Organ Donation and Transplantation: An Updated Overview

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Abstract
This article reviews and describes the theoretical concept of organ donation (OD) and transplantation, historical milestones, need, shortage, status of global activities, health system capacity, survival outcome, and update on legislative environment in India, Central/State contribution and Nongovernment Organizations actively involved in OD.

Key words: Brain death, cadaver, capacity building, cardiac death, cornea, diabetes, health system, heart, hypertension, kidney, legislation, liver, living donor, noncommunicable, procurement, program

Introduction
The consequences of rising burden of noncommunicable diseases (especially diabetes and hypertension), living geriatric population, and other risk exposures are propelling the graph of organ failure across the globe including India. This, in addition, is causing morbidity, mortality, poor quality of life, social and financial catastrophe of the health system. Precious human lives can be saved if ethically good quality organs are retrieved from individual and transplanted to needed person in prescribed time frame. However, it is assuming public health significance due to ever increasing gap between need and supply of human organs. Dead bodies are being burnt or buried without even iota of thought being shed on wastage of such vast “natural reservoir.” This phenomenon is akin to “scarcity” in “abundance” as there is no lab manufactured product available until date. Transplantation comprises the processes of organ donation (OD) and subsequent implantation or grafting. Organ donation and transplantation (ODT) has roots in ancient Indian mythology with vivid examples, such as guru Dadeech and Lord Ganesha, considered epitomes of our rich culture, tradition, religion, spirituality, charity, salvation, and science. This article reviews and describes the theoretical concept of ODT, historical milestones, need, shortage, status of global transplantation activities, health system capacity, survival outcome, central/state contribution, and update on legislative environment in India. Table 1 depicts selected modern evolutionary milestone in the field of organ transplantation.[1-5]

Global Status of Organ Donation and Transplantation Activities and Health System Capacity
Worldwide, kidneys are the most commonly transplanted solid organs followed by liver and then heart. Cornea and musculoskeletal grafts are the most commonly transplanted tissues; these outnumber organ transplants by more than tenfold. Nobody knows the actual need of people requiring an organ transplant. Since the untreated patients die and are not to be found in the hospital statistics or registries. The patients who die untreated may not be seen by specialist physicians or may never be admitted to a hospital; they may, in fact, never

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Table 1: Historical milestones in the field of ODT

| Year | Milestone | Undertaken by/at |
|------|-----------|------------------|
| 1760 | Coinage of the term transplant | John Hunter |
| 1903 | Pioneering work on renal transplantation and cross-switched kidneys between two dogs | Alexis Carrol (French surgeon) |
| 1905 | First successful corneal transplant | Eduard Konrad Zirm |
| 1933 | First cadaveric renal transplant | Yuri Y Voronovy (Russian surgeon) |
| 1951 | Understanding of tissue rejection | Peter Medawar (British zoologist) |
| 1954 | Successful living renal transplant | Joseph Murray and John Merrill |
| 1958 | Discovery of major histocompatibility complex and HLA | Jean Daussset (French Physician) |
| 1959 | First experimental small intestine transplant in dogs | Lillehei |
| 1960 | First successful corneal transplant in India (Indore) | Dhanda |
| 1962 | First successful cadaveric renal transplant | Joseph Murray and David Hume |
| 1963 | First hepatic transplant | Thomas Starzl |
| 1963 | First lung transplant | James Hardy |
| 1966 | First pancreatic transplant | WD Keely, RC Lilliehei, FK Merkel, and Y Idezuki |
| 1967 | First cardiac transplant | Christiaan Barnard |
| 1967 | First successful cadaver kidney transplant in India | KEM Hospital, Mumbai |
| 1968 | First heart lung transplant | Denton Cooley |
| 1977 | Discovery of immuno-modulatory property of cyclosporine | Jean Borel (Swiss physician) |
| 1981 | First successful heart lung transplant | Bruce Reitz |
| 1984 | NOTA | USA |
| 1988 | Successful multi-visceral (liver and small intestine) transplant | David Grant, William Wall, and Calvin Stiller |
| 1989 | Living donor liver transplant | Christoph Broelsch |
| 1994 | Tacrolimus new immune suppressive molecule (discovered in 1984) approved for use in liver transplant | Food Drug Administration (USA) |
| 1994 | First Indian cardiac transplant | P Venugopal |
| 1994 | THOA | India |
| 1995 | Transplantation of Human Organ Rules | India |
| 1998 | India's first cadaveric liver transplant | Surgeon from Singapore at Apollo Hospital, Chennai |
| 1998 | India's first successful lung transplant | Chennai |
| 2005 | Facial transplant | Bernard Devauchelle, Benoit Lengele, Jean Michel Dubernard |
| 2005 | India's first successful ovarian transplant | PN Mhatre, Mumbai |
| 2008 | Transplant of a bioengineered trachea | Paolo Macchiariini |
| 2014 | First successful uterine transplant resulting in live birth | Sweden |
| 2014 | First successful penis transplant | South Africa |
| 2014 | First neonatal organ transplant | United Kingdom |
| 2014 | Amendments/notification of transplantation of human organ and tissues rules: 2008, 2011, 2014 | India |

HLA: Human leukocyte antigens, KEM: King Edward Memorial, NOTA: National Organ Transplant Act, THOA: Transplantation of Human Organ Act

be diagnosed or ever be seen by a doctor in many countries. In advanced Western economies, however, death certificate records are one way of assessing the causes of death of the population, and while they have their weaknesses, these records can provide reasonable estimates of need.[6] No country in the world till date collects sufficient organs to meet the needs of their citizens. Spain, Austria, Croatia, USA, Norway, Portugal, Belgium, and France stand out as countries with high rates of deceased organ donors.[7] OD is popularly reflected as per million population (pmp) and OD across the world is shown in Figure 1 (deceased OD).

Turkey recorded the highest living donor rate with 46.6 pmp followed by South Korea (36.5 pmp), Lebanon (27.2 pmp), Iceland (24.7 pmp), and USA (18.8 pmp).

During the consultative meet at Madrid 2010, a hierarchical framework of country capacity[12] was agreed on for ODT, ranging from the lowest (level 1) with no activity to the highest (level 5) of well-developed health system [Table 2]. Developing country like India falls in intermediate stage (level 3). A recent development of last decade (2007) was starting of the global observatory on OD and transplantation. According to latest available (2013) information, approximately 118,127 solid organs were reported to be transplanted across the globe that is roughly 2.98% increase from the previous year. These included kidney (79,325, 67.1%), liver (25,050, 21.2%), heart (6270, 5.3%), lung (4834, 4.0%), pancreas (2474, 2.0%), and small bowel (174, 0.1%).[13]
It is estimated that currently organ transplantation covers <10% of the global need. Each day, about 60 people around the world receive an organ transplant, while another 13 die due to nonavailability of organs. Of 194 World Health Organization (WHO) member countries, 57% were engaged in some level of solid organ transplant activities and over a third (36%) reported deceased organ transplantation activity; 62% transplants were performed in high-income member states, while only 28%, 9%, and <1% were performed in upper-middle, lower-middle and low-income member states. The practice of organ transplantation has now diffused across all income strata and has reached the populations of Bangladesh, Kenya, Kyrgyzstan, Myanmar, Nepal, and Tajikistan also.\[14\]

Unfortunately, India with a 1.2 billion population is lagging behind in OD with a national deceased donation rate of <1 pmp; however, Tamil Nadu has shown exemplary performance in OD with 1.3 donor pmp. Although India falls in the second position with numbers of live donor transplants undertaken in the world after the USA, but stand nowhere in the list of deceased donor transplant.\[15-17\] Country needs 260,000 organs every year; that is, 180,000 kidneys, 30,000 livers, and 50,000 hearts whereas only 6000 kidneys, 1200 livers, and 15 hearts are transplanted annually (National Organ Transplant Program [NOTP]). India has a fairly well-developed corneal donation and transplant program; however, donation after brain death has been relatively slow to take off. In the backdrop of annual requirement of 100,000 corneas, around 40,000 were collected (National Program for Control of Blindness) during past few years yet <25% could be transplanted due to various administrative, technical, and quality issues.

**Definitions**

Until 2007, there were no set definitions and terminologies of OD and related field. A need for standardization for uniform collection of data and information was felt for the global database on donation and transplantation and resulting collaborative effort of the WHO and Organizacion Nacional de Trasplantes of Spain resulted in ground-breaking spade work.

Some of the standard definitions are as follows.\[18\]

Donation refers to donating human cells, tissues, or organs intended for human applications. The donor is a human being, living or deceased, who is a source of cells, tissues, or organs for the purpose of transplantation.

An actual organ donor is deceased or living person from whom at least one solid organ or part of it has been recovered for the purpose of transplantation.

Living donor is a living human being from whom cells, tissues, or organs have been removed for the purpose of transplantation. A living donor has one of the following three possible relationships with the recipient:

Table 2: Framework of health system capacity for organ donation and solid organ transplantation in a country

| Level 1 | No local transplantation activity |
| Level 2 | At least one kidney transplant center - with the capacity to perform living donor nephrectomy, kidney transplantation and post-transplant management of recipients - within the country’s borders. No deceased donor activity reported |
| Level 3 | Countries that have commenced deceased donor kidney transplantation within their own borders. Sufficient local capacity - including local medical expertise - exists to perform kidney recovery surgery from deceased and living donors, kidney transplantation and recipient management. Activities may also include liver transplantation and isolated cases of heart and lung transplantation |
| Level 4 | Deceased donor kidney and liver transplantation have been performed for at least 5 years. Heart and lung transplantation also available, either locally or via formal international cooperative organ-sharing agreements such as Eurotransplant and Scandiatransplant. Legislation permits and regulates organ donation and transplantation |
| Level 5 | An established multi-organ deceased donor transplant program exists that is capable of providing kidney, liver, heart, lung, and pancreas transplantation either locally or via formal international cooperative organ-sharing agreements. The transplant program has been providing multi-organ deceased donor transplants consistently for at least 5 years, with an overall rate of transplantation in 2010 above 30 solid organ transplants per million populations. The country has a government-recognized authority that is responsible for oversight of organ donation and transplantation activities |

Figure 1: Worldwide actual deceased organ donors, 2013 (per million population). Source: International registry in organ donation and transplantation: 2013. Available from www.irodat.org (last accessed June 2015)
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• A = Related:
  • A1 = Genetically related:
    • 1st degree genetic relative: Parent, sibling, offspring
    • 2nd degree genetic relative, e.g., grandparent, grandchild, aunt, uncle, niece, nephew
  • Other than 1st or 2nd degree genetically related, e.g., cousin
  • A2 = Emotionally related: Spouse (if not genetically related); in-laws; adopted; friend.
• B = Unrelated

Not genetically or emotionally related.

Deceased donor is a human being declared, by established medical criteria, to be dead and from whom cells, tissues, or organs are recovered for the purpose of transplantation. The possible medical criteria are:
  • Deceased heart beating donor (donor after brain death): Is a donor who was declared dead and diagnosed by means of neurological criteria
  • Deceased nonheart beating donor (NHBD) (donor after cardiac death): NHBD: Is a donor who was declared dead and diagnosed by means of cardiopulmonary criteria.

Brain death is irreversible cessation of cerebral and brain stem function characterized by the absence of electrical activity in the brain, blood flow to the brain, and brain function as determined by the clinical assessment of responses. A brain dead person is dead, although his or her cardiopulmonary functioning may be artificially maintained for some time.

Cardiac death: Death resulting from the irreversible cessation of circulatory and respiratory function; an individual who is declared dead by circulatory and respiratory criteria may donate tissues and organs for transplantation.

Transplantation refers to transfer (engraftment) of human cells, tissues, or organs from a donor to a recipient with the aim of restoring function(s) of the body.

What can be Donated by Humans Under What Conditions?

Nearly, 25 different organs (kidney, heart, lung, liver, pancreas, uterus, and ovary) and tissues including cornea, eardrum, bone and bone products, blood transfusion, blood vessels, islets of Langerhans, heart valves, cartilage, bone marrow, hand, face, skin, nerve, and tendon can be donated after medical screening. A donor can live with one kidney and half of the pancreas and skin, nerve, and tendon can be donated after medical screening. In a recent development from United States of America, HIV Organ Policy Equity (HOPE) Act of 2013 has been passed that permits HIV-positive individual to donate organs to HIV-positive recipients and utilization of such organs for research purpose. [22] The graft survival and outcome status have been found to be of similar order as in HIV-negative individuals.

Reasons for Organs Shortage

The myriad reasons of shortage are administrative, legal, health system, and knowledge, attitude, and practice gap of stakeholders. Contrary to many studies, cultural, social, educational issues, language barrier, and religious concerns do not play a significant role in the decision for or against donation. [23-25] Some of the specific reasons for organ shortage are: [26-33]
  • Fear of death and surgical mutilation
  • Lack of awareness of brain death concept among medical professionals and public
  • A misapprehension about brain death
  • Fear to declare patient dead even before they are actually dead
  • Religious fallacies
  • Out-of-pocket expenses
  • Lack of system regarding identification and maintenance of brain dead donors
  • Socio-cultural beliefs including desire to be buried/burnt completely and re-birth without a missing organ
  • Mental non-acceptance of idea living with another person's organ say kidney
  • Lack of government support
  • Public and professionals attitude to brain death and OD
  • Lack of system transparency and perception of misuse of organs
  • Dynamics of decision making for actual donation
  • Poor funding and budget due to competing need/demand
  • Inadequate health insurance
  • Adverse media reporting and negative publicity
  • Legal, administrative/bureaucratic, and equity issues
  • Non-availability of trained transplant coordinators/counselors
  • Hospital infrastructure, logistics, manpower, functional linkage, and support system.

Commercial Organ Donation

Since demand outstrips donation, there was a spurt of commercial activities in almost all developing countries but less than what was prevalent more than two decades ago. Many nations including India is considered as favorite destination for international medical tourism due to high quality medical services at very low cost [34] though there have been some instances in the past of unethical removal of organs in this country also. On a positive note, dynamics have changed in current context due to deterrent legislation. Countries such as Pakistan and Philippines have facilitated organ trafficking. [35,36] However, it was mostly related to kidney donation since a person could survive with one kidney.
followed by parts of liver and pancreas which all can be harvested from living donor in exchange of lump sum money. In Pakistan, 40–50% of residents of some villages have only one kidney because they have sold the other for a transplant to a wealthy person, probably from another country. In the current context, any kind of payment or reward for OD is banned throughout the world with the notable exception of Iran.[37,38] As of 2005, it was estimated that 10% of organ transplants performed worldwide involved these unacceptable activities leading to a resurgence of transplant tourism. [39] In a few countries such as China, approximately 1.5 million patients need transplants each year but only 10,000 organs are available, organs were even harvested from executed prisoners; however, this practice was banned recently in 2013.[40-42]

**Types of Donors**

- Living donors
- Deceased donors

Both kinds of donation are now recognized as critical to the capacity of nations to develop self-sufficiency for ODT. Deceased (erstwhile cadaveric heart beating or non-heart beating) donors account for the majority of organ sources, but this source is heavily constrained by the willingness of donation. Recent years have seen a steady increase of living (related or un-related) donors partly due to medical profession’s consensus that this option provides a comparative improved medical outcome over deceased donor transplantation.[43]

Living donor kidney transplantation is taking on a more predominant role than ever. According to the Donor Nephrectomy Outcomes Research Network, nearly 40% of all kidney transplants worldwide are derived from living donors.[44] Currently, kidneys from living donors account for over 95% in India, 41.5% in the USA, 29% in Scandinavia, while only 8% of transplant in Belgium.[45] In China, nearly 80% of the organs came from voluntary OD after citizens’ death in 2014.[46] The waiting time for receiving organ transplantation vary significantly based on severity of illness and other factors e.g. median national waiting time for kidney is nearly 4 years and 1.5 years for liver in United States of America.[47] Most of cadaver transplanted kidneys are obtained from brain dead donors with functional circulation. Brain death can occur due to spontaneous intracranial hemorrhage, head trauma, cerebral ischemia, or primary cerebral tumors. Corneal transplant, simplest of all transplants can be undertaken on retrieval of the cornea from deceased person only. OD can be considered when there is a beating heart which supplies blood and oxygen to the vital organs and this situation can occur in-case of hospital death only. If someone dies outside of the hospital/at the accident site or home, OD is not an option but tissue donation is still possible depending upon time of death.

**Strategy of Voluntary Donation**

The goal of voluntary OD could be achieved through a system of

- Opt-in-where the donor/legal guardian gives consent at the time of donation
- Opt-out-where anyone who has not refused is considered as a donor (presumed consent).

In India, we have opt-in system, while many western countries with high organ transplant activities practice opt-out system.

**Process of Organ Donation and Registration**

There are two ways to donate organs:

1. By pledging for OD when a person is alive
2. By consent of family after death.

The potential donor can also approach OD agencies for a donor card which is available free of cost. During lifetime, a person can pledge for OD by filling up a donor form in the presence of two witnesses, one of whom shall be a near relative. Although not legally binding, the donor card is a means of expressing one’s willingness to donate organs and make family more understanding towards the cause. However, the prerogative on the decision eventually rests with the next of kin of the deceased after expressed written consent. If a person expires without registration, the family members can donate his/her organs. For this they need to sign a consent form, which is provided at that time and organs are harvested within a few hours. The family of the donor does not face any difficulty or extra burden upon them. The transplant coordination team carries out the entire process till the relatives receive the body of the deceased. The deceased body is given back to the family in a dignified way with no disfigurement. The body can be viewed as in any case of death and funeral arrangements need not be delayed.[48] Living donation entails undertaking formalities with transplant centres directly.

**Types of Transplant**

Different types of transplant are as follows:

- Autograft: A transplant of tissue from the person to oneself (e.g., skin grafts, vein extraction for coronary artery bypass graft, etc.)
- Allograft: A transplanted organ or tissue from a genetically non-identical member of the same species
- Isograft: Organs or tissues are transplanted from one to genetically identical other person (identical twin)
- Xenotransplant: When transplantation is performed between different species e.g., animal to human.

**Process of Transplantation**

Deceased donor:

1. Potential donor identification and screening of individuals with brain death
2. Consent, administrative, legal, and social formalities
3. Organ removal, preparation, preservation, and packaging
4. Recipient preparedness
5. Allocation and transplantation within stipulated time frame
6. Transplant care and follow-up [Figure 2].

**Cost and Survival Outcome**

The cost of organ transplant varies across the globe, but most common kidney transplant can range from as low as $5,000 (India), $70,000 (China) to $100,000 (USA). Another recent report is referring to estimated billed cost per member per month in the USA depicts that transplantation is indeed a costly affair cornea ($28,000), kidney ($300,000) and liver ($700,000). Even in the government sector in India, the renal transplant may incur personal expenditure ranging from Rs. 50,000/- to Rs. 100,000/- depending on the availability of sophisticated investigations; cornea (Rs. 8000/-), liver transplant (AIIMS, New Delhi: Free of cost; PGI Chandigarh: Rs. 7/-Rs. 8/-lakhs, ILBS New Delhi: Rs. 12/-Rs. 14/-lakhs) while in private sector renal transplant may range from Rs. 3.5 lakh to 15 lakh depending on compatible or non-compatible blood group transplant; cornea (Rs. 35,000/-/Rs. 65,000/-), liver (Rs. 18–30 lakh), and heart transplant may cost ranging from Rs. 10 lakh to Rs. 20-lakhs (Times of India). Contrary to general perception, the long-term cost of renal transplantation is lower compared to hemodialysis or peritoneal dialysis. Even the quality of life and survival are reportedly better among renal transplant recipients.

Survival outcome is dependent on many factors such as status of disease pathology/concomitant illness, operative risk, graft rejection, infection, posttransplant care, nutrition, adverse effects of immunosuppressive therapy, and very small additional risk of malignancy development. The patient and graft survivals are similar with donation after circulatory death as compared to conventional deceased donor transplantation. Five-year survival rates for most organs are now at least 70%. More than 1 million people worldwide have received an organ transplant, and some have already survived more than 25 years. The top runners in patient survival are recipients of live -donor kidneys, with 95% surviving for at least 1-year and 65% for 10 years, heart and liver recipients have survival rates of 85% for 1-year and 70% for 5 years. Lung recipients show similar results at 1-year but only 55% surviving beyond 5 years [Figure 3].

Globally, organ donors are never told of the identity of the recipient but many federation in USA, UK, Canada, Sweden, Singapore, Austria, Holland, and Australia to name a few countries have been organizing transplant games to increase public awareness and thereby increase OD rates, as well as promote full rehabilitation and well-being of participants and inter-alia have brought donors/ recipients, their families, medical and transplant teams on a single platform.

**Table 3: Available information on number of solid organ transplantation undertaken by states in India**

| Year | Tamil Nadu | Andhra Pradesh | Delhi | Gujarat | Karnataka | Kerala | Punjab | Orissa | Uttar Pradesh | West Bengal |
|------|------------|----------------|-------|---------|-----------|--------|--------|--------|---------------|------------|
| 2000 | 459        | 87             | 70    | 103     | 105       | -      | 113    | 130    | -             | -          |
| 2001 | 452        | 76             | 73    | 136     | 101       | -      | 94     | 126    | -             | -          |
| 2002 | 437        | 79             | 87    | 125     | 102       | 41     | 62     | 2      | 117           |            |
| 2003 | 478        | 78             | 89    | 116     | 85        | 59     | 24     | 4      | 110           | 03         |
| 2004 | 468        | 88             | 97    | 99      | 110       | 76     | 41     | 9      | 129           | 18         |
| 2005 | 326        | 99             | 107   | 70      | 102       | 45     | 31     | 6      | 100           | 10         |
| 2006 | 141        | 106            | 110   | 76      | 253       | 55     | 28     | 7      | 105           | 9          |
| 2007 | 144        | 99             | 124   | 80      | 110       | 74     | 50     | 2      | 10            | 9          |
| 2008 | 93         | 304            | 90    | 96      | 36        | 57     | 23     | 7      | 11            | 52         |
| 2009 | 69         | 132            | 139   | 93      | 107       | 60     | -      | 14     | 71            |            |
| 2010 | 93         | 18             | 49    | 97      | 98        | 46     | -      | 5      | 135           |            |
| 2011 | 33         | -              | -     | -       | 72        | -      | -      | 9      | -             |            |
| 2012 | 39         | 4              | 11    | -       | -         | -      | -      | -      | -             |            |

*: Information: Not available
Developments in India

Central level
An ambitious start was made with announcement of NOTP in the year 2009; however, its current budget has been scaled down to one-tenth of the initial proposal due to other present and clear challenges with the onus now on states to take leadership in ODT activities. National Organ and Tissue Transplant Organization (NOTTO) situated at Safdarjung Hospital, New Delhi has been commissioned and has two divisions: (1) National Human Organ and Tissue Removal and Storage Network (2) National Biomaterial Centre (National Tissue Bank). Regional/ State level organ and tissue transplant institutions would be established in a phased manner at Kolkata, Chennai, Mumbai, Chandigarh, and Guwahati in addition to six cities where AIIMS are established. The NOTTO website has become functional and operational guideline of NOTP has been released in 2015. A call center is being set up which will set up contact between donors and people in the waiting list, on a real-time basis. Indian OD day is observed every year, since 2010. Department of Health Research under the government of India is boosting funding for research activities including molecular and transplant immunology, stem cell, and genomics. With the objective of learning, sharing, and emolliate best practices in ODT, a memorandum of understanding is expected to be signed with Spain. Many of such practices though have been articulated and reflected in the legislation and executive orders; however, these need to be implemented in an environment of mutual trust in letter and spirits. Country has well developed accredited training system for capacity building of health workforce.

States level
Tamil Nadu is the model state for ODT in India with OD of 1.3 pmp (India: 0.05–0.08) because of mandatory executive actions, public-private partnership, good coordination and added facilities, the number of cadaveric transplant increased drastically in the last decade. This model also takes care of the poorer section of society by conducting ODT through government run public facilities free of cost. Other leading states in ODT activities are Delhi, Andhra Pradesh, Kerala, Karnataka, Gujarat, Maharashtra, and Uttar Pradesh. Available details of solid organ transplant undertaken by selected states during last decade are shown in Table 3. Pioneering work has been undertaken by large number of Nongovernment Organizations (NGOs) such as Multi Organ Harvesting Aid Network, Chennai; Foundation for Organ Transplantation and Education, Bangalore; Delhi Organ Procurement Network and Transplant Education, Delhi; Organ Retrieval Banking Organization, New Delhi; and Deceased Organ Retrieval Sharing Organization, Delhi in contributing immensely on community and health staff awareness, training of transplant coordinator, monitoring, evaluation, and coordination. Selected list of government agency/active NGOs is shown in Annexure 1 with their website.

Health education
Government of India through various institutions/agencies undertakes specific OD awareness generation activities including release of postal stamp. National Program for Control of Blindness (NPCB) under the government of India, observes eye donation awareness fortnight from 25th August to 8th September every year throughout the country with the help of state authorities and NGOs. Recently, social and print media have started undertaking online awareness generation activities; 13th August is being observed as OD day. Successful OD by deceased family member is highlighted as case-study in various media. Various studies conducted in India indicate reasonably high awareness on organ/tissue donation. However this heightened awareness is not getting translated into actual donation, probably motivation/training of health personnel is also required along with appropriate linkage.

Registry
Since health is a state subject, there is no central collation of data with regard to solid ODT; however, the government of India is planning to start online-registry. Indian transplant registry started in the year 2005 by the efforts of the Indian Society of Organ Transplantation and provides a fair collation and reflection of data of participating center on trend, state, and gender related information of kidney and liver transplant. NPCB provides funds to states/NGOs for corneal disease management, training, development of eye-banks/eye donation center, and salary component of grief (eye) counselor, hence there is central collation of data related to corneal donation. There were 400 eye banks in India at one point of time; however, due to non-donation of corneas/eyes after death, significant proportion have become nonfunctional with only 250 at present. The majority of solid organ transplants done in India are living related or unrelated transplants with approximately 200 transplant centers in the country mostly led by private players and NGOs.

Legislation
In spite of the existence of Transplantation of Human Organ and Tissues Act since the year 1994, the journey of ODT...
continues to be in the infancy stage. On a positive note, there have been recent amendments with the view to enlarge its scope and promote cadaver OD. Some of the broad areas included in recent amendments are:[66-68]

1. Provision of registration and renewal of retrieval and transplant centers
2. Definition of term “near relatives” to include grandparents and grandchildren
3. Removal of eyes/corneas permitted by a trained technician
4. Brain death certification board has been simplified so as to enable a surgeon/physician and an anesthetist/intensivist to be included in the medical board in the event of non-availability of a neurosurgeon/neurologist for certification of brain death
5. Authorization committee to be hospital based if number of transplants undertaken is 25 or more in a year at the respective transplantation centers, and if the number are <25 in a year, then the state or district level authorization committee would grant approval(s)
6. Medical practitioner involved in transplantation team will not be a member of authorization committee
7. It is mandatory for the intensive care unit (ICU)/treating medical staff to request relatives of brain dead patients for OD
8. Swap donations of organs between near relatives allowed
9. Procedures for foreign nationals notified if they happen to be donor or recipient
10. Detail procedures notified to prevent commercial activities and exploitation of minors
11. Establishment of a National Organ Retrieval, Banking, and Transplantation Network
12. Maintenance of registry of donors and recipients waiting for organ transplants
13. Mandatory position of a “transplant coordinator” in all hospitals registered for ODT
14. Every authorized transplantation center must have its own website. The identity of the people in the database shall not be in public domain
15. The authorization committee is required to take a final decision within 24 hr of holding the meeting for grant of permission or rejection for transplant. The website of transplantation center shall be linked to state/regional/ national networks through online system for organ procurement, sharing, and transplantation
16. The cost for maintenance of the cadaver (brain-stem dead declared person), retrieval of organs or tissues, their transportation and preservation, shall not be borne by the donor family and may be borne by the recipient or institution or government or NGO or society as decided by the respective state government or union territory administration
17. Detailed procedures regarding quality assurance, donor screening, qualification and experience of doctor/ transplant coordinator, laboratory investigations, equipment, documentation, other requirements, etc., should be notified.

**Conclusion**

At any given time, every major city would have 8–10 brain dead patients in various ICUs with 4–6% of all hospital deaths being brain death. In India, road accidents account for around 1.4 lakh deaths annually and of these almost 65% sustain severe head injuries as per a study carried out by AIIMS, Delhi, meaning that there are almost 90,000 patients who may be brain dead.[69] It is not that people do not want to donate, but that there are no mechanisms in hospitals to identify and certify brain deaths. It may also be pertinent to mention that no one empowers the relatives of a brain dead person to save lives of other people by donating their relative organs. Most importantly young deaths occurring either due to road traffic accidents or cardiovascular phenomenon provide the best option of yielding high quality organs but also requires air and road linkage (popularly known as dedicated green corridor) with appropriate trauma and transplant hospitals. There is no second thought that there are other imminent public health challenges being faced by country and ODT may not receive priority attention in the current socioeconomic and political scenario. However, with each passing day, growing need and demand, technological advancement, and spirits are taking this movement forward. In our opinion, the day is not far off in future when WHO declares OD as a theme for World Health Day (7th April) to generate global interest, awareness, and preparedness. To conclude, in an environment of flexible bureaucratic procedures, system readiness, technical know-how, and abundance of organs linked with high motivation, positive attitude of health staff, transparent communication, counseling and functional coordination of different institutions/units will lead the graph reversal from low to high ODT activities in India and may offer another functional model to the world.

**Annexure 1: Selected list of government agency/active NGOs involved in OD**

| Name of agency | Website |
|----------------|---------|
| NOTTO (Central Agency) | http://notto.nic.in |
| ORBO (Delhi, AIIMS) | www.orbo.org.in |
| DORSO (Delhi) | www.dors.org |
| Mohan Foundation (Chennai) | www.mohanfoundation.org |
| Ganadarpam (Kolkata) | www.ganadarpaindia.in |
| Gift Your Organ (Karnataka) | www.giftyourorgan.org |
| Narmada Kidney Foundation (Mumbai) | www.narmadakidney.org |
| Shatayu (Ahmedabad) | www.shatayu.org.in |
| Apex Kidney Foundation (Mumbai) | www.apexkidneyfoundation.org |
| TANKER (Tamil Nadu) | www.tankerfoundation.org |
| ZTCC (Mumbai) | www.ztccmumbai.org |
| ZCCK (Karnataka) | www.zcck.in |

**NOTTO**: National Organ and Tissue Transplant Organization, **ORBO**: Organ Retrieval Banking Organization, **DORSO**: Deceased Organ Retrieval Sharing Organization, **TANKER**: Tamil Nadu Kidney Research, **ZTCC**: Zonal Transplant Coordination Committee, **ZCCK**: Zonal Coordination Committee of Karnataka, **NGOs**: Nongovernment Organizations, **OD**: Organ donation
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