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Strategies to optimize deceased organ donation

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Abstract

Organ shortage is one of the main limitations to deal with in organ transplantation. Although the number of patients in the waiting list increases over time, the number of transplants performed does not increase or increases at a much lower rate because of the scarcity of organs to fulfil the demands. Several classic approaches have proven to have a limited or transient impact on the figures of organ donation. The sustained increase in deceased organ donation rates in Spain during the last years, reaching values of 33 to 35 donors per million population, obeys to the implementation of a set of measures, mainly of organizational nature, that is internationally known as the Spanish Model of Organ Donation. With the creation of the National Transplant Organization in 1989, always acting as an agency in support of the process of donation besides organ sharing, a network of highly trained and motivated physicians with the main responsibility of developing a proactive donor detection program was established. A continuous audit of brain death in intensive care units of transplant procurement hospitals has been applied in the last 7 years as a valuable tool to evaluate the potential of donation and the weaknesses of the process, identifying areas to be improved. Great effort in training and education, close attention to the mass media, and reimbursement to procurement and transplant centers for the developed activity have been other measures indeed contributing to the successful Spanish results. The application of the Spanish Model of Organ Donation to other regions and countries across the world, such as the region of Tuscany in Northern Italy and some Latin American countries, has proven to be feasible always that minimal requirements are fulfilled. What these figures show is that a positive change in organ donation rates can be achieved if steps are taken into the right direction.

1. Introduction

The Nobel Prize winner Joseph Murray was the first to report a successful kidney transplant between identical twins, performed in 1954 [1]. Since then, organ transplantation has progressively become a well-established therapy of unequivocal importance. Kidney transplantation represents the best therapeutic option for patients with end-stage renal disease, providing best outcomes of survival [2], quality of life [3], and cost-effectiveness [4], compared with other renal replacement therapies. In a meta-analytic review of the medical and economical literature evaluating renal replacement therapies, published during a 20-year period, the authors concluded that renal transplantation has become more cost-effective over time. Although center hemodialysis remained between $55 000 to $80 000 per life-year saved, kidney transplantation reached values of $10 000 per life-year saved [4].

Liver, heart, and lung transplantation represents an almost unique therapeutic alternative for patients with end-stage liver, heart, and lung failure, although liver transplantation has been also applied for the treatment of specific pathologies not causing end-stage liver failure. Pancreas transplantation, in its different modalities, has become a solution to reestablish insulin secretion in selected diabetic patients, aiming to improve patient survival and quality of life. Small bowel transplantation, usually performed as a part of a multiorgan transplant, is still a relatively rare procedure but aimed to solve life-threatening conditions.

Results with organ transplantation have also progressively improved over time, thanks to the advance in surgical techniques, availability of new immunosuppressive drugs, and longer experience of the transplant surgical and medical teams. According to the United States Organ Procurement and Transplantation Network and the Scientific Registry of Transplant Recipients 2006 annual report, in the United States, 1-, 3-, and 5-year unadjusted graft survival were 91%, 80%, and 70%, respectively, for kidney recipients of deceased nonexpanded criteria donors who received their grafts during the period 1999 through 2004. For the same follow-up periods, unadjusted graft survival for kidney

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recipients of expanded criteria donors was 82%, 68%, and 53% [5].

Improvement over time is apparent also regarding patient survival after liver transplantation. For instance, 3-year patient survival was 47.2% for patients transplanted in 1984 to 1987, increasing up to 76.6% for those patients receiving a liver during the period 2003 through 2005, according to the Spanish Liver Transplant Registry [6]. Similar improved figures are drawn up by the European Liver Transplant Registry. Although 10-year patient and graft survival was 36% and 31%, respectively, for liver transplants performed during 1968 to 1988, the corresponding values were 60% and 51% for transplants performed after the year 1988 [7].

Half-life of adult heart-transplanted patients during the years 1982 to 1988 was 8.2 years, reaching 10.2 years for those patients who received their grafts during the period 1994 through 1998, and survival figures continue to improve according to the International Registry of Heart and Lung Transplantation [8].

Although, many problems ought to be solved in organ transplantation: grafts are mainly lost in the long term because of the so-called chronic rejection and death with a functioning graft, mainly occurring in the context of cardiovascular pathology [9]. Besides, short- and long-term consequences of immune suppression decrease longevity and quality of life of organ recipients.

Despite these problems, organ transplantation faces an earliest barrier represented by the important gap existing between the number of patients waiting for a transplant and the number of patients who are indeed transplanted. This is due to the shortage of organs for transplantation in relation with organ demands. Although the number of patients being included in the waiting list increases, the rate of donation and the number of organs available for transplantation does not increase or improves at a slower rate.

The result of more patients joining the waiting list with a little increase in the number of patients transplanted is a longer time in the waiting list. Time waiting for a kidney transplant is expensive and may have a negative impact on graft and patient survival [10]. Besides, the number of patients who may die while waiting for a transplant may also increase. The shortage of organs for transplantation may still be underestimated because the scarcity of organs may preclude physicians from including more patients into the waiting lists.

In this context, severe organ shortage represents a universal challenge in organ transplantation, which should be faced under the scope of a planned and integrated approach.

2. The process of donation after brain death

Deceased donation activity is primarily based on donation after brain death. It has to be outlined that no more than 1% of dead people and no more than 3% of people who die in the hospital hits this situation. Therefore, the number of potential brain-dead donors is limited. Keeping in mind this limitation, the potential of deceased donation after brain death is difficult to reach because organ donation and procurement is a very delicate and complex process that needs the cooperation of many actors and that can be broken at any time. Even more, the whole process should take place in a very short period—what enhances the weaknesses of the process itself. Several basic steps may be identified in this process [11], as represented in Fig. 1.

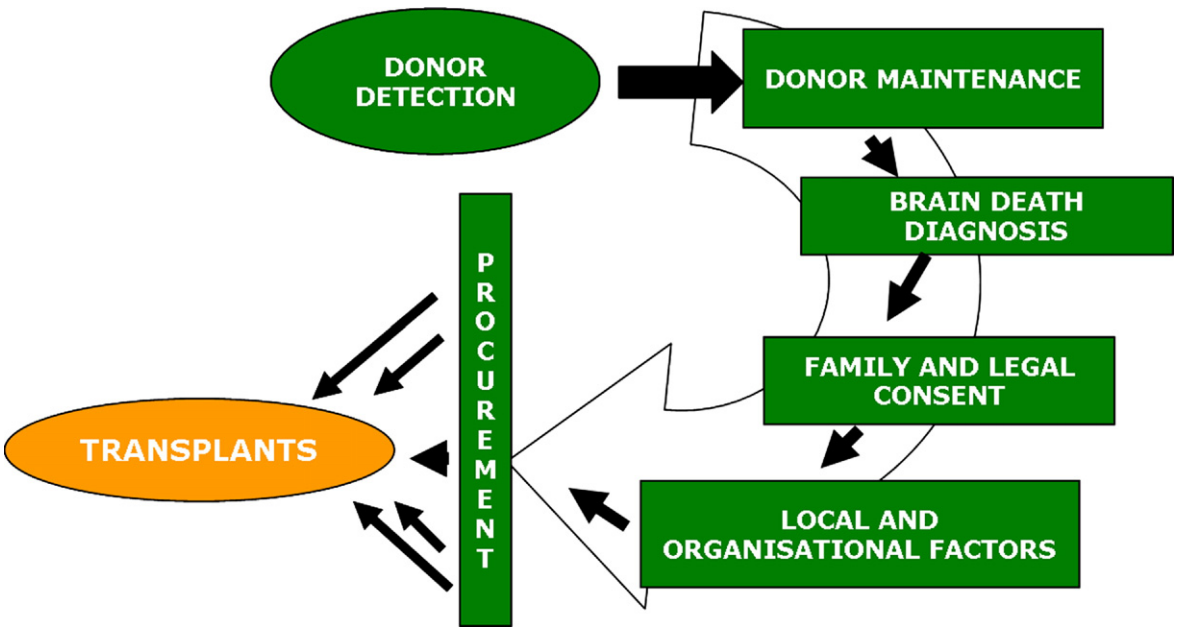


Fig. 1. Steps in the process of donation after brain death.

2.1. Donor identification

All potential donors should be identified at the earliest stage as possible. This early identification will facilitate donor screening and maintenance but undoubtedly implies a proactive attitude at this first and crucial step.

2.2. Donor screening

The risk of transmission of a serious disease through organ transplantation (neoplasia and infection) from the donor to the recipient should be minimized. However, it must be ensured that only organs that should be discarded are so, avoiding an unjustified loss of organs.

2.3. Donor maintenance

It is essential that organs procured are kept in adequate conditions before retrieval. The maintenance of the potential donor's physiological state while on intensive care and of the donor before and during retrieval can make a major difference to the condition of the organs. Poor donor maintenance can make organs unusable or increase the incidence of primary graft failure.

2.4. Consent/authorization

Appropriate consent or authorization has to be obtained before organs can be removed. Countries have different legal requirements to obtain consent: although some countries apply the presumed consent (or opting-out approach), in others, specific consent (opting-in approach) has to be expressed.

2.5. Organ retrieval

The surgical technique for removing organs from the body and the way those organs are subsequently handled and preserved before and during transportation are critical to the successful outcome of the transplant. Each year, several organs are damaged during removal and/or transportation. Some can be repaired, but a few will have to be discarded. Coordination of retrieval activities is needed to guarantee the success of the process.

2.6. Organ allocation

For some organs, particularly kidneys, hearts, and pediatric organs, the successful long-term outcome of the transplant depends partly on ensuring an appropriate matching between donor and recipient. A well-organized system for allocating and transporting donated organs in the most adequate way is important. In some cases, optimum allocation will require exchange of organs between transplant organizations and countries. Cooperation between countries is increasingly important.

It is easy to understand that the process of donation and transplantation after brain death is a delicate, complex, and long one. On one hand, it requires the participation of very different professionals, and at every one of the steps in the process, losses of the donor and/or organs may potentially occur.

3. The Spanish Model of Organ Donation: an integrated approach to face organ shortage

Along the years, several classic approaches to face the scarcity of organs and donors for transplantation have proven to be of limited usefulness. There is evidence that the shortage of organ donors is not primarily the result of a lack of suitable donors but, rather, the result of the failure to identify them, obtain the consent, and procure the organs [12]. Partial strategies in many countries have resulted in mild or transient increases in organ donation or even no improvement at all [13].

Although an adequate legal framework seems to be an imperative requirement to construct a program on deceased donation, modifications of the legal structure have not proven to be effective with regard to the increase in organ donation. A recent example may be represented by Singapore changing from informed-consent (opting-in) to a presumed-consent (opting-out) law, which was not related to a significant increase in the rates of donation [14]. In addition, promotional campaigns seem to have a transient impact on the donation rates [15]. Finally, the development of tools which may facilitate the expression of the wishes of the deceased on organ donation may be considered a social tool, far from being effective when increasing organ donation rates. Besides, the cost-effectiveness of some of these tools, as donor's registries, should be deeply analyzed and have been a matter of discussion.

Spain is the only country in the world in which a progressive and sustained increase in the number of deceased organ donors has been described. This has led Spain in an outstanding position when compared with other European countries and other countries across the world [16].

The Spanish National Transplant Organization (ONT) was created in the year 1989 [17], and with it, a national network of specifically trained, part-time dedicated and strongly motivated hospital physicians in direct charge of the whole process of donation was established [18,19]. Since then, rates of deceased donation have progressively increased from 14.3 donors per million population (pmp) at that time to rates of 33 to 35 donors pmp in the very last years [16] (Fig. 2). In parallel, the absolute figures and the rates of kidney and liver transplants performed have also progressively increased. For instance, the number of kidney transplants performed in Spain has doubled, reaching absolute numbers well above 2000 interventions each year, and the activity in liver transplantation, being almost anecdotic at the end of the 80s, is well above 1000 procedures yearly at the present moment [16] (Figs. 3 and 4).

The impressive evolution attended in Spain with regard to donation and transplantation activities is the result of a set of measures, mostly of organizational nature, which was

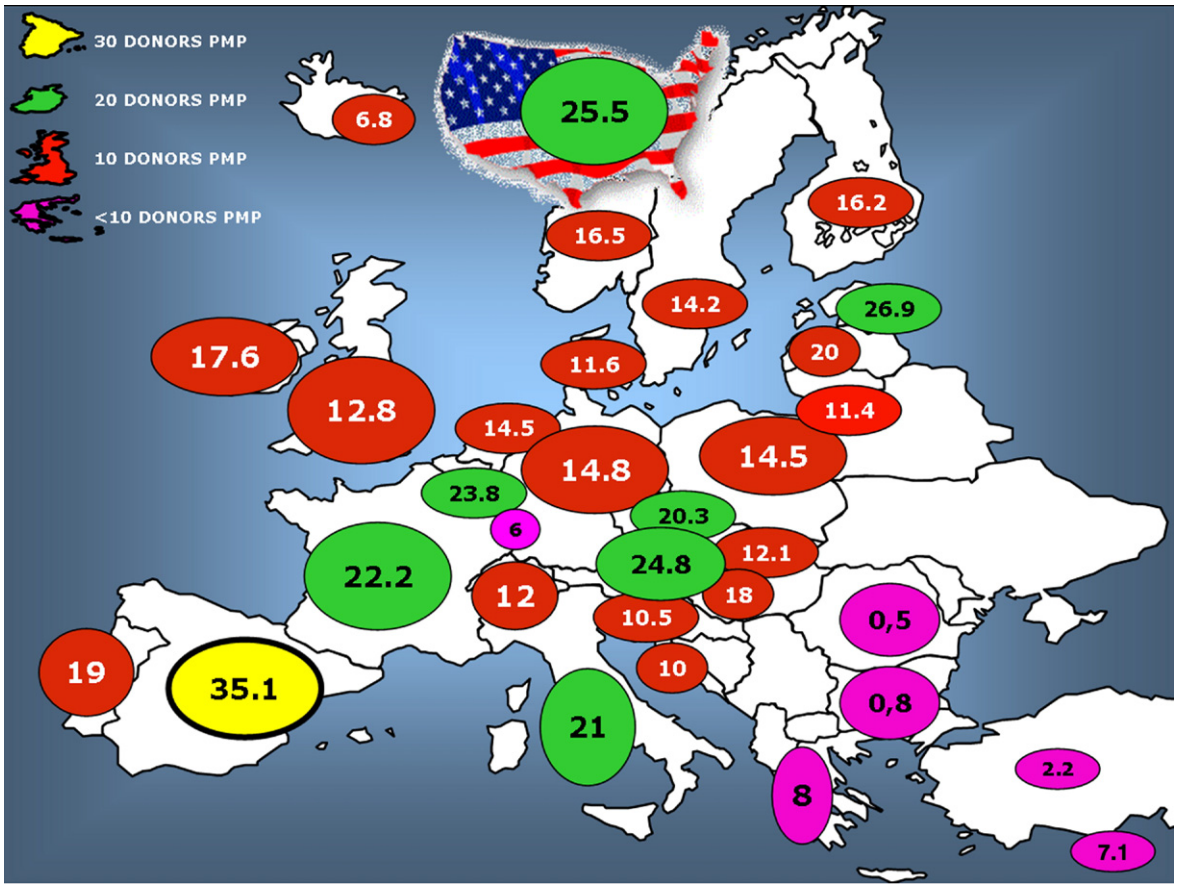


Fig. 2. Deceased donation activity (donors pmp) in European countries and the United States (year 2005).

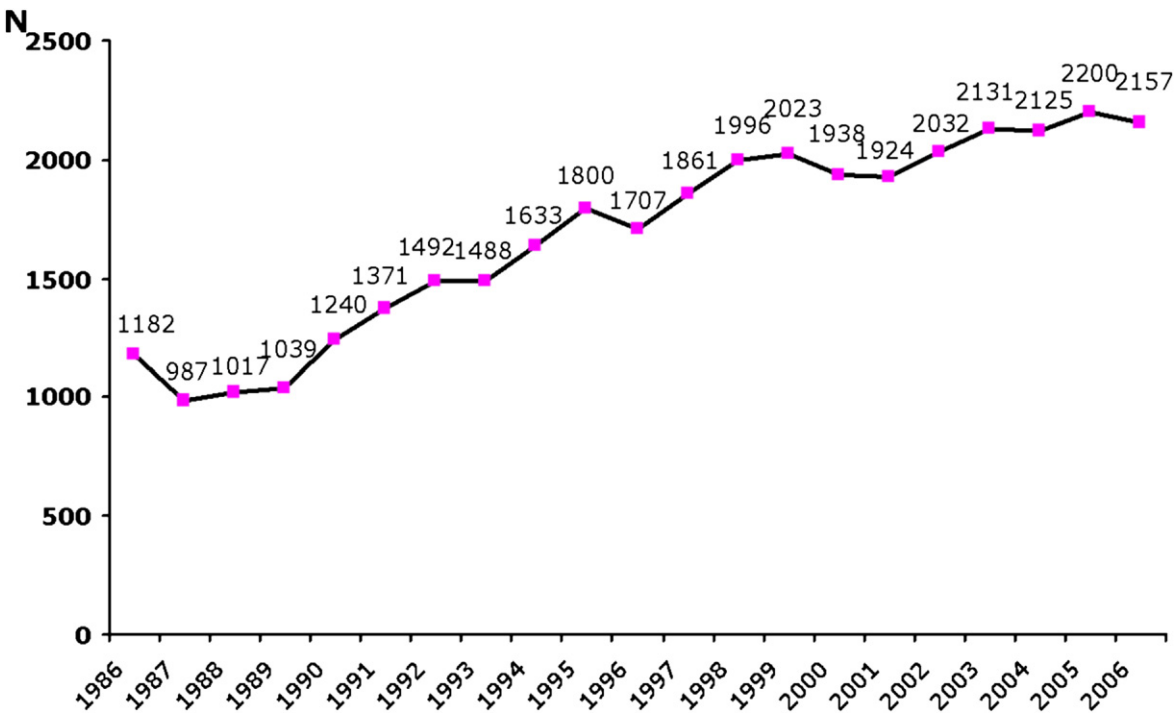


Fig. 3. Evolution in the absolute number of kidney transplants performed in Spain.

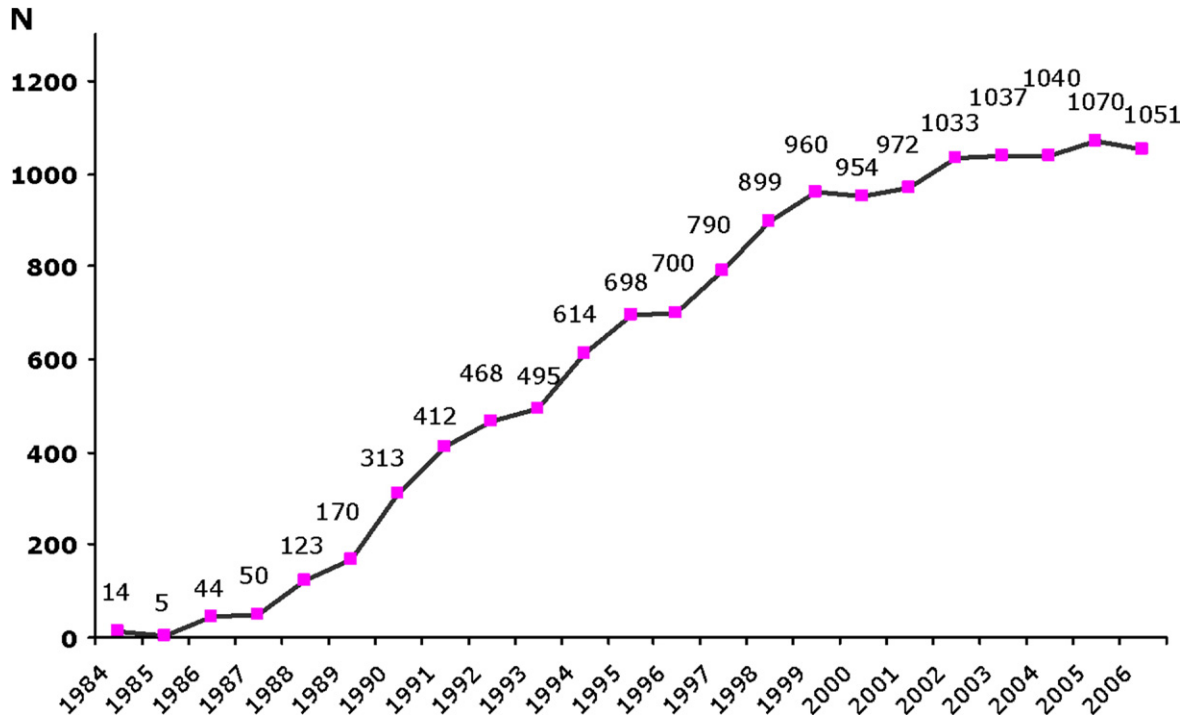


Fig. 4. Evolution in the absolute number of liver transplants performed in Spain.

established in our country from the year 1989 on [20,21]. This set of measures, which, altogether, is known as the Spanish Model of Organ Donation, has been internationally considered as the only set of initiatives that have proven to be effective in increasing deceased donation rates in a sustained way [12,22].

The Spanish Model of Organ Donation was developed based on an adequate legal, technical and political framework. From the legal point of view, the situation was similar to that of other western countries [23]. The principles of altruism and confidentiality were set, and main aspects covered by the law included the protocol for brain death diagnosis, organ retrieval, or consent to donate. Since the first transplantation law was enacted in 1979, Spain has a presumed consent or opting-out law. However, and in a similar way to what it has been described in other European countries, the families are always approached as a way of understanding the wishes of the deceased about donation or as a way of getting the permission to proceed with donation in case the wishes of the deceased are unknown. Therefore, from a practical point of view, an informed consent or opting-in model has always been applied.

From a technical perspective, proper health care facilities were present. Besides, very experienced, enthusiastic, and innovative transplant teams have been a key issue from the very beginning. Finally, an adequate political framework existed, although a characteristic of the Spanish structure is its decentralization. For instance, in the last 10 years, political competencies have been transferred to 17 regional authorities.

Far from the simplistic approach of summarizing the Spanish Model as placing in-house coordinators in every hospital, there is a set of measures that, altogether and properly integrated, has been progressively established in our country and that represents the basis of the success on donation and transplantation activities. The principles of the Spanish Model of Organ Donation (Table 1) are explained below.

3.1. Transplant coordination network

Transplant coordination in Spain has been organized at 3 different, but related, levels—hospital, regional, and national—each of these levels with their own and specific responsibilities in the process of organ donation (Fig. 5).

The national level of the network, the ONT, is a central office which supports the whole process of donation, not acting solely as an organ sharing office. Along with the regional organizations, the ONT also acts as a real interface between the hospital and the political level, and both are nominated and paid by the regional and national authorities, respectively. Outstandingly, every technical decision is taken

Table 1

Principles of the Spanish Model of Organ Donation
1. Transplant coordination network
2. Special profile of the 3 levels of transplant coordination
3. Continuous audit on brain deaths and outcome of donation at ICUs in transplant procurement hospitals
4. Central office as an agency in support of all the process of donation (besides organ sharing)
5. Great effort in medical training
6. Hospital reimbursement
7. Close attention to the mass media

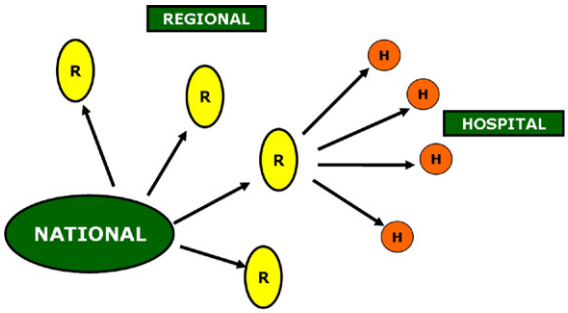


Fig. 5. Spanish Transplant Coordination Network. Three different levels of coordination—central, regional, and hospital levels.

as a consensus by a commission constituted by the ONT and the responsibility of every one of the regional offices.

The third level of the transplant coordination network is represented by the hospital coordinators, who are directly involved in the process of donation; developing a proactive program on donor detection; and in charge of donor evaluation and maintenance, family and judicial approach (this last one when needed), as well as coordination of all the process of organ procurement.

The number of hospitals integrating the transplant procurement network seems to have a direct impact on the number of deceased organ donors. As a matter of fact, along the last years, the number of transplant procurement hospitals has progressively increased in our country from less than 20 units in 1988 to 156 units in the year 2007. Outstandingly, the contribution of the small hospitals (defined as those with procurement but without transplantation facilities) has been clearly efficient. For instance, 40% of deceased donors in Spain are detected and referred by these 112 small hospitals, representing a deceased donation activity as high as 14 donors pmp—a rate which is similar to the one described for several European countries as a whole [16]. On the other hand, large hospitals (defined as those with procurement and transplantation facilities), in a number of 44 in the year 2007, contribute with 60% of the deceased donation activity, this meaning a rate of approximately 20 donors pmp.

3.2. Special profile of the 3 levels of transplant coordination

The figure of the transplant coordinator is considered by many as the one that is able to establish the difference between a successful and a nonsuccessful program on deceased donation. The main responsibility of this figure (also referred to as key donation person) is represented by a proactive donor detection program [11].

The profile of the hospital transplant coordinator in Spain is probably one of the most important differences when comparing the organizational and structural system on transplantation among the European countries.

Transplant coordinators are mainly physicians, supported by nurses in those hospitals with a quantitatively important donation activity. The medical specialty of the transplant coordinator in Spain has necessarily evolved in the last years; in fact, although most of the coordinators were nephrologists in the 80s, most of them are intensive care unit (ICU) specialists at the present moment.

Except for a few cases, the figure of the coordinator is part-time dedicated to the transplant coordination activities. This characteristic allows the possibility of having a transplant coordinator appointed even in small hospitals. Although having a close relation to the transplant teams, the figure of the transplant coordinator in Spain does not depend, neither report, to the transplant team. The transplant coordinator is, in fact, nominated by and must report to the hospital direction, although is functionally linked to the regional and the national transplant organization. Finally, the hospital coordinator is an in-house figure who works inside the hospital—a situation that guarantees proper donor detection.

The network of transplant coordinators, with their characteristics and profile previously described, along with a high level of training and motivation, is without a doubt one of the keys of success of the deceased donation program in Spain. Unfortunately, this ideal figure of the transplant coordinator is not easy to be appointed in many countries.

3.3. Continuous audit on brain deaths and outcome of donation at ICUs

A program for a continuous brain death audit in ICUs of transplant procurement hospitals has been put in place in Spain for the last 7 years. This program, also known as Quality Program on Organ Donation, allows to define the theoretical capacity of organ donation according to each hospital's characteristics, as well as to evaluate all the process of organ donation, identifying weak areas which contribute to potential donor losses [24,25]. Therefore, areas for improvement are identified, and corrective measures may be put in place.

The Spanish Quality Program on Organ Donation was first described during the 90s and has served as a basis of other international programs, such as Donor Action. The program is based on a continuous self-auditing of the performance in the process of organ donation, which may be complemented by external audits [24]. Evaluation requires the retrospective review of the medical charts of patients dying at the ICUs. The internal audit is performed by the hospital transplant coordinator, and the external audit is usually performed by coordinators coming from different regions of the one which is being evaluated. Final data allow knowing the number of deaths, brain deaths, and organ donors for every ICU. Taking into account local hospital factors affecting every one of these numbers (available beds, neurosurgery procedures, transplantation facilities, patients admitted at the ICU, and emergency departments), a calculation of specific indexes of efficiency of the whole process of donation may be performed and compared with standard or reference values.

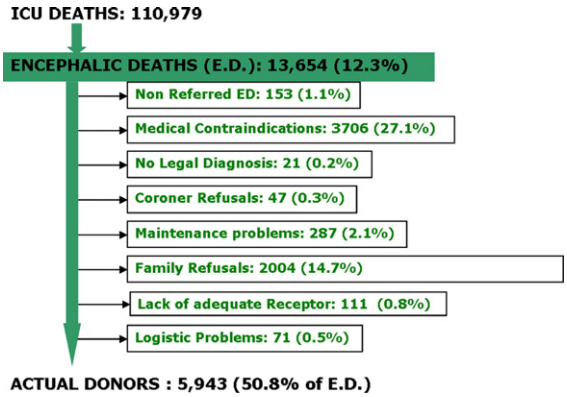


Fig. 6. Spanish Quality Program on Organ Donation, 1995 to 2005 results. Number of encephalic deaths at transplant procurement hospitals. Reasons for brain death people not becoming actual donors and final number of actual donors.

Very valuable information has been obtained from this program, which evaluates the performance of the transplant procurement hospitals in Spain. From the analysis of cumulated results from the period 1999 through 2005 (Fig. 6), we know that 12.3% of deaths occurring at the ICUs are brain deaths and that 50.8% of them become actual donors [26]. The main reasons that justify that a potential donor (brain death person) does not become an actual donor are represented by medical contraindications (27.1%) and refusals to donate (14.7%). Even more, we have also understood that the concept of *medical contraindication to donate* is a real area to be improved, since relative contraindications to donate are considered as absolute contraindications in some occassions.

3.4. Central office as a support agency

The ONT acts as a central office in support for the whole process of organ donation, not acting solely as an organ sharing office. For instance, this first level of the transplant coordination network is also in charge of the organization of organ and transplant teams' transportation, management of the waiting lists, registries and statistics, as well as general and specialized information and development of activities and actions aimed to improve the performance in the whole process of donation and transplantation. The support of this central office, as well as some regional offices, to the small hospitals, frequently with no possibilities of developing all the process of donation on their own, has been outstanding.

The ONT has been also acting as a real interface between the hospital and the political level by suggesting and supporting the implementation of legal measures that allow the adaptation of the process to the scientific advance and knowledge.

3.5. Great effort in training

A great effort in training may be considered as one of the main principles of the Spanish Model of Organ Donation. Continuous training programs are targeted to all the professionals directly or indirectly involved in the process of donation, with special emphasis in the training of new and already existing hospital transplant coordinators. Training covers each one of the steps in the complex and delicate process of donation—donor detection and maintenance and legal aspects including brain death diagnosis, family approach, and organizational issues. Besides, training in areas such as management of resources, relation to the mass media, and others has been also developed. Both types of training approaches, through general courses covering all the steps of the process of donation or specific courses on each of these issues, have been put in place.

The contribution of training to the successful results of the deceased donation activity may be exemplified by the progressive decrease in refusals to donate and training in family approach. As a matter of fact, we have performed a survey to the general population at 3 different occasions—in 1993, 1999, and 2006. The attitude of the population toward donation has not significantly changed along these years [27]. For instance, a similar percentage of the surveyed people was in fact a donor (had a donor card), would donate, or were not prone to donate. In spite of this lack of change in the general attitude of the population toward donation, a progressive decline in the rates of refusals to donate has been observed. In fact, in 1993, 27.5% of the approached families expressed a refusal to donate, whereas in 2006, this rate was 15.2%. This decrease in refusals to donate, in spite of a lack of change in the position of the population toward donation, has made us conclude that the way the family is approached has possibly improved, mainly because of the effort in training.

3.6. Hospital reimbursement

As any other medical activity performed at the public health care system, the donation and transplantation activities in Spain are properly reimbursed by the regional health care authorities [28]. Each procurement and transplantation hospital is yearly budgeted according to the donation and transplantation activities performed in the previous year. Reimbursement covers all human and material resources needed to efficiently develop the donation and transplantation program within the hospital. Without a proper financial coverage, it is impossible for a hospital to efficiently maintain a program of deceased donation, especially for those small nonuniversity hospitals without transplantation facilities. In general terms, organ donation should never be a disincentive activity.

3.7. Close attention to the media

With the aim of improving the level of knowledge on donation and transplantation of the population, close attention to the media has been dedicated [29,30]. A 24-hour telephone hotline and an updated Web site are available for consultation, questions, and answers. The transplant hotline, originally intended for the public, has

become popular among health care professionals, especially general practitioners, and the media. That anyone, including the media, can, at any time, obtain medical, legal, or statistical information about organ donation has helped reduce the incidence of adverse stories about transplantation, increase public confidence, and help to generate a climate of trust and transparency about organ transplantation. Besides, transplant coordinators receive specific training courses on communication with the media. Controversial issues such as organ trafficking and brain death are deeply discussed at these forums. Meeting with journalists are periodically held in a proactive fashion or under specific requests. Specific meetings attended by journalists and opinion leaders on transplantation issues have been performed on a yearly basis. Outstandingly, a quick and efficient management of adverse publicity and other critical situations have also helped to generate a positive thinking on donation and transplantation among the Spanish population.

4. Factors influencing the adaptation of the Spanish Model of Organ Donation

It is easy to understand that the adaptation of the Spanish Model of Organ Donation to other countries or regions may be a complex task, not merely solved by appointing transplant coordinators at every acute care hospital. Even more, the feasibility and success of such a project may be very variable, mainly depending upon organizational and structural differences among the countries [31]. For instance, the type of health care system, the economical resources dedicated to health, the number of available physicians and their salaries, the acute care beds and ICU facilities available, and the age distribution of the population are all factors that may have an influence on the adaptation of the model.

4.1. Type of health care system

One sine qua non prerequisite to adapt the Spanish Model of Organ Donation to other countries or regions is the existence of a public health care system universally covering the health care needs of the population [28]. Organ donation can hardly be a concern for private medicine, although this is not the case for organ transplantation. Consequently, the development of a deceased donation program, such as the Spanish one, needs a public health care background. Despite this being an important condition, it does not necessarily mean that the model cannot be partially implemented in a set of selected hospitals or in specific regions. For instance, this has been the case for some Latin American countries [32].

4.2. Economic resources dedicated to health

The economic resources dedicated to health care, as well as the ratio between the public and the private funding of health care facilities, are 2 important factors to be considered in the adaptation of the model. With regard to the first of the factors, there is a minimal level under which it is impossible to develop a program such as the Spanish one. Table 2 shows the economic resources dedicated to health care and differences in the economical background among some European countries.

4.3. Number of available physicians and salaries

The number of available physicians in every country and the average basic annual salary of the physicians represent 2 other limiting factors when adopting the Spanish Model of Organ Donation. These numbers are widely variable among the countries. Countries with a low number of physicians per 1000 inhabitants and high incomes for medical doctors can hardly develop a transplant coordinator network based on specialized physicians. The opposite situation, in fact, present in countries such as Italy or Spain, represents the ideal background, with a higher number of physicians per 1000 inhabitants and lower incomes susceptible of being increased based on achievements and objectives.

The number of available nurses may be considered also as an influencing factor not only because of their potential as transplant coordinators but also because of their availability per acute care bed. This ratio has a clear impact on the

Table 2
Economic framework and resources dedicated to health care in European countries (year 2004)

	GNP ($)	GDP ($)	HDI	Total Health expenditure (% of GDP)	% Public	% Private
Austria	32300	35766	0.944	7.5	70.7	32.4
Belgium	31030	33807	0.945	9.3	70.9	29.1
Croatia	6590	7724	0.846	7.9	83.0	17
Cyprus	17580	18668	0.903	6.2	47	52.2
Czech R.	9150	10475	0.885	7.2	88.8	9.3
Denmark	40650	44673	0.943	9	82.6	17.4
Estonia	7010	8331	0.858	5.5	75.5	24
Finland	32790	35562	0.947	7.5	76.6	23.2
France	30090	33896	0.942	10	78.4	23.5
Germany	30120	33212	0.932	10.9	78.1	21.9
Greece	16610	18560	0.921	9.8	53.9	48.3
Hungary	8270	9962	0.869	8.4	72.5	28.2
Ireland	34280	44644	0.956	7.2	79.5	21.5
Italy	26120	29143	0.94	8.7	75.1	23.6
Latvia	5460	5868	0.845	6.4	52.03	48.4
Lithuania	5740	6480	0.857	6.5	70.6	24.6
Luxembourg	56230	70295	0.945	6.9	90.4	9.8
Malta	12250	13256	0.875	9.2	78.19	21.8
Netherlands	31700	35560	0.947	9.8	62.3	38.8
Poland	6090	6346	0.862	9.9	83.5	16.2
Portugal	14350	15970	0.904	6.4	68.6	30
Slovakia	6480	7635	0.856	9.8	71.9	30.3
Slovenia	14810	16115	0.91	5.8	88.0	12
Spain	21210	24360	0.938	8.7	79	22.8
Sweden	35770	38525	0.951	7.8	70.9	28.1
Switzerland	48230	48385	0.947	9.5	84.9	14.6
UK	33940	35485	0.94	8.1	85.5	14.1

GNP indicates gross national product; GDP, gross domestic product; HDI, Human Development Index.
Data from World Health Organization Regional Office—European Health for All Database [33].

possibility of an adequate implication in the care of the potential donor.

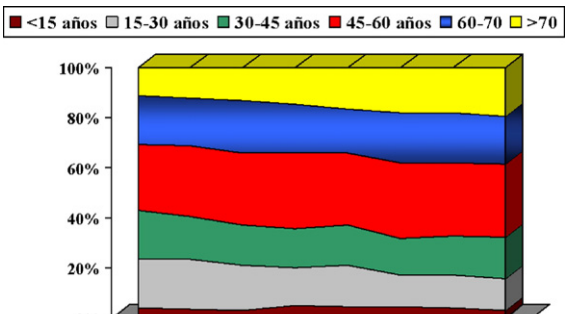
4.4. Availability of acute care beds and ICU facilities

Keeping in mind the lack of harmonized information on the number of acute care beds and ICU facilities, it is easy to understand that these issues may highly influence the application of the Spanish Model of Organ Donation. For instance, acute care beds (hospital beds not dedicated to chronic patients) and ICU facilities (where the possibility of mechanical ventilation exists) represent basic needs to detect and maintain a potential donor.

Among the various data relevant for organ donation, the number of ICU beds pmp and the ratio between ICU beds and total acute beds should be considered [24,28]. Differences among the countries could explain some of the difficulties encountered when detecting potential donors and caring adequately for them until the full process of brain death diagnosis and organ procurement is completed.

4.5. Age distribution of the population

The integrated approach of the Spanish Model to increase deceased organ donation has included an adaptation to the changes that occurred in the profile of the potential donor. This adaptation has been necessarily followed by a progressive increase in the use of aged and more complex organ donors [22]. As a matter of fact, only in the last 10 years, the mean age of organ donors in Spain has increased from 45.4 to 51.4 years, and the percentage of organ donors 60 years or older has risen from 10% to almost 40%, a higher rate than the one reported in other European countries (Fig. 7) [34]. Aged donors mainly represent a source for liver and kidney transplants, sometimes placed in a dual fashion, according to functional and histologic criteria [35]. Trying to numerically represent the efficiency of these old donors, the number of used organs per donor with donors 60 years or older was



	1999	2000	2001	2002	2003	2004	2005	2006
>70	11,2	12,4	13,5	14,7	16,5	18,3	18,2	19,5
60-70	19,4	19	20,5	19,7	17,5	19,9	19,8	19,1
45-60 años	26,6	28,1	28,8	29,8	28,7	29,8	29,1	29
30-45 años	19,2	17,1	16,3	15,5	16,2	14,7	15,9	16,7
15-30 años	19,5	19,7	17,8	15,1	16,6	12,8	13,1	12,5
<15 años	4,2	3,8	3,2	5,2	4,5	4,5	4	3,2

Fig. 7. Evolution in the age distribution of deceased donors in Spain.

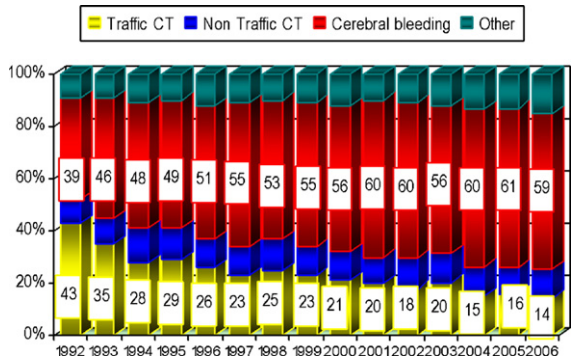


Fig. 8. Evolution in the causes of death of donors in Spain. CT indicates craneoencephalic.

1.62 vs 2.91 with younger donors in the year 2006. In parallel to the increase in the age of organ donors, the cause of death has also suffered a progressive change, so most organ donations are due to cerebral bleeding, whereas traffic deaths accounted just for 14.3% of all donors during the year 2006 (Fig. 8) [34].

Differences among countries and regions in age distribution of the population may explain relevant differences in the potential of organ donation. The age differences are explained by, and are also the consequences of, epidemiological data (cerebral bleedings, tumoral deaths, etc). All these and other data, together with the number of road accidents, form a clear definition of the basic state of a country or region, which is necessary when considering an approach such as the Spanish Model.

There are some other relevant factors which are not so easy to standardize, such as the concentration or dispersion of the population and the access to computerized axial tomography and neurosurgery facilities, but are, nevertheless, highly relevant for a specific situation of organ donation.

5. Some experiences adapting the Spanish model

The adaptation of the Spanish Model of Organ Donation to other countries and regions in the world has been accomplished with variable rates of success. This has been the case of the region of Tuscany, in Northern Italy, where many aspects of the model have been implemented, resulting in a sustained increase in the deceased donation activity. As a matter of fact, deceased donation has increased from a rate of 10 donors pmp in the year 1997 to rates of more than 40 donors pmp in the year 2006 [36]. When referring to Italy as a whole, after the new transplantation law was approved in 1999, a transplant coordinator network organized at 3 different levels (national, regional, and hospital), similar to the Spanish structure, has been developed. Great effort in training has also been made through general and specific courses focused on the family approach, communication with the media, brain death diagnosis, or the application of a quality assurance program [37]. Still with problems in

specific areas, there are regions in Italy, besides the Tuscany, that have reached deceased donation rates of 30 donors pmp.

In addition, a great effort in the adaptation of the Spanish model to the local circumstances of Latin American countries is underway. This ambitious project has been accomplished through the Iberoamerican Council of Organ Donation, which represents 21 Spanish- and Portuguese-speaking countries. One of the most outstanding features of the program is represented by the training of professionals from these countries in the most important aspects of the model during periods of 2 to 6 months in Spain. This has resulted in more than 100 transplant coordinators trained in Spain. Results have been impressive. Uruguay has reached a deceased donation rate of 25.2 donors pmp in the year 2006, which represents a similar level of deceased donation activity than the one reported for the United States. Argentina has been able to double deceased donation activity in only 3 years (from 6 to 12 donors pmp). Other countries have also widely increased their organ donation rates during the year 2006 (Colombia by 60%, Venezuela by 27%, Chile by 25%, and Cuba by 30%) (Fig. 9). What these figures show and what these experiences reflect is that everything is possible. If the right measures are adopted, a positive change in organ donation rates can be achieved.

Many aspects of the Spanish Model of Organ Donation have been deeply analyzed in the document entitled "Meeting the organ shortage: current status and strategies for improvement" [11], including 19 recommendations summarizing the critical aspects of the Spanish Model of Organ Donation and that has been approved by the Health Committee of the Council of Europe.

6. Other alternatives to increase the donor pool: non–heart-beating and living donation

6.1. Non–heart-beating donors

In the early days of organ transplantation, the source of transplantable kidneys was either living donors or deceased donors who have died of cardiorespiratory arrest. However, wide acceptance of the brain death definition and criteria made that the use of organs from brain death donors almost fully replaced the use of the former. Because of the shortage of organs for transplantation, together with promising results with kidney transplants from these donors, a renewed interest in obtaining organs from donors after cardiac death, also called non–heart-beating donors (NHBD), has been observed. This interest has led to several consensus conferences and meetings that tried to face the inherent technical, ethical, and legal subjects that did arise [38-40]. Although activity with NHBD has increased in United States, activity in this field is almost anecdotic in Europe, with some exceptions. During 2005,

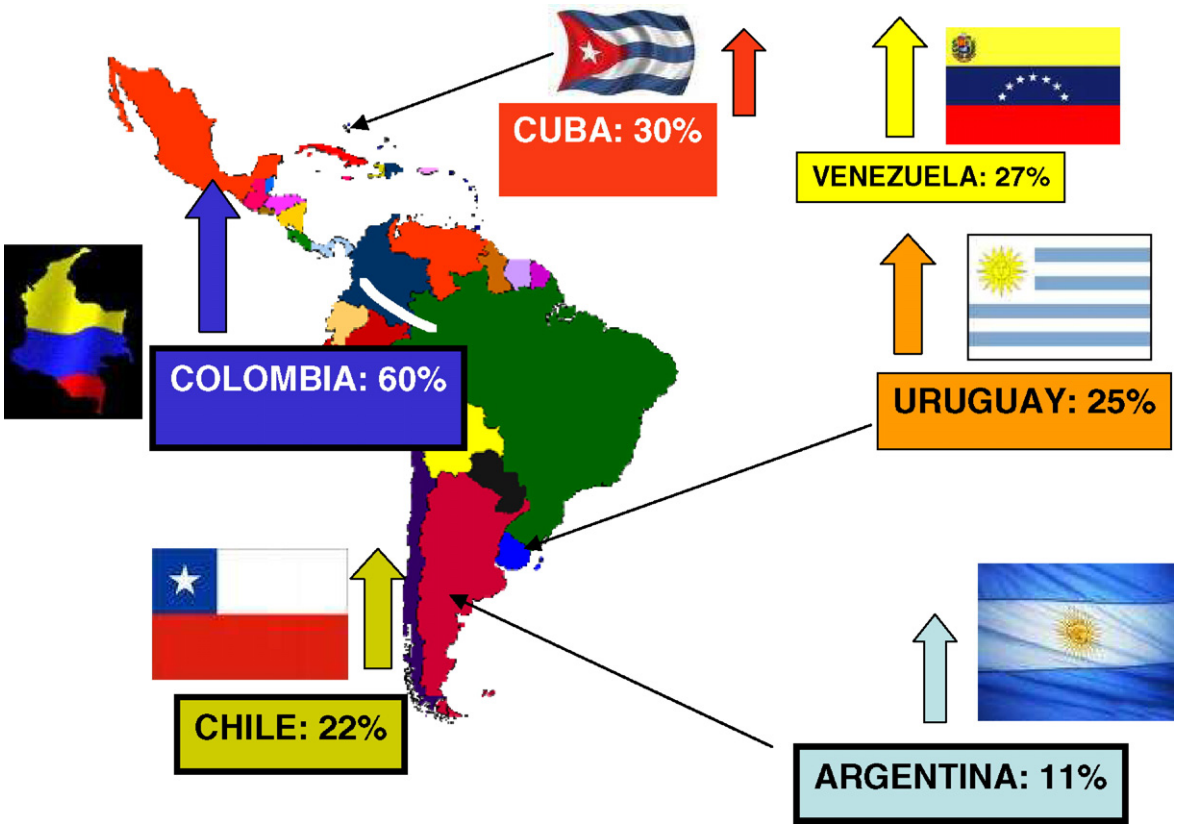


Fig. 9. Increase in deceased donation activity in Latin American countries (year 2006).

only 3 European countries did register a significant number of donors after cardiac death (120 in the Netherlands, 121 in the United Kingdom, and 71 in Spain), probably as a reflection of the difficulties and dilemmas that this activity deserves [16].

Maastricht types I (dead on arrival) and II (unsuccessful resuscitation) NHBDs have been increasingly used in Spain after a period of almost inexistent activity. At the present moment, non–heart-beating donation represents 5% of all deceased donation activity in our country. This progressive use of NHBD has provided the following cumulative figures for the last 12 years: from 554 NHBDs, 710, 58, and 26 kidney, liver, and lung transplants, respectively, have been performed so far. Nevertheless, it has to be outlined that these procedures are sustained basically by 2 hospitals: 1 placed in Barcelona (Clinic Hospital) and 1 in Madrid (San Carlos Clinic Hospital). Teams in charge of these difficult programs are characterized by their high level of training and motivation. Results after kidney transplantation [41] with this specific type of NHBD have been impressive, and pilot programs with lungs [42] and livers from such a source are also underway.

Non–heart-beating donation, especially Maastricht category I, represents a real alternative to expand donation activities. However, donation after cardiac death must be recognized as a more complex process than donation after brain death. The exploration of this alternative must be faced based on a careful evaluation of each region or country's possibilities, particularly in large populated areas with excellent emergency medical care.

6.2. Living donation

Living donation is an increasing alternative to face the scarcity or organs from deceased donors. Mostly kidney and liver, but also lung, pancreas, and small bowel transplantation from living donors, has been reported. Results with living kidney transplantation are even better than those achieved with kidneys from deceased donors [43] and with an apparent low risk of mortality for the donor estimated on 0.03% [44]. Results after living liver transplantation are not so good, and risks for the donor are higher. This situation, along with the ethical implications of living donation, basically the violation of the traditional first rule in medicine "primum non nocere" (above all, do not harm), has made that living donation is very variably implemented across the countries.

For instance, kidney transplantation from living donors represented 4.6% of all the kidney transplantation activity in Spain in the year 2006. Although this percentage has been progressively increasing in our country, it is a much lower activity than the one described for other countries in Europe and for other countries across the world [16]. The same situation applies to living liver transplantation activities.

Room for improvement exists in living donation activity in many countries. However, living donation activity should always be promoted as a complementary activity to deceased donation, not in competition, avoiding a negative correlation between the living transplantation activity and the deceased one.

7. Conclusions

Organ shortage remains one of the main challenges in organ transplantation. An adequate organization seems to be the clue to increase deceased donation activity in a sustained way. Organization is in fact the whole philosophy of what it has been internationally known as the Spanish Model of Organ Donation, a model that has led Spain in an outstanding position when referring to deceased donation. The figure of the transplant coordinator, the central office in support of all the process of organ donation, great effort in training and education, close attention to the media, and reimbursement to the hospitals are the measures that, altogether and appropriately integrated, constitute this model. If some basic conditions exist, the Spanish Model of Organ Donation can be successfully reproduced in other countries or regions in the world.

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