

# Trends in Deceased Organ Donation and Utilization in Korea: 2000-2009

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Continuous efforts have been made by the organ donation and transplantation community in Korea to increase organ donation by the deceased. The authors detailed trends of organ donation and utilization over the past 10 yr using data provided by the KONOS. The yearly number of deceased donors has grown gradually since 2003. The number and percentage of old donors ( $\geq 50$  yr) and donors dying from intracranial hemorrhage has increased continuously. Therefore, the percentage of standard criteria donors (SCD) has been declining significantly, from 94% in 2000 to 79.2% in 2009. The number of organs transplanted per donor (OTPD) has also declined slightly since 2007, from 3.28 in 2007 to 2.95 in 2009. This decline may be attributable to increases in the number and percentage of extended criteria donors (ECD) and donors after cardiac death (DCD), since the OTPD was 2.25 for DCD, 2.5 for ECD, and 3.09 for SCD in 2009. In summary, the makeup of donors has changed significantly. There is an urgent need for establishment of an institutional framework including an independent organ procurement organization and for improvement for the National Transplant Act to increase deceased donor pool and to optimize management of ECD and DCD.

**Key Words:** Deceased Organ Donors; Expanded Criteria Donors; Donors after cardiac death; Tissue and Organ Procurement; Organ Utilization

## INTRODUCTION

The glorious history of organ transplantation in Korea began with the first renal transplantation from a living donor in 1969 (1), and the first transplantation of a kidney from a deceased donor was performed in 1979 (2). The transplant community and transplant professionals have made remarkable progress in transplantation in recent years. However, a critical shortage of human organs for transplant continues to pose a significant obstacle to further progress. In 2008, 256 deceased donors donated their organs, corresponding to a rate of 5.3 donors per million people (pmp) which is significantly lower than in Western countries, where the rates range between 10 and 34.2 pmp (3, 4).

The organ donation and transplantation community have made continuous efforts to increase organ donations from the deceased in Korea. The 'National Transplant Act' was enacted and the Korean Network for Organ Sharing (KONOS) was founded in February of 2000. Since that time, organ recoveries from deceased donors and allocation have been performed exclusively at the direction of the KONOS. In 2003, health authorities began to select Donor Managing Hospitals (DMHs) to manage deceased donors, and to recover and transplant organs. However, since 2005, continued stagnation in deceased organ donation has been causing a drift in opinion, toward the Independent

Organ Procurement Organization (IOPO) (5). Pilot projects for the IOPO were performed in 2007 (6) and 2008 (7) and the first IOPO, dubbed the Korea Organ Donation Agency (KODA), was founded in Region 1, Seoul in May 2009. Currently, there are three regions, 1 IOPO, 26 DMHs, and 79 organ transplant centers in Korea.

The effects of these aforementioned efforts on deceased organ donation and transplantation can be determined only via thorough ongoing analyses of national deceased donor data. However, only a few publications have analyzed the annual reports released by the KONOS, and thus there is a paucity of knowledge regarding this issue (8).

Herein, the authors have examined and detailed the trends in deceased organ donation in Korea over the past 10 yr. This study represents the first systematized analysis that includes all data from the KONOS donor registry since the establishment of the KONOS.

## MATERIALS AND METHODS

The authors evaluated all deceased donors from the KONOS database between February 2000--when the KONOS was founded--and May 2009. Deceased donors were divided into three mutually exclusive and complete categories: all donors meet-

ing the criteria for expanded criteria donors (ECD) for kidneys were classified as ECD (9); non-ECD donors were classified as standard criteria donors (SCD) or donors after cardiac death (DCD). Organs that can be divided into segments were counted only once per actual organ, and the number of organs transplanted per donor (OTPD) was compared by donor type.

Statistical analyses were conducted using SPSS software (version 15.0, SPSS Inc., Chicago, IL, USA). Data were expressed as means±standard deviation (SD) values or as frequencies (percentages).

**RESULTS**

**Changes in number and regional distribution of deceased donors**

After the enforcement of National Transplant Act in 2000, a significant decrease in the number of deceased donors, from 162 (3.5 pmp) in 1999 to 52 (1.3 pmp) in 2000 (3) was noted. The situation grew increasingly worse--the number of deceased donors in 2002 was a paltry 36 (0.9 pmp). Since that time, though, there has been gradual but continuous growth in the numbers of deceased donors, and the number of deceased organ donations in 2008 reached 256 (Fig. 1). Although organ donation in 2008 had increased by 611% as compared with 2002, the pmp rate was still only 5.3.

In 2000, 57.5% of deceased donors were from Region 1, 25.0% from Region 3, and 17.3% from Region 2. This disparity in the regional distribution of deceased donors has become increasingly apparent over the past 10 yr. By May 2009, the percentages of deceased donors were 80.6%, 14.3% and only 5.1%, respectively for Region 1, Region 3, and Region 2 for the year.

**Changes in demographics**

The distribution of gender has been generally stable, with males accounting for 66-71% of the deceased donor population. Interesting findings appeared in the analyses of deceased donor population by age and cause of brain death. Namely, the deceased donor population is aging (Fig. 2A). The percentages of deceased donors aged 50 yr and over increased from 15.4% of donors in 2000 to almost 36% in 2009, whereas the percentages of deceased donors aged less than 30 yr decreased--from 48.1% of donors in 2000 to 23.5% in 2009. Donors between ages 30 and 49 comprised almost 56% of the donor population in 2004, which represented an increase from the 36.5% in 2000 and then dropped to 40.9% in 2009, in lockstep with the increase in donors 50 yr old or older. The average age of deceased donors increased steadily over the past 10 yr, from 32.9 yr in 2000 to 41.3 in 2009.

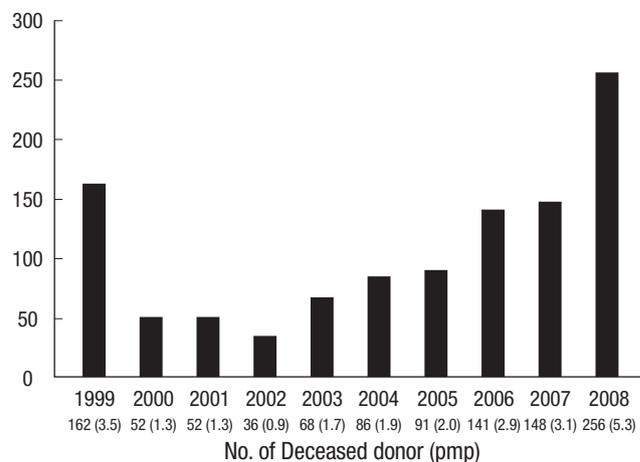


Fig. 1. Total number of deceased donors of organs recovered for transplantation, 1999-2008. Pmp, donors per million people.

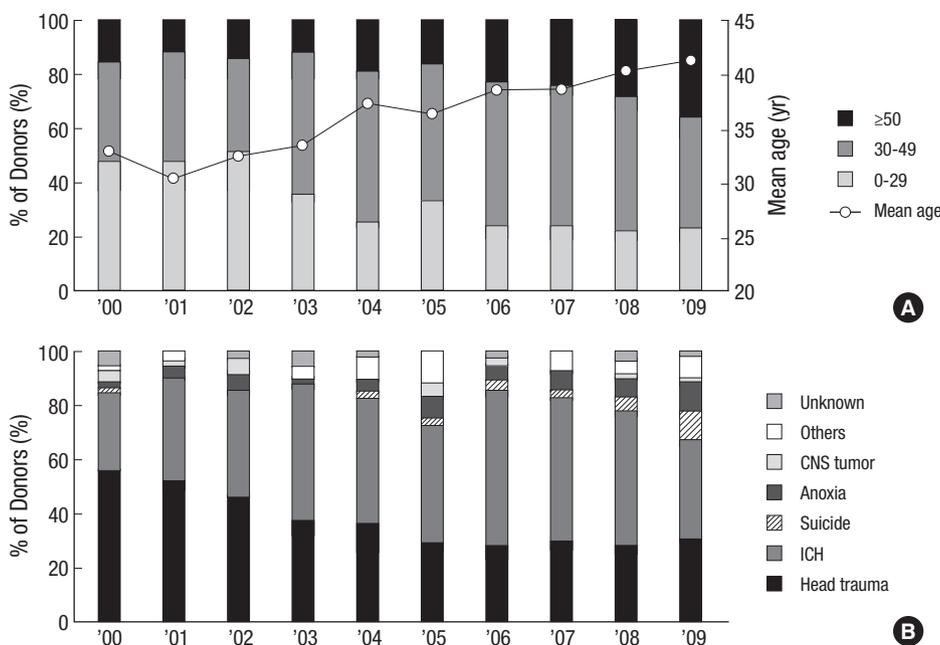


Fig. 2. Changes in demographic data. (A) Ages of deceased donors, and (B) causes of death of deceased donors.

There are also trends in the mechanisms of death data that confirm that a major change has taken place (Fig. 2B). The percentage of brain deaths owing to head trauma had clearly decreased in 2009 as compared with 2000 (28.6% from 55.8%). On the other hand, deceased donors with intracranial hemorrhage (ICH) increased significantly, from 28.8% in 2000 to 57.9% in 2006. The increase in the percentages of deceased donors with ICH has been faltering (34.7% in 2009), and it appears that this slowdown in the appearance of ICH donors is partly due to suicide and anoxia, both of which have been trending upward in recent years (10.2% from 2.7% and 10.2% from 6.8% three years previously, respectively).

### Changes in donor type and Influence in organ utilization

Increases in old donors and donors with ICH and anoxia (both of which can severely damage the organs) indicate that expanded criteria donors are being used increasingly in Korea.

Although a marked increase in the number of deceased donors has been noted in recent years, as illustrated in Fig. 1, this increase occurred along with a significant alteration in the make-up of the donor population. The percentage of SCD has been steadily declining, from 94% in 2000 to 79% in 2009 (Fig. 3). This decline can be attributed to recent increases in the numbers and percentages of ECD and DCD. Expanded criteria donors accounted for only 7.7% of all deceased donors in 2007; however,

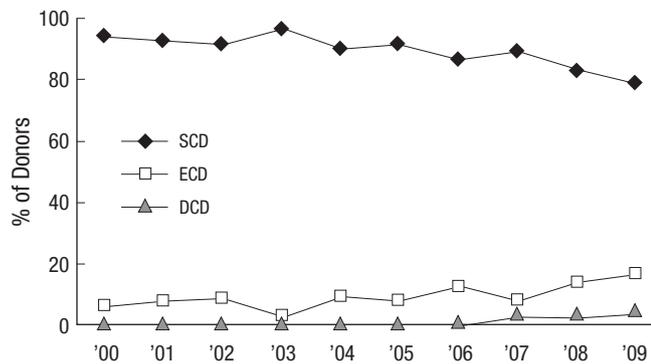


Fig. 3. Changes in deceased donor population, by donor type. SCD, standard criteria donor; ECD, expanded criteria donor; DCD, donation after cardiac death.

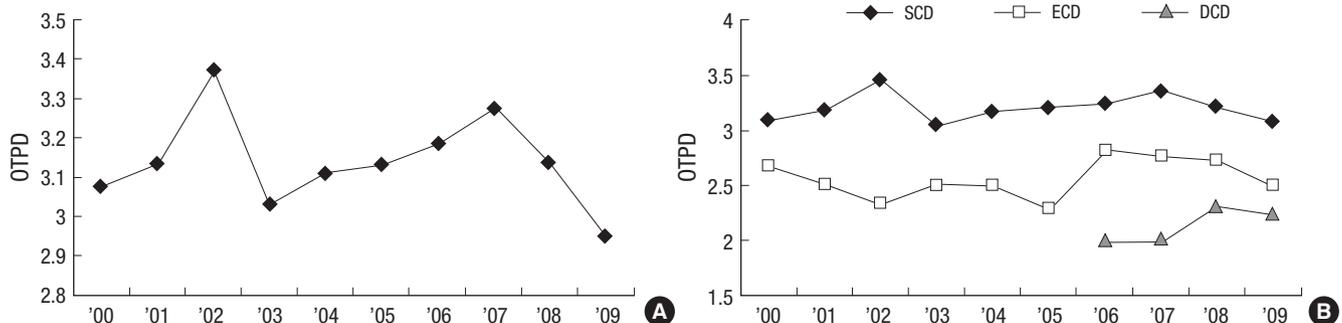


Fig. 4. Changes in organs transplanted per donor (OTPD). (A) all deceased donors and (B) OTPD changes by donor type.

er, this increased to 16.7% in 2009. Donors after cardiac death also increased, from a percentage of 0.7% in 2006 to 4.2% in 2009. These recent increases in ECD and DCD have significant implications for overall organ utilization--namely, fewer OTPD (Fig. 4A). The OTPD have declined since 2007. OTPD declined from 3.28 in 2007 to 2.95 in 2009. As the OTPD (respective of donor type) have not dramatically changed over the last 10 yr (OTPD was 2.25 for DCD, 2.5 for ECD and 3.09 for SCD in 2009), the aforementioned increases in the numbers and percentages of ECD and DCD explains why fewer organs per donor are transplanted overall (Fig. 4B).

Changes in the numbers of specific organs per donor type are illustrated in Fig. 5. The number of kidneys transplanted per SCD has not changed dramatically over the past 10 yr (2.0 in 2000 and 1.95 in 2009). However, with increases in ECD, the number of kidneys transplanted per ECD has dropped, from 2.0 to 1.85 over that period. DCD did not affect the numbers of transplanted kidneys. As the ECD numbers increase and begin to account for a larger fraction of the percentage of national deceased donors, its impact on OTPD increases. Although the current definition of ECD is specific for the kidney and many groups have attempted to define the ECD for other organs (10), their guidelines have yet to be generally accepted. Considering this lack of definition for 'expanded criteria' livers, pancreata, and hearts, the authors compared the numbers of these organs transplanted per donor providing organs after brain death (DBD) to the numbers of donors providing organs after cardiac death (DCD). The numbers of other solid organs (livers, pancreata, and hearts) transplanted per DBD have not changed markedly. The utilization of livers has increased slightly, with the number of livers transplanted per DBD increasing from 0.62 in 2000 to 0.8 in 2009. Pancreas and heart utilization from DBD has remained relatively stable, at approximately 0.1 to 0.2 pancreata or hearts transplanted per DBD donor. However, that number per DCD donor is relatively low. The number of livers transplanted per DCD donor was only 0.25 in 2009. Neither pancreata nor hearts have been procured and transplanted from DCD.

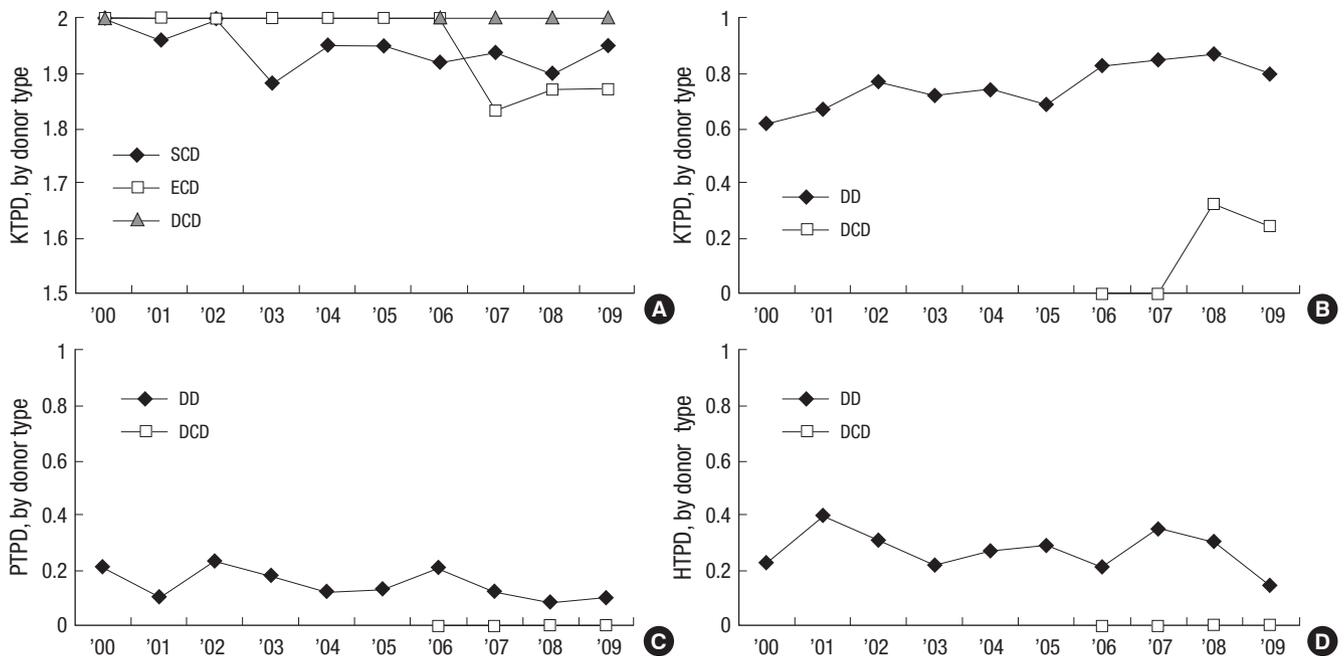


Fig. 5. Organs transplanted per donor (OTPD) by donor type and organs transplanted. (A) Kidney, (B) Liver, (C) Pancreas and (D) Heart.

## DISCUSSION

To the best of our knowledge, this work is the first systematic analysis of Korean deceased donor data, and the results of the present study clearly show some current trends in deceased organ donation and utilization in Korea. The absolute number of deceased donors, which dropped significantly after the enforcement of the National Transplant Act in 2000 increased gradually but continuously in recent years. The number of deceased donors in 2008 was 256, which corresponds to 5.3 pmp.

The most important finding of the current study involved the donor types and organ utilization analysis. Recently, a rapid increase was noted in the numbers and percentages of ECD and DCD donations, and a consequent decrease in the percentage of SCD. The SCD, ECD, and DCD donations accounted for 79.2%, 16.7%, and 4.2% of donations, respectively, in 2009. This increase in the numbers and percentages of ECD and DCD donations caused a drop in the number of organs transplanted per donor; the OTPD dropped from 3.28 in 2007 to 2.95 in 2009. Although ECD and DCD represent a small subset of all current deceased donors, those pools have the potential to substantially augment the total deceased donor pool and to reduce further the number of OTPD. Indeed, in the United States the ECD and DCD categories accounted for, respectively, 26.7% and 9.8% of all deceased donors in 2007, which have increased from the percentages of 20.4% and 1.3% in 1998. This increase in ECD and DCD donors brought about a steady decline in the percentage of SCD--from 78.5% in 1998 to about 65.1% in 2007--and a reduction in OTPD--from 3.21 in 1998 to 2.99 in 2007--since the OTPD for ECD and DCD category have remained relatively stable and low;

approximately 1.75 for ECD and 2.1 for DCD (13). Hence, the transplant community and the relevant professionals should prepare to optimize the system for ECD and DCD organ procurement and transplantation.

The current pmp numbers in Western countries range between 10 to 34.2 (4). In the United States, in order to achieve a conversion rate of 75%, 3.75 organs transplanted per donor, 10% of all donors from DCD sources and 20% growth of transplant volume, the organ donation and transplantation community continues to pursue sustainable work and performance. Such initiatives include the Organ Donation and Transplant Collaboratives, Transplant Growth and Management Collaborative, and DonorNet® (12). Indeed, the US has reported an 11% increase in deceased donations in 2004 as compared to 2003, largely as the result of the work of the Organ Donation and Transplant Collaboratives (11). In European countries, Spain is well known as the role model for deceased organ donation and transplantation. Since 1989, when the Organizacion Nacional de Transplantes (ONT) was created and a structure of national, regional and in-hospital efforts to increase organ donation was established, Spain experienced a 136% increase in deceased donation, from 14.3 pmp to 33.7 pmp over a 10-yr period (14). One distinguished feature of the so-called 'Spanish Model' is the potential donor identification and management system--which consists of a network of in-hospital transplant donor coordinators. The transplant donor coordinators, who are largely intensive care specialists and nephrologists, are fully involved in and accountable for donor recruitment efforts (15). The Declaration of Istanbul, which was recently released by The Transplantation Society and the International Society of Nephrology, emphasizes the need for

effective practices that support organ donation from deceased donors (16). Therefore, health authorities and transplant professionals still have many things to do in order to augment the deceased donor pool to the same level as in other advanced Western countries. In short, it is time for a paradigm shift in the organ procurement structures of Korea.

In Korea, there are currently 26 authorized Donor Managing Hospitals (DMHs) and 79 organ transplant centers. The DMH network is authorized to manage deceased donors, to make diagnoses of brain death, to recover organs from deceased donors, and to transplant them, and has operated in that capacity since 2003. Although in some respects this arrangement is similar to the hospital-based organ procurement organization (HOPO), the DMHs suffer from several noteworthy limitations (17): 1) they do not have exclusively assigned territory and consequently incur overlapping investments; 2) the manpower shortage at each DMH results in ineffective potential donor identification; and 3) the DMHs are basically 'for-profit' hospitals, and are authorized to recover and transplant organs. Therefore, the possibility remains that the moral purity of their mission might be tainted by their financial interest. In the United States, there are two distinct organizational forms--HOPOs (although the HOPOs in the United States are financially independent from their hospitals) and the independent organ procurement organizations (IOPOs). The IOPOs have generally proven to be more effective in organ procurement, because they are usually larger than the HOPOs and maintain more full-time employees (18). Therefore, the IOPOs have grown at the expense of the HOPOs--there are currently 50 IOPOs extant, and only 8 HOPOs (19). Considering this, Korea has recognized the need to build up a new national system for donor identification, management, and organ procurement, and thus Korea launched its first IOPO in May 2009. IOPOs, which are private and non-for-profit organizations, are scheduled to be founded in Regions 2 and 3, where they will supplant the current DMH system.

Finally, in order to ensure the success of the IOPO system and augment the deceased donor pool, the required referral system should be introduced. The National Transplant Act needs to be amended, to allow hospitals to refer all deaths and imminent deaths to their local IOPOs.

The authors of this article could not perform any recipient-related analysis, because the KONOS database includes only donor-related factors, and recipient data are currently unavailable. Therefore, the establishment and implementation of a National database that covers recipients as well as donors should be started.

In summary, the past 10 yr have seen a gradual but continuous growth in the number of deceased donors in Korea. However, this increase occurred concomitantly with a significant change in the makeup of the deceased donor population. The percentages of SCD have been on the decline, from 94% in 2000

to 79% in 2009. This decline can be attributed to increases in the numbers and percentages of ECDs and DCDs. These increases in ECDs and DCDs explain the decline in OTPD from 3.28 in 2007 to 2.95 in 2009. There has also been an increased emphasis on the need to establish a new national system--thus far, this increased emphasis has been partially responsible for the establishment of Korea's first IOPO this year, which was chartered to optimize ECD and DCD care. Although the organ donation and transplantation community, in addition to the relevant health authorities, have made great strides in recent years, there remain many challenges to overcome. At this point, rapid solidification of IOPO as an optimal deceased donor management system and revision of the law which would introduce the 'required referral' is needed to augment the deceased donor pool.

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