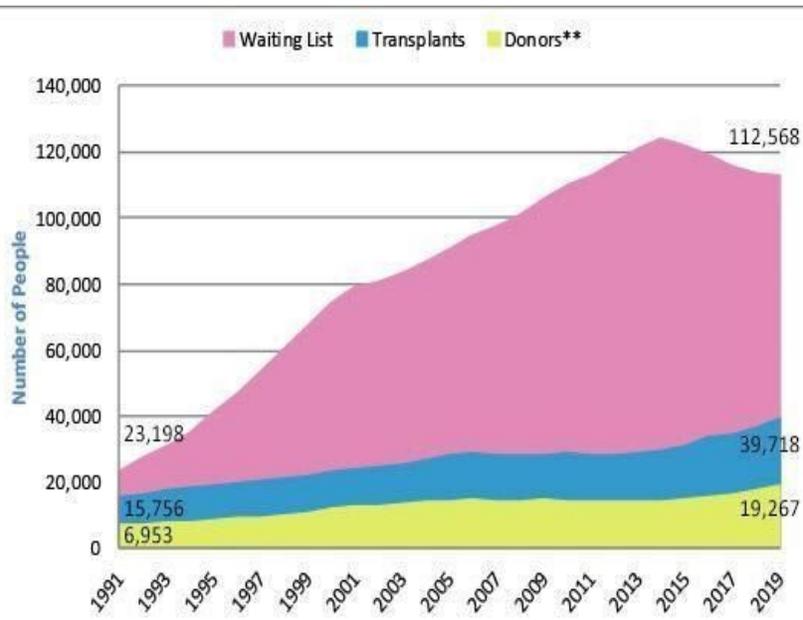


Figure 1. The organ shortage continues. Reprinted from *The Harvard Medical School Guide To Men's Health*" (p. 107), by H. B. Simon, 2002, Free Press.

However, efforts are being made to increase the number of people willing to support organ donation and register to donate their organs, with 90% support and 60% adult donors signed in the U.S. currently (organdonor.gov, n. d.) However, the fact that only 3 in 1000 individuals die in a way that allows for organ donation means that increased education and acceptance among the public alone will not be able to bridge the gap between organ demand and the organ supply. This is where xenotransplantation comes in.

Xenotransplantation refers to a set of processes and technologies, which involve the grafting or transplanting of organs or tissues from an individual of one species into an individual of another species (Boneva et al., 2001). For the purpose of this study, xenotransplantation is defined as a cross-species transplantation where the recipient/beneficiary is an individual of the human species. Simply put, it is a subject that deals with life and death.

Currently, the World Health Organization (WHO, 2019) classifies xenotransplantation as straddling four categories :

1. Solid state xenotransplantation
2. Cell and tissue transplantation that does not warrant any surgical connection
3. Extra corporal perfusion that involves a process whereby human blood is circulated outside of the human body through an animal organ
4. Exposure to living animal-derived material. Under this procedure which also falls under the purview of xenotransplantation, human body fluids, cells, tissues or organs are removed from the body, come into contact with animal cells, tissues or organs and are then placed back into a human patient.

The practical adoption of xenotransplantation is predicated on the fulfilment of three conditions:

1. Developing effective techniques to overcome the immune response that a xeno-transplant triggers in the host body.
2. Finding the right size/species of organ/animal to harvest the organ from to ensure a reasonable degree of overlap between organ functioning across the species.
3. Managing the ethical dilemmas resident in killing one healthy life form to extend the life of another (human) life form.

The focus of this paper is on the third condition relating to ethics. Beyond the complexity of the medical challenge, the widespread implementation of xenotransplantation comes with many associated ethical dilemmas. These include whether we should consider taking away a life form to sustain another. For instance, in the case of pigs, this has been justified so far by the fact that we condone their consumption (Toi te Taioa, 2005). Other ethical dilemmas are centered around crossing the animal-human boundary (intermixing of life forms and the ethical implications underlying that), addressing cultural and religious concerns about the use of pigs that are considered 'unclean', dealing with post-decisional dissonance in recipients and reconciling current animal rights campaigns with this form of snuffing out animal lives

Several research studies have sought to explore attitudes around xenotransplantation. A study conducted by Omnell Persson et al. (2003) compared the acceptance levels of xenotransplantation between the recipients with that of the general public in Sweden. The study concluded that 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 to 66% of the patients. The proportion in favour of receiving

a heart remained at 60% for the public, but rose to 70% for patients. If a human heart was not available, 61% of the public would support the use of an animal heart, compared to 73% of the patients. What the study underlined is that, while ethical conditions are a priority for a wide swathe of the public, the urgency and necessity of a transplant overrode ethical dilemmas in most cases.

Another important attitude-related study on xenotransplantation conducted focused on the recipients' post-decisional dissonance. As part of the study, Stadlbauer et al. (2011) conducted a survey on the attitude of patients on the waiting list and the attitude of already transplanted patients toward xenotransplantation. In general, irrespective of educational qualification or other demographic considerations, around 65% of the population supported xenotransplantation. Xenotransplantation seems to be well-accepted among patients who are potential future candidates for organ transplantation. Informing patients about the current status of research tended to decrease acceptance rates slightly. This study confirmed that understanding ethical dilemmas related to transplantation do have an impact, even on direct recipients of a xeno-transplant. This is powerful evidence of the influence that ethical and moral questions pose specific to the technique of xenotransplantation

In another attitudinal study, Omnell Persson et al. (2003) assessed the impact of the following two factors that might play a role in influencing attitude to xenotransplantation: 1) the usage of cell grafts (cells and tissue from xeno-transplants) versus usage of organs (whole xeno-organs) in xenotransplantation; and 2) the levels of uncertainty regarding the result and risk of infection related to both types of transplants. The researchers concluded that the people were more concerned with the first factor.

Taken together, these three studies indicate a reluctant willingness to accept the xenotransplantation considering the ethical trade-offs, even among the beneficiaries of xenotransplantation. Furthermore, there appears to be a pronounced preference across the public for cell grafts-based xeno-transplants, which suggests that considerations about the ethical dimensions persist.

In this context, it is important to note that no research study to date had been undertaken to investigate the attitude of teenagers towards xenotransplantation, particularly with regards to the ethical controversies surrounding this practice. Given that xenotransplantation is still in its infancy with transplantation technique(s) and is likely to mature as teens step into full adulthood. They then would

be the generation determining the fate of practice, both as primary beneficiaries and adopters of this technology if it were to become a mainstream practice. As a high schooler in Haryana, India, I have constructed and conducted a study to focus exclusively on the attitude of this demographic towards xenotransplantation.

Section B : The Research Study

B (i) : Research Aim, Question, and Hypotheses

The research study aimed to assess the impact of a deeper understanding of the process, trade-offs and the ethical dilemmas on the attitudes of teenagers towards the practice of xenotransplantation. More specifically, the research question that was investigated is stated as follows:

To what extent does a deeper understanding of the process, the trade-offs and the ethical dilemmas inherent in xenotransplantation impact the attitude of teenagers towards it?

Given the audience and their preferred mode of information consumption, two video clips were used to educate the students on the pros and cons of xenotransplantation. The first video outlines the demand-supply gap in the organ transport world and shows the real-life impact on a struggling individual awaiting a transplant and his family. The second video exposes viewers to the animals who are being used for experiments, thus allowing the former to get an understanding of the real-life impact of xenotransplantation on a live animal.

The following hypotheses were tested:

Null Hypothesis H_0 : Watching the two video clips on xenotransplantation has no effect on the attitude of respondents towards xenotransplantation.

Alternate Hypothesis H_A : Watching the two video clips on xenotransplantation has an effect on the attitude of respondents towards xenotransplantation.

B (ii) : Research Design

A mixed-method approach involving the gathering of quantitative and the qualitative data through an online survey with both close-ended and open-ended questions was adopted. The steps are described as follows:

B (ii) a : Stimulus (video) selection process

In choosing video clips as an instrument to educate teens about the pros and cons of xenotransplantation, the positive and negative aspects were considered. On the one hand, videos that

provide vivid realistic images are highly effective in concretizing the realities of xenotransplantation, thus bringing home the trade-offs between saving a life and sacrificing another. With these concise, but powerful video clips, the unaware and uninitiated can get emotionally invested, while gaining a sufficient grasp of the topic to reflect on their position. On the other hand, watching the videos may be overly distressing for some of the respondents to be able to evaluate it. In addition, it is important to point out that it would be unrealistic to think that the full scope of the concerns surrounding xenotransplantation could be covered by short video clips. One obvious missing area of concern is religious objections. Ultimately, given the scope of this research study, it was determined that the video clips constitute the most effective means of educating the teens within a short amount of time, thus ensuring that they could participate in the research study.

The videos were selected based on their length, approximately three minutes each, and their capacity for conveying the pros and cons of xenotransplantation for the unaware/uninitiated effectively—the ethical dilemmas surrounding saving a human’s life at the expense of a living being of another species. The first video directs attention to the plight of the humans who are in terminal heart failure and would pass away unless a transplant is provided. The second video offers good insight into the actual animals that are involved and builds up empathy for the animals that are being experimented on and will later have their organs harvested.

B (ii) b : Questionnaire formulation

Once the videos were selected, the following online questionnaire was formulated. It contains two key sections. In the first section, respondents were asked to rate the following statements on a scale of a 1-5. The purpose of the two sets of pre- and post-video questions were meant to determine the changes in the ratings of the respondents’ awareness and their receptivity towards xenotransplantation.

Before the videos

Question 1 (#A1) : To what extent do you currently know about xenotransplantation (transplanting animal organs for human needs)

1 Not at all 2 Somewhat Aware 3 Aware 4 Very Aware 5 Expert

Question 2 (#A2): To what extent do you think xenotransplantation should be practiced?

1 Not at all 2 Somewhat 3 Neutral 4 Probably 5 Convinced

After the videos

Question 3 (#B1): To what extent are you now familiar with xenotransplantation (transplanting animal organs for human needs)?

1 Not at all 2 Somewhat Aware 3 Aware 4 Very Aware 5 Expert

Question 4 (#B2): To what extent do you think xenotransplantation should be practiced?

1 Not at all 2 Somewhat 3 Neutral 4 Probably 5 Convinced

The second section comprises open-ended questions to elicit elaborated responses that could capture and verify the integrity of the quantitative assessments in Questions # 1-4. The intent was to gauge the intensity of the belief and to see what the overriding points that had stuck in the respondents' minds from the video were. Qualitative commentary was also solicited to supplement the statistical analyses as it could offer confirmation or otherwise attitudinal changes in a more nuanced fashion that extended beyond quantitative ratings. The two statements were framed in a manner to elicit the elements for both the pros and cons of xenotransplantation to be understood:

Question 5. Please complete the following: I believe animal rights are as important as human rights because

Question 6. Please complete the following: I believe that the government should improve the organ donation advertisement campaign to increase the availability of replacement organs because

B (ii) c : Respondent selection process

The research study was conducted with a set of 35 teenagers from the G.D. Goenka World School, Sohna Road, Haryana, India. They represented both the sexes, multiple ethnicities and religions. All the students fell under the middle class and upper middle class economic background brackets. The group of students came with widely varying levels of awareness of xenotransplantation. The number of respondents selected exceeded the minimum number of 30, which is required to ensure the integrity of a paired t-test.

Section C : The Results and Inferences/comparisons

Section C (i) : The Results

Analysis of pre- and post-video knowledge ratings

The raw data of the pre- and post-video knowledge ratings can be found in Appendix A. Descriptive analysis presented in Table 1 below shows that the post-video knowledge rating exceeds ($M = 2.83, SD = 0.89$) the pre-video knowledge rating ($M = 1.80, SD = 0.80$) by 1.03.

Table 1

Descriptive Statistics of Pre- and Post-Video Knowledge Ratings

Pre-Video Knowledge Ratings		Post-Video Knowledge Ratings	
Mean	1.8	Mean	2.828571
Standard Error	0.134727	Standard Error	0.150549
Median	2	Median	3
Standard Deviation	0.797053	Standard Deviation	0.890661
Count	35	Count	35

To determine whether the mean change in the rating is statistically significant, a paired t-test was run. The results showed that the change is statistically significant: $t(34) = 6.83, p < .01$ (see Table 2).

Table 2

T-Test: Paired Two Sample for Means: Pre- and Post-Video Knowledge Ratings

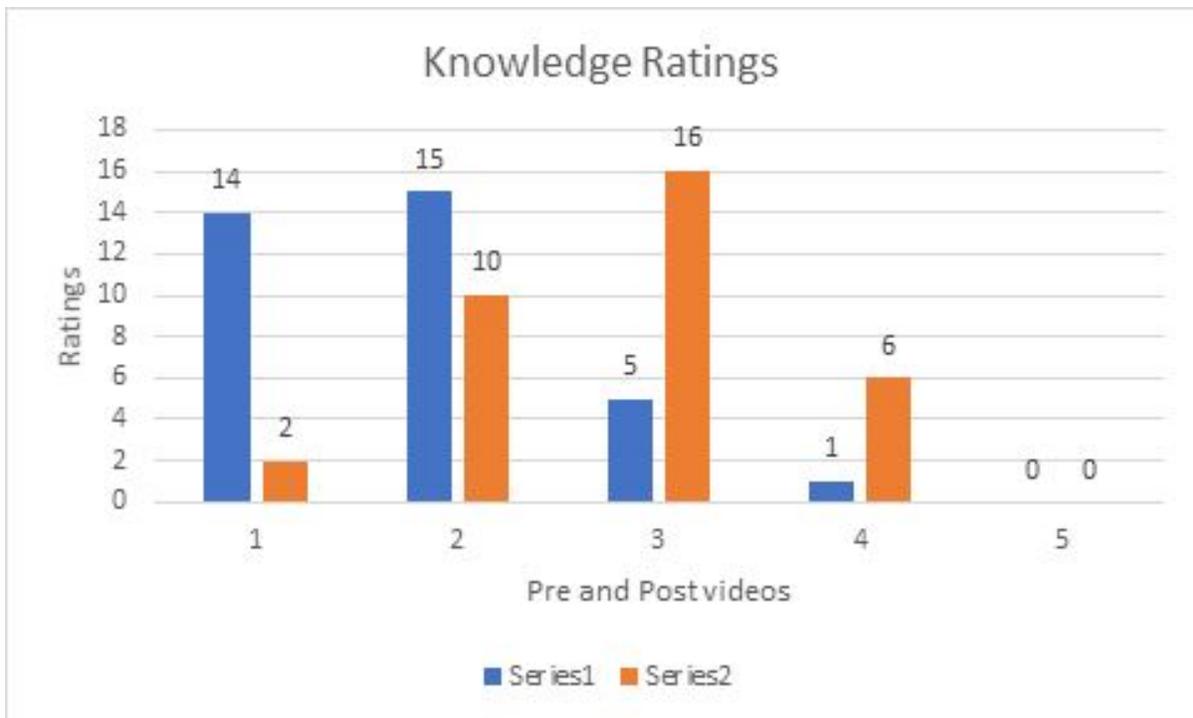
	Pre-Video Knowledge Ratings	Post-Video Knowledge Ratings
Mean	1.8	2.828571429
Variance	0.635294118	0.793277311
Observations	35	35
Pearson Correlation	0.447450404	
Hypothesized Mean Difference	0	
Df	34	
t Stat	-6.832127495	
P(T<=t) one-tail	3.65345E-08	
t Critical one-tail	1.690924255	
P(T<=t) two-tail	7.3069E-08	
t Critical two-tail	2.032244509	

As shown in Table, the correlation function is 0.45 (>0.3), thus showing a moderate level of correlation. A moderate correlation is to be expected, since respondents would likely know more about xenotransplantation after watching the video than before. Nonetheless, this result is important in confirming that the respondents did watch the video, which would be important for their responses to the next set of related questions pertaining to their receptivity towards xenotransplantation.

Additional observations can also be derived from Figure 1, which showcases the drastic changes between the pre- and post-video knowledge ratings. The most noticeable change can be seen in the drop in the number of respondents who knew “nothing at all” about xenotransplantation from 14 to 2 after the viewing of the video clips and the leap in the number of respondents who became “aware” from just 5 before viewing the video clips to 16.

Figure 2

Bar Chart Showing Number of Respondents Across Knowledge Ratings (Pre- and Post-Video)



Analysis of pre- and post-video receptivity ratings

Detailed individual-wise response to the questionnaire can again be found in the appendix.

Descriptive analysis presented in Table 2 below shows that the post-video knowledge rating exceeds ($M = 2.91, SD = 0.78$) the pre-video knowledge rating ($M = 1.80, SD = 0.78$) by 1.11.

Table 3

Descriptive Statistics of Pre- and Post-Video Receptivity Ratings

A1 – Descriptive Stats		B1 – Descriptive Stats	
Mean	1.8	Mean	2.914286
Standard Error	0.134727	Standard Error	0.132026
Median	2	Median	3
Mode	1	Mode	3
Standard Deviation	0.797053	Standard Deviation	0.781079
Count	35	Count	35

Table 4

T-Test: Paired Two Sample for Means for Pre- and Post-Video Receptivity Ratings

	A2	B2
Mean	1.8	2.914285714
Variance	0.635294118	0.610084034
Observations	35	35
Pearson Correlation	0.255113004	
Hypothesized Mean Difference	0	
Df	34	
t Stat	-6.844150152	
P(T<=t) one-tail	3.52678E-08	
t Critical one-tail	1.690924255	
P(T<=t) two-tail	7.05356E-08	
t Critical two-tail	2.032244509	

Observation : $P(T \leq t)$ two-tail $< \alpha$ (0.05), => Reject Null hypothesis

To determine whether the mean change in the rating is statistically significant, a paired t-test was run.

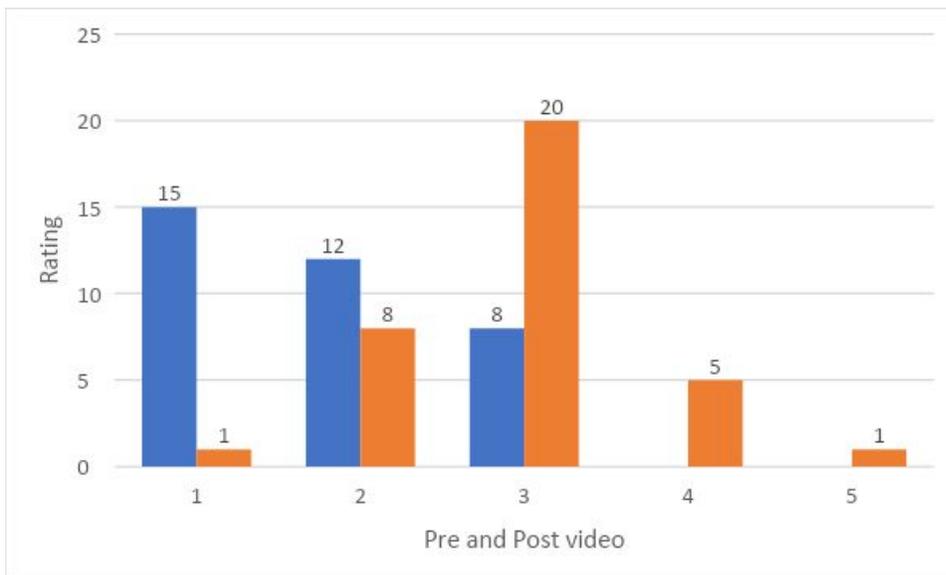
The results showed that the change is statistically significant: $t(34) = 6.84, p < .01$ (see Table 2).

In the case of this second data set, the correlation function is 0.25. As a correlation of >0.3 reflects a moderate level of correlation, this figure suggests that there is a zero to low correlation between the two questions, which suggests that the respondents' post-video receptivity ratings are not influenced by their pre-video receptivity ratings.

Figure 2 offers a powerful visual representation of how the respondents' receptivity towards xenotransplantation changed from before watching the video to after. The number of respondents who were entirely unreceptive, with a rating of "1", declined from 15 to 1. The number of respondents who were neutral (rating of "3") to receptive ("4" and "5") climbed from 8 to 26.

Figure 2

Bar Chart Showing Number of Respondents Across Receptivity Ratings (Pre- and Post-Video)



Thematic Analysis

This section presents a summation of the responses that will supplement the quantitative analysis.

- There is a very wide difference in the understanding of the process of xenotransplantation and where the technology stands today. Public health policy planners should try and bridge this knowledge gap. Most respondents who were made aware of the tradeoff walked into the

thematic survey response under the assumption that the techniques were already widespread whereas the technology is still likely to go mainstream only over the next few years

One interesting thread in this context is that nearly 70% of the respondents wrote about their desire for the final goal of human life preservation/extension to be optimized. Essentially, they were concerned that organ rejection would be far higher in the case of xenotransplantation.

Furthermore, around 75% of the respondents argued that if organ donation from humans increased, then the number of animals that would have to be “unnecessarily” killed/hurt would go down drastically. A respondent who was vegan pointed out that the banning of the experimentation with non-human primates like baboons had been banned since 1963, which should be extended to pigs. As veganism and vegetarianism pick up, the fact that humans eat pigs or consume animal products would no longer constitute a valid reason for using pigs for xenotransplantation.

Apart from the concerns they showed towards animals, the respondents also expressed their concern that all benefits of xenotransplantation should be extended to all strata of society. Beyond addressing the need to ensure that people would be informed about xenotransplantation five respondents expanded on their responses to say that increased advertisements using public funds that lead to more organ donations should be linked to mechanisms for a more equitable distribution of organs, cutting across community and privilege lines. It is a reflection of the teens’ heightened concerns about the issues of equitability in today’s age of rights and historic injustice correction campaigns such as “Black Lives Matter”.

Section D : Conclusion

Based on the results of this study, the null hypothesis under this study has been rejected. Watching the videos exerted a statistically significant effect on the respondents’ level of knowledge on the topic of xenotransplantation and their receptivity towards it. Therefore, we can conclude that an increased awareness of the process, the trade-offs and the ethical dilemmas inherent in xenotransplantation can shape the attitude of teenagers and prepare them for a time when xenotransplantation may be practiced on a wide scale. The findings of this research study thus confirm earlier studies that show a high level of consensus (>60% acceptance in most studies) around xenotransplantation (Omnell Persson et al., 2003).

However, the studies in the past have not explicitly focused on teenagers as a demographic or introduced the impact of awareness of this topic on opinions and attitudes towards xenotransplantation. Therefore, this study, with its focus on teen attitudes, addressed both these important gaps, thus paving the foundation towards a more comprehensive understanding of this space. Xenotransplantation is an evolving field. This renders the implications of further education on a demographic (teenagers) that will possibly be the first beneficiary of this global study all the more important. Those attitudes will establish the boundaries within which this technique can be developed, experimented upon and implemented in the long run.

It is important that the communication that is done with regards to xenotransplantation highlights the following:

1. Emphasize that there are four distinct approaches to xenotransplantation as defined by the WHO (2019), referenced earlier in this study, with the emphasis that only one of them involves a solid organ transplant.
2. Emphasize efforts being done to maximize human-to-human transplants to ensure that the reliance on xeno-transplants to bridge the organ gap is minimized.
3. To reiterate the fact that in cell-based xenotransplantation (e.g., using pathogen-free pigs), the animals are housed and kept in the best possible conditions
4. Emphasize advances in the creation of mechanical parts (e.g., mechanical hearts) to decrease reliance on animal parts in the long term.

While the teen respondents do support transplantation due to their concerns for suffering humans, it is tempered at the same time by their concern for the animals involved. Hence, improving the communication outlined above is essential to ensure that the next generations of adults would be receptive to the idea of xenotransplantation as a life-saving option. Teenagers have not been targeted so far as a constituency with an important voice to determine the boundaries under which experimentation around xenotransplantation should proceed. If the experimentation on animals to support xenotransplantation lies outside the boundaries of what the current teenagers regard as acceptable, they are then going to push for the reversal of the medical advances in this space. Stakeholders including firms that are investing in and developing xenotransplantation-related equipment, medical establishments (hospitals and research institutes), research organizations, and

governmental bodies should take into account the attitudes of the teenagers towards this topic. The communication approach outlined earlier in this section might be a useful roadmap in this regard.

- Research organizations must fill the void by ensuring that the positive aspect of the tradeoffs are emphasized in transplant literature and that two key criteria viz, ensuring comfort of animals being used to support xenotransplantation and efforts being made to create mechanical organs and to drive preventive measures to avoid chronic diseases are highlighted .
- Governmental health agencies need to attempt broader information dissemination on the lines of the emphasis points highlighted earlier
- Health insurance carriers should also keep in mind that scaling up of treatment with xenotransplantation means that costs need to be lowered and this should help ensure that access to this process and the technologies are available to the weakest section of society.

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APPENDIX A

Participation Invitation Letter

Dear invitee,

My name is Anika Singh. I am part of your grade at our school, the GD Goenka World School. I am kindly requesting your participation in an attitudinal study that deals with an analysis of the effect of an increased awareness on teen attitudes towards xenotransplantation.

Xenotransplantation involves the grafting or transplanting of organs or tissues from an individual of one species into an individual of another species. The intent of this research study is to understand how the attitudes of teenagers like us, who will likely be the first generation to benefit fully from the benefits of xenotransplantation, changes when we learn about xenotransplantation from different perspectives.

The study involves completing a survey and watching two short 3-minute videos. The survey is administered before and after you see two videos regarding xenotransplantation. Participation is completely voluntary and you may withdraw from the study at any time. The study is completely anonymous; therefore, it does not require you to provide your name or any other identifying information.

If you would like to participate in the study, please let me know.

Your participation in the research will be of great importance to fill a void in the research around teen attitudes towards xenotransplantation.

Thank you in advance for your time and participation.

Sincerely,

Anika Singh

Grade XII A, G.D. Goenka World School

Sohna Road, Haryana, India

APPENDIX B**Raw data: Ratings of Pre- and Post-Video Knowledge**

Respondent number	Response to Question A1	Response to Question B1
1	3	3
2	2	3
3	2	4
4	1	1
5	3	4
6	1	4
7	2	4
8	1	2
9	2	2
10	2	4
11	1	3
12	2	3
13	1	3
14	3	3
15	4	4
16	1	2
17	1	2
18	2	2
19	2	2
20	1	3
21	2	5
22	1	2
23	1	2
24	2	3
25	1	2
26	2	2
27	1	3
28	2	3
29	1	3
30	3	3
31	3	3
32	2	3
33	1	1
34	2	3
35	2	3

APPENDIX C**Raw data: Ratings of Pre- and Post-Video Receptivity Towards Xenotransplantation**

Respondent number	Response to Question A2	Response to Question B2
1	1	3
2	3	3
3	2	3
4	2	2
5	1	3
6	2	3
7	3	2
8	2	3
9	1	2
10	3	3
11	2	4
12	1	2
13	3	3
14	2	3
15	1	2
16	3	3
17	2	3
18	1	3
19	1	2
20	2	3
21	1	1
22	1	3
23	1	4
24	2	3
25	3	3
26	1	2
27	2	3
28	3	3
29	2	4
30	1	2
31	3	5
32	1	4
33	2	3
34	1	4
35	1	3

