Societal Impacts and Implications of Xenotransplantation*

- A Delphi Survey in Jeju, South Korea -

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Abstract: This paper is aimed at identifying the societal impacts of xenotransplantation when it is actually implemented. A Delphi survey was conducted in Jeju, South Korea for achieving this aim, and then the implications of the societal impacts perceived by these experts were interpreted.

The impact of xenotransplantation, if implemented, has been debated based largely on moral dilemmas and the risks inherent in its technology, focusing on its negative impacts. However, this paper identified that xenotransplantation, if implemented, will have a negative and positive impact on many societal areas and the natural world, with difference in its strength by the category of societal area and natural world. Even for the same area, xenotransplantation will have both positive and negative impacts. This implies that xenotransplantation has

Key words: Xenotransplantation, Impact of xenotransplantation on society, Impact of xenotransplantation on the natural world, Relationship between xenotransplantation and societal change

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two conflicting faces. This would mean the impacts are not discrete, but rather relative.

The impact will not be the end in itself, but rather it will work as a determinant of a societal system being restructured, and the restructured societal system will be again a determinant of xenotransplantation in terms of how to and in what way it should be implemented. This process may be termed a D(driving-force)-S(state)-R(response) causal mechanism.

Ⅰ. Introduction

It is no doubt that we are at the dawn of a genetic age. The history of genetics is long and complex, encompassing numerous strands from G. Mendel's discovery of the rules of inheritance in 1859 to the Human Genome Project done in 2001. Xenotransplantation, even though it is related directly with biotechnology and its development, is a product resulting from the development of genetics.

The history of xenotransplantation is summarized as follows (Deschamps et al, 2005). The pioneers realized xenotransfusions as early as the 16th century without any knowledge of the species barrier, and then, again cell and tissue xenotransplantations in the 19th century. At the beginning of the 20th century, xenotransplantation of testicles became the latest craze. At the same time, and later in the 1960s, organ xenotransplantations were attempted, with disappointing results. Recent trials concerned above was all tissue and cell xenotransplantation. Nowadays, with encapsulation, transgenesis, and cloning, great advances have been made for controlling xenograft rejection.

On the other hand, a lot of critical debates have raised on xenotransplantation within the scientific community and the general population. The debates may be classified into two categories. One is on the technical problems inherent yet in xenotrans- plan-

tation such as organ rejection and virus transfer. The other is on social issues included in the implementation of xenotransplantation. In particular, the latter has focused on the aspects of ethics, religion, animal right, and animal welfare, etc. (e.g. Bach et al, 1998; Cortesini, 1998; Conrad and Gabe, 1999; Hodges and Han, 2000; Karen et al, 2002; Grosse, 2003; Rothbaltt, 2004).

However, the public is not currently well-informed about xenotransplantation. Some surveys showed that xenotransplantation, particularly of pig tissue, is rather well accepted by patients and by the general population, although most subjects would prefer a human or even a simian donor (Hagelin, 2004), but the population is not as aware as the scientific community of the specific health risks (Deschamps et al, 2005).

In South Korea, there also has been some research on xenotransplantation in terms of its technical risk and social issues. Unlike in Western countries, the social issue focuses mainly on the two headings; ethics and religion (e.g. Hong, 2003; Kim, S. J. 2003; Kim, M. J. 2004; Lee, 2003; Park, 2004). However, domestically and internationally, no empirical survey has been done on the public's perception of xenotransplantation in terms of awareness, risk, and ethical impacts, etc. The result of this research will contribute to the future sample survey with the public in terms of capturing the main issues to be covered in the survey.

We identified three key trends of the research undertaken so far. Firstly, the research was confined to some limited categories such as ethics, religion, animal welfare, animal rights. Secondly, the research was confined to the issues perceived by scholars themselves. Thirdly, the research focused on the issues as societal impacts of xenotransplantation, paying little attention to their implications in a context of the principle of social construction. Such limitations result in a narrow perspective in terms of the category of societal impact to be covered.

This paper aims at identifying the societal impacts of xeno-

transplantation in a comprehensive way and their implications. In this paper, the term, 'societal', is defined as all components consisting of a society including political, economic, social, and cultural, religious, and ethic elements, etc.

Ⅱ. Research Method

In order for this research to be a societal approach, it is necessary to examine the possible impacts of xenotransplantation on society as widely as possible. For this, the paper conducted a Delphi survey with a group of experts for collecting their opinions.

Delphi technique was developed in the 1950s at the Rand Corporation as a qualitative research methodology for forecasting and problem solving of complex topics (Woudenberg, 1991). It has proven a popular tool in information systems research for identifying and prioritizing issues for managerial decision-making (Suzanne et al, 2004). At present, Delphi methodology is applied in many fields such as public administration, economics, business, resources and environmental management, education, health care, energy policy, and urban and regional analysis (For the research topics in detail, see Ali, 2005).

Delphi survey is based on a structured process for collecting and synthesizing knowledge from a group of experts by means of series of questionnaires accompanied by controlled opinion feedback (Fontana and Frey, 1994). Its main purpose is to capture up the holistic informations on a research questions when we do not have them. Therefore, Delphi technique is developed to capture expertise in uncertain domains. These are the reasons why this research employs Delphi survey.

Two approach of Delphi technique should be distinguished: conventional and policy (De Loe, 1995). Conventional Delphi is a decision-making tool that has been adopted in most Delphi studies forecasting future human behaviour or human conditions on

the research topic of inquiry. On the other hand, policy Delphi is a decision-facilitation tool to generate possible opposing views for certain polity issues by participants who are not necessarily experts in the research topic.

This research employed the conventional Delphi technique. In South Korea, the conventional Delphi technique is used in many fields (e.g. Chang, 1995; Lee and Kim, 2001; Kwon et al, 2003; Lee et al, 2004; Choi et al, 2005; Yu et al, 2005).

In this research, the opinions on the societal impacts of xenotransplantation were collected by a personal interview with experts, using a unstructured questionnaire being defined as open-ended questions that respondents answer on research questions in their own words.

The experts were selected from their population in Jeju, South Korea due to the limitation of research fund supported. They were contacted by phone, and 50 experts who were willing to be respondents were interviewed. The composition of the 50 experts as the respondents is on Table 1.

Table 1. The Composition of Respondents in Delphi Survey

Categories	Number of Respondents
Professor of natural science	9
Professor of social science	8
Professor of veterinary science	3
Surgeon	4
Religious (Minister, Priest, Monk)	8
Science journalist	8
Social welfare official in government	8
Executive member of civic organization	2
Total	50

Among those in Table 1, the science journalists and the executive members of civic organizations were recruited from outside Jeju. This was because no science journalist was available in

Jeju, and no executive member of a civic organization in Jeju was willing to be a respondent.

The Delphi survey was conducted for one month from January 12, 2005. A unstructured questionnaire was prepared as follows.

(1) 15 societal categories, which we anticipated to be influenced by xenotransplantation were prescribed in the questionnaire. They were medical science, ethics, religion, animal rights, The system of species, the ecosystem, human identity, bio-industry, insurance industry, medical industry, the position of incurable patients, the position of incurable patient's family, population, way of life, and attitude towards life and death.

The categorization was based on the empirical operationalization of conceptual hierarchy rather than theoretical conceptual hierarchy in terms of their genetic and specific conceptual meaning. This is because if theoretical conceptual hierarchy is used for the categorization, the research questions are converged into two or three at broadest level. This will result in a too much broad research question.

(2) The respondents were asked to specify the possible positive and negative impact of xenotransplantation on each prescribed category if it is implemented.

(3) The respondents were asked further to specify other categories to be possibly impacted by xenotransplantation, and to specify their positive and negative impacts.

(4) Finally, the necessity of xenotransplantation for humans was evaluated in two ways. One was to rank the 15 prescribed societal categories in terms of possible strength of the impact of xenotransplantation. The rank was done separately for the positive and negative impact. The other was to evaluate the necessity of xenotransplantation for humans on the basis of a 10-point scale, defining 10 as being definitely necessary, and 1 as being definitely unnecessary.

The former is the perception on the relative importance of the impact of xenotransplantation, meanwhile the latter is the opinion on whether or not to advance the development of xenotransplantation. In a broad sense, the two imply the social acceptability of xenotransplantation when it is implemented. The analysis of social acceptability will be more valid and significant when a national sample survey is conducted. 50 samples in this research are not enough to identify the social acceptability, but will provide a prior valuable information.

Ⅲ. The Societal Impacts of Xenotransplantation

Some respondents perceived that xenotransplantation will have neither positive nor negative societal impact on each of the 15 prescribed categories. However, most respondents perceived a wide range of positive and negative societal impacts if it is put in practice.

The first finding was that in addition to the 15 prescribed categories, 6 categories were suggested as the possible ones to be impacted by xenotransplantation. They were law, national economy, world economy, black market of animal organs, livestock industry, and mass culture. Therefore, this paper finalized a total of 21 categories which xenotransplantation is likely to impact if it is put in practice.

Table 2 shows the possible positive and negative societal impacts perceived by the respondents, if xenotransplantation is implemented.

Table 2. The Positive and Negative Impacts of Xenotransplantation

Categories	Positive Impacts	Negative Impacts
1. Medical Science	• Finding the biological base of organ rejection • Preparing the technological foundation for the extension of human life • Development of fundamental medical science • Improvement of surgical operation • Preparing the scientific foundation for the development of medical science in general • Overcoming the present incurable disease	• Unidentified side effect • Genetic side effect • Xeno-infection • Other internal disease technology will be underdeveloped • Underdevelopment of therapeutic medical science
2. Ethics	• Increase in the thought of human respect • Extension of happiness by the extension of life span for patients and their family	• Neglecting animal right • Making light of human life • Neglecting the providence of nature • Social chaos by the decrease decrease in differentiation between human and animal • Human discrimination among those who have a high and a low quality of xeno-organ
3. Religion	• Increase in the significance of life • Reduction of the difference between human and animal • Realization of the Christian ideology to overcome nature	• A Challenge to God • Making light of human life • Weakening social integration by disregarding religion
4. Animal Rights	• Increase in the thought of coexistence between human and animal • Decrease in animal cruelness	• Invasion of animal right • Making light of animal • The birth of more valuable animals than humans will make light of humans

Categories	Positive Impacts	Negative Impacts
5. Ecosystem	• Restoration of the present unbalanced food-chain • Restoration of the destroyed natural order by the realization of the importance of animals	• Destructing the natural state of the ecosystem • Destructing bio-diversity and its balance • Reconstructing the natural state of the ecosystem in an anthropocentric way
6. The System of Species	• Development and improvement of the quality of existing species • Restoring the system of species by producing the rare and exterminating species • Stable adjustment of natural order	• Destruction of the natural system by the birth of new species in the laboratory • Emergence of mutation by modified genes • Crisis of special species being exterminated by excessive use
7. Human Identity	• Extension of human identity given to animals • Recovery of human dignity • Improvement in quality of life	• Loss of self-identity • Chaos of self-identity in the next generation • Decrease in human value • Human discrimination by different quality of organs used in xenotransplantation • Psychological chaos due to more human discrimination
8. Bio-Industry	• Emergence of bio-revolution being ranked next to industrial revolution • Activation of bio-industry accompanies the development of other areas related to xenotransplantation such as biology, immunology, and veterinary science, etc. • Development of industry related to biological science	• Underdevelopment of other industries such as existing medical industries

Categories	Positive Impacts	Negative Impacts
9. Insurance Industry	• Professionalization of insurance industry by the product of organ being developed • The professionalization will bring about diversification of the whole industrial structure	• Increase in medical expenses • Decline of the existing insurance industry such as cancer
10. Medical Industry	• Development of the medical industry related to organ production • Development of the medical industry related to animals • Development of the medical industry related to the side effects of organ transplantation	• Decrease in existing fundamental medical industry • Decrease in existing medicinal substance industry
11. Livestock Industry	• Livestock industry related to xeno-organs will be bigger	• Livestock industry other than xeno-organs will be declined
12. Mass Culture	• New sources of literature will emerge • New sources of movies will emerge	• The existing sources of literature and movie will be declined
13. The Position of Incurable Patients	• A definite technique to save life • A ray of hope in life	• Making other patients yield to despair • Giving more serious pain if other disease is infected from xenotransplantation • Chaos of psychological and emotional identity
14. The Position of Incurable Patient's Family	• Decrease in the psychological pain of the patient' s family • Providing a healthy life which will contributes to a healthy society • Saving time being spent for patient care • The saving allows family to spend time for social activity	• Economic burden which brings about a psychological pain • A possibility of conflict in the disagreement about xenotransplantation between patient and family

Categories	Positive Impacts	Negative Impacts
15. Population	• Increase in physically healthy population • Increase in aging population • Extension of average life span	• Emergence of unbalanced population structure • Emergence of social problem by the increase in aged population
16. Way of Life	• Psychologically affluent life being free from the burden of disease • Increase in psychological stability • Positive and active attitude and behaviour in life which will contribute to a good human relationship and activation of social life • Activation of life culture for the aged	• Carelessness of own health management • Bringing about alienation towards the low social class • Prevalence of mammonism-typed way of life • Occurrence of a different way of life between normal human beings and xenotransplanter
17. Attitude towards Life and Death	• Spread of the importance of life • Decrease in the fear of death • Spread of positive and progressive attitude towards life	• Re-assessment of the value of life • Increase in the negative consciousness of death • Emergence of a trend making light of life
18. Law	• Existing laws should be re-enacted in a constructive way to a new pattern of human life emerged by the universalization of transplantation	• Emergence of social chaos due to the conflict between animal cruelty and human rights
19. National Economy	• Countries developed in life science can gain a huge increase in national economic wealth through the export of xeno-organs and its technology • Development of enotransplantation industry will be a foundation stone to enter into a developed country	• Countries underdeveloped in life science will have a huge outflow of money due to importing xeno-organs and its technology

Categories	Positive Impacts	Negative Impacts
20. World Economy	• The xenotransplantation industry will emerge as a new world-wide dominant industry, and then, the present dominant industrial structure will be changed	• Deep economic gap will emerge among countries by whether or not they are able to monopolize the technology of xenotransplantation
21. Black Market of Animal Organ	• Present black market dealing with human organs will disappear	• Emergence of a black market dealing with the xeno-organs of low quality with low price

The contents of positive and negative impacts described in Table 2 are just the cognitive mapping the respondents draw in their mind on the assumption that xenotransplantation is implemented. The contents are synthesized as follows.

(1) Medical Science: The respondents perceive 6 positive and 5 negative impacts on medical science. Reviewing the positive impacts, they can be classified into two categories. The first five perceptions imply that xenotransplantation will provide a foundation for medical science to develop. Meanwhile, the last perception, as a result of the first five, refers to the contribution to overcoming present incurable diseases.

The negative impacts are synthesized into two categories. One is the possibility of side effects. As the existing researches have raised (e.g. Bach et al, 1998; Karen et al, 2002; Hagelin, 2004), the respondents also worry about unidentified and genetic side effects, and xeno-infection. The other is that the implementation of xenotransplantation will impede the development of other areas of medical science such as remedy technology of internal diseases and therapeutic medical science.

(2) Ethics: The existing researches have raised some ethical issues. However, the focus tends to be the negative impacts of xenotransplantation on ethics (e.g. Hong, 2003; Ravelingien et al,

2004). Five negative impacts on ethics were identified in this research. However, they are synthesized into three categories. One is to neglect the providence of nature through the creation of an ethos neglecting animal rights and of making light of human life. Another is the emergence of social chaos by the decrease in differentiation between human and animal. The other is the emergence of human discrimination among those xeno-transplanted with a high or low quality of xeno-organ.

Unlike the previous research, this research found that xeno-transplantation has some positive impact on ethics such as an increase in human respect and extension of happiness by extending the life span for patients and their family. This means that xeno-transplantation is perceived as rather moral for patients and their family. Thus, it may be maintained that the ethical issues on xenotransplantation should be understood relatively in terms of its focus whether it is on the general population or on patients and their family.

In addition, it is identified that regardless of the positive and negative impacts, the issues on ethics can be classified into three categories-on the relationship between humans and animals, on patients and their family, and on humans themselves. However, even though medical ethics was issued to be important in the existing research (e.g. Munzarova, 2002), this research does not prove it.

(3) Religion: The core argument on religion in the existing research is that xenotransplantation is a challenge to God. This is a Jewish-Christian point of view (e.g. Grosse, 2003; Hong, 2003). This argument is also identified as a core negative impact in this research. However, the negative impacts the respondents perceive are to make light of human life and to weaken social integration by disregarding religion. This perception is also interpreted as a Christian perspective.

On the other hand, the respondents perceive that xeno-

transplantation is likely to increase the significance of life, to reduce the difference between human and animal, and to realize the Christian ideology by overcoming nature rather than a challenge to God. Such positive impacts are perceived mostly by the Buddhists among the respondents. This means that the impacts of xenotransplantation on religion are perceived differently according to what religion the respondents profess.

(4) Animal Rights: It is of course true that animals also have the right not to be invaded by humans. In this sense, the existing researches have raised animal rights as an important issue on xenotransplantation even in South Korea (e.g. Hong, 2003). As part of such a perspective, the respondents also perceive that xenotransplantation is a human invasion of animal rights, and this invasion will be extended in the end to an ethos that neglects humans themselves. In addition, the respondents perceive that xenotransplantation will foster an ethos that makes light of human by the birth of animals being more valuable than human.

On the other hand, the respondents perceive two positive impacts on animal rights. One is the increase in the thought of coexistence between human and animals through the recognition of the importance of animals for human, and this recognition will decrease animal cruelty.

(5) The Ecosystem: In this research, the concept and its implication of ecosystem is used on the basis of the empirical operationalization of theoretical conceptual hierarchy as below. This is because the system of species that is a specific concept of ecosystem from a point of view of theoretical conceptual hierarchy is used as a category of research question.

Ecosystem is a structural characteristic of nature, and defined as a set of living organisms and non-living substances interacting to produce an exchange of material and energy between the living and the non-living parts. The interaction among the components of an ecosystem is characterized as a self-regulating

system through ecological process such as competition, symbiosis, adaptation, invasion, and succession, etc. Confining to the living organisms, ecosystem consists of producers, consumers, and decomposers (for details, see Jeong, 2002: 40-42). In this sense, this research implies the impact on ecosystem as an impact on the interaction among the components of ecosystem.

It is also rare in the existing researches to focus on the impact of xenotransplantation on the ecosystem. The respondents perceive that xenotransplantation will contribute to the restoration of the present unbalanced food-chain and the destruction of natural order. Meanwhile, the respondents perceive xenotransplantation has a possibility to destruct the original state of the ecosystem, bio-diversity and its balance, and to reconstruct the original state of the ecosystem in an anthropocentric way.

The positive impact is synthesized as a contribution to the restoration of the present destructed ecosystem, and the negative impact as a possibility to disturb the ecosystem. These two are in a conflicting position.

(6) The System of Species: From a point of view of the theoretical conceptual hierarchy, the system of species is a specific concept being included in ecosystem as a genetic concept. However, this research defined the impact of xenotransplantation on the system of species as the impact on the individual species and its result from the empirical operationalization of theoretical conceptual hierarchy.

It is quite rare in the existing researches to bring up this issue in relation to xenotransplantation. The respondents perceive a wide range of positive and negative impacts of xenotransplantation on the system of species. Three issues are perceived as positive impacts. They are the development and improvement of the quality of existing species, the restoration of the system of species by producing the rare and exterminating species, and stable adjustment of natural order.

Meanwhile, three negative impacts are perceived. They are the destruction of the natural system of species by the birth of new species in the laboratory, the emergence of mutation by modified genes, and the crisis of special species exterminated by excessive use.

Then, the core meaning of the positive impacts may be summarized as the possibility to restore and adjust the system of species, and the core meaning of the negative impacts as the possibility to destruct the original system of species.

(7) Human Identity: Human identity is defined as what humans are. The respondents perceive three positive and five negative impacts of xenotransplantation on human identity. In regard to the positive impact, the respondents perceive that xenotransplantation will contribute to the extension of human identity to animals, to the recovery of human dignity, and to the improvement in the quality of life. Meanwhile, the respondents perceive that xenotransplantation will make people lose self-identify, bring about a chaos of self-identity in the next generation, and decrease human value. In addition, their perception is extended to the possibility of human discrimination among people who are with a high or low quality of xenotransplantation. As a result, human discrimination will bring about more psychological chaos.

In synthesizing, xenotransplantation will be a moment to reconsider what humans are, to destroy the self-identity as a human, and to bring about a social discrimination among people.

(8) Industry: The impact of xenotransplantation on industry includes five categories: bio-industry, insurance industry, medical industry, livestock industry, and mass culture. As shown in Table 2, the respondents perceive a wide range of positive and negative impacts on industry.

In synthesizing, xenotransplantation will contribute to the development of bio-industry and sciences related to biology, but will make other industries underdeveloped. The insurance in-

dustry will be professionalized by the product of organs being developed, and this will bring about a diversification of the whole industrial structure. Then, the insurance industry will be structured as a dual system by the decline of the existing insurance industry involving such illness as cancer and there will be an the increase in medical expenses. The medical industry related to organ production will be developed, while non-organ industries will decline. Livestock industry related to xeno-organs will be bigger, while livestock industry other than xeno-organs will decline. Xenotransplantation will be a new source of literature and movies. Meanwhile, the existing sources of literature and movie will be devaluated. This trend has a possibility to emerge a new pattern of mass culture.

(9) The Position of Incurable Patients: The respondents perceive three positive and three negative impacts on the incurable patients. The positive impacts are that xenotransplantation will provide a light of life, a definite technique to save life, and a ray of hope to live a full life. The negative impacts are that other patients who lack finance will be driven to despair, and that even the recipients will be in more serious pain if other diseases develop due to infection from xenotransplantation. In addition, the recipients have a possibility to develop a chaotic psychological and emotional identity.

These perceptions imply that xenotransplantation may be a new birth for the incurable patients, but shake self-identity and leave an ethos of relative deprivation.

(10) The Position of Incurable Patient's Family: The positive and negative impacts on the incurable patient's family are synthesized as follows. The incurable patient's family can decrease their psychological pain, and then enjoy a healthy life which, in turn, contributes to healthy society. In addition, the incurable patient's family can save time spending to care patients, and as a result, can spend time for social activity. Meanwhile, the in-

curable patient's family will be in a psychological pain if they do not have enough finances. Another negative impact is that conflict might occur between the patients and their family in the decision transplanting xeno-organs.

These impacts are interpreted that xenotransplantation will contribute to the happiness of family and be extended to a healthy society. But, it also brings about psychological pain and conflict due to economic burdens.

(11) Population: The positive impacts perceived by the respondents are the increase in a physically healthy population, the increase in aged population, and the extension of the average life span. However, the respondents perceive that xenotransplantation will make the natural age structure unbalanced, and create social problems by the increase in the aged population.

These perceptions are interpreted that xenotransplantation will increase population in an unbalanced structure. In particular, the increase in the aging population, as a result, will be a social problem in terms of the high ratio of dependents on the population.

(12) Way of Life: Four positive impacts on way of life are perceived by the respondents. Xenotransplantation will give people a psychologically affluent life being free from the misery of disease, and then as a result, will increase psychological stability. In addition, xenotransplantation will enable people to have a positive and active attitude towards and behaviour in life. This will contribute to the possibility of positive human relationship, and activate social life. In particular, xenotransplantation will allow the aged to have an active life culture.

The negative impacts perceived are as follows. People will not take care of their health. Alienation will prevail among economically disadvantaged groups that are likely to be short of purchasing xeno-organs. The culture of mammonism-typed way of life will increase. A different way of life will occur between normal

human beings and xenotransplanters.

These would be interpreted that xenotransplantation will bring about an active way of life, while xenotransplantation will cause a dual structured way of life to emerge.

(13) Attitude towards Life and Death: The respondents perceive three positive and negative impacts of xenotransplantation, respectively, on the attitude towards life and death. The positive impacts include the spread of the importance of life, decrease in the fear of death, and the spread of positive and a progressive attitude towards life. The negative impacts are the re-assessment of the value of life, increase in the negative consciousness on death, and emergence of a trend making light of life.

These perceptions may imply that xenotransplantation will increase the consciousness of keeping aloof from life and death, and simplify the significance of life and death as a mechanical process.

(14) Other Societal Categories: Other societal categories on which xenotransplantation will impact include law, national economy, world economy, and the black market of animal organ. The respondents perceive the following as positive and negative impacts on these categories.

Law: Existing laws should be re-enacted in a constructive way for a new pattern of human life which will emerge from the influence of xenotransplantation. Social chaos would result if the existing laws were re-enacted due to the conflict between animal cruelty and human right.

National Economy: Developed countries of life science can make a huge national wealth through the export of xeno-organs and its technology. For developing countries, the development of xenotransplantation industry will be a foundation stone to enter into a developed country. Meanwhile, underdeveloped countries of life science will have a huge money outflow for importing xeno-organs and its technology from developed countries.

World Economy: The xenotransplantation industry will emerge as a new worldwide dominant industry, and then, the present dominant industrial structure will change. In accordance with the change, a deep economic gap will emerge among countries according to her ability of monopolizing the technology of xenotransplantation.

Black Market of Animal Organ: There is a worldwide shortage of organs for clinical transplantation and, sadly, many patients due to receive new organs die on the waiting list. As already known, there are black markets of human organs. If xenotransplantation is implemented, the present black market will disappear, but new black markets which sell the low quality of xeno-organs with low price will emerge.

Ⅳ. The Necessity of Xenotransplantation for Humans

In order to identify how strongly the respondents perceive the necessity of xenotransplantation for humans, they were asked two questions. One was to rank the 15 prescribed societal categories in terms of strength of impacts by xenotransplantation. The rank was done separately for the positive and negative impact. The other was to evaluate the necessity of xenotransplantation for humans on the basis of a 10-point scale, defining 10 as being definitely necessary, and 1 as being definitely unnecessary.

The former was to identify the necessity of xenotransplantation indirectly through the relative importance among the 15 societal categories in terms of being impacted by xenotransplantation. Meanwhile, the latter was to identify the necessity directly.

For identifying the relative importance, the respondents were asked to rank 1 on the category being impacted strongest and 15 on the category being impacted weakest. Table 3 is the average score the respondents ranked on the basis of a 15-scale ranging

from 1 to 15. As mentioned in instruction, this approach is for identifying a social acceptability of xenotransplantation as a prior valuable information for further national sample survey with public people.

Table 3. Average Score of the Rank of Societal Impact by Xenotransplantation

Categories	Average Score of Rank (Positive Impact)	Average Score of Rank (Negative Impact)
Medical Science	2.667	11.706
Ethics	10.895	3.500
Religion	12.158	4.056
Animal Right	12.000	3.800
The System of Species	10.579	4.684
Ecosystem	11.000	4.350
Human Identity	10.842	5.316
Bio-Industry	3.429	12.500
Insurance Industry	7.526	10.647
Medical Industry	4.429	12.177
The Position of Incurable Patient	2.714	11.706
The Position of the Incurable Patient's Family	4.238	10.529
Population	9.790	6.778
Way of Life	8.842	7.526
Attitude towards Life and Death	8.632	9.000

The following are found to be significant from Table 3. In regard to the positive impact, the respondents perceive that the development of medical science will be impacted strongest, followed by the position of incurable patients, bio-industry, the position of the incurable patient's family, medical industry, insurance industry, attitude towards life and death, way of life, and population. The remaining categories are minor in terms of the positive impact.

In regard to the negative impact, ethics is perceived strongest, followed by animal rights, religion, ecosystem, the system of

species, human identity, population, way of life, and attitude towards life and death. The remaining categories are minor in terms of the negative impact.

To identify how strongly the respondents perceive the necessity of xenotransplantation for humans, they were asked to evaluate it on the basis of a 10-point scale, defining 10 as being definitely necessary, and 1 as being definitely unnecessary. The necessity ranged from 1 to 10, with an average of 7.09. This would mean that the respondents perceive xenotransplantation to be necessary for humans in terms of overall consideration, even though they perceive a wide range of possible negative impacts on each societal category.

Ⅴ. The Implications of the Societal Impacts of Xenotransplantation

As shown in Table 2, the respondents perceive a wide range of possible positive and negative impacts of xenotransplantation when it is implemented. We can draw some significant implications of the societal impacts of xenotransplantation from the findings in Table 2.

First; The positive and negative impacts perceived are not discrete, but rather relative. For example, the respondents perceive that xenotransplantation will contribute to the solution of the present problems A, B, and C, but will bring about another new problems which do not exist at present.

Second; The positive impacts were perceived in relation to the societal benefits which will possibly result from the application of xenotransplantation. Meanwhile, negative impacts were also perceived on the social problems which will possibly result from its application. This may imply that xenotransplantation has two conflicting faces.

Third; The perceived benefits of the positive impacts cover a wide range of categories. They are converged into individual person, the state, and international relations. This implies that the societal benefits of xenotransplantation are not only applied to patients, but also extended to the restructuration of the present society and international relationship.

Fourth; The perceived social problems inherent in xenotransplantation are categorized into two areas. One is xenotransplantation itself, and the other is the undesirable results arising from its application. The former is an issue arising from the present perspective on what human is, while the latter is an issue arising from a sense of anxiety about the change of the existing societal structure to a new pattern in the future which is uncertain. These would imply that even though xenotransplantation has a possibility to bring about many benefits on a wide range of societal components, a possible serious problem is a chaos and conflict until a new perspective on the value of human is universalized, as well as until people are ready to accept the new societal structuration to be rationale.

Fifth; The third and fourth implications are that xenotransplantation will be a significant factor determining the restructuration of the existing societal system. This raises two other important issues. One is how strongly xenotransplantation will impact on the restructuration of the existing societal system? The other is whether or not the existing societal system has an adaptive capacity of restructuration without chaos and conflict? The former is an area of sociological inspection on the impact of technology on societal change. The latter is how to absorb and institutionalize the positive and negative impacts.

Based on the above five implications, it is possible to develop a holistic causal process of the societal impacts of xenotransplantation, as follows.

There is no doubt that the existing societal system, in particular the policy of technology determines the existence mode of technology, and is a result determined by technology (Bijker and Law, 1994). In this sense, the existing societal system is a cause determining the way of xenotransplantation in terms of its technology itself. Then, xenotransplantation which is shaped by the encouragement and regulation of the existing societal system will be developed and implemented (See the first box in Figure 1).

The implementation of xenotransplantation will impact positively and negatively on many areas of the existing societal system as is listed in Table 2. Thus, the implementation of xenotransplantation may be defined as a Driving-Force (D) that exerts a pressure on the existing societal system (See the second box in Figure 1).

Those perceived as negative impacts will exert as threat to the existing societal system because they will be a cause bringing about a social chaos and/or social disorder. Meanwhile, those perceived as positive impacts will be an opportunity for the existing societal system to be developed to a new way (e.g. Kopacek, 2002). In short, the negative impact exerts a challenge to the existing societal system, while the positive impact exerts a driving-force of societal development

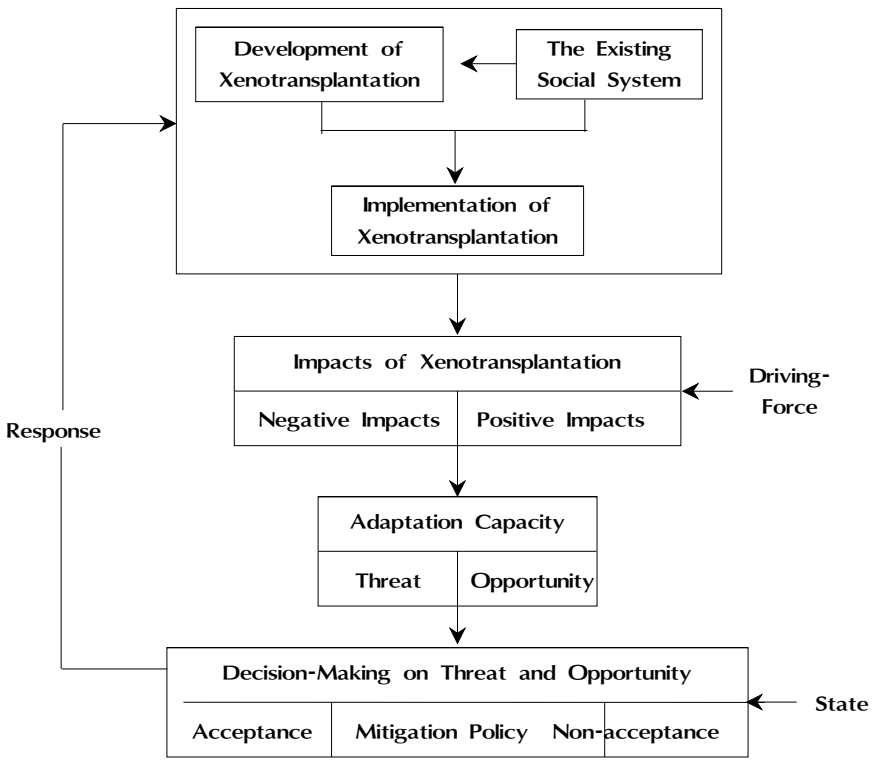
What impacts exert threat or opportunity will depend upon the capacity of the existing societal system. This may be termed adaptation capacity. The example includes technology, human resources, and information, etc. (See the third box in Figure 1).

Based on the adaptation capacity, the existing societal system will decide what elements of xenotransplantation to accept and to reject. In addition, it is anticipated that a mitigation policy will be applied to some elements of threat in order to accept them. Based on the adaptation capacity, the mitigation policy will also be applied to the elements judged to providing an opportunity. Through such a decision-making process, the existing societal sys-

tem will be re-constructed as a new system. The existence mode of the new system is termed State (S) being determined by Driving-Force (D) (See the fourth box in Figure 1).

The new societal system will exert the extent of reaction to the change in the development of the existing xenotransplantation in terms of its technology, scope to be implemented, and policy, etc. This reaction may be termed Response (R) in that it is a result from the implementation of xenotransplantation as a Driving-Force. In this sense, Response is a policy option providing a measure of the willingness and effectiveness of our existing

Figure 1. A Causal Framework between the Impacts of Xenotransplantation and Change in the Societal System



societal system. As a result, a new societal system will be again structured.

The above causal processes may be termed a D-R-S framework. Based on the causality explained above, the D-R-S framework is diagrammed as Figure 1.

Ⅵ. Summary and Discussion

1. Summary

This paper aimed at identifying the societal impacts of xenotransplantation and their implications. In this paper the term, 'societal', was defined as all components consisting of a society including political, economic, social, and cultural, religious, and ethic elements, etc

A Delphi survey with 50 experts in Jeju Province, South Korea was conducted for identifying their perceptions on the societal impact of xenotransplantation when it is implemented. The interpretations were also attempted as to the implications of the societal impacts.

As shown in Table 2, a wide range of positive and negative societal impacts were perceived on each of the 21 categories. This would mean that xenotransplantation will have both positive and negative faces on even the same societal category and natural world when it is implemented. The categories of findings and their contents perceived were much more wider than those included in the existing researches.

However, as shown in Table 3, the respondents perceived that the strength of the impact on each category of society and the natural world will be different. For the positive impact, medical science was perceived to be impacted strongest, and followed by the incurable patient, bio-industry, the incurable patient's family, medical industry, and the insurance industry, etc. For the negative impact, ethics was perceived to be impacted strongest,

and followed by animal right, religion, ecosystem, the system of species, and human identity, etc.

Even though the respondents perceived a wide range of both positive and negative impacts of xenotransplantation on society and natural world, they perceived strongly the necessity of xenotransplantation, showing an average score of 7.09 based on a 10-point scale.

The implications of the above findings are summarized as follows. The positive and negative impacts are not discrete, but rather relative. The positive impact will be a social benefit resulting from the implementation of xenotransplantation. Meanwhile, the negative impact will arise from two sources. One is xenotransplantation itself, and the other is the undesirable result arising from its application.

The positive and negative impacts of xenotransplantation will be significant factors determining the existing societal system being restructured. The restructured societal system also will exert a factor determining how and in what way xenotransplantation should be implemented. This causal process may be termed a D-R-S framework. D is defined as Driving-Force, S as state, and R as response.

2. Discussion

There are numerous theoretical and empirical works on how society and technologies have shaped each other. Broadly, the trend on which the existing research has focused may be classified into two areas.

One is the research on the interactions shaping technology in a social context (e.g. Bijker and Law, 1994; Kopacek, 2002; Joerges and Nowotny, 2003).

The other is the impact of technology on society. The impact has been studied on a variety of societal areas, treating technology as a cause bringing about societal change to a desirable

and/or undesirable way. The examples include the positive and negative contribution of technology to corporations, society, and the economy (e.g. Geisler, 2001), the relationship between technology and cultural studies (e.g. Feenberg, 2002), and the link the development in communication technology with the social conditions (Gary, 2005). In addition, Geels (2005) explains the impact of technology on society in terms of societal functions such as socio-economy, transport, housing, energy supply, environment, public policies and regulation, and infrastructure, etc.

However, no theoretical and/or empirical research has been done on the impact of xenotransplantation on societal system. As has been reviewed earlier, the key positive debates on xenotransplantation have focused on an organ shortage problem and the human rights of recipients. Meanwhile, the key negative debates have been concerned about moral dilemmas and risks inherent in its technology.

However, as identified in this research, the positive and negative impacts are much wider than debated hitherto. The coverage of positive and negative impacts includes individuals, society as a whole, and natural world.

Such findings and implications of the societal impacts of xenotransplantation suggest at least three topics to be considered. Firstly, societal change is generally defined as a difference in a system undertaken at different points in time. However, if the time interval for observing the difference is short, no difference can be found even though the impacts of xenotransplantation are strong enough to change the existing societal system. Secondly, societal change has its scope and depth. This refers to 'how widely and deeply xenotransplantation will change the existing societal system.'

Considering the above three points, the societal impacts of xenotransplantation and their implications can be studied with more comprehensiveness and deep explanation if further research

covers the time interval as its impacts emerge, the scope and depth of change in our societal system, and the impacts of the restructured societal system on the development of xenotransplantation.

As diagrammed in Figure 1, the impacts will be in a mutual influential interaction with society. Then, it may be generalized that societal system and technology in general including xenotransplantation are intertwined and influence each other with never-ending cyclical co-dependence. This synergistic relationship occurred from the dawn of humankind, with the invention of the simple tools, and continues into modern technologies such as the printing press, the telephone, and the many forms of computer-mediated communication. Just about every technological advancement is due to some influence from society, and the nearly every aspect of modern life is influenced by the development of technology.

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