



# Allocation and Distribution of 8488 Consecutive Kidneys Obtained in Mexico During a 12 Years Period

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Published online: 17 February 2020  
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## Abstract

Renal transplantation is the treatment of choice for end-stage renal disease, considered a major health problem in Mexico and important cause of disability and mortality. We describe allocation and distribution of 8488 kidneys obtained from deceased donors from January 2007 to December 2018. We describe a fragmented health system without universal coverage for organ donation and transplantation, a huge regional variability in organ donation and transplantation activity, a great disparity in access to the waiting list, and a faulty system for organ allocation requiring reform to achieve international standards of transparency and traceability.

**Keywords** Renal transplantation · Organ donation · Equity of access · End stage renal disease

## Introduction

End-stage renal disease (ESRD) represents a major health problem in Mexico; it is reported among the 3 leading causes of death, with an annual mortality rate of 12.3 deaths per 100,000 inhabitants [1–3]. It ranks second as a cause of years of life lost (YLL) due to premature death [2–4]. Per the Global Burden of Disease Study, ischemic heart disease, ESRD, and diabetes are the most frequent causes of death in Mexico [2–4, 5, 6]. Renal transplantation was incorporated in therapeutic armamentarium for ESRD in 1963, since then 52,658 operations have been done in the country until the end of December

2018 [7]. 12,722 transplants (24.1%) were from a deceased donor (DD) reflecting the deceased donor rate observed in Mexico of around 4 donors per million population (pmp). Herein is described how 8488 DD kidneys, obtained from 2007 to 2018, were distributed, allocated, and transplanted.

## Healthcare in Mexico

Approximately 50% of Mexican population does not have universal health protection with coverage provided through a complex and fragmented system. Healthcare in Mexico is provided through a mix of Social Security services for formal employees, traditional public sector services for the poor, and private services for those who can afford it. The Social Security system includes five sectors: Mexican Social Security Institute (IMSS, country's largest provider), Bureaucracy (ISSSTE), Army (SEDENA), Navy (NAVAL), and Public Oil Company (PEMEX). Total health expenditure is 6.35% of GDP with a government contribution of only 49%. Organ donation and transplantation are fully covered only in Social Security Institutions [8••].

## Mexican Legislation in Organ Donation and Transplantation (GHL)

It is the responsibility of CENATRA (National Transplant Center) under the umbrella of Secretary of Health to control

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This article is part of the Topical Collection on *OPTN Policy*.

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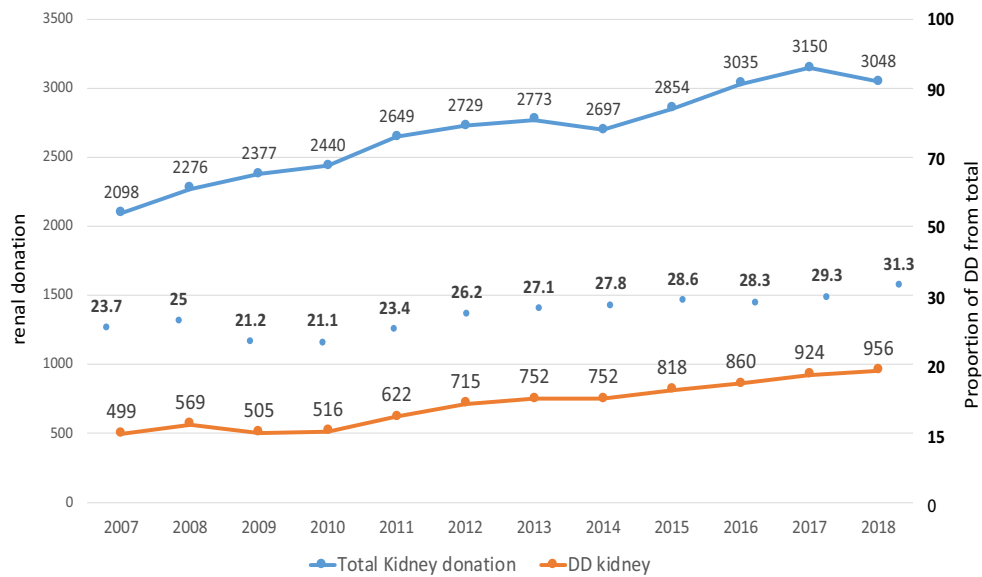
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**Fig. 1** Deceased donor and total renal transplants per year are shown in the figure. Percent of deceased donor transplants is shown

and monitor donation and transplantation activity in the country. CENATRA operates in coordination with State Transplant Centers and Health Institutions. Public policies on the matter should be based on transparency, equity, and efficiency (GHL Art 313–314).

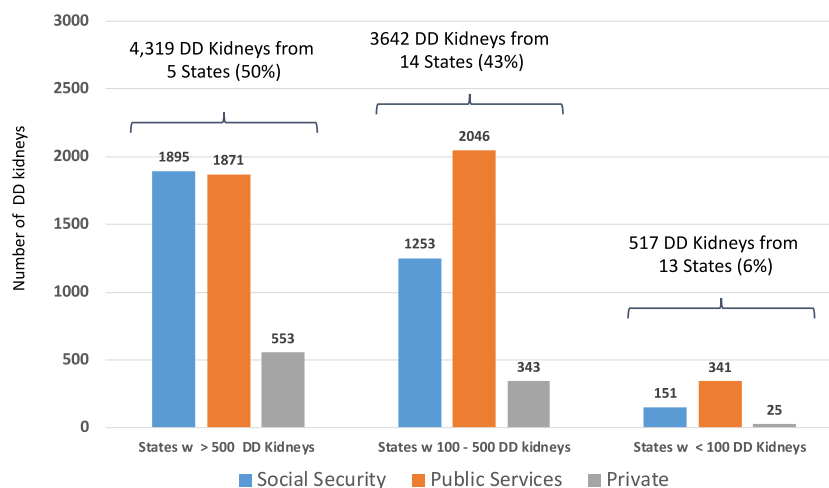
Any institution authorized for organ and tissue donation and transplantation activities must have an Internal Committee (IC), either for donation or transplantation. IC is responsible for coordinating process; its main responsibility with mandatory participation of Bioethics Committee is organ allocation (GHL Art 316).

CENATRA coordinates organ distribution and allocation in strict compliance with Mexican law. However, final decision of distribution and allocation of each organ is an exclusive faculty of each Hospital IC (GHL Art 339).

For the purpose of organ and tissue distribution, Mexican regulation (Art 38) mandates priority to the generating hospital. Secondly, organs should be allocated to hospitals of the same health branch (Social Security, Public, or Private) and hospitals of other health branch in the same State act as third option, and finally organs are distributed to any hospital nationwide. In any case, Internal Committee is legally authorized and responsible for organ and tissue distribution. Exportation or sending abroad of any organ and tissue is not permitted (GHL Art 317).

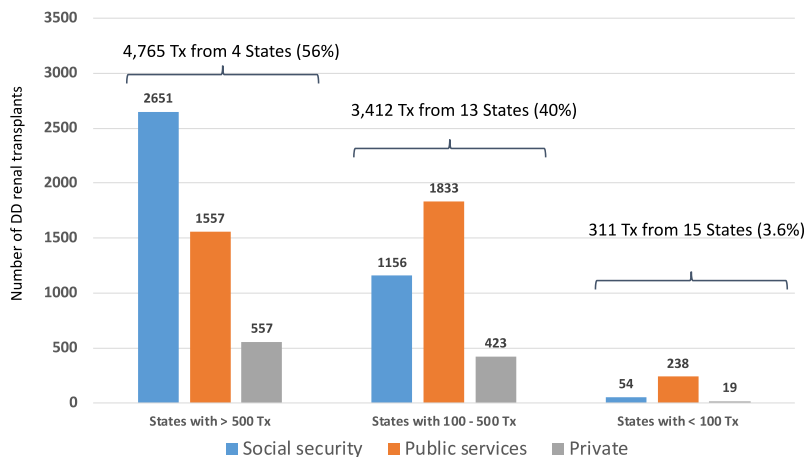
Organ and tissue allocation and selection of recipients should consider the following criteria: patient’s condition, opportunity for transplant, expected benefit, compatibility, geographic location of donor, and other medical criteria. Every recipient must be enrolled in the National Transplant Registry

### DD Kidney per state of origin



**Fig. 2** Distribution in origin of deceased donor kidneys according to states of country and type of institution

### DD Renal transplant per state of country



**Fig. 3** Distribution of deceased donor kidneys transplanted according to states of country and type of institution

before being considered for assignment of an organ or tissue. Additional restrictions and specific requirements for non-Mexican citizens (recipients and donors) are expressed in law (GHL Art 336). Supervision and sanction of any irregularity in this process is the responsibility of CENATRA and the Federal Commission for Protection Against Sanitary Risks (COFEPRIS), respectively. Every hospital with activity in organ donation and transplantation must have a sanitary license after fulfilling requirements; licenses are granted or revoked by COFEPRIS (GHL Art 339).

Demographic data of patients, origin, and destiny of kidneys were obtained from data base of National Transplant Registry.

For the purpose of considering geographic trends in the analysis, States of Mexico were placed in three groups either according to number of transplants and/or number of procured kidneys: > 500 events (Group 1), 100–500 events (Group 2), and < 100 events (Group 3). Healthcare systems were also grouped for analysis as follows: Social Security, Public services, and Private.

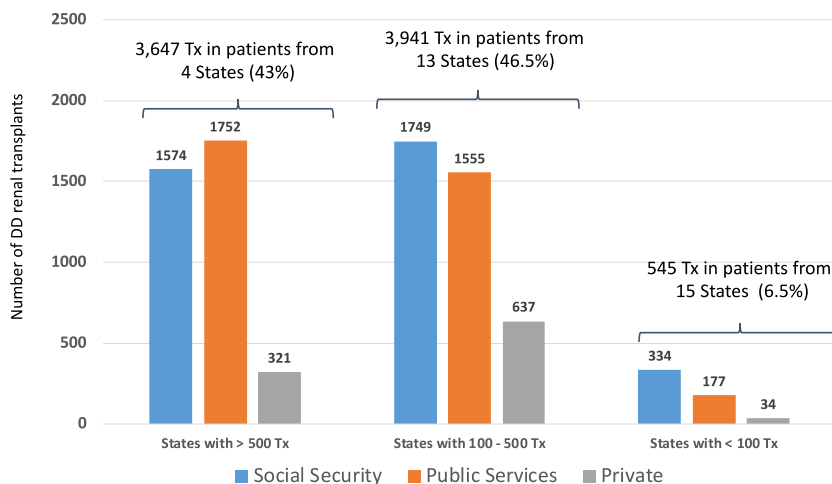
### Patients and Methods

This is an observational, descriptive analysis of total DD kidney allografts and transplant recipients obtained in Mexico from January 2007 to December 2018.

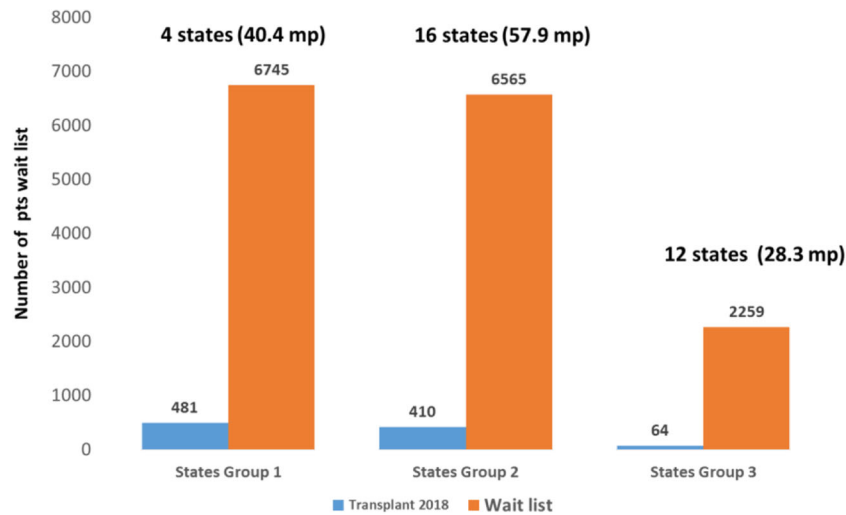
### Statistics

Descriptive statistics was used according to the type of variable. For continuous variables with normal distribution, we used mean and standard deviation; for continuous variables with

### DD Tx per state of residence



**Fig. 4** Distribution of deceased donor transplant recipients according to state of residence and type of institution



**Fig. 5** Distribution of patients in waiting list and number of patients transplanted in 2018 according to state of residence

non-parametric distribution, we used median and interquartile range. Dichotomous and ordinal variables were expressed with absolutes and relative frequencies. The donation rate was calculated based on population of the State of donation, and the transplant rate was calculated based on the State of patient residence and the State where the transplant was done.

The rate of donation and transplantation of the States was the result of the average of rates reported between 2015 and 2018. The analysis was done with STATA 11.1 and Excel 2013 software.

### Results

About 8488 events of deceased donation and transplantation were done in Mexico from January 2007 to December 2018. Deceased donation rate in the country increased from 3.0 to 4.6 pmp during 12-year period. Number of donated kidneys

increased from 499 in 2007 to 996 in 2018. Proportion of DD transplantation from total number of renal transplants in the country moved from 23.7 to 31.3% during same period (Fig. 1).

### Kidney Procurement

Public services obtained 50.2% (4268), Social Security 38.8% (3299), and Private 10.8% (921). Five States obtained > 500 kidneys (Mexico City, Jalisco, Nuevo Leon, Guanajuato, Estado de Mexico), mean DD rate in such States was 6.6 pmp (IQR 4.7–9.9), and a total contribution of 4319 (50.8%). Fourteen States obtained 100–500 donations resulting in a mean DD rate of 4.7 pmp (IQR 3.9–7.1) and a total contribution of 3628 (42.9%). Thirteen States obtained < 100 donations had a mean DD rate of 1.25 pmp (IIC 0.9–1.8) and a total contribution of 527 (6.2%) (Figs. 2, 3, 4, 5 and 6).

### Transplants and Institutions

45.8% of deceased donor kidney transplants were done in Social Security hospitals ( $n = 3861$ ), 42.7% in public hospitals (3628), and 11.7% in private hospitals (999). Kidney exchange and total productivity are shown in Table 1.

### Transplants and Region of Country

Four States of Mexico reported > 500 transplants (Mexico City, Guanajuato, Jalisco, Nuevo Leon). Mean DD rate for those States was 16.5 pmp (IQR 12.1–24.9) and a total of 4765 transplants (56%). Thirteen States performed 100–500 transplants with a DD rate of 6.7 pmp (IQR 3.2–8.9) and a total of 3412 operations (40%). Fifteen States performed < 100 transplants exhibiting a DD rate of 0.2 pmp (IQR 0–1.1) and a total of 311 transplants (3.6%) (Figs. 3 and 7).



**Fig. 6** Regional variability in organ donation. 5 states (yellow) more than 500 kidneys, 13 states (green) 100–500 kidneys and 15 states (blue) less than 100 kidneys harvested

**Table 1** Relation of total DD kidneys and transplants according healthcare systems

	Donation ( <i>n</i> = 8488)	Transplants ( <i>n</i> = 8488)	Kidneys shared to Social Security ( <i>n</i> = 629)	Kidneys shared to Public sector ( <i>n</i> = 148)	Kidneys shared to Private ( <i>n</i> = 231)
Social Security	3299	3861	–	57	10
Public	4268	3628	567	–	221
Private	921	999	62	91	–

## Transplantation and State of Residence

3447 transplants (43%) were done in residents of 4 States doing > 500 transplants and a rate of transplant of 11.6 pmp (IQR 9.1–15.8). 3941 transplants were done in residents of 13 States doing 100–500 transplants and a rate of transplant of 8.6 pmp (IQR 5.1–9.8), and finally a total of 545 operations (6.5%) were done in 15 States doing < 100 transplants with a rate of transplant of 3.1 (IQR 1.8–4) Fig. 4.

## Waiting List and State of Residence

Waiting list according to State of residence was analyzed. Four States (Group 1) with a population of 40.4 million, 16 States (Group 2) with a population of 57.9 million, and 12 States (Group 3) with a population of 28.3 million depict waiting lists of 6745, 6565, and 2259 patients, respectively. Rates of registered patients in waiting list pmp are 166, 113.3, and 79.8 for Groups 1, 2, and 3 (Fig. 5).

## Discussion

Allocation of 8488 consecutive DD kidneys obtained for 12 years is shown in this article; those numbers represent 24.1% of total transplant activity during period analyzed and 66.7% of total of all DD renal transplantation every performed in the country.

Although a modest increase in DD rate from 3.2 to 4.6 donors pmp is observed in the last 12 years, the enormous dependence of living donation in Mexico is more than evident (Fig. 1).

A huge and complex geographic variability is observed in organ donation and transplantation in Mexico. Fifty percent of organs were procured in 5 States, 44% in 14 States with 6% in the third group of 13 States (Fig. 2). Similar numbers are seen for renal transplant operations: 56% of transplants were done in 4 States, again a group of 13 States contributed with 40% of total operations, and a third group of 15 States provide 3.6% of total transplants (Fig. 3). Deceased donation rates for each group of States show large differences: 6.6 pmp (IQR 4.7–9.9), 4.7 pmp (IQR 3.9–7.1), and 1.25 pmp (IQR 0.9–1.8). Similarly, the rate of transplant for each group of States is 16.5 pmp (IQR 12.1–24.9), 6.7 pmp (IQR 3.2–8.9), and

0.2 pmp (IQR 0–1.1). The largest volume in donation and transplantation is a consequence of centralized activity in Social Security hospitals with nationwide influence and location in the largest cities of the country (Mexico City, Jalisco, Nuevo León, Guanajuato, Estado de Mexico). The second group of 14 States of Mexico has been able to organize deceased donation and renal transplant programs and altogether contribute about 40% of total activity in donation and transplantation. Both healthcare systems exhibit comparable numbers in donation and transplantation, but this is not the case for the third group which reports minimal activity and represents about half of the national territory.

Furthermore, kidney allocation was analyzed according to State of residence of patients receiving transplant. Data shows 43% of kidneys were assigned to patients living in the 4 States doing > 500 transplants, 46.5% to patients living in 13 States doing 100–500 transplants, and finally about 10% to residents in States with < 100 transplants. Even when Social Security hospitals belong to a federal system receiving patients from the whole country, numbers show that patients living in a region with low donation and transplant activity have much lesser opportunity for transplantation.

As mentioned above, Mexican healthcare system includes hospitals from Social Security, Public Services, and Private. Contribution of kidney donation of different health systems is as follows: Social Security 39%, Public 50%, and Private 11%. Transplant activity shows slightly different proportions:



**Fig. 7** Regional variability in renal transplantation. 4 states (yellow) performed more than 500 transplants, 13 states performed 100–500 transplants, and 15 states performed less than 100 transplants

Social Security 45%, Public 43%, and Private 12% (Table 1). Those numbers reflect interaction and organ exchange between different systems. It is worth to mention that public sector shared 567 kidneys to Social Security and 221 organs to private hospitals. These numbers reflect a better relative capacity of public sector hospitals for organ procuring with possibly more difficulties offering transplantation considering that public hospital expenses are only partially supported by the government.

Same trend is observed when access to the waiting list is analyzed. State of residence as unique variable is again a determinant for access to the waiting list and eventually for transplantation. Residents in Groups 1 and 2 States have twice the chance for being incorporated into the waiting list compared to patients from regions with the lowest donation and transplantation activity (Fig. 5). State of residence should not be understood as a unique determinant for access to waiting list and transplantation. It applies specially in the case of patients receiving a transplant in Public Sector hospitals; paradoxically these hospitals demand that the transplant recipients have some form of affiliation to Social Security as they are not able to provide immunosuppression therapy. Therefore many patients living in regions with high transplant activity may have same opportunities as those from minimal donation and transplant activity.

A sort of riddle is faced for retrospectively attempting to understand lines of decision for allocating 8488 kidneys under a system that allows by law to Internal Transplant Committees the authority and responsibility for organ distribution. Most of kidneys remained in same institutions and country region for transplantation and some exchange among different branches occurred.

DD kidneys comprise only 26.4% of a total of 32,126 kidneys transplanted in referred 12-year period. First evident conclusion is the need for improving current rate of donation in Mexico, at this time 4.6 donors pmp. Here in we describe a fragmented health system without universal coverage for organ donation and transplantation, a huge regional variability in organ donation and transplantation activity, a great disparity in access for wait listing, and a faulty system for organ allocation needing to be reformed to achieve international standards of transparency and traceability. Such considerations

might therefore explain the excessive dependence on living donation for kidney transplantation as the more immediate alternative for receiving a transplant; such historic emphasis on living donation could be considered at least partially as a barrier for improving deceased donation rates.

Data shown in this article confirms the widely held beliefs of the regional disparities that exist in Mexico. Many thoughtful solutions are required for these challenging problems.

## Compliance with Ethical Standards

**Conflict of Interest** The authors declare that they have no conflict of interest.

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