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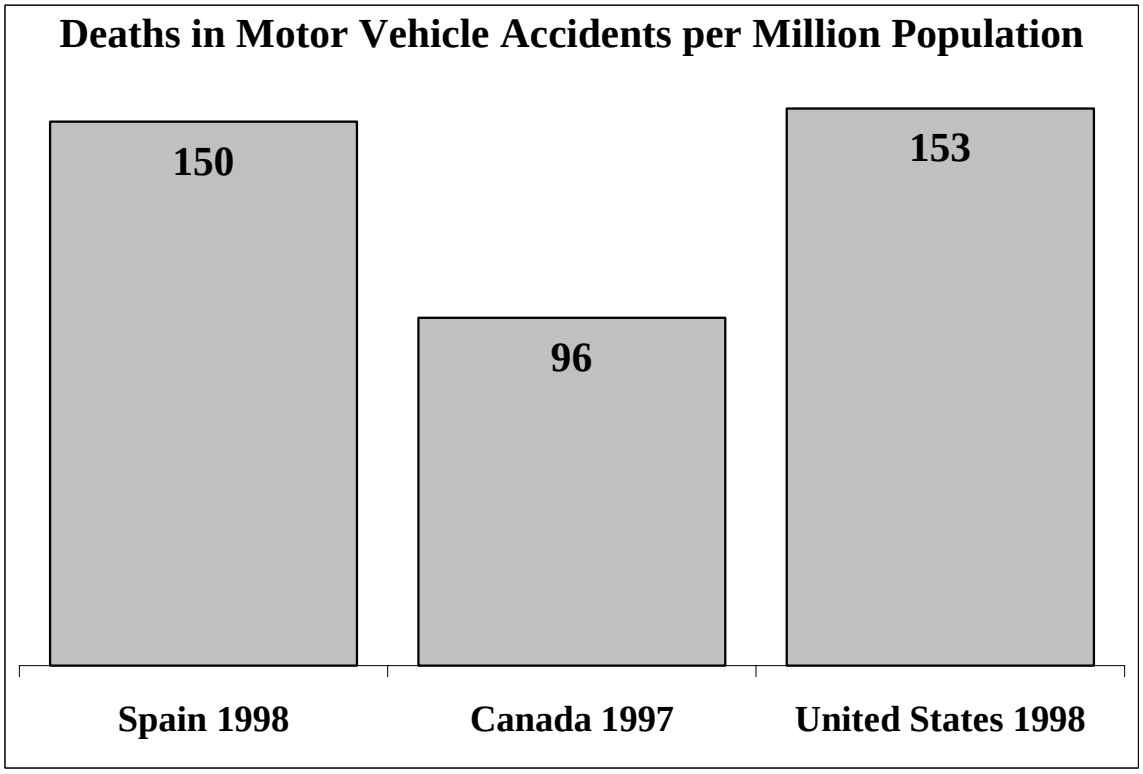
Research on Population, Community Change and Land Use

Beyond Comparison:

Canada's Organ Donation Rates in an International Context

by David Baxter



The Urban Futures Institute Report 51

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A4 ☆ THE VANCOUVER SUN, MONDAY, APRIL 9, 2001

Canada sets up council to boost organ donation

OTTAWA — The federal government and provinces will unveil a $20-million plan later this week to improve Canada's dismal rate of organ donation.

Federal Health Minister Allan Rock will join the provinces in Edmonton Wednesday to announce the creation of the National Council on Organ and Tissue Donation and Transplantation.

The council — made up of government officials, transplant experts, epidemiologists, ethicists and the public — will lead a national strategy to create a more coordinated and comprehensive system. Currently, the organ-donor system is a patchwork of programs based in the provinces.

As a result, the country lags behind donor rates in other western nations. There are 14 donors per million people here compared with 21 donors per million in the U.S. and 31.5 per million in Spain, which has the kind of coordinated council Rock and his provincial counterparts are putting into place.

The council will be supported by a secretariat, to be based in Edmonton, which will receive $20 million in federal funding over five years.

"We know that people who need transplants — livers, hearts, lungs — have very great difficulty finding the organs for the surgery," Rock said. "I think there's a leadership role for the government of Canada in putting this issue high on the national agenda."

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Conclusions

It is irresponsible and misleading to suggest that Canada has a "low" organ donation rate and that adoption of the system of a "high" rate country would result in Canada achieving the apparent donor rates of that other country. Canada's cadaveric donor rate of 13.8 actual donors per million population accurately reflects the demography and mortality patterns of Canada: no transplant system can change either our thankfully relatively low mortality rates or the age profile of Canada's population. Canada's live donation rate of 12.2 live donors per million population, which is never mentioned when Canada's "dismal" donation rate is discussed, ranks fourth highest in the world, is almost equal to our cadaveric donation rate, and is above or on par with the cadaveric donor rates of 22 of the 32 countries.

This is not to suggest that donor rates – both live and cadaveric – in Canada cannot be improved. They can be, but not by constantly looking for easy solutions to complex problems from places with dramatically different social, demographic and mortality characteristics: rather the focus must be on the reality of Canada, and how to make our very good donation and transplant procedures better. And while they can be made better, we should never anticipate, or desire, that Canada will have cadaveric donor rates that match those of high mortality rate countries such as Spain.

Spain has traditionally been the poster country for organ donation, and the one to which Canada is most often unfavorably compared. In the context of live donation, Spain has a rate of 0.4 live donors per million, the sixth lowest live donor rate of the 32 countries for which data is published, something that we should not seek to emulate. It is with respect to cadaveric donation that our rate of 13.8 donors per million inhabitants is referred to as "dismal": why can't we have Spain's cadaveric donation rate of 33.4 donors per million or the United States' rate of 21.4 donors per million? Why can't we, as Health Minister Alan Rock puts it, "lead the world in organ donation"? We can't for two reasons. First, Spain does not have a donor rate of 33.4 donors per million: Spain has a rate of 33.4 potential donors per million, for it includes situations where no transplants occur as donations. So does the United States': its rate of 21.4 donors per million includes situations where an organ is recovered but is not transplanted.

Canada's rate is for actual donors, counting only those situations where at least one solid organ is actually transplanted into a recipient. Both Spain's and the United States' donor rates are inflated relative to that of Canada: to compare Canada's rate to those of these countries is to compare apples to oranges and pears – it is impossible as the definitions are not the same. The effect of including non-transplants in donor counts in Spain and the United States is shown in the ratio of the number of organs transplanted per donor. The ratio for Canada, where donors are counted only when a transplant actually occurs, is 3.2 organs transplanted per donor: the ratio for the United States is 3.0 per donor, and for Spain is 2.6 per donor. It is not that Spain is much less efficient in recovery and transplant of organs from donors than Canada is, but that its donor count is inflated relative to Canada's.

The second reason that Canada cannot achieve the donor rates of Spain or the United States, even if the data were adjusted for definitional differences, is that Canada has a much different demographic structure and mortality pattern. The differences in mortality patterns are particularly striking. With respect to causes of mortality in the 15 to 74 age groups that have the greatest potential of providing the opportunity for cadaveric donation (Class I causes), Spain has age specific mortality rates that range from 20% to 63% higher than those in Canada, while the United States has rates that range from 8% to 70% higher. Considering, as an example, age specific mortality rates due to motor vehicle accidents, Spain's rates in the 15 to 74 age group range from 21% to 77% higher than those in Canada, while the rates for this age

group in the United States range from 39% to 91% higher than those in Canada.

Demographically, Canada and the United States have much greater proportions of their populations in the low mortality under 15 years of age group than Spain has, resulting in a relatively low number of deaths due to these causes than occurs in Spain.

Standardizing for demography and mortality rates indicates that Spain has a potential cadaveric donor pool relative to size of its population that is much greater than Canada's. On its own, Spain's older age profile means that it had 15% more Class I deaths of people aged 0 to 74, and, specifically, 4% more motor vehicle accident deaths of people aged 0 to 74, than it would have had with Canada's age profile. Own their own, Spain's age specific mortality rates mean that it had 28% more Class I deaths of people aged 0 to 74, and 50% more motor vehicle accident deaths of people aged 0 to 74, that it would have had with Canada's mortality rates. Combined, Spain's age composition and age specific mortality rates resulted in 48% more Class I, and 57% more motor vehicle accident, deaths of people aged 0 to 74 than it would have had with Canada demographic and mortality characteristics. Thus, even without consideration of definitional issues, Spain has a potential cadaveric donor pool that is approximately 50% greater than Canada's.

Demographics and mortality rates also combine to create a pool of potential cadaveric donors of people aged 0 to 74 in the United States that is in the order of magnitude of 57% larger on the basis of motor vehicle, and 27% on the basis of Class I, mortality than it would be if Canada's demographics and mortality rates prevailed. On this basis, the United States should have a donors per million rate in the order of 27% to 57% greater than Canada's: it had an estimated 1998 actual donor rate of 18.8 per million, 37% greater than Canada's 13.8 donors per million.

Canada cannot achieve Spain, or the United States' cadaveric donation per million population rates because it does not have the mortalities to start with. All of the published evidence indicates that Canada is making relatively efficient use of the donation potential of its current mortality patterns: certainly there are places where improvements may be made, for example in regard to referral to donation teams, obtaining consent, and providing more medical infrastructure. While these improvements should be made, they should not be undertaken with the misguided expectation that they will greatly increase donation rates: increase, yes; greatly, no.

What Canada, Spain and the United States must all prepare for is a decline in the number of potential cadaveric donors as the population of all three countries age; as continued efforts at road, workplace and home safety reduce the number of deaths due to accidents and violence; and as medical and pharmaceutical technology, and lifestyle change, reduce mortality due to strokes. At the same time, they must also prepare for an increase in the need for organs for transplantation as their populations age.

In Canada this will mean giving up the quixotic pursuit of Spain's current apparent donor rates, which even after adjustment for definitional overstatement, reflect high mortality rates and different demographics. While we continue to make improvements to the cadaveric donation system, we must also focus energy and resources on the pursuit of innovation in the areas of live related and live anonymous donation. These two sources of donation have, numerically, a much greater absolute potential, and rely, ironically, on health in contrast to cadaveric donation's reliance on death. They also involve processes, procedures, perceptions, concerns, and risks, both medical and societal, which have not been fully explored and are not fully appreciated or understood. These are the sources, combined with biomedical innovation, that organ donation will be forced to increasingly rely on if the transplant gap is to be narrowed. Otherwise, we will be forced to watch it become ever wider.

Beyond Comparison:

Canada's Organ Donation Rate in an International Context

by David Baxter, April 2001

I. Introduction.

This is the third report on organ donation in Canada prepared by The Urban Futures Institute. The first report, Donation Matters: Demographics and Organ Donation in Canada, 2000 to 2040[1], was primarily concerned with the projection of the future demand for, and supply of, solid organs for transplantation. The second report, A Decade of Donation: Measurement of Organ Donation Rates in Canada, 1988 to 1997[2] used readily available data to present and evaluate a range of possible measures of the level of cadaveric organ donation in Canada. In turn, this report considers a) published measures of organ donation rates and what these rates do, and more importantly do not, indicate about comparative levels of organ donation over time or between regions, and b) the reasons for measuring organ donation rates, and how these reasons determine, in terms of both data and methodology, the appropriate donation rates to be used.

The fundamental purpose of this report is to demonstrate the importance of not simply measuring donation rates, but of doing so in a logical and statistically valid way. The current practice of using donors per million population (or any other proxy measure that is not based on eligible donors) is not only misleading and inappropriate, but in fact can do harm, as it may lead to either adoption of approaches to donation that may not be warranted or to representation of a potential supply of donors that does not exist.

Pick up any introductory textbook on statistics, and you will find medical clinical trials used as the example of the required statistical rigor to be applied in evaluations of procedures and products. Similarly, read any medical journal and you will find that it abounds with references to randomized, double-blind, placebo-controlled, sample rotated, age-, gender-, and ancestry-standardized trials. No new procedure, no new product, would be introduced into medical practice without such rigorous evaluation. Yet decisions about the effectiveness and quality of organ transplantation programs are made on the basis of crude donation rates calculated simply by dividing the numbers of donors in a region by the region's population, without either standardization of populations or consideration of functional or causal relationships.

The measurement of donation rates is not an academic issue: it is of vital practical significance for two reasons. First, high gross donation rates, in terms of donors per million population, are often equated with highly effective donation programs, leading to the assertion that the practices of "high" donation rate regions should be adopted in "low" donation rate regions:

> Ontario will use the force of law to increase organ donation, Premier Mike Harris announced yesterday in a move … a coordinator of London's multi-organ transplant service called "silly". (Harris) intends to adopt systems similar to B.C. and Nova Scotia, in which all deaths and imminent deaths would be reported to an agency to determine if patients are suitable donors… (the coordinator) questioned why Harris cited B.C., which has a donor registry, as an example for Ontario when its organ donation rate is only 10 people per million while Ontario's is 14 per million. The London region leads Ontario with 24 per million. … the president of London Health Sciences Centre said Southwestern Ontario's donor rate is an example to the whole province.[3]

Implicit in the "example" is the assumption that regions are identical except for donor programmes, and if only the practices of the high donor rate areas were universal, donor rates would be, something that ignores demographics and causes and location of mortality.

It is not merely within countries that the questionable leap between high ratios of donor per million and highly effective programs is made. For example, Spain has long been the poster country of organ donation:

> "The fact that the increase in donation of organs maintained in Spain has coincided with the stabilization of a marked collapse of the rates of donation in most parts of the countries of the world and has attracted the attention of numerous transplant professionals and responsible health officials of the five continents. The Spanish Organizacion Nacional de Transplantes has turned into a compulsory international reference when the topic of shortage of donations is approach, and that has propitiated the reception of numerous requests for cooperation on the institutional level as well as on the part of numerous professionals all over the world. The Spanish has received recognition from the highest European institutions:
> The Committee of Experts on the subject of the Council of Europe recommended its member countries adopt the guidelines of the Spanish model of the Organizacion de Transplantes ….
>
> 6.1. Adaptation of the Spanish System to other countries:
> - Latin-American Countries…..
> - Brazil …..
> - U.S.A. …..
> - Australia ….."[4]

If one accepts published donors per million inhabitants ratios at face value, there is no question that Spain has a bigger number than other countries. If one does not, then two fundamental questions are raised: 1. Does bigger mean better? and 2. Is Spain's donors per million ratio comparable to that of other countries? There has been no evaluation thus far that answers "Yes" to these questions. This is not to say that Spain's system is not an excellent system – it may be and may be the one that best serves its population. However, it is to say that a high gross donation rate in Spain (or in London, Ontario) is not, in itself, evidence of a superior system, and that the rates that appear to be achieved in Spain may not be achievable elsewhere, even using the "Spanish model". Only when standardized for the definition of donor, for demographics and for causes and location of mortality can systems be compared. No one would accept the efficiency of a pharmaceutical product on the basis of an un-standardized rate per million inhabitants: it is astonishing that anyone would accept the efficiency of a donor system on such a basis.

Not everyone does:

> Arkansas' primary organ procurement agency can continue to operate, U.S. District Judge George Howard Jr. ruled. Calling the federal government's performance standards for organ procurement "arbitrary, capricious and an abuse of discretion", Howard granted the Arkansas Regional Organ Recovery Agency, ARORA, its motion for a summary judgment against the U.S. Department of Health and Human Services Department. The Health Care Financing Administration … had notified the agency this spring that it was about to be decertified for poor performance. … At the core of the lawsuit were the Health Care Financing Administration's performance standards for organ procurement organizations. … ARORA said in the suit that it would have scored better if the performance standards had taken into account local factors that influence the number of potential donors and organs available. Instead, the agency argued, the standards rely solely on population.[5]

Donation rates are of value as indicators of performance only if they actually measure effectiveness, which means determining how well the system works given the demographics and health characteristics of the donor population. Comparison of donation rates are of value only if, in addition to actually measuring effectiveness, they use the same definitions of donors.

Given the widening of the transplant gap, it is critical that the most efficient system for each population be found: accurate evaluation will be essential if this is to occur. So is realism: if, because of the unique definition of donors, mortality rates and demographics of Spain, its nominally high donation rate cannot, regardless of the system used, be achieved elsewhere, it will represent an unattainable goal that will create false hope both for people working in the transplant system and, most importantly, for those in need of solid organ transplants.

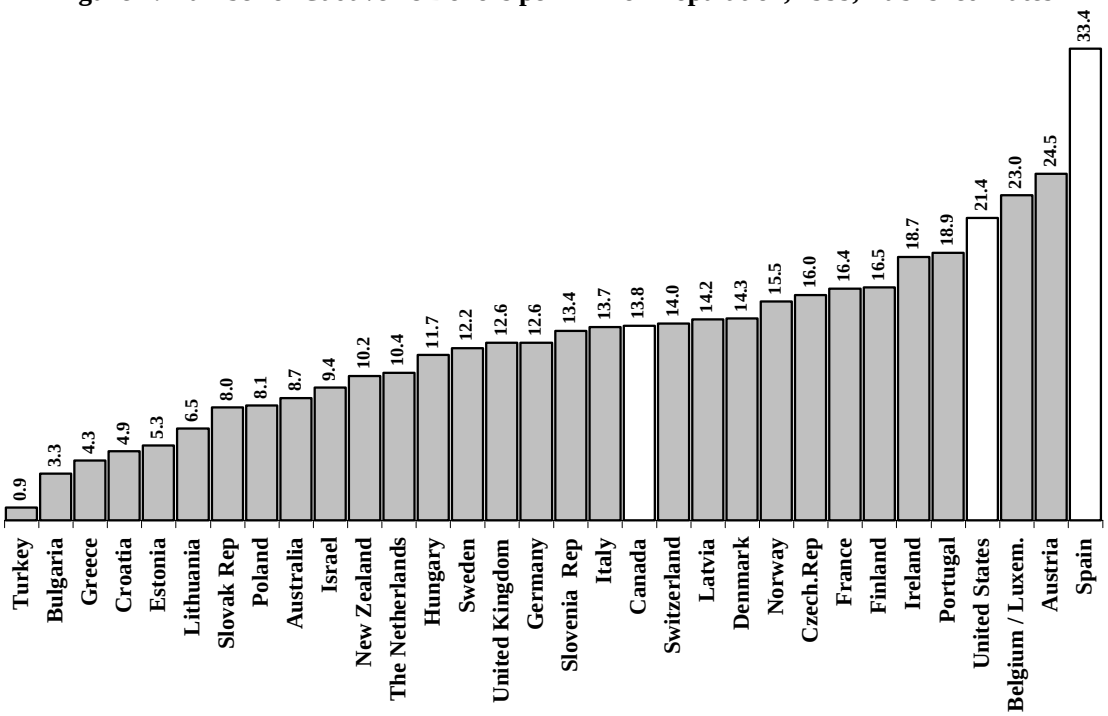
As this report shows, there is not sufficient information, standardization or evaluation, to endorse Spain's, or any other country's, transplant system as being the model. Again this is not to find fault with Spain's system, but simply to say that conclusions cannot be drawn as to its suitability either for Spain or for other countries on the basis of its published donors per million rate.

[Note on data: In the following sections, published data on organ donation in an international context are considered, with a focus on the data for Spain, Canada, and the United States. The Urban Futures Institute neither solicits nor receives funding for its research: while this ensures independence in research, it also limits the resources available to fund data acquisitions. As a result, published data that are available to the public at no cost are the major source of information used in research. Unpublished data, and data for which data retrieval charges are levied, may provide greater insights into the issues raised here: it is hoped that those responsible for such data will use it to further the research presented here to assist in the continued development of statistically valid and logical comparative measures of organ donation.]

II. Published Donation Rates.

A. Published Rates

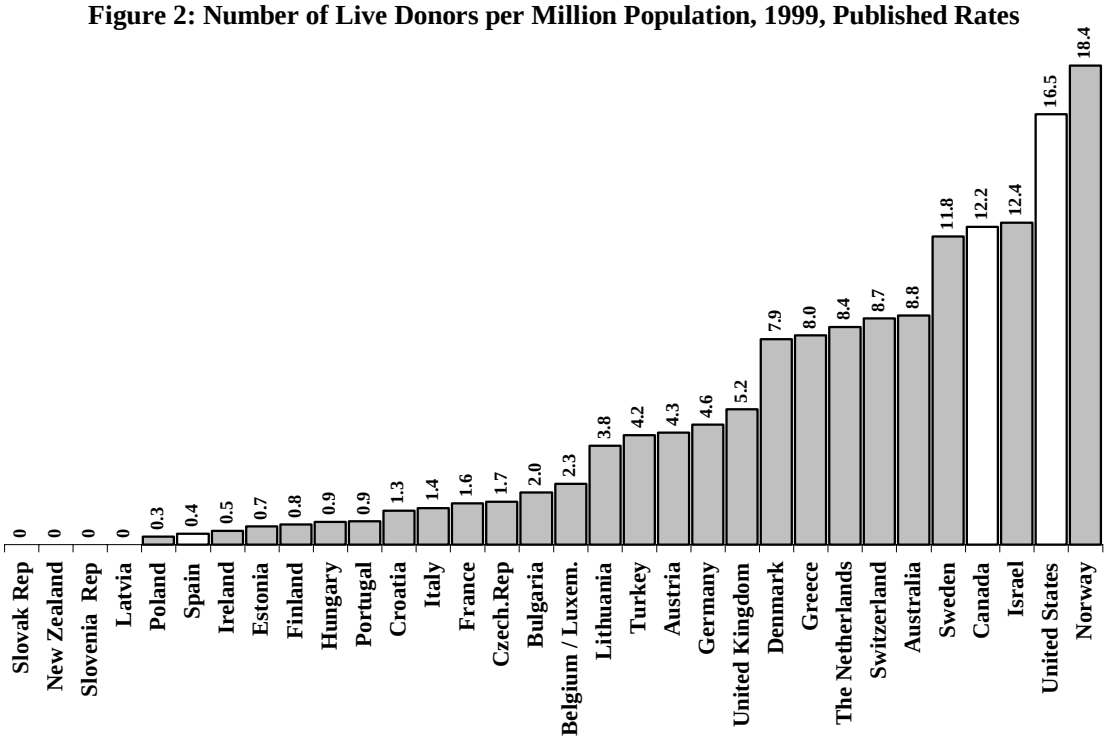
Figure 1: Number of Cadaveric Donors per Million Population, 1999, Published Rates



From the Canadian Organ Recovery (CORR) website[6] to those of the Spanish Organizacion Nacional de Transplantes (ONT)[7] and the International Transplant Coordinators Society (ITCS)[8], almost every discussion of organ donation in an international context makes reference to data such as that presented on Figure 1[9], which shows the number of cadaveric donors per million

inhabitants, with Spain far in the lead with 33.4 donors per million, 56% above the United States of America's rate of 21.4 donors per million and 142% above Canada's 13.8 per million. Herein lies the source of the perennial cry that "Canada unfortunately has one of the worst organ donor rates in the developed world"[10], a claim that assumes that the published data on cadaveric donor rates are both comparable and tell the whole story. Neither is correct: first, they do not tell the full story, as they leave out data on live donation, which cast a much different light on both Canada and Spain. As Figure 2[11] shows, the live donation rate in Spain is an extremely low 0.4 donors per million inhabitants, a fraction of Canada's 12.2 per million and the United State's 18.4 per million.

Figure 2: Number of Live Donors per Million Population, 1999, Published Rates



Ignoring live donors as a component of donation rates is unusual, as live donation rates in some countries not only exceed cadaveric donation rates, but, in the case of the United States and Norway, exceed the cadaveric donor rates in all but six of the countries for which data are published. Donation systems must be evaluated on their entire scope, not on the single aspect of cadaveric donation.

Combining live and cadaveric donors to determine the total donor rate, the United States has the highest published rate with 37.9 donors per million, with Spain ranking third with 33.8 and Canada fifth with 26.0 per million (Figure 3). If published donor rates per million are used as a criteria, which they must not be, it is the United States, not Spain, which should be the point of reference.

The reason that published cadaveric donor rates per million must not be used is that they are not comparable. For example, the rates for Spain, Canada, and the United States are based on three very different definitions of donation, definitions that inflate the donors per million rates of Spain and United States relative to that of Canada.

B. Definitions of Donation

Placing donation rates from a range of countries on a single chart or table implies that they can be compared and contrasted: in order to do so, they must all use the same definition of donor. Given the importance of the measurement of donation rates, it is quite surprising, at least to an outsider, that there is not only no standard definition of a organ donor, there is often no definition.

Definition is not the strong suit of organizations publishing data on organ donation: it is rare to find accompanying the data on organ donation a definition of what constitutes a donation. For example, while both the Canadian Organ Recovery (CORR) website and the Spanish Organizacion Nacional de Transplantes (ONT) present comparisons of international cadaveric donation rates, neither, at the time of writing of this report, defined what measure of donation was being compared.

The United Network for Organ Sharing (UNOS) in the United States publishes its definition of a donor, which provides a useful starting point for comparisons of donation rates:

> UNOS defines a (recovered) cadaveric donor as one from whom at least one vascularized solid organ (kidney, liver, pancreas, heat, lung, or intestine) was recovered for the purposes of transplantation.[12]

This is the definition of donor that results in a 1999 donor rate of 21.4 donors per million, the fourth highest cadaveric donor rate in the tabulation. Note, however, that donation is distinct from transplantation: the UNOS is careful to point out "that not all recovered organs are actually transplanted"[13]. Thus the published rate for organ donors in the United States is an organ recovery donor rate, not an organ transplant donor rate.

The definition of donors used in Canada requires that organs are actually transplanted:

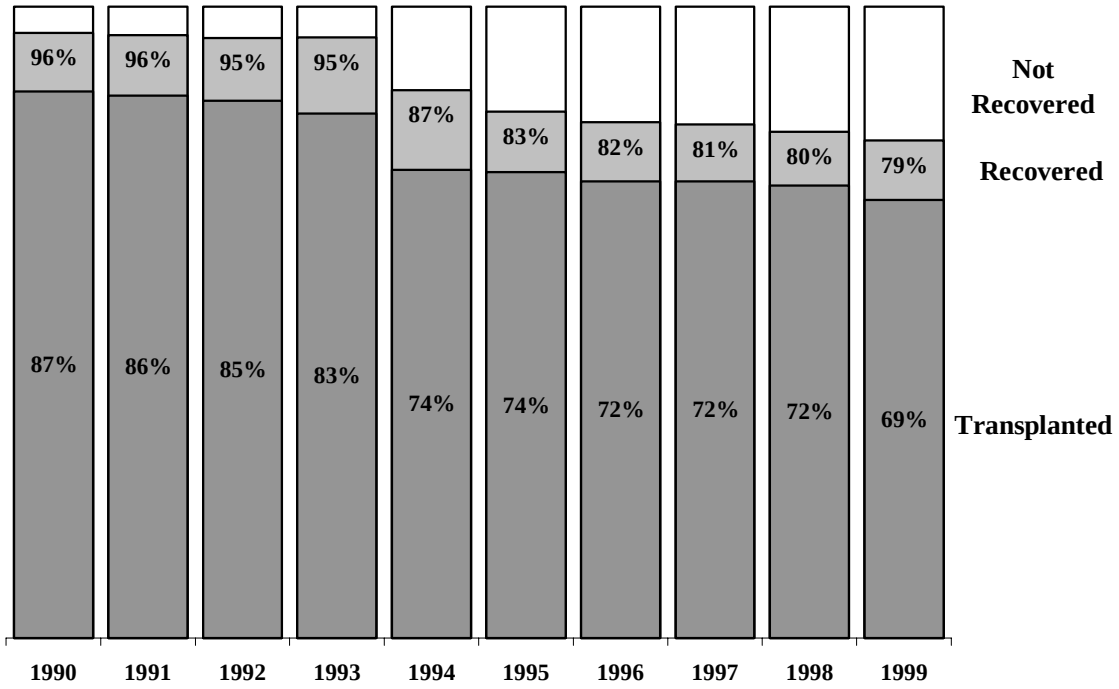
> A solid organ donor is one where at least one solid organ has been used for transplant. If something (e.g., infection, cancerous tumors, etc.) renders a potential donor unsuitable and no transplant occurs, we cannot count that patient as being a donor even if an organ is recovered.[14]

Canada's definition, more restrictive than United States', is an organ transplant donor rate.

Spain's ONT uses yet a third definition of donor: "a donor: any potential donor from whom at least one vascularized solid organ was recovered for the purposes of transplantation"[15]. While this sounds like the Canadian definition, it does not require that a recovered organ actually be used in a transplant: donation in Spain, therefore, includes instances where organs are recovered but not used in a transplant[16]. Acknowledging this, the Spanish definition appears to be similar to that of the UNOS: however, there is no definition of what "potential donor" means. This could range from everything from the UNOS definition to all instances where consent is obtained even if an organ is not retrieved. There are no published data to indicate how a "potential donor" compares to a consented donor, a consented donor from whom an organ is recovered, or an actual donor.

As Canada does not publish data on either donations where organs are recovered but not used in transplants or donations where consent given but no organs are recovered, and Spain does not publish data on donations where organs are recovered and transplanted or on what "potential" means, it is not possible to formally standardize the data to a common definition of donation for Canada, the United States and Spain. As without a common definition of cadaveric donation it is impossible to compare and contrast rates, it is not possible, from published data, to draw any conclusion about the relative effectiveness of these three models of organ donation, recovery and transplantation. Spain may, or may not, have a system worth emulating: no one can say on the basis of currently published empirical evidence.

Figure 4: Recovered and Transplanted Organ, % of Consented Organs, United States



Data published by UNOS is helpful in providing an indication of the possible magnitude of the differences between definitions of donation: it shows that the differences are likely to be very large. UNOS publishes two sets of data with respect to its donation and transplant activity: the disposition of organs recovered from cadaveric donors and the reasons for non-recovery of consented organs. Note that these data refer to organs rather than donors, and hence can only be used as general indicators of the relationship between the three definitions of donors.

From these two sets of data, it is possible to determine the number of recovered organs and the number of transplanted organs as a percentage of consented organs (Figure 4[17]). In 1999, 79% of the consented organs were recovered while 21% were not; 69% of the consented organs were transplanted organs were transplanted and 31% were not. Thus out of every 100 consented organs, 21% were not recovered, 10% were recovered but not transplanted, and 69% were transplanted.

The UNOS data give reasons for both why consented organs were not recovered and why recovered organs were not used (Figure 5[18]). The major reason for the non-recovery of consented organs was poor organ function and infection (52% of the cases in 1999), followed by recipient not located or recipient list exhausted (12%), organ damage and anatomic abnormalities (9%), donor medical and social history (4%), and positive hepatitis/HIV/HTLV-1 (3%), with all other causes (including cardiac arrest and biopsy results) combining to account for 20%. Only one of these reasons, that a recipient could not be located or the list was exhausted, is procedural, with all the rest being medical.

Out of every 100 organs recovered from cadaveric donors in 1999, 88% were transplanted, 9% were not used, and 3% were used for research and other purposes (Figure 6[19]). Thus not only is there a significant margin between the number of consented organs and the number recovered, there is an even greater margin between the number of consented organs and the number transplanted.

Figure 5: Reasons for Non-recovery of Consented Organs, United States

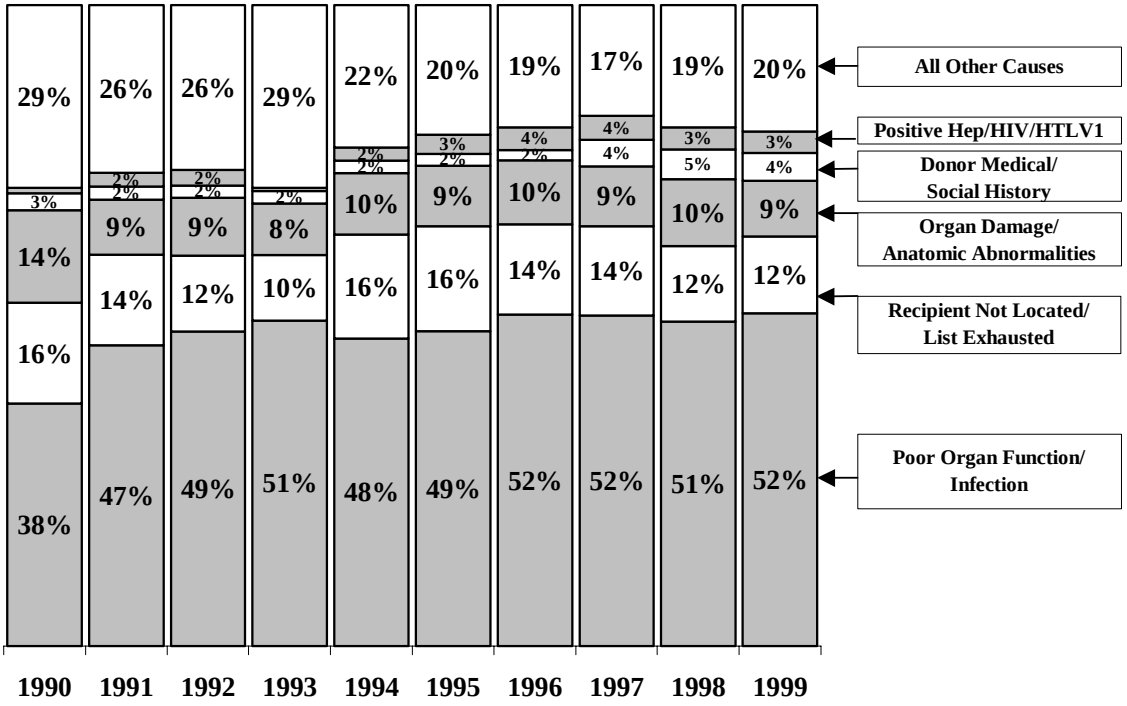
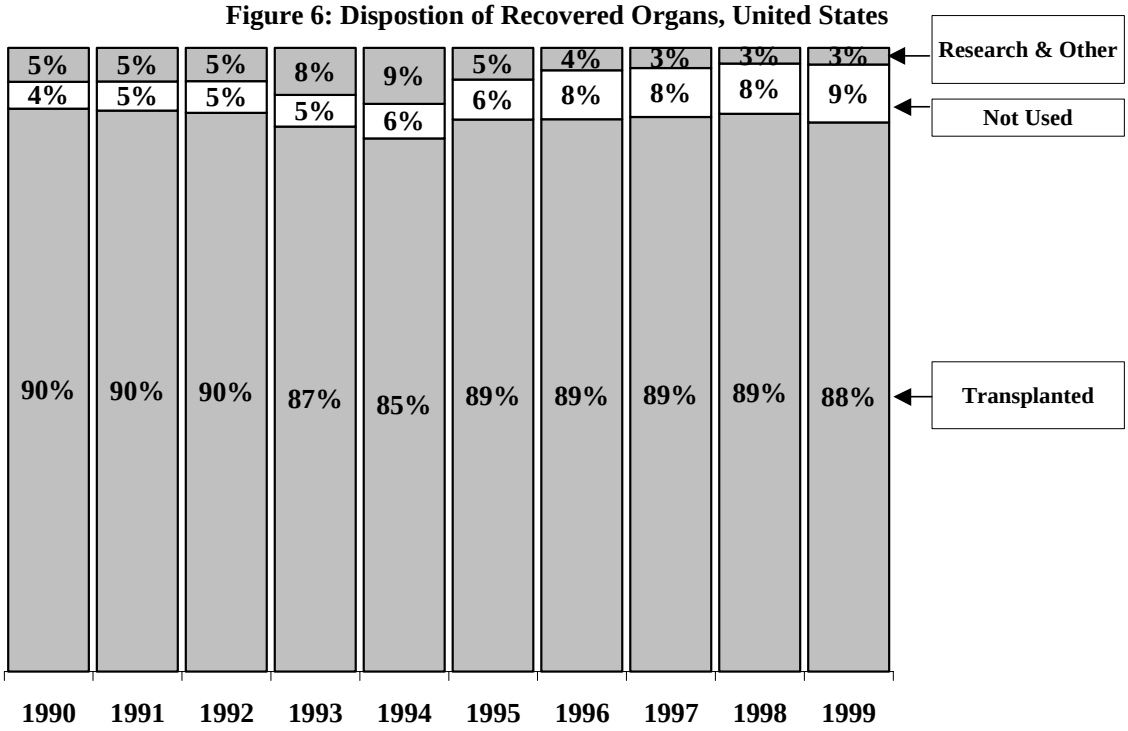


Figure 6: Dispostion of Recovered Organs, United States



The single largest reason for non-use of a recovered organ in 1999 was that a recipient could not be located or the list was exhausted (22% of the cases, Figure 7[20]), followed by poor organ function and infection (18%), biopsy findings (9%), donor medical and social history (7%), organ damage and anatomic abnormalities (6%), and positive hepatitis/CMV/HTLV-1 (3%), with all

other causes (including extended ischemia time) combining to account for 35%. Again, only one of these reasons, that a recipient could not be located or the list was exhausted (22%), is procedural, with all of the rest being medical causes.

Figure 7: Reasons for Non-use of Recovered Organs, United States

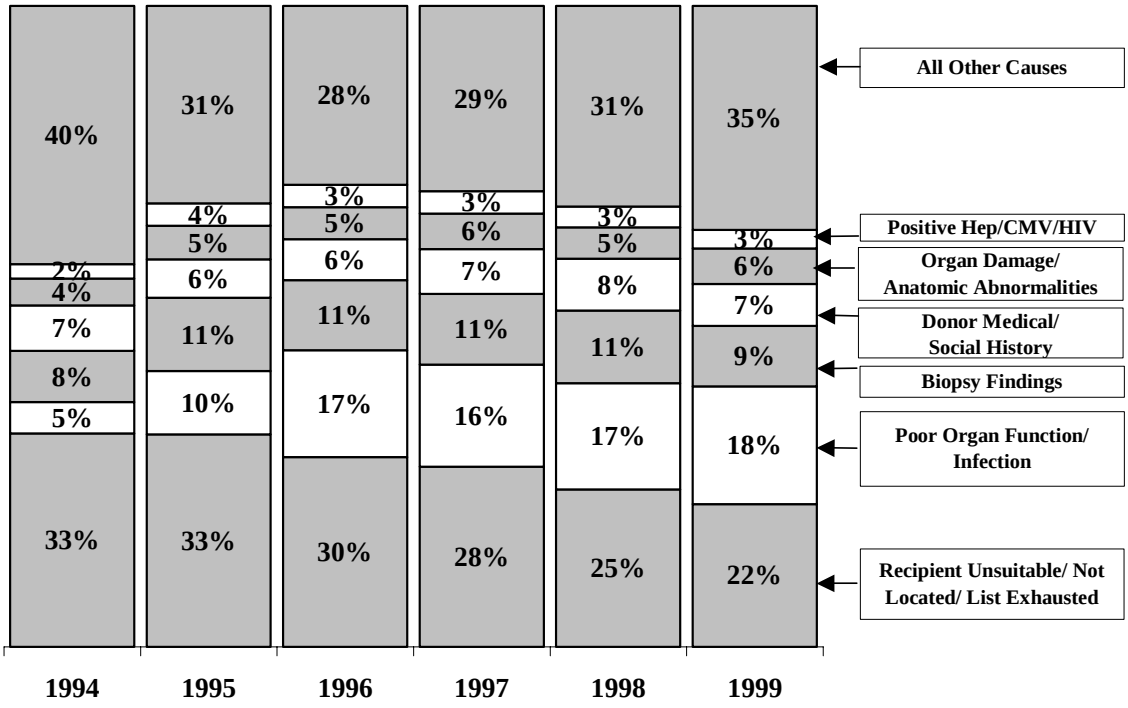
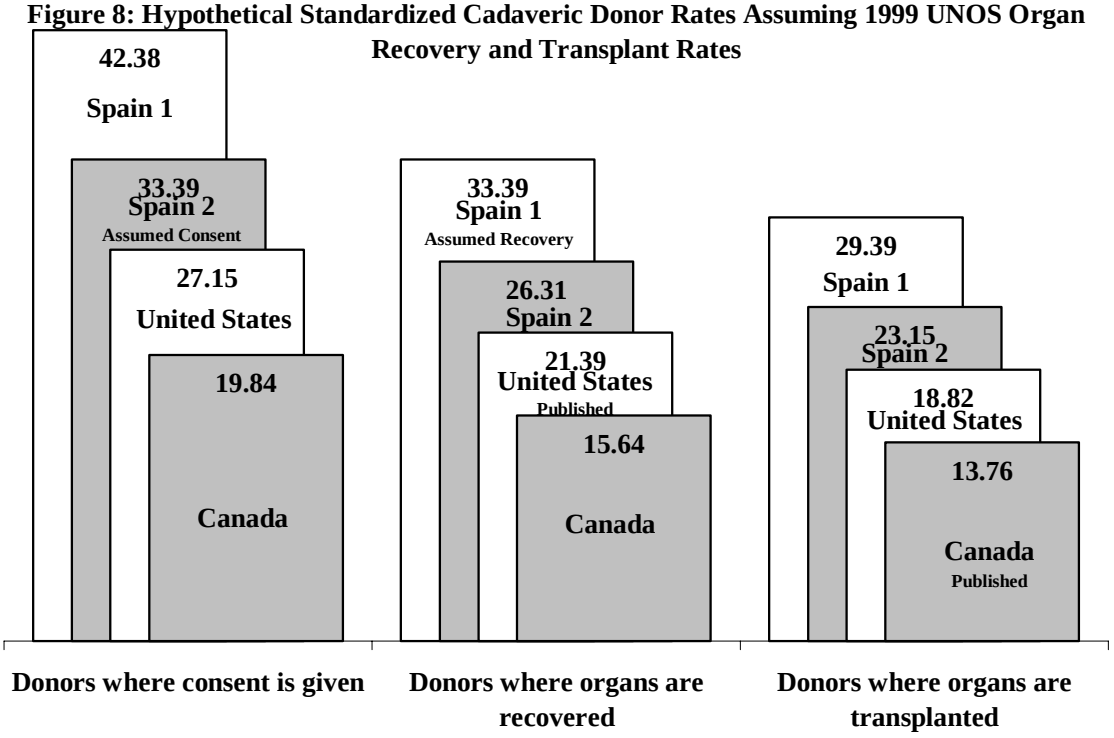


Figure 8: Hypothetical Standardized Cadaveric Donor Rates Assuming 1999 UNOS Organ Recovery and Transplant Rates



For illustrative purposes, if it is assumed that the same ratios of non recovery of consented organs and non-transplant of recovered organs applies to donors and to the data for Canada, Spain and United States, a hypothetical comparison of donor rates using a standardized definition is possible (Figure 8). The United States published donor rate of 21.39 donors per million is based on donors from whom an organ is recovered whether or not it is ultimately transplanted: adjusted for the fact that 88% of the recovered organs are transplanted, this is equivalent to an organ transplant donor rate of 18.82 per million. This compares to Canada's published organ transplant donor rate of 13.76 per million: the United State's rate remains above Canada's, but only by 37%, rather than the 56% indicated by incorrectly comparing the published rates without adjusting for the differences in definition of donation.

Conversely, if there is the same 12% proportion of donors where organs are recovered but not used in Canada as there is in the United States, then Canada organ recovery rate is 15.63 donors per million, compared to the United State's 21.39 per million. Further, if in both Canada and the United States donors where organs are recovered account for only 79% of all donors where consent is obtained, then the donor consent rates for Canada and the United States would be 19.84 and 27.15 donors per million respectively.

This is not to argue that the organ transplant ratio in the United States is 18.82 donors per million (as the recovery rate is based on organs rather than donors), but rather to show the magnitude of the impact of using standard definition. It is to argue that the United States rate of 21.39 donors where organs are recovered per million population cannot be compared to Canada's 13.76 donors where organs are recovered and transplants occur per million. Only when data using corresponding definitions is available can comparisons and evaluations be made.

In order to present a hypothetical standard rate for Spain, it is necessary to make assumptions with respect to the meaning of a "potential donor". Two possible definitions are considered here. The first (Spain1 on Figure 8) is to assume that Spain's definition is equivalent to the UNOS organ recovery donor rate. If this is the case, then Spain's published rate of 33.39 donors per million can be compared directly to the United State's published rate of 21.39 per million, but not to Canada's published rate. Rather, Spain's 33.39 per million would be compared to a rate for Canada that had been adjusted for situations where organ's were recovered but not used, for example, the 15.64 per million used in the hypothetical ratios presented on Figure 8.

A second possible definition of potential donor would be where consent was given but where an organ was not necessarily recovered. The UNOS data indicates the 21.39 donors per million where an organ is recovered represent 79% of the organs where consent for recovery is given. If the same ratio applies to donors as to organs, then the United States has an organ donor consent rate of 27.15 per million inhabitants. Assuming the same ratios apply for Canada gives it an equivalent rate of 19.84 per million. These compare to the 33.4 rate (Spain 2) that would prevail in Spain if this were the definition of donor that applies to the Spanish data.

This hypothetical example demonstrates both the rationale for, and the methodology of, using the same definition for donor in the comparison of donor rates between regions. It shows that the difference between Canada, the United States and Spain is not as great as the superficial comparisons of published data indicate. Without the necessary data, the actual rates cannot be calculated: without a standardized definition of "donor" comparison of published rates, and hence judgment of system efficiency, is meaningless. The answer is not to avoid comparing rates, but to publish data so that valid comparisons – and evaluation - may be made.

Two approaches could be taken to facilitate such evaluation. The first would be for all countries to adopt a standard definition of donor: as the goal of organ donor organizations is

transplantation, the definition of donor should be the Canadian and Eurotransplant definition, of cadaveric donors of whom at least one organ has been used in a transplant[21], excluding consented donors where no organ was recovered or where an organ was recovered but not transplanted.

The second approach would be to follow the model of the UNOS and publish data for consented donors, for donors where an organ was recovered, and for donors where an organ was recovered and transplanted, along with the reasons for non-recovery of consented organs and the disposition of recovered organs, including reasons for non-use of recovered organs. Publication of this information, which organ donor and transplant organizations already have on file, would permit evaluators to focus on the individual components of the donation and transplant process and to calculate comparative standardized measures for each of its stages.

C. Systems

A second issue that arises from the common comparison of published donor rates at the nation level is that they imply not only a standard definition of donor, but that they also imply a national system. In the case of Spain, explicit reference is made on the ONT website to the Spanish "system", and to the "adaptation of the Spanish system to other countries". Clearly if Spain's system, or that of any other country, is to be held up as a model, there should first be some evidence that this model is transferable, and is not dependent of unique national conditions (such as demographics and mortality causes) than are not portable. One indicator of the portability of a system would be its ability to achieve uniform standards within its national boundaries. Using this measure, Spain does not demonstrate any great superiority to Canada or the United States, nor does it demonstrate any great evidence of the benefits of a national "system": all three countries are characterized by as much internal variation as is found between countries.

Considering Spain first, Figure 9[22] demonstrates the 1160% range between the 3.8 donors per million rate for the La Rioja region and the 44.2 donors per million rate for Cantabria that existed in 1998. It also shows the 860% range that exists between the 1990 to 1998 averages for regions in Spain, and the significant differences that exist between the annual rate and the long term average for each region (with La Rioja's 1998 rate being only 32% of its average and Extremadura's being 170% of its 1990 to 1998 average).

Three factors explain such a pattern of variance: a) regional differences in mortality patterns, demographics and health infrastructure, b) the small number of donors in each region in any year, and c) regional differences in the organ procurement and donation processes. The facts that the national average of donation is not consistently achieved within regions of Spain and that there is significant annual variation in rates in regions and between regions mean that it should not be anticipated that the Spanish national average can be attained in regions outside of Spain simply as a result of the adoption of the "Spanish" model.

The data for donation within regions of the United States shows a similar pattern of variation, from New Mexico's 1999 rate of 12 donors per million to the Pennsylvania/Delaware/West Virginia region's rate of 35 donors per million (Figure 10[23]). It should not be concluded from this chart that there is less variance in regional donor rates in the United States than there is in Spain. First, there are states, such as Montana and Idaho, where there are neither organ procurement organizations nor transplant hospitals. Residents for these states must travel to other states to be either donors or recipients of solid organs. Second, proximity means that residents of one state may be part of the transplant process in another state even if their state has its own program: where such sharing could be identified, states were grouped together into larger regions.

Figure 9: Published Cadaveric Donation Rates, Spain

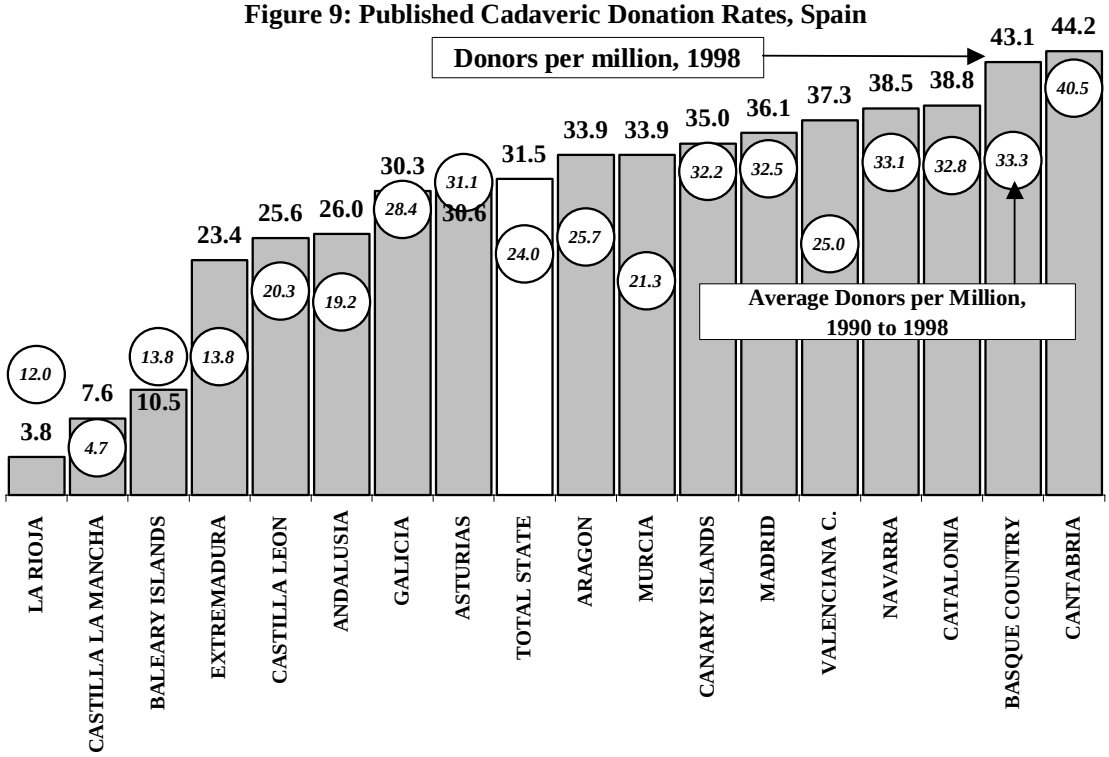
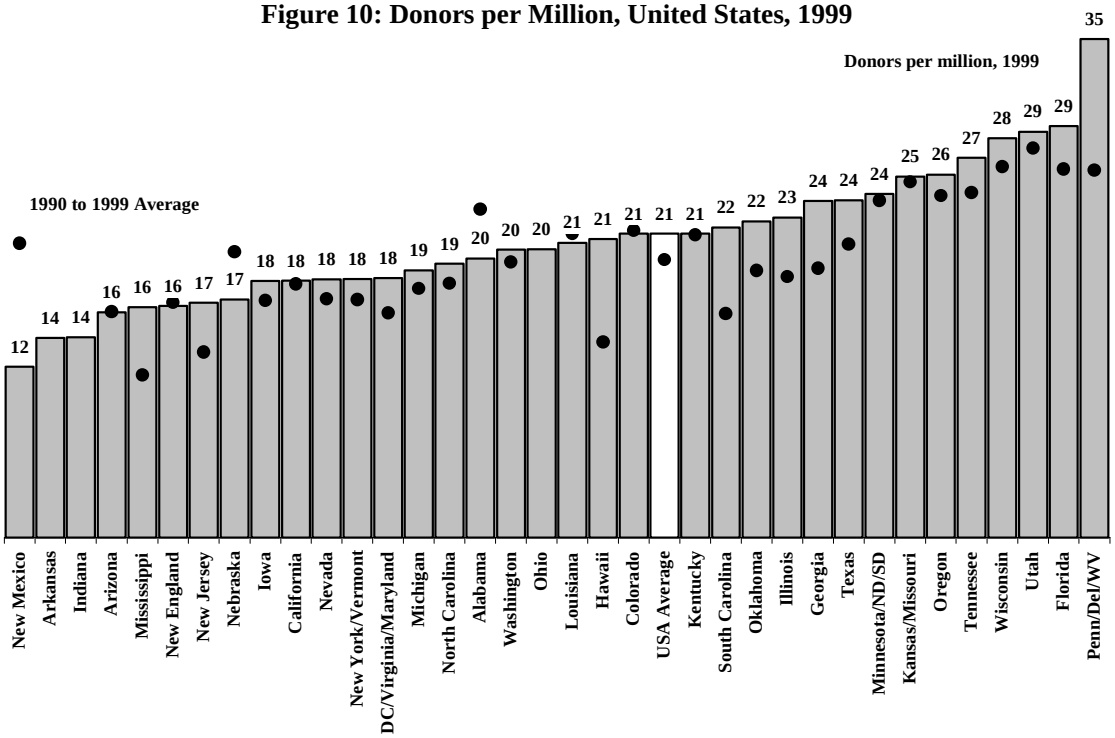
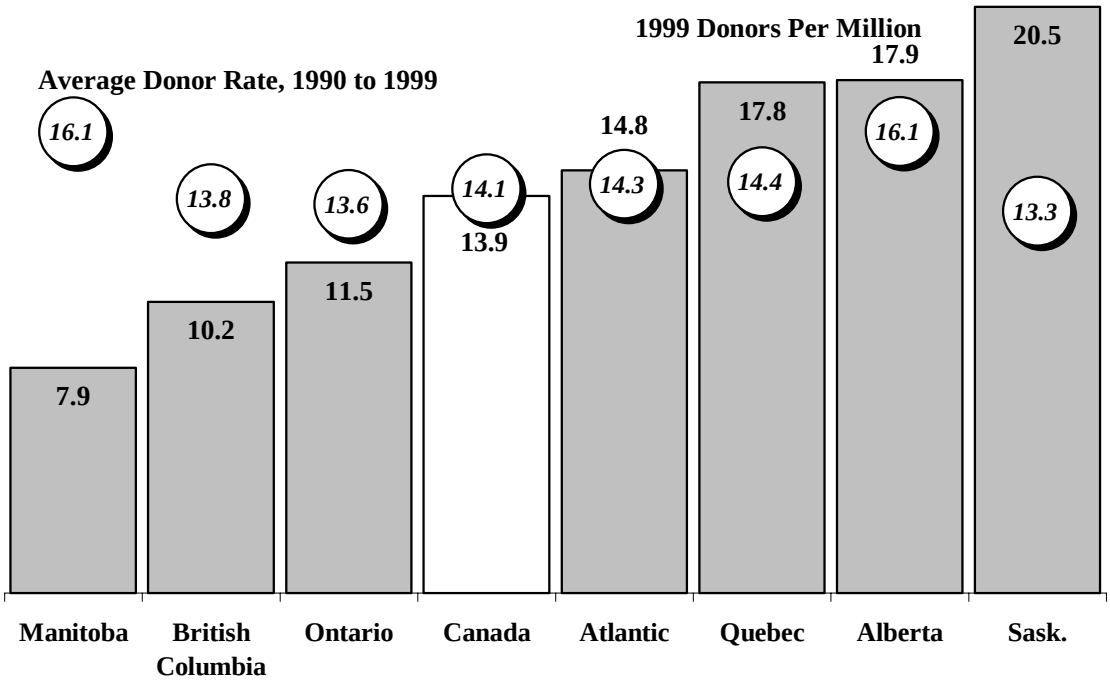


Figure 10: Donors per Million, United States, 1999



Even with its exact definition of a donation having to involve at least one solid organ being transplanted, Canada demonstrates a significant pattern of spatial and temporal variation in donor per million rates (Figure 11[24]). It also shows the statistical consequences of the very small numbers involved in organ donation is some regions: the 1999 leader, in terms of donors per million, was Saskatchewan, with 20.5 donors per million, and a grand total of 21 donors. The long-term average donor rate for Saskatchewan of 13.3, however, is the lowest in Canada. The neighbouring province, Manitoba, had the lowest donor rate in 1999, 7.9 per million, with a grand total of 9 donors: Manitoba has the highest long term donor rate in Canada, 16.1 per million. The number of donors involved in these regions is simply too small to draw any conclusions about system efficiency using donors per million population.

Figure 11: Transplant Donor Rates Per Million, Canada



As the data for Spain so clearly indicate, the existence of a wide range of donor rates within national jurisdiction, where a single definition of donor prevails, demonstrates that regional differences play the primary role in determining regional donation rates, not the "system".

D. Definition of Donor and Characteristics of Donation

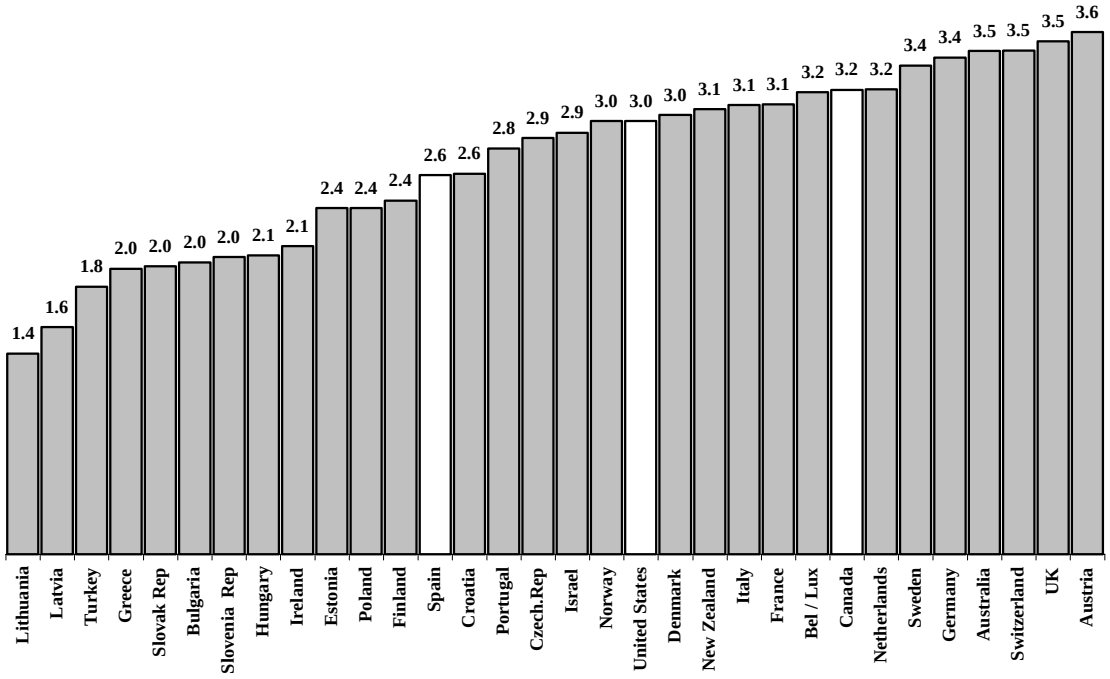
1. Ratio of Transplants to Donors.

Differences in definitions of donors, as well as differences in location and characteristics of mortality and demography, are reflected in the tabulation of characteristics of donation. Two examples of how definition affects donation characteristics are considered here. The first is the ratio of the number of organs transplanted to the number of donors. If the definition of donor is restricted to donors where an organ is transplanted, as it is in Canada, then the ratio of transplant per donor will be relatively high. All other things equal, the more situations where transplants do not occur that are included as donations, the lower the ratio of transplants to donors.

Figure 12[25] presents the published data on the number of organs transplanted (for which there should be not definitional differences) per cadaveric donor using the non-standardized published definitions of donors. On this basis Spain appears to have a much less efficient system with

respect to the number of organs that it is able to successfully transplant per donor when compared to the United States, Canada or Austria. Spain's rate of 2.6 organs transplanted per donor is the 20th, being 19% lower than Canada's 3.2 organs transplanted per donor and 28% below Austria's 3.6 organs per donor.

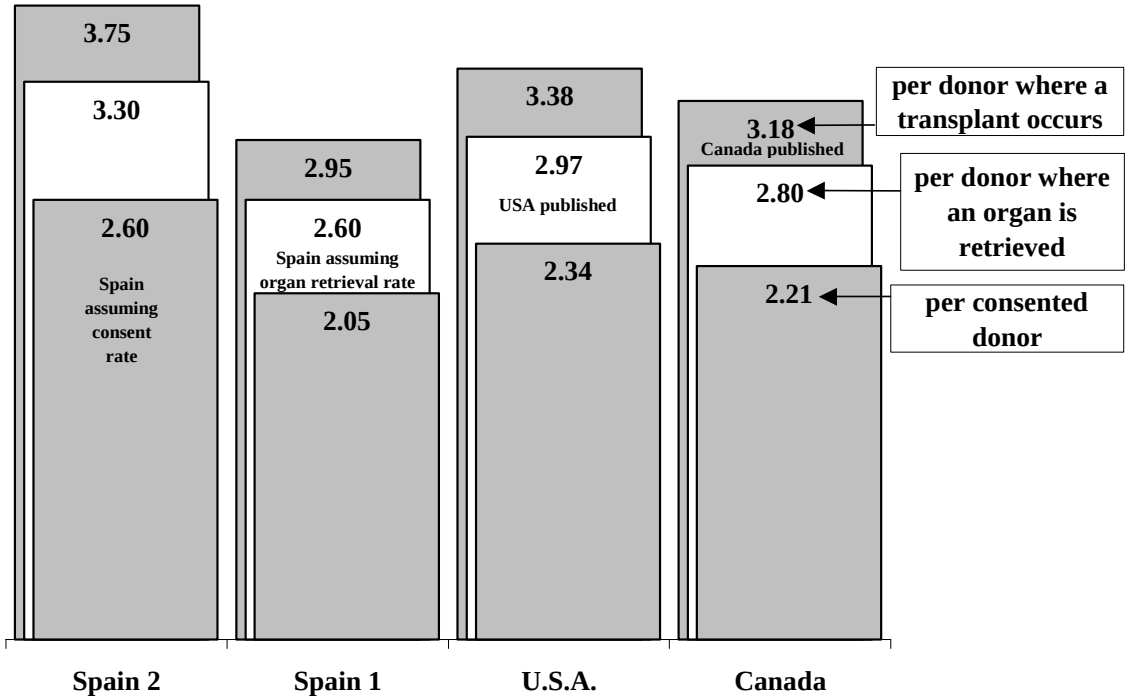
Figure 12: Organs Transplanted Per Cadaveric Donor, Published Defintions, 1999



This apparent inefficiency in the Spanish transplant system is most likely the result of its wide definition of donors rather than any actual shortcomings in the Spanish system. Of the three countries being compared in this report, note that Canada, with the narrowest definition of donor has the highest ratio of organ transplants to donors, while the United States, with a wider definition that includes situations where organs are recovered but not transplanted, has a lower transplants per donor ratio. Hypothesizing that Spain uses an even wider definition that includes consented donors where organs are not recovered would explain its even lower ratio of transplants to donors.

The UNOS data on the percentage of consented organs that are retrieved and on the percentage of retrieved organs that are transplanted can be used to provide a hypothetical standardization of the ratios of organs transplanted per donor (Figure 13). The published number of donors for the United States includes donors where organs are retrieved but not transplanted: if this accounts for the same 12% of donors as it does of recovered organs, then the number of organs per donor where a transplant occurs would be 3.38. This would bring the ratio for the United States to slightly above the comparable ratio of 3.18 organs per donor for Canada. Conversely, if in Canada 12% of the donations where organs are retrieved do not culminate in a transplant, then Canada achieves a rate of 2.80 organs per donor where an organ is retrieved, compared to the 2.97 rate achieved in the United States. This is not to suggest that these are rates that actually occur, but rather to reiterate that the published rates for Canada and the United States cannot be directly compared (as they use different definitions of donors), and that when adjustment is made for the differences in definition, the gap between the two rates narrows.

Figure 13: Organs Transplanted Per Donor 1999, Hypothetical Standardization



As the "potential donor" used in the data for Spain is not defined, it is necessary to make an assumption about what it may mean. At the minimum, it must include donation where an organ is retrieved but not transplanted (Spain 1). If this is the case, then Spain averages 2.60 organs per donor where an organ is retrieved, below the equivalent (published) rate of 2.97 for the United States and the estimated rate of 2.80 for Canada: using this standard definition of donor suggests that Spain's transplant to donor ratio is, in fact, inferior to those of Canada and the United States.

If, however, Spain's definition of donor includes situations where consent is given but no organ is retrieved and where organs are retrieved but no transplant occurs, then the published ratio is 2.60 per consented donor: using the UNOS ratios on consent, recovery and transplant indicates that this ratio would be equivalent to a rate of 3.30 organs per donor where an organ is retrieved and 3.75 per donor where a transplant occurs. This would give Spain ratios of transplanted organs per donor at the high end of the efficiency range: it would also mean that Spain's donor per million rates are significantly inflated relative to those of many other countries. Until there is a full and explicit statement of what a "potential donor" is, it will not be possible to determine how much of the low number of organs transplanted per donor in Spain is the result of an overly inclusive definition of donor and how much is the result of inefficiency in its transplant system. Unless these apparent discrepancies are removed from the data, it is not prudent to suggest that Spain's transplant system is superior to that of other countries.

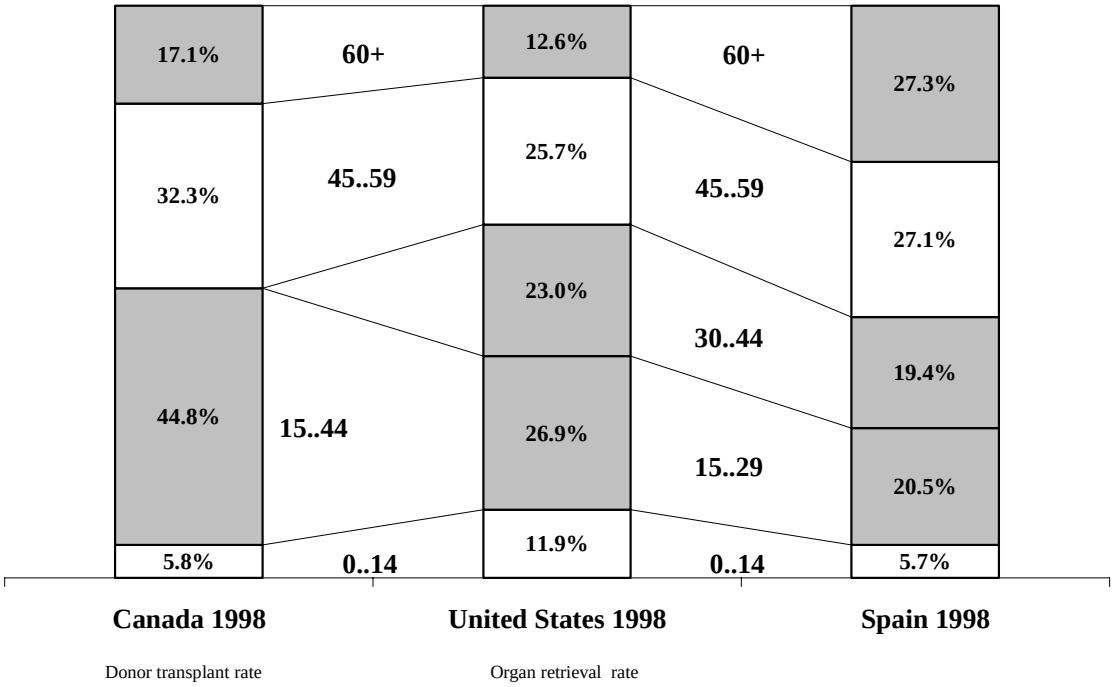
2. Age Profile

A review of the reasons for non-retrieval of organs from consented donors and for non-transplant of retrieved organs from consented donors indicates that a significant number of medical reasons for not using organs become apparent after a prospective (potential?) donor has not only been identified but also for which consent for retrieval has been obtained. Many of these reasons are the result of contraindications, factors that render an organ unusable for transplantation. Many of these contraindications are the result of age related factors and diseases. As a result, the 65 plus

population is not a major source of organs that are used in transplantation: in the decade from 1990 to 1999 in British Columbia, only 1.4% of the donors involved in 1431 transplants were 65 and older[26]. In the United States, where donation includes situations where organs are recovered but not necessarily used in a transplant (and hence involving more contraindicated patients), only 5.6% of the 51,419donations between 1990 and 1999 involved donors who were 65 and older[27]. The share of the 65 plus population of all donors in the United States climbed from 1.8% to 9.0% between 1990 and 1999: as there are no published data on the age of medical rule-outs by age of donor, it is not possible to determine the extent to which this increase in the 65 plus age group's share of the donors was responsible for the increase in the number of situations where organs were recovered but not used from 4% in 1990 to 9% in 1999 (Figure 6).

UNOS was kind enough to re-tabulate for this report its published data to age groups that matched those used in the published data by Canada and Spain. This permitted comparison of the age profile of donors, acknowledging the different definitions of donor, for the three countries (Figure 14[28]). There are many reasons for such differences, including the demographic profile of the resident population, the age and cause pattern of mortality, and the definition of donor. Spain, where published data refers to "potential donors", has the greatest share of donors in the 60 plus age group, with 27.3% of its donors in this age group, compared to only 17.1% in Canada and 12.6% in the United States. To the extent that there is a greater prevalence of medical rule out due to contraindication in the older age groups, the large share of "potential donors" in this age group would contribute to Spain's low ratio of organs transplanted per donor and/or to its high number of potential donors per million population.

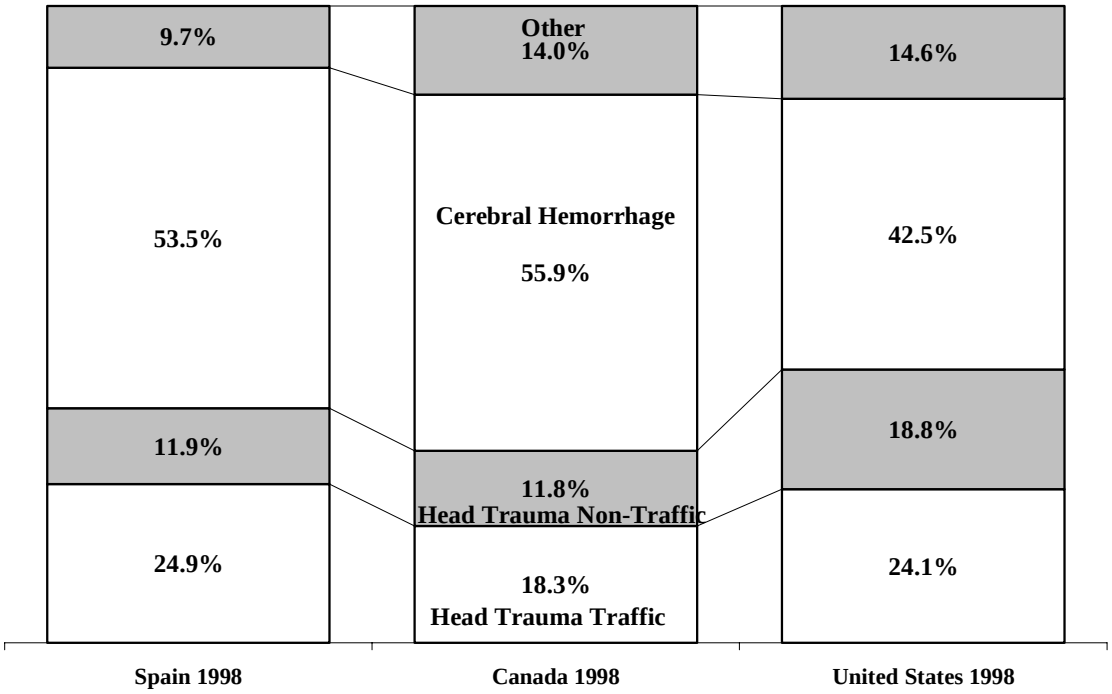
Figure 14: Age Profile of Donors, Published Rates and Definitions



The age distribution of donors also indicates the much greater role of children as donors in the United States, accounting for 11.9% of all donors compared to 5.7% in Spain and 5.8% in Canada. This coincides with significantly different patterns of causes of death of cadaveric donors found in these three countries (Figure 15), with motor vehicle accidents playing a much

greater role in donation in the United States and Spain (accounting for one quarter of donors) than they do in Canada (18.3%). Non-traffic accident head trauma also accounts for a much greater share of donations in the United States (18.8%) than it does in either Canada or Spain (11.8%).

Figure 15: Donors by Cause of Death, Published Definitions of Donors



Some of the differences in the percentage share of each cause will be the result of differences in definition of donors, as both the United States and Spanish data include situations where a transplant does not occur. For example, if these were disproportionately in the head trauma categories, it would contribute to these causes having a greater share of donations in Spain and the United States than in Canada.

Having said this, most of the differences in the causes of death of donors will be attributable to the differences in the patterns of mortality in the three countries. As the next section demonstrates, head trauma in motor vehicle accidents account for a much greater share of donors in the United States and Spain because motor vehicle accidents account for a much greater relative level of mortality in the United States and Spain.

This section has shown that the published cadaveric donor rates of Canada, the United States and Spain cannot be compared because they involve different definitions: only when a standard definition of donor is used in all three regions can we determine if Spain's cadaveric donation rate is actually higher than that of Canada and the United States. Even with a standard definition of donor, Canada cannot have a cadaveric donors per million population ratio as high as that of Spain or the United States because Canada does not have as high a level of mortality, and specifically of mortality from causes that hold the potential for transplants, as either the United States or Spain. Regardless of the donor system used, Canada will not attain levels of cadaveric donation per million population that are recorded in Spain, nor should it aspire to, given the levels of mortality that it requires. What Canada should be concerned with is the number of donors, not per million population, but per thousand eligible donors, something that requires consideration of patterns of mortality, as is discussed in the following section.

III. Donation Potential

The preceding section focused on the numerator of the donors per million ratio, arguing that a standard definition must be used if rates are to be compared and demonstrating that the rates for both the United States and Spain include in donation situations that do not involve transplants, and hence overstate their donation rates relative to Canada's. This section focuses on the denominator of the ratio, on the source that the number of donors is compared to. There is no definitional problem with the denominator used in the published donors per million population ratios: it is the number of people resident in the region during the year under consideration.

The problem lies with using population as the base for measuring either the rate or the efficiency of donation. Consider two regions that have the same number of residents and identical organ donor and transplant systems, but where, in the past year, one region had only half the number of deaths that the other region had. With all other things equal, on a population basis, the high mortality region will have a donor rate that is twice that of the low mortality region. Is the donor system in the high mortality region twice as good as that of the low mortality region? No, the two systems are identical: the low mortality rate region cannot achieve the donors per million rate of the high mortality rate region because it does not have the supply of potential cadaveric donors.

This is exactly the situation that Canada finds itself in with respect to both Spain and the United States. In 1998 Spain had a population of 39.4 million people[29], and 357,950 deaths[30], for a ratio of 9,092 deaths per million people. In 1997 (the most recent year for which mortality by cause data are available for Canada), Canada had a population of 30.0 million people[31] and 215,669 deaths[32], resulting in a ratio of 7,192 deaths per million. All other things equal, Spain should have had a donor rate at least 26% higher than Canada simply because it had 26% more deaths per million people to draw upon for donors. Similarly, in 1998 the United States had a population of 275.5 million people[33] and 2,337,256 deaths[34], for 8,484 deaths per million people. All other things equal, the donor rate for the United States should be 18% above that of Canada simply because it has more deaths per million people than Canada has.

While it is true that the number of cadaveric donors is more closely linked to the number of deaths than it is to the number of people living (i.e., the population), the number of deaths is no more appropriate as the base for donor ratios than the total population, as many deaths do not offer the potential for organ donation. For example, deaths involving HIV/AIDS, smallpox, malaria, viral encephalitis, and a wide range of other diseases and symptoms cannot be a source of organs for transplantation, and hence must be excluded from the pool of potential donors. To have any meaning, a (cadaveric) donor rate must measure the number of actual donors compared to those who are eligible to be donors, not those who are not, either because they are alive or because they die of a cause that precludes donation.

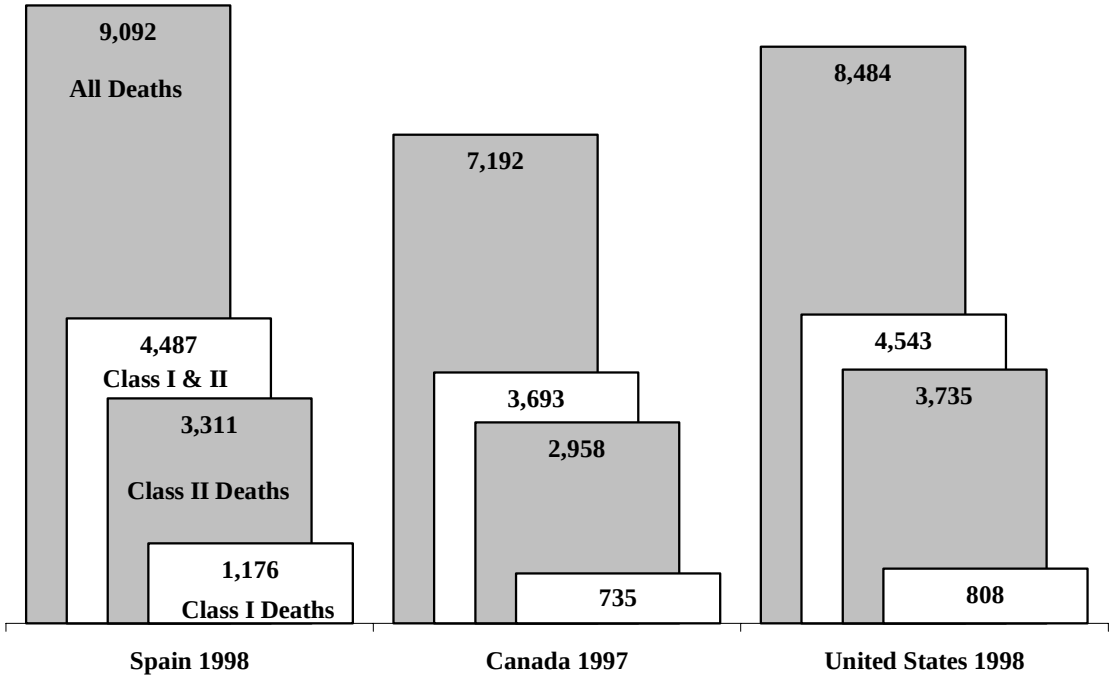
Using the International Classification of Diseases (ICD9), causes of deaths can be grouped into those which precluded transplants and hence where organs cannot be used, those which are generally associated with organ donation, such as motor vehicle accidents (referred to as Class I potential causes), and those which, while in themselves not precluding donation often involve circumstances that do (Class II) [35]. Table One of the Appendix to this report presents the classification, Table Two presents the tabulation of the total number of deaths and the number per million by ICD9 category for Spain[36], Canada[37], and the United States[38] (coded for transplant suitability by the author of this report with the assistance of BC Transplant Society), and Tables 3, 4, and 5 present the age specific mortality patterns for the three countries in the same order.

Note that, in order to compare the rates for the three countries, it was necessary to use the ICD9 groupings as published for Spain, as this is the most aggregated of the three sets of data. This

means that some detailed categories where organs are suitable for transplant are contained in larger groups where most diseases preclude transplants: in such cases the characteristic of the larger group was applied to all sub-groups. While the loss of this finer level of detail could be avoided by the release of more disaggregate data for mortality for Spain, the use of these larger categories does not affect the general conclusions. A common limitation to all data sets is the absence of cross classification with location of death (in or not in-hospital): which may have a greater impact on measurement of potential for donation than use of 4 digit ICD9 codes.

Figure 16 shows a summary of mortality per million residents by Class I and Class II for Spain, Canada and the United States for the year for which the most recent data are available. The greater overall mortality rates in Spain (9,092 per million) and the United States (8,484 per million) compared to Canada (7,192 per million) are clearly shown on this chart. More significantly, it shows that Spain had 1,176 Class I (greatest potential for transplantation) deaths per million inhabitants, 60% more than Canada's 735 Class I deaths per million. The United States had 808 Class I deaths per million, 10% more than Canada but only 68% of Spain's.

Figure 16: Deaths per Million Population by Suitability for Donation



Simply on the basis of the relative number of Class I deaths per million inhabitants, it would be expected that Canada's donor's per million rate would be 62% of Spain's and 91% of the United States. Figure 8 presented estimated donor rates per million adjusted for definitional differences based on the UNOS data on transplanted organs as a ratio of consented donors and donors where organs were recovered. If Spain's definition of "potential donor" is equivalent to the UNOS definition of donors where consent is obtained, then its adjusted ratio for donors where organs are transplanted is 23.15 per million, 68% greater than Canada's 13.76, essentially the same as the difference between the number of Class I deaths per million in the two countries.

Considering the definitional differences and the levels and causes of mortality in Canada, it is possible to argue that Canada's donor rate is of the same magnitude, and its organ retrieval and transplant system is as efficient, as those of Spain. This is not to say that Canada's system is as efficient, or that its donor rates are as high, as they could be, but rather to say that other systems

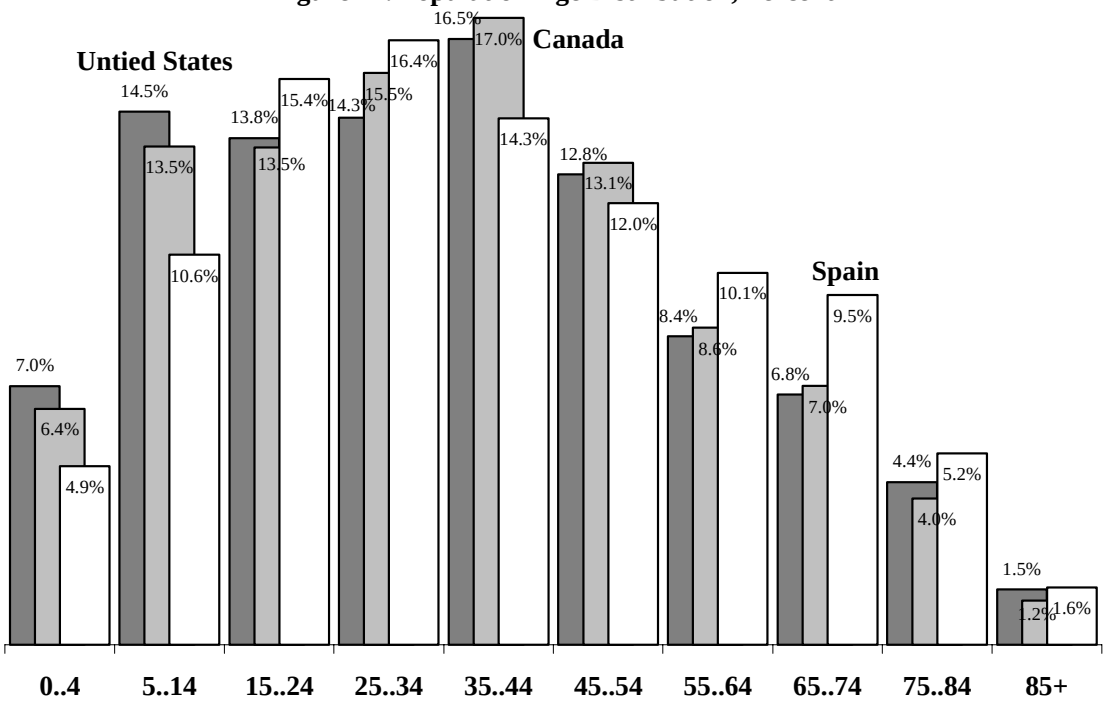
and approaches should be critically examined for better ways of doing things, not simply because they have bigger (un-standardized) numbers of donors per million. While much more unpublished data would be required to prove that differences in definitions and mortality rates are the sole reasons for differences in donor rates between Canada and Spain, the available published data demonstrate that there is no proof that Spain's system is superior to Canada's. It may well be, but it must not be assumed to be simply on the basis of donors per million.

Turning to the United States shows why more data is required before comparison of donor systems. The estimated actual cadaveric donation rate for the United States is 18.82 per million (Figure 8), 36% above Canada, while the differences between the number of Class I deaths per million in the two countries is only 10%. If Class I and Class II mortalities are combined, then the 4,543 deaths per million in the United States with some potential for transplantation are 23% above the 3,694 deaths per million from these causes in Canada.

The available data on mortality clearly show is that there is a great deal of variance in the potential number of donors between countries, something that is not reflected in donor per million population ratios. Canada cannot, nor should it aspire to, attain the cadaveric organ donation rates per million population of Spain or the United States, even after adjustment for definitional differences, as these involve mortality rates that are much higher than those of Canada.

For example, Spain has a rate of 150 motor vehicle accident mortalities per million population, and the United States has a rate of 153 per million. If these two countries were to have Canada's motor vehicle accident mortality rate of 96 per million, their organ donation rates would be much lower than they current are, as head trauma sustained in motor vehicle accidents account for a 40% share of causes of death of organ donors in these two countries greater (25% to Canada's 18%, Figure 15). Given its accompanying high motor vehicle mortality rate, rather than Spain's high donors per million rate being held out as the model, perhaps Canada's low motor vehicle mortality rate, with its accompanying low donors per million rate, should be the model.

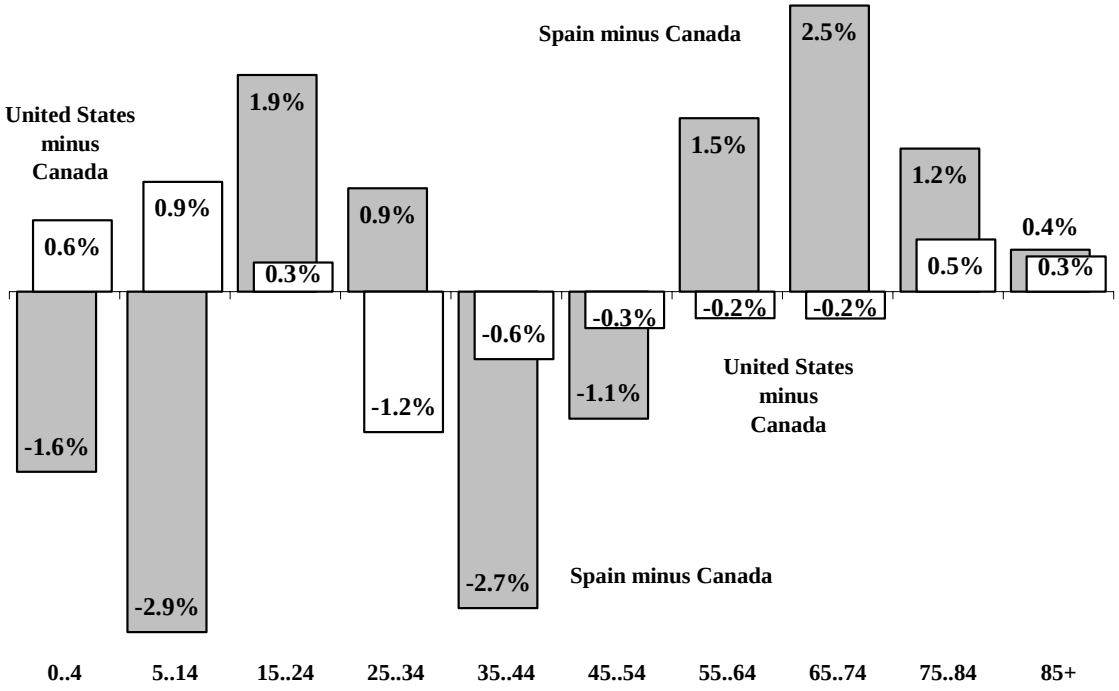
Figure 17: Population Age Distribution, Percent



There are two fundamental causes for regional differences in the number of deaths per million inhabitants by cause. The first includes all of the environmental factors (socio-economic, geographical, genetic, cultural and physical) that determine age specific mortality rates; the second, given the life cycle patterns found in age specific mortality rates, is the age composition of the population itself. The role these two factors play in determining the number of deaths per million, and hence on the relative size of the potential pool of organ donors, can be measured by using, in turn, standardized age profiles and standardized age specific mortality rates by cause.

There are significant differences between the age profiles of Canada, the United States and Spain (Figures 17 and 18). In keeping with its replacement level birth rate (during their lifetimes women give birth to an average of 2.1 children), the United States has the youngest population, with 7% in the 0 to 4 age group and 14.5% in the 5 to 14 age group. In keeping with its very low birth rate (women giving birth to an average of only 1.2 children during their lifetimes) Spain has the oldest population, with only 4.9% in the 0 to 4 age group and 10.6% in the 5 to 14 age group. Canada, where women give birth to an average of 1.6 children during their lifetime, sits in the middle, with 19.9% of its population under the age of 15, 1.5% less that this age group's 21.5% share of the United States' population but 4.5% more than its 15.5% share of Spain's population.

Figure 18: Difference Between Population Distributions by Age Group Relative to Canada



Spain has a much greater share of its population in the 15 to 34 age group and the 55 and older age group than either the United States or Canada has. The 15 to 34 age group has traditionally been a major source of cadaveric donors: 31.8% of Spain's population is in this age group, compared to only 28.1% of the United States' population and 29.0% of Canada's. Spain has 19.6% of its population in the 55 to 74 age group, compared to only 15.2% in Canada and 15.6% in the United States: this age group is of increasing importance in cadaveric donation associated with cerebral hemorrhage. The age profile of Spain's population, therefore, currently has a relative concentration in age groups where cadaveric donation rates are relatively high.

Spain and the United States also have age specific mortality rates that are relatively high in those causes that traditionally form the major source of cadaveric donors. For example, in all but the 5

to 14 age group, Spain has a higher number of deaths per million people for Class I causes than Canada does (Figure 19)[39]: in every age group Spain has higher age specific mortality rates for motor vehicle accidents than Canada (Figure 20)[40].

Figure 19: Class I Age Specfic Mortality Rates per Million Population (Log Scale)

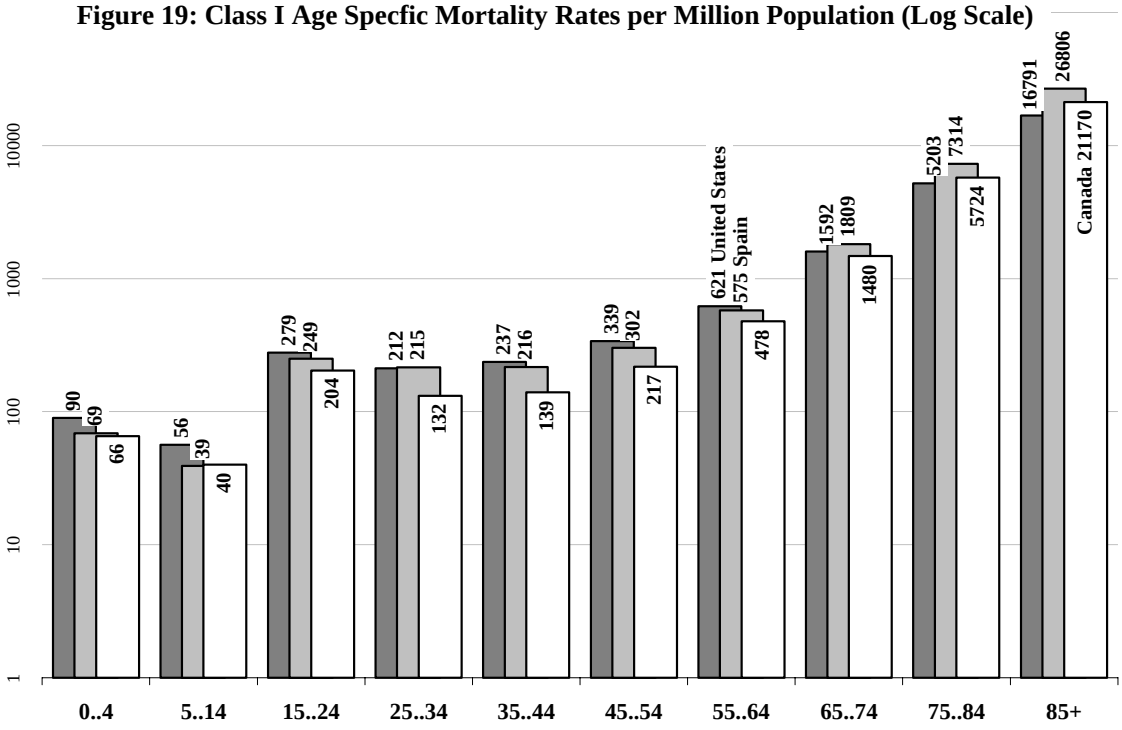


Figure 20: Motor Vehicle Accident Age Specfic Mortality Rates per Million Population

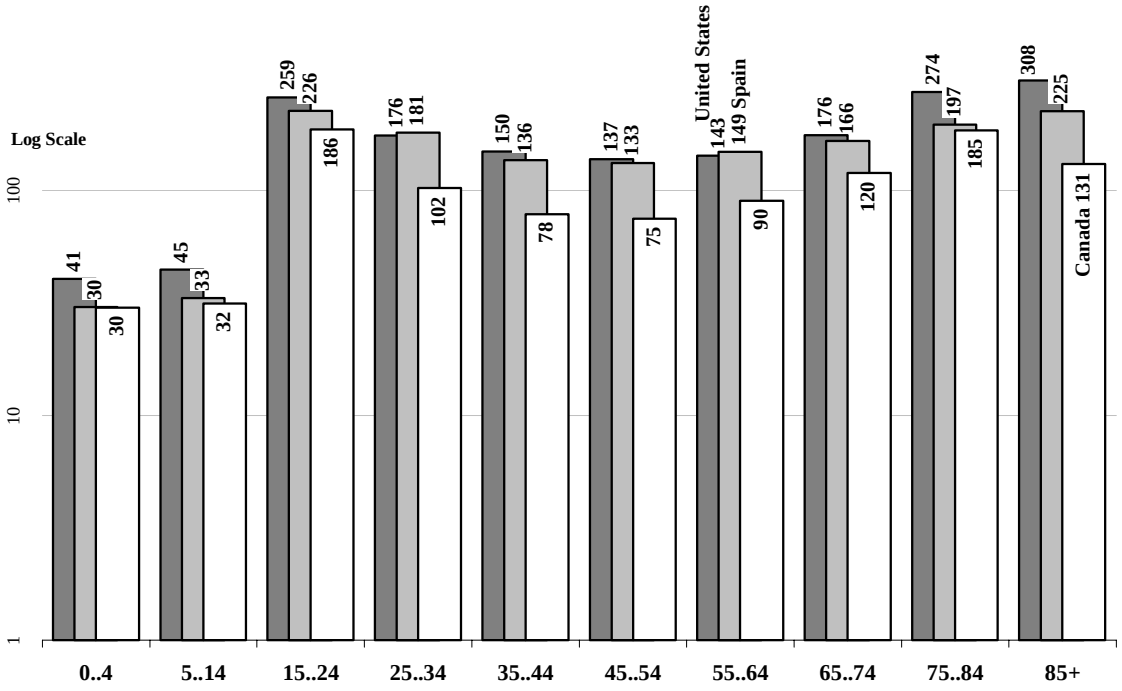


Figure 21: Percent Difference in Selected Age Specfic Mortality Rates per Million, Canada (1997) and Spain (1998)

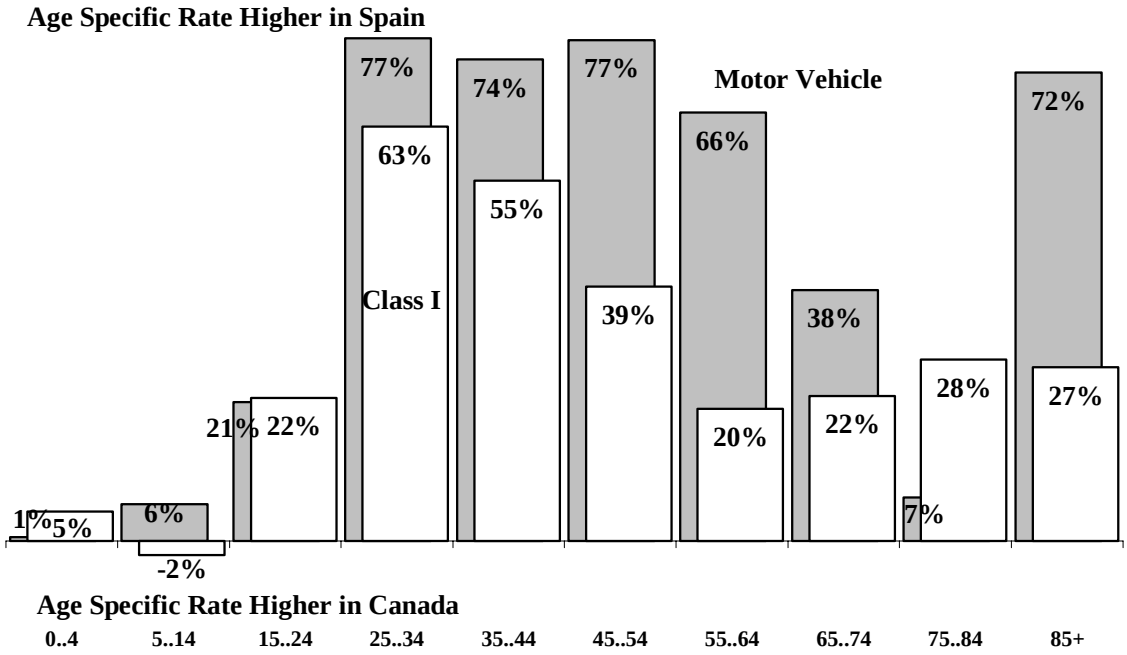
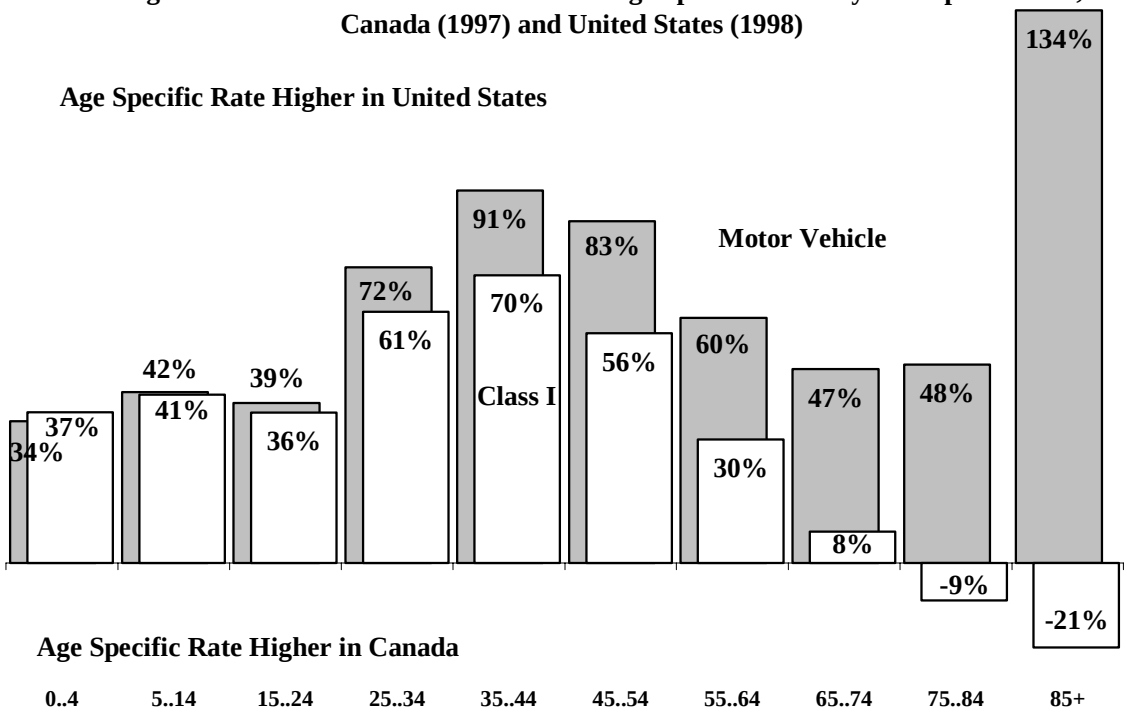


Figure 22: Percent Difference in Selected Age Specfic Mortality Rates per Million, Canada (1997) and United States (1998)



The extent of the difference between the rates for Canada, Spain and the United States is somewhat muted using the logarithmic axis that age specific mortality rates require: plotting the percentage difference between the age specific rates shows emphatically the extent of the differences (Figures 21 and 22). For example, Spain's age specific mortality rates from Class I

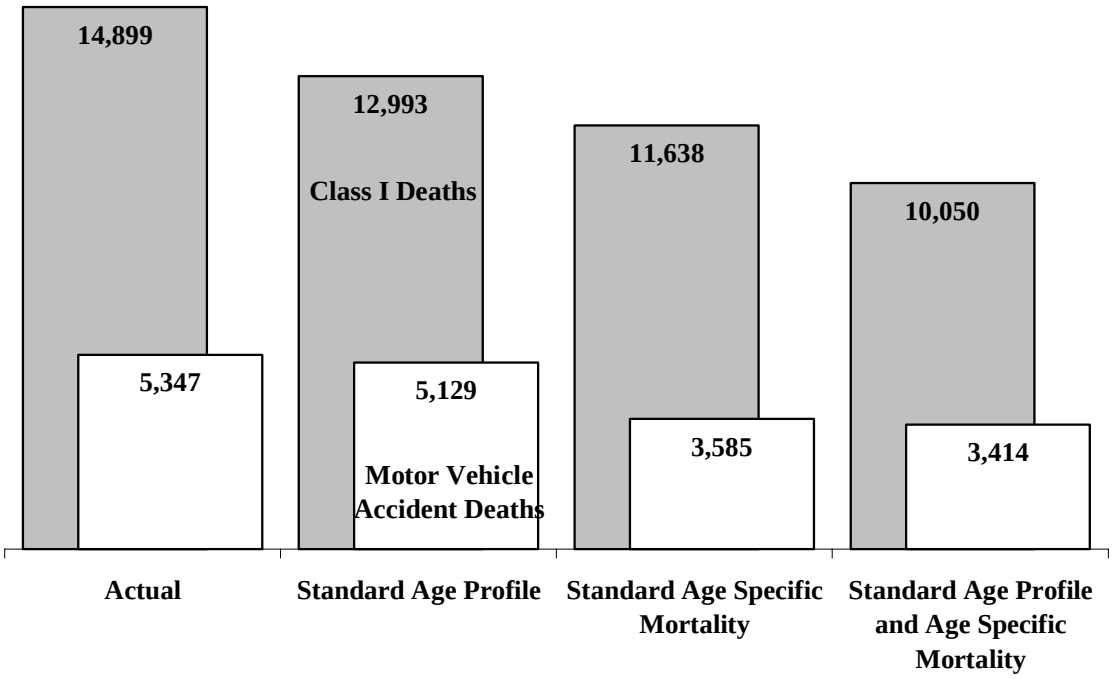
causes for the 25 to 54 age group are between 39% and 63% higher than the corresponding rates in Canada (Figure 21). Age specific mortality rates due to motor vehicle accidents for the 25 to 54 age group in Spain are more than 75% higher than the corresponding rates in Canada.

Age specific mortality rates due to Class I causes, and to motor vehicle accidents specifically, are also generally higher in the United States than they are in Canada (Figure 22). For example, in the 25 to 34 age group in the United States, age specific mortality rates for Class I causes range from 56% to 70% higher than the corresponding rates, while those for motor vehicle accidents range from 72% to 83% higher.

It is possible to estimate the magnitude of the extent to which differences in demographic composition and in the age specific patterns of mortality by cause create differences in the potential number of cadaveric organ donors, and hence in number of donors per million population. This is done by using the techniques of standardization, applying, in turn, a standard percentage age distribution and standard age specific mortality rates by cause to the populations of the countries being compared.

In Spain in 1998, there were 14,899 deaths of people aged 0 to 74 from Class I causes and 5,347 from motor vehicle accidents (Figure 21). With the same total population of 39 million people, and the same age specific mortality rates, if Spain's population had the age profile of Canada's population, there would have been only 12,993 deaths due to Class I causes of people in this age group, and only 5,129 due to motor vehicle accidents. Thus, if Spain had Canada's younger age profile, it would have had 13% fewer potential donors due to Class I causes, and 4% fewer specifically due to motor vehicle accidents. If, however, with its own 1998 age profile it had Canada's age specific mortality rates, there would have been only 11,638 deaths (22% fewer) due to Class I causes and 3,585 deaths (33% fewer) due to motor vehicle accidents. Finally, if Spain had both Canada's age profile and its age specific mortality rates, there would have been 30% fewer deaths due to Class I causes and 36% fewer deaths due to motor vehicle accidents.

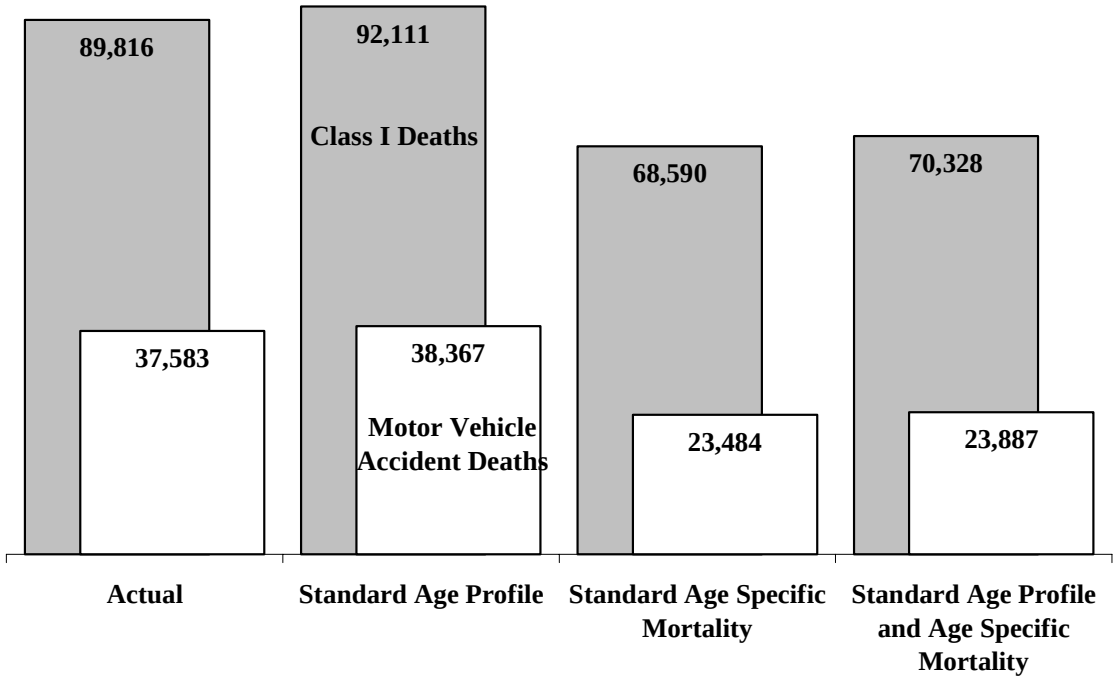
Figure 23: Spain, Number of Deaths of Persons Aged 0 to 74, 1998, Age & Mortality Standardized



Mortality rates are clearly the major factor in differences between the number of both Class I and motor vehicle deaths of people aged 0 to 74 in the two countries. On its own, Spain's older age profile means that it had 15% more Class I deaths and 4% more motor vehicle accident deaths than it would have had with Canada's age profile. Own their own, Spain's age specific mortality rates mean that it had 28% more Class I deaths, and 50% more motor vehicle accident deaths, that it would have had with Canada's mortality rates. Combined, Spain's age composition and age specific mortality rates resulted in 48% more Class I, and 57% more motor vehicle accident, deaths of people aged 0 to 74 that it would have with Canada demographic and mortality characteristics. Thus, even without consideration of definitional issues, Spain has a potential cadaveric donor pool that is approximately 50% greater than Canada's. Much of the difference in donor rates per million between Canada and Spain has little to do with differences in the organ procurement and transplant process, but rather is due to differences in demographics and mortality rates. This is not to either criticize or find fault with Spain's donation process, but rather to clearly state that published data do not support the assertions that it is remarkably better than those of other countries.

Demographics play quite a different role in the comparison of donation rates in the United States and Canada (Figure 24). In 1998, there were 89,816 Class I deaths of people aged 0 to 74 and 37,583 deaths in motor vehicle accidents. If the United States had its age specific mortality rates and Canada's age distribution, it would had 3% more Class I deaths (92,111), and 2% more motor vehicle deaths (38,367) of people aged 0 to 74. Its younger age profile reduces the size of the potential donor pool compared to Canada. The opposite holds true with respect to its pattern of mortality rates: with its 1998 age profile and Canada's age specific mortality rates, the United States would have had 24% fewer Class I deaths (68,590) and 38% fewer motor vehicle deaths (23,484). With Canada's age profile and Canada's age specific mortality rates, the United States would have had 22% fewer Class I deaths and 36% fewer deaths in motor vehicle accidents.

Figure 24: United States, Deaths of Persons Aged 0 to 74, 1998, Age & Mortality Standardized



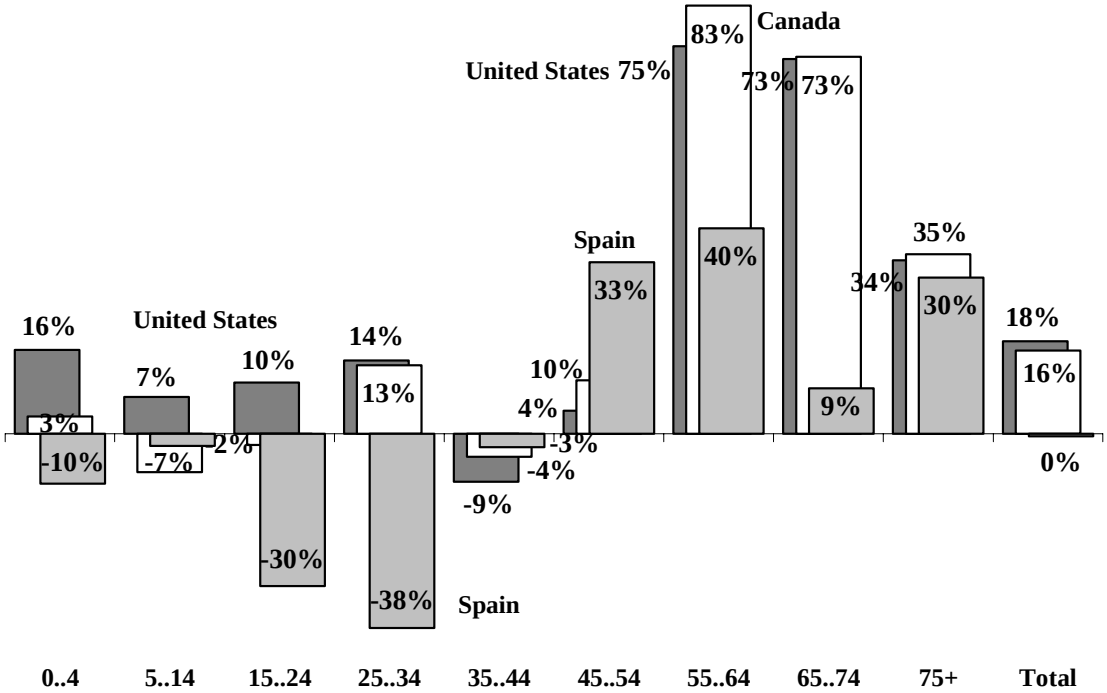
Demographics and mortality rates create a pool of potential cadaveric donors in the United States that is in the order of magnitude of 57% larger on the basis of motor vehicle, and 27% on the

bases of Class I, mortality than it would be if Canada's demographics and mortality rates prevailed: on this basis, the United States should have a donors per million rate in the order of 27% to 57% greater than Canada's. Figure 8 shows that the United States had an estimated 1998 actual donor rate of 18.82 per million, 37% greater than Canada's 13.76 donors per million.

Demographics and age specific mortality patterns, factors that lie beyond the influence of organ procurement and transplants organizations, explain most of the difference in donor rates per million between regions and countries. Neither logic nor data support the use of such rates to compare donation procedures either over time or between regions. Without the use of standard definitions, and without adjustment for differences in age profiles and age specific mortality patterns, the use of donor rates per million is both misleading, as it suggests that "low" donor rate regions can attain higher donor rates by following the practices of "high" donor rate regions, and dangerous, as it may divert attention to procedures that do not reflect the reality of local conditions, rather than focusing it on local innovations that do.

It must be noted that there are significant demographic reasons for all three countries, but particularly Spain and Canada, to be concerned about their future potential demand for, and supply of, transplanted organs from cadaveric donors. The total population of Canada is projected to increase by 16% over the next twenty years (Figure 25)[41]. With a slightly below replacement level birth rate of 1.6 children per woman, net immigration is anticipated to keep Canada's population under the age of 45 essentially constant (projected to increase by 16,100 people, 0.1%), with declines of 7% in the 5 to 14, 2% in the 15 to 24, and 4% in the 35 to 44 age groups offsetting increases of 3% in the 0 to 4, and 13% in the 25 to 34 age groups. The 45 and older age groups, in contrast, are all projected to increase by between 10% in the 45 to 54 age group and 35% in the 75 plus age group, with the 55 to 64 age group increasing by 83% and the 65 to 75 age group by 73%. In total, the 45 plus age group in total is projected to increase by 4,964,400 people, a 45% increase.

Figure 25: Projected Population Growth by Age Group, 2000 to 2020

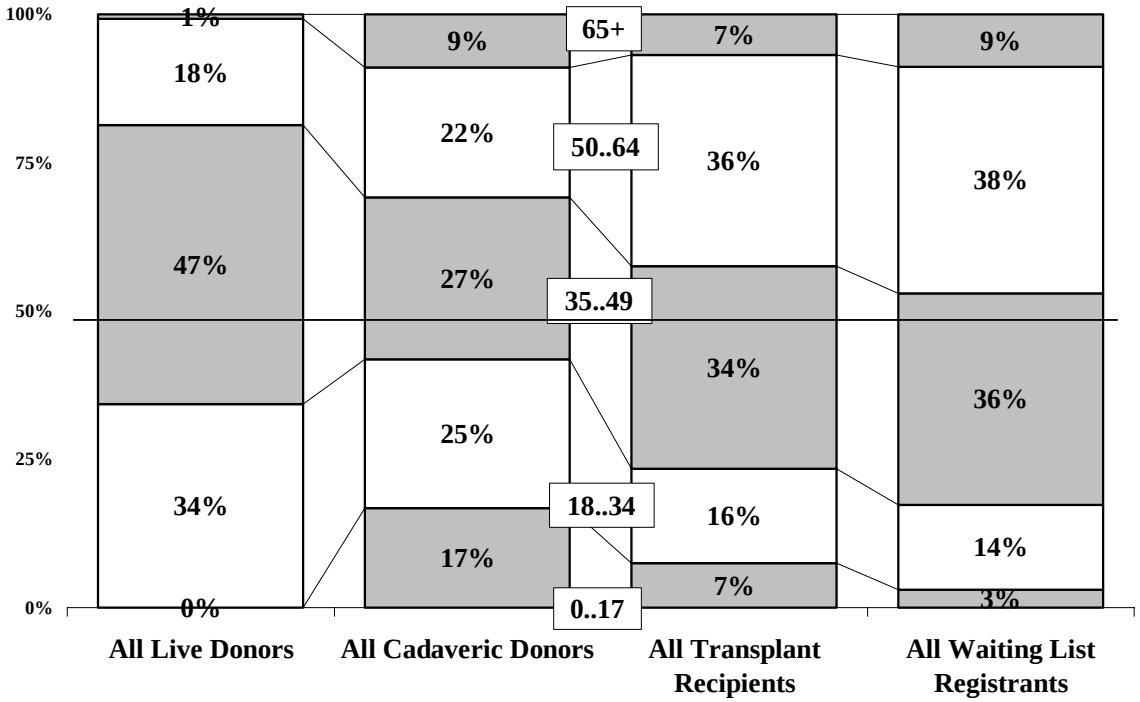


With the current pattern of donation, 51% of cadaveric donors in Canada are under the age of 45 while 55% of the recipients of transplants are 45 plus. A 45% increase in the 45 plus age group with its high propensity to require transplants in the face of no growth in the younger population will greatly widen the transplant gap, at least with respect to cadaveric donors.

The total population of the United States is projected to increase by 18% over the next twenty years (Figure 25)[42]. With a replacement level birth rate of 2.1, and positive net migration, both the younger and older populations of the United States will increase. The under 45 population is projected to increase by 11 million people (a 6%) increase, with growth in the range of 7% to 16% in the 0 to 34 age groups, and a decline of 9% in the 35 to 44 age group. Having noted this, the 45 and older age group is projection to increase by 40 million people, a 40% increase over the next 20 years, with the 55 to 64 and 65 to 74 age groups projected to increase by almost 75%.

Figure 26[43] shows that there is a significant age difference between donors and recipients: while there is not a precise match in age groups for donors and population projections, the implications of the aging of United States population for organ demand and supply are obvious. Only 19% of the live donors, and 31% of the cadaveric donors (from whom organs are retrieved, whether or not they are used in a transplant), are 50 years of age and older. In contrast, 43% of all transplant recipients, and 47% of the people on the transplant waiting list are 50 years of age and older.

Figure 26: Transplant Paricipants, United States, 1999, Age Distribution



In keeping with its very low birth rate of an average of 1.2 children born per woman during her lifetime, Spain's total population is projected to remain essentially constant over the next twenty years (Figure 25)[44]. This apparent stability conceals a significant absolute decline of 4.6 million (-19%) in the number of people under the age of 45 (including a 38% decline in the number of people aged 25 to 34, and a 30% decline in the 15 to 24 population): this is balanced with 4.4 million (29%) increase in the 45 and older population (including an 83% increase in the 55 to 64 population and a 73% increase in the 65 to 74 age group). In terms of donors where organs are both retrieved and transplanted, one can only presume that the same situation that is indicated in the data for Canada and the United States prevails in Spain, as data on the age of actual transplant

donors, all transplant recipients, and of all people on the waiting list are not published (although there are published data for recipients and waiting list for some organ categories). To the extent that is a correct presumption, Spain is going to face a significant increase in the demand for organs for transplantation at the same time that the number of cadaveric donors, effectively its current source of actual donors, will decline significantly.

This section has clearly shown that there exists a significant difference in the relative size of potential donor pools between countries, a difference created by the unique demographic profiles and age specific mortality patterns of each country. These differences will be reflected in the number of potential donors, but not in the size of the population, of each country. Countries with high mortality rates due to causes of death that are most likely to offer the potential for cadaveric organ donation, and with population concentrations in the age groups where these rates are highest, will have much higher donors per million rates than countries with lower mortality rates and smaller percentages of their population in the age groups where these causes are prevalent. The higher donor rates that mortality and demographics create are in no way evidence of a superior transplant system: to suggest that other countries would achieve the same high rate, or even improve their current rate, solely as a result of emulating the high nominal donor per million rate system is both simplistic and misleading. It will create false hope and failed expectations in the lower mortality rate country. Given the ever increasing transplant gaps in lower mortality rate countries, energy should be focused on evaluation of processes and procedures that have applicability in their communities, not on pursuit of the unsubstantiated claims for systems from countries and regions with different demographic and mortality patterns.

Evaluation must involve use of a single definition of donor, so that the same situations are being compared, and must be standardized for the unique regional conditions that lie outside the sphere of influence of organ donation and transplant organizations. The number of people living in a population is not an appropriate base, as it in no way reflects the constraints imposed on donation and transplantation by demographics and mortality patterns. While consideration of the number of Class I and/or Class II deaths moves closer to acknowledgement of the reality of these constraints, even they do not account for all of the factors that are external to transplant systems.

The defining constraint that donor and transplant organizations must work within is the number of deaths in hospitals from eligible causes where there are no contraindications and the potential donor is brain dead (i.e., medically acceptable for transplants). If the concern is with measuring the relative effectiveness to difference approaches to organ donation and retrieval, this must be the base for measurement, for this is the point at which the donation and transplant process begins. The process cannot reasonably be expected to affect the extent to which deaths occur outside of hospitals, nor the extent to which deaths are from causes that preclude donation, either directly (non-eligible causes) or indirectly (contra-indications), nor the extent to which brain death does not occur: evaluation must exclude deaths that do not offer the potential for organ donation and transplantation.

The process can reasonably be expected to affect the extent to which it is able to respond to deaths that do offer the potential for organ donation and transplantation, namely in-hospital deaths that are medically acceptable for transplants. The donation and transplant process can do something about the availability of ventilators and ICUs in hospitals; about compulsory referral; about obtaining consent; about staffing levels and availability of appropriate equipment, personnel, and OR facilities; and about finding suitable recipients. It is what the process does to ensure successful transplants from the pool of suitable and available donors that must be the focus of evaluation, not how many people there are in the country.

IV. Approaches to Evaluation

To some people, allocating time and resources to measure solid organ donation rates may seem like at best merely intellectually interesting and at worse a waste. They are wrong: while the process is certainly intellectually interesting, it is far from a waste of either time or resources, as without accurate measurement, it is not possible to evaluate the effectiveness of registration programs; of referral, consent, retrieval or transplant procedures; it is not possible to determine if changes in donation levels are the result of changes in procedure or serendipitous; it is not possible to determine if improvements can be made; and it is certainly not possible to identify the most effective approaches.

The preceding section argued that the measure of donation should be effective donation, the number of actual donors (organs are retrieved and transplanted) compared to the number of in-hospital deaths that are medically acceptable for transplants. This is the only measure that will define the effectiveness with which a donation and transplant system converts its potential into organ transplants. Having said this, this should by no means be the only measure used in the evaluation of organ donor and transplant procedures. No single measure should, or can, reflect the characteristics of such a multi-stage and complex process. In this section, the major stages of cadaveric organ donation and transplant processes are reviewed in the light of measures that might be used in the evaluation of procedure effectiveness.

The first component of the donation process is the registration stage, wherein people formally express their intention to become organ donors (in the case of positive registration systems) or to not become organ donors (non-donor registry in presumed consent systems) should the necessary circumstances occur at some point in the future. While of fundamental importance, this step is essentially separate from the rest of the donation process, as registration occurs far in time, location and circumstance from the situation where donation may occur. Any evaluation of the registration process would have to compare the number of people registered relative to the number who could be registered; the most likely context of evaluation would be temporal, aimed at examining the impact on the number registered of formal or informal donor awareness programs. Spatial comparison would have to be, again, standardized for the subject populations, and would be most effective when the effects of changes in registration or awareness are considered, rather than simply levels of registration. Neither the number of actual donors nor the number of medically acceptable potential donors is relevant in this context.

The second component is the donation stage, which begins when circumstances arise such that a person (registered as a donor or not) becomes eligible to be a donor. Specifically, this component involves in-hospital deaths that are medically acceptable for transplantation. The first issue to be explored in this context is the extent to which this pool of potential donors becomes part of the organ donation and transplant process. In-hospital deaths that are otherwise medically acceptable for transplantation that occur in facilities without ventilators and ICUs, and hence will not have access to the donation process, should be included in the potential, as a change in medical infrastructure will grant them this access. As well, the extent to which otherwise eligible donors are not referred to the donation process by hospital personnel must be measured in evaluation of system efficiency.

The second issue for evaluation in this component is the extent to which consent for a donation to proceed can be obtained: the measure of effectiveness would be the ratio of the number of cases where consent is obtained divided by the pool of potential donors, the total of in-hospital deaths that are medically acceptable for transplantation. Three examples indicate the range of evaluative questions that should be explored in this context. The first is whether consent is more readily obtained in a presumed consent system, compared to explicit registries, linked registries (such as

with driver licenses), and to the absence of any system. The second is whether general changes in the awareness of organ donation issues change the rate of consent. The third is whether different approached to families and relatives to obtain consent (for example, dedicated transplant teams) result in different levels of consent.

The next component of the donation process involves consented organ donors who are medically acceptable. As the UNOS data presented shown of Figure 5 indicate, organs are not retrieved from all consented donors: 21% of the consented organs in the United States in 1999 were not transplanted. Of these 88% (of the 21%, or 18% of the total) were ruled out due to medical causes, and hence should be removed from the potential donor count. The remaining 12% (3% of the total), however, must be included, as they involved circumstances where either a recipient could not be located or the list was exhausted: these are aspects of donation that can be affected by the donation process, and hence should be included in the measure of efficiency.

The final component of the process is the transplant stage, where actual donation occurs. The specific measure of efficiency of this stage is the number of transplants that occur for the number of consented donors without medical rule out. This means again reducing the number of consented donors from whom organs are recovered by those excluded by subsequent medical examination. In the case of the United States, the UNOS data for 1999 shown on Figure 7 indicate that 88% of recovered organs from consented donors are transplanted: the remaining 12% are not transplanted, with 78% of this 12% not transplanted due to medical rule out, and the remaining 22% of the 12% not transplanted because a suitable recipient could not be located, or the list was exhausted. Of consented organs, 69% were transplanted, 26% were ruled not medically acceptable and 5% were not used due to recipient availability. Added to this last category would be situations where transplants did not occur because transplant O.R.s and/or personnel were not available.

Each of these measures permit evaluation of stages in the organ donation process. The measure of success is the number of transplanted organs (or, in donor terms, the number of donors where a recovered organ was transplanted). The measure of potential is the number of in-hospital deaths excluding those medically ruled out, but including those which would have been medically acceptable if ventilators and ICUs were available or if the death had been referred to transplant teams; those for which consent could not obtained; those for which recipients could not be found; and those for which transplant facilities could not be obtained.

It may be argued that data cannot be made available to carry out such an evaluation. There are two responses to this claim. The first is that the United States comes pretty close to not only having the data, to not only making it publicly available, but also to publishing it and making it available for free. The missing data are 1) the number of in-hospital deaths by cause (deaths by cause are published – the difficulty is finding the in-hospital sub-group); 2) the number of cases where potential donors are not made accessible to the donation opportunity through medical referral; and 3) the number of cases where consent is requested and refused.

The second response is that while these precise data sets may not be available, every donor organization knows the number of actual donors – donors where at least one solid organ is recovered and transplanted – and could publish and use it. Every donor organization also has access to the number of deaths by cause, and, most likely could obtain the number of these that are in-hospital, as most vital statistics agencies require death certificates to state if deaths occurred in hospitals. Thus, at the least, actual donors could be compared to Class I and Class II deaths in hospitals of between the ages of 0 and 65 (to reduce contra-indication) as a standard for comparison of donor rates over time or between regions. Anything less serves no useful purpose.

V. Conclusions

It is irresponsible and misleading to suggest that Canada has a "low" organ donation rate and that adoption of the system of a "high" rate country would result in Canada achieving the apparent donor rates of that other country. Canada's cadaveric donor rate of 13.8 actual donors per million population accurately reflects the demography and mortality patterns of Canada: no transplant system can change either our thankfully relatively low mortality rates or the age profile of Canada's population. Canada's live donation rate of 12.2 live donors per million population, which is never mentioned when Canada's "dismal" donation rate is discussed, ranks fourth highest in the world, is almost equal to our cadaveric donation rate, and is above or on par with the cadaveric donor rates of 22 of the 32 countries.

This is not to suggest that donor rates – both live and cadaveric – in Canada cannot be improved. They can be, but not by constantly looking for easy solutions from places with dramatically different social, demographic and mortality characteristics: rather the focus must be on the reality of Canada, and how to make our very good donation and transplant procedures better. And while they can be made better, we should never anticipate, or desire, that Canada will have cadaveric donor rates that match those of high mortality rate countries such as Spain.

Spain has traditionally been the poster country for organ donation, and the one to which Canada is most often unfavorably compared. In the context of live donation, Spain has a rate of 0.4 live donors per million, the sixth lowest live donor rate of the 32 countries for which data is published, something that we should not seek to emulate. It is with respect to cadaveric donation that our rate of 13.8 donors per million inhabitants is referred to as "dismal": why can't we have Spain's cadaveric donation rate of 33.4 donors per million or the United States' rate of 21.4 donors per million? Why can't we, as Health Minister Alan Rock puts it, "lead the world in organ donation"[45]? Two reasons. First, Spain does not have a donor rate of 33.4 donors per million: Spain has a rate of 33.4 potential donors per million, for it includes situations where no transplants occur as donations. So does the United States': its rate of 21.4 donors per million also includes situations where an organ is recovered but is not transplanted.

Canada's rate is for actual donors, counting only those situations where at least one solid organ is actually transplanted into a recipient. Both Spain's and the United States' donor rates are inflated relative to that of Canada: to compare Canada's rate to those of these countries is to compare apples to oranges and pears – it is impossible as the definitions are not the same. The effect of including non-transplants in donor counts in Spain and the United States is shown in the ratio of the number of organs transplanted per donor. The ratio for Canada, where donors are counted only when a transplant actually occurs, is 3.2 organs transplanted per donor: the ratio for the United States is 3.0 per donor, and for Spain is 2.6 per donor. It is not that Spain is much less efficient in recovery and transplant of organs from donors than Canada is, but that its donor count is inflated relative to Canada's.

The second reason that Canada cannot achieve the donor rates of Spain or the United States, even if the data were adjusted for definitional differences, is that Canada has a much different demographic structure and mortality pattern. The differences in mortality patterns are particularly striking. With respect to causes of mortality in the 15 to 74 age groups that have the greatest potential of providing the opportunity for cadaveric donation (Class I causes), Spain has age specific mortality rates that range from 20% to 63% higher than those in Canada, while the United States has rates that range from 8% to 70% higher. Considering, as an example, age specific mortality rates due to motor vehicle accidents, Spain's rates in the 15 to 74 age group range from 21% to 77% higher than those in Canada, while the rates for this age group in the United States range from 39% to 91% higher than those in Canada.

Demographically, Canada and the United States have much greater proportions of their populations in the low mortality under 15 years of age group than Spain has, resulting in a relatively low number of deaths due to these causes than occurs in Spain.

Standardizing for demography and mortality rates indicates that Spain has a potential cadaveric donor pool relative to size of its population that is much greater than Canada's. On its own, Spain's older age profile means that it had 15% more Class I deaths of people aged 0 to 74, and, specifically, 4% more motor vehicle accident deaths of people aged 0 to 74, than it would have had with Canada's age profile. Own their own, Spain's age specific mortality rates mean that it had 28% more Class I deaths of people aged 0 to 74, and 50% more motor vehicle accident deaths of people aged 0 to 74, that it would have had with Canada's mortality rates. Combined, Spain's age composition and age specific mortality rates resulted in 48% more Class I, and 57% more motor vehicle accident, deaths of people aged 0 to 74 than it would have had with Canada demographic and mortality characteristics. Thus, even without consideration of definitional issues, Spain has a potential cadaveric donor pool that is approximately 50% greater than Canada's.

Demographics and mortality rates also combine to create a pool of potential cadaveric donors of people aged 0 to 74 in the United States that is in the order of magnitude of 57% larger on the basis of motor vehicle, and 27% on the bases of Class I, mortality than it would be if Canada's demographics and mortality rates prevailed. On this basis, the United States should have a donors per million rate in the order of 27% to 57% greater than Canada's: it had an estimated 1998 actual donor rate of 18.8 per million, 37% greater than Canada's 13.8 donors per million.

Canada cannot achieve Spain, or the United States' cadaveric donation rates because it does not have the mortalities to start with. All of the published evidence indicates that Canada is making relatively efficient use of the donation potential of its current mortality patterns: certainly there are places where improvements may be made, for example in regard to referral to donation teams, obtaining consent, and providing more medical infrastructure. While these improvements should be made, they should not be undertaken with the misguided expectation that they will greatly increase donation rates: increase, yes; greatly, no.

What Canada, Spain and the United States must all prepare for is a decline in the number of potential cadaveric donors as the population of all three countries age; as continued efforts at road, workplace and home safety reduce the number of deaths due to accidents; and as medical and pharmaceutical technology, and lifestyle change, reduce mortality due to stroke. At the same time, they must also prepare for an increase in the need for organs for transplantation as their populations age.

In Canada this will mean giving up the quixotic pursuit of Spain's current apparent donor rates, which even after adjustment for definitional overstatement, reflect high mortality rates and different demographics. While we continue to make improvements to the cadaveric donation system, we must also focus energy and resources on the pursuit of innovation in the areas of live related and live anonymous donation. These two sources of donation have, numerically, a much greater absolute potential, and rely, ironically, on health in contrast to cadaveric donation's reliance on death. They also involve process, procedures, perceptions, concerns, and risks, both medical and societal, which have not been fully explored and are not fully appreciated. These are the sources, combined with xeno-transplants, stem cell technology, and biomedical innovation, that organ donation will be forced to increasingly rely on if the transplant gap is to be narrowed, rather than watching it continually widen.

Endnotes:

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Appendix

Table One: Classification of Mortality Data According to Potential for Transplantation

	ICD-9	Major Group	Minor Group	Transplant Potential
1	[001]	Intestinal infectious diseases	Cholera	Do Not Use
2	[002]	Intestinal infectious diseases	Typhoid and paratyphoid fevers	Do Not Use
3	[003-009]	Intestinal infectious diseases	Other Infectious diseases	Do Not Use
4	[010-018]	Tuberculosis	Tuberculosis	Do Not Use
5	[033]	Other bacterial diseases	Whooping cough	Class II
6	[036]	Other bacterial diseases	Meningococcal infection	Do Not Use
7	[037]	Other bacterial diseases	Tetanus	Do Not Use
8	[038]	Other bacterial diseases	Septicemia	Do Not Use
9	[050]	Viral diseases accompanied by exanthem	Smallpox	Do Not Use
10	[055]	Viral diseases accompanied by exanthem	Measles	Do Not Use
11	[064]	Arthropod-borne viral diseases	Viral encephalitis transmitted by other/unspec arthropods	Do Not Use
12	[070]	Other diseases due to viruses and Chlamydiae	Viral hepatitis	Do Not Use
13	[082-083]	Rickettsiosis	Rickettsiosis	Do Not Use
14	[084]	Rickettsioses and other arthropod-borne diseases	Malaria	Do Not Use
15	[090-099]	Syphilis and other venereal diseases	Syphilis and other venereal diseases	Do Not Use
16	[122]	Helminthiases	Echinococcosis	Do Not Use
17	[020-139 minus *5* to *16*]	Other infectious and parasitic diseases	Other infectious and parasitic diseases	Do Not Use
18	[140-209]	Malignant neoplasms	Malignant neoplasms	Do Not Use
19	[210-229]	Benign neoplasms	Benign neoplasms	Class I
20	[230-234]	Carcinoma in situ	Carcinoma in situ	Do Not Use
21	[235-239]	Neoplasms of uncertain & unspecified behaviour/nature	Neoplasms of uncertain & unspecified behaviour/nature	Do Not Use
22	[250]	Diseases of other endocrine glands	Diabetes mellitus	Do Not Use
23	[260-269]	Nutritional deficiencies	Nutritional deficiencies	Do Not Use
24	[270-279]	Other metabolic disorders and immunity disorders	Other metabolic disorders and immunity disorders	Do Not Use
25	[240-246,251-259]	Other diseases of the endocrine glands, nutrition, metabolism, and immune system	Other diseases of the endocrine glands, nutrition, metabolism, and immune system	Do Not Use
26	[280-285]	Anemias	Anemias	Do Not Use
27	[286-289]	Other diseases of the blood and blood organs	Other diseases of the blood and blood organs	Do Not Use
28	[290]	Organic psychotic conditions	Senile and presenile organic psychotic conditions	Do Not Use
29	[291]	Organic psychotic conditions	Alcoholic psychoses	Class II
30	[303]	Neurotic disorders, personality disorders, and other nonpsychotic mental disorders	Alcohol dependence syndrome	Class II
31	[292-302,304-319]	Other mental disturbances	Other mental disturbances	Class II
32	[320]	Inflammatory diseases of the central nervous system	Bacterial meningitis	Do Not Use
33	[323]	Inflammatory diseases of the central nervous system	Encephalitis, myelitis, and encephalomyelitis	Do Not Use
34	[332]	Hereditary & degenerative diseases of central nervous system	Parkinson's disease	Do Not Use
35	[345]	Other disorders of the central nervous system	Epilepsy	Class II
36	[320-389 minus *32* to *35*]	Other diseases of the nervous system	Other diseases of the nervous system	Do Not Use
37	[390-392]	Acute rheumatic fever	Rheumatic fever without mention of heart involvement	Do Not Use
38	[393-398]	Chronic reheumatic heart disease	Chronic reheumatic heart disease	Class II
39	[401-404]	Hypertensive disease	Hypertensive disease	Class II
40	[410]	Ischemic heart disease	Acute myocardial	Class II
41	[411]	Ischemic heart disease	Other acute and subacute forms of ischemic heart disease	Class II
42	[415-417]	Diseases of pulmonary circulation	Diseases of pulmonary circulation	Class II
43	[430-438]	Cerebrovascular diseases	Cerebrovascular diseases	Class I
44	[440]	Diseases of arteries, arterioles, and capillaries	Atherosclerosis	Class II
45	[412-414,441-459]	Other diseases of the circulatory system	Other diseases of the circulatory system	Class II
46	[480-486]	Pneumonia	Pneumonia	Do Not Use
47	[487]	Pneumonia and influenza	Influenza	Do Not Use
48	[490-496]	Chronic obstructive pulmonary diseases and allied	Chronic obstructive pulmonary diseases and allied	Do Not Use
49	[460-478,500-519]	Other diseases of the respiratory system	Other diseases of the respiratory system	Do Not Use
50	[530-537]	Diseases of esophagus, stomach, and duodenum	Diseases of esophagus, stomach, and duodenum	Class II
51	[540-543]	Appendicitis	Appendicitis	Class II
52	[571]	Other diseases of digestive system	Chronic liver disease and cirrhosis	Do Not Use
53	[520-579 minus *50* to *53*]	Other diseases of the digestive system	Other diseases of the digestive system	Class II
54	[580-589]	Nephritis, nephrotic syndrome, and nephrosis	Nephritis, nephrotic syndrome, and nephrosis	Do Not Use
55	[600]	Diseases of male genital organs	Hyperplasia of prostate	Class II
56	[590-599,601-629]	Other diseases of the genitouinary system	Other diseases of the genitouinario system	Class II
57	[630-638]	Pregnancy with abortive outcome	Pregnancy with abortive outcome	Class II
58	[640-648]	Complications mainly related to pregnancy	Complications mainly related to pregnancy	Class II
59	[650-659]	Normal delivery, and other indications for care in pregnancy, labor, and delivery	Normal delivery, and other indications for care in pregnancy, labor, and delivery	Class II
60	[660-669]	Other Complications related to pregnancy	Other Complications related to pregnancy	Class II
61	[680-709]	Diseases of the skin and subcutaneous tissue	Diseases of the skin and subcutaneous tissue	Do Not Use
62	[710-739]	Arthropathies Dorsopathies, Rheumanisms, and related	Arthropathies Dorsopathies, Rheumanisms, and related	Class II
63	[740-759]	Congenital anomalies	Congenital anomalies	Class II
64	[767]	Certain conditions originating in the perinatal period	Birth trauma	Class I
65	[760-766,768-779]	Other Certain conditions originating in the perinatal period	Other Certain conditions originating in the perinatal period	Do Not Use
66	[780-799]	General Symptoms	Symptoms	Class II
67	[E800-E807]	Railway accidents	Railway accidents	Class I
68	[E810-E819]	Motor vehicle traffic accidents	Motor vehicle traffic accidents	Class I
69	[850-869]	Accidental Poisoning	Accidental Poisoning	Class II
70	[E880-E888]	Accidental falls	Accidental falls	Class I
71	[E890-E899]	Accidents caused by fire and flames	Accidents caused by fire and flames	Class I
72	[E800-E949 minus *67* to *71*]	All other accidents	All other accidents	Class II
73	[E950-E959]	Suicide	Suicide	Class II
74	[E960-E969]	Homicide	Homicide	Class II
75	[E970-E999]	Other Violence	Other Violence	Class II

Table Two: Mortality According to Potential for Transplantation, Total and Per Million Population

			Spain 1998		Canada 1997		United States 1998	
			Deaths	per Million	Deaths	per Million	Deaths	per Million
1	[001]	Do Not Use	0	0	0	0	1	0
2	[002]	Do Not Use	0	0	0	0	0	0
3	[003-009]	Do Not Use	247	6	5	0	1,108	4
4	[010-018]	Do Not Use	475	12	183	6	1,112	4
5	[033]	Class II	0	0	0	0	5	0
6	[036]	Do Not Use	60	2	22	1	234	1
7	[037]	Do Not Use	9	0	1	0	7	0
8	[038]	Do Not Use	2,184	55	969	32	23,731	86
9	[050]	Do Not Use	0	0	0	0	0	0
10	[055]	Do Not Use	0	0	0	0	0	0
11	[064]	Do Not Use	0	0	0	0	2	0
12	[070]	Do Not Use	822	21	225	8	4,796	17
13	[082-083]	Do Not Use	6	0	0	0	5	0
14	[084]	Do Not Use	10	0	1	0	6	0
15	[090-099]	Do Not Use	16	0	4	0	55	0
16	[122]	Do Not Use	43	1	0	0	0	0
17	[020-139 minus *5* to *16*]	Do Not Use	611	16	1,072	36	20,190	73
18	[140-209]	Do Not Use	89,462	2,272	58,703	1,958	541,532	1,966
19	[210-229]	Class I	314	8	156	5	1,618	6
20	[230-234]	Do Not Use	1	0	1	0	11	0
21	[235-239]	Do Not Use	2,331	59	915	31	6,304	23
22	[250]	Do Not Use	9,509	242	5,699	190	64,751	235
23	[260-269]	Do Not Use	11	0	219	7	4,077	15
24	[270-279]	Do Not Use	103	3	1,194	40	16,958	62
25	[240-246,251-259]	Do Not Use	3,441	87	216	7	2,372	9
26	[280-285]	Do Not Use	947	24	474	16	4,544	16
27	[286-289]	Do Not Use	874	22	322	11	6,093	22
28	[290]	Do Not Use	11,151	283	2,557	85	24,478	89
29	[291]	Class II	54	1	77	3	405	1
30	[303]	Class II	215	5	526	18	5,266	19
31	[292-302,304-319]	Class II	364	9	2,695	90	22,670	82
32	[320]	Do Not Use	132	3	26	1	422	2
33	[323]	Do Not Use	79	2	37	1	243	1
34	[332]	Do Not Use	1,476	37	1,271	42	13,167	48
35	[345]	Class II	278	7	257	9	1,348	5
36	[320-389 minus *32* to *35*]	Do Not Use	5,901	150	4,966	166	42,582	155
37	[390-392]	Do Not Use	3	0	8	0	95	0
38	[393-398]	Class II	1,745	44	491	16	4,697	17
39	[401-404]	Class II	5,099	130	1,344	45	44,435	161
40	[410]	Class II	25,487	647	21,962	732	203,551	739
41	[411]	Class II	13,955	354	557	19	2,907	11
42	[415-417]	Class II	2,489	63	942	31	12,622	46
43	[430-438]	Class I	37,961	964	16,051	535	158,448	575
44	[440]	Class II	4,707	120	1,393	46	15,279	55
45	[412-414,441-459]	Class II	41,776	1,061	36,709	1,224	502,928	1,826
46	[480-486]	Do Not Use	7,830	199	7,728	258	90,147	327
47	[487]	Do Not Use	618	16	304	10	1,724	6
48	[490-496]	Do Not Use	3,566	91	9,618	321	112,584	409
49	[460-478,500-519]	Do Not Use	25,991	660	2,386	80	34,544	125
50	[530-537]	Class II	975	25	579	19	8,002	29
51	[540-543]	Class II	64	2	42	1	439	2
52	[571]	Do Not Use	6,207	158	2,030	68	25,192	91
53	[520-579 minus *50* to *53*]	Class II	11,566	294	4,979	166	45,724	166
54	[580-589]	Do Not Use	5,556	141	2,654	89	26,182	95
55	[600]	Class II	134	3	54	2	410	1
56	[590-599,601-629]	Class II	2,084	53	912	30	21,785	79
57	[630-638]	Class II	0	0	4	0	32	0
58	[640-648]	Class II	9	0	7	0	92	0
59	[650-659]	Class II	1	0	0	0	10	0
60	[660-669]	Class II	0	0	8	0	147	1
61	[680-709]	Do Not Use	902	23	240	8	3,222	12
62	[710-739]	Class II	2,938	75	1,032	34	10,166	37
63	[740-759]	Class II	1,125	29	955	32	11,934	43
64	[767]	Class I	49	1	33	1	201	1
65	[760-766,768-779]	Do Not Use	720	18	863	29	13,227	48
66	[780-799]	Class II	6,972	177	5,942	198	25,992	94
67	[E800-E807]	Class I	135	3	47	2	515	2
68	[E810-E819]	Class I	5,889	150	2,867	96	42,191	153
69	[850-869]	Class II	1,023	26	703	23	10,801	39
70	[E880-E888]	Class I	1,753	45	2,622	87	16,274	59
71	[E890-E899]	Class I	197	5	272	9	3,255	12
72	[E800-E949 minus *67* to *71*]	Class II	3,606	92	2,115	71	24,799	90
73	[E950-E959]	Class II	3,234	82	3,681	123	30,575	111
74	[E960-E969]	Class II	331	8	431	14	17,893	65
75	[E970-E999]	Class II	127	3	311	10	4,142	15
76	All Causes		357,950	9,092	215,669	7,192	2,337,256	8,484
		Do Not Use	181,294	4,605	104,913	3,499	1,085,698	3,941
		Class I	46,298	1,176	22,048	735	222,502	808
		Class II	130,358	3,311	88,708	2,958	1,029,056	3,735
		Class I + II	176,656	4,487	110,756	3,693	1,251,558	4,543
	Population in Millions		39,371,147		29,987,200		275,499,037	

Table Three: Age Specific Mortality Rates (Deaths per Million), Spain, 1998

			All Ages	0..4	5..14	15..24	25..34	35..44	45..54	55..64	65..74	75..84	85+
1	[001]	Do Not Use	0	0	0	0	0	0	0	0	0	0	0
2	[002]	Do Not Use	0	0	0	0	0	0	0	0	0	0	0
3	[003-009]	Do Not Use	6	3	0	1	0	0	1	1	6	37	212
4	[010-018]	Do Not Use	12	0	0	1	2	4	10	12	32	75	105
5	[033]	Class II	0	0	0	0	0	0	0	0	0	0	0
6	[036]	Do Not Use	2	17	1	1	0	0	0	0	1	3	5
7	[037]	Do Not Use	0	0	0	0	0	0	0	1	1	0	2
8	[038]	Do Not Use	55	9	1	2	4	7	14	41	119	366	1,088
9	[050]	Do Not Use	0	0	0	0	0	0	0	0	0	0	0
10	[055]	Do Not Use	0	0	0	0	0	0	0	0	0	0	0
11	[064]	Do Not Use	0	0	0	0	0	0	0	0	0	0	0
12	[070]	Do Not Use	21	1	0	1	4	8	10	29	79	109	96
13	[082-083]	Do Not Use	0	0	0	0	0	0	0	0	1	1	0
14	[084]	Do Not Use	0	0	0	0	0	1	0	0	1	0	0
15	[090-099]	Do Not Use	0	0	0	0	0	0	1	0	1	2	3
16	[122]	Do Not Use	1	0	0	0	0	1	0	1	3	6	21
17	[020-139 minus *5* to *16*]	Do Not Use	16	4	1	2	3	4	5	15	44	92	176
18	[140-209]	Do Not Use	2,272	31	43	50	106	468	1,519	3,524	7,135	12,655	19,176
19	[210-229]	Class I	8	0	0	0	1	1	5	9	24	55	60
20	[230-234]	Do Not Use	0	0	0	0	0	0	0	0	0	0	0
21	[235-239]	Do Not Use	59	12	7	3	6	13	30	66	155	343	755
22	[250]	Do Not Use	242	1	0	1	3	8	26	135	561	1,796	4,889
23	[260-269]	Do Not Use	0	0	0	0	0	0	0	0	0	2	7
24	[270-279]	Do Not Use	3	0	0	0	0	0	0	1	2	12	106
25	[240-246,251-259]	Do Not Use	87	27	6	9	120	131	50	55	92	241	817
26	[280-285]	Do Not Use	24	0	2	2	1	1	3	11	32	157	663
27	[286-289]	Do Not Use	22	3	0	1	1	4	6	13	56	159	350
28	[290]	Do Not Use	283	0	0	0	0	0	1	16	216	1,861	10,552
29	[291]	Class II	1	0	0	0	0	1	2	3	5	2	7
30	[303]	Class II	5	0	0	0	1	4	11	14	15	9	8
31	[292-302,304-319]	Class II	9	0	0	1	5	7	5	14	18	41	91
32	[320]	Do Not Use	3	9	1	0	1	1	2	5	8	18	10
33	[323]	Do Not Use	2	2	0	0	1	1	1	2	6	9	16
34	[332]	Do Not Use	37	0	0	0	0	0	1	10	66	366	706
35	[345]	Class II	7	1	1	2	4	5	5	6	13	30	65
36	[320-389 minus *32* to *35*]	Do Not Use	150	40	18	20	15	19	49	114	316	1,096	2,150
37	[390-392]	Do Not Use	0	0	0	0	0	0	0	0	0	1	0
38	[393-398]	Class II	44	0	0	0	0	4	19	49	150	292	448
39	[401-404]	Class II	130	0	0	0	1	2	14	51	194	899	3,656
40	[410]	Class II	647	2	0	3	15	86	262	647	1,718	4,323	9,425
41	[411]	Class II	354	0	0	0	2	16	60	227	728	2,457	8,006
42	[415-417]	Class II	63	0	0	1	5	10	25	47	144	403	1,179
43	[430-438]	Class I	964	5	2	7	17	51	135	375	1,528	6,840	25,541
44	[440]	Class II	120	0	0	0	0	1	1	10	70	617	5,114
45	[412-414,441-459]	Class II	1,061	29	6	22	45	79	182	479	1,537	6,355	31,495
46	[480-486]	Do Not Use	199	9	2	3	7	14	30	73	272	1,248	5,972
47	[487]	Do Not Use	16	0	0	0	0	0	1	3	11	85	626
48	[490-496]	Do Not Use	91	3	1	3	2	5	15	62	196	653	1,815
49	[460-478,500-519]	Do Not Use	660	14	2	8	19	28	67	303	1,290	4,849	15,249
50	[530-537]	Class II	25	0	0	0	0	3	6	14	49	182	516
51	[540-543]	Class II	2	0	0	0	0	1	1	1	6	10	20
52	[571]	Do Not Use	158	2	0	1	13	76	164	307	527	671	557
53	[520-579 minus *50* to *53*]	Class II	294	7	2	5	13	35	70	182	550	1,990	6,603
54	[580-589]	Do Not Use	141	3	0	1	3	9	22	74	270	962	3,421
55	[600]	Class II	3	0	0	0	0	0	0	0	4	23	116
56	[590-599,601-629]	Class II	53	1	0	1	1	2	8	19	68	370	1,518
57	[630-638]	Class II	0	0	0	0	0	0	0	0	0	0	0
58	[640-648]	Class II	0	0	0	0	1	0	0	0	0	0	0
59	[650-659]	Class II	0	0	0	0	0	0	0	0	0	0	0
60	[660-669]	Class II	0	0	0	0	0	0	0	0	0	0	0
61	[680-709]	Do Not Use	23	1	0	0	0	0	2	5	25	141	786
62	[710-739]	Class II	75	0	0	2	2	4	7	24	81	447	2,524
63	[740-759]	Class II	29	369	12	9	9	9	12	10	11	23	33
64	[767]	Class I	1	25	0	0	0	0	0	0	0	0	0
65	[760-766,768-779]	Do Not Use	18	368	1	1	0	0	0	1	0	0	0
66	[780-799]	Class II	177	58	3	9	15	23	32	59	165	773	6,493
67	[E800-E807]	Class I	3	0	1	3	3	2	3	3	11	4	7
68	[E810-E819]	Class I	150	30	33	226	181	136	133	149	166	197	225
69	[850-869]	Class II	26	1	1	21	77	41	10	8	10	14	20
70	[E880-E888]	Class I	45	6	2	10	11	21	24	34	69	201	918
71	[E890-E899]	Class I	5	2	1	2	2	4	3	5	11	18	54
72	[E800-E949 minus *67* to *71*]	Class II	92	31	14	46	56	67	80	99	139	307	902
73	[E950-E959]	Class II	82	0	2	47	83	79	85	101	148	213	276
74	[E960-E969]	Class II	8	1	1	8	12	13	10	9	8	7	10
75	[E970-E999]	Class II	3	1	0	2	3	2	4	5	7	7	11
76	All Causes		9,092	1,125	170	542	881	1,514	3,242	7,534	19,166	55,127	175,669
		Do Not Use	4,605	556	87	112	313	803	2,030	4,881	11,525	28,017	70,328
		Class I	1,176	69	39	249	215	216	302	575	1,809	7,314	26,806
		Class II	3,311	500	44	180	353	495	909	2,079	5,833	19,795	78,535
		Class I + II	4,487	569	83	429	568	711	1,211	2,654	7,641	27,109	105,341
	Total Deaths		357,950	2,151	711	3,281	5,704	8,533	15,331	29,999	71,725	112,973	107,542
	Population in millions		39.37	1.91	4.18	6.06	6.47	5.64	4.73	3.98	3.74	2.05	0.61

Table Four: Age Specific Mortality Rates (Deaths per Million), Canada, 1997

			All Ages	0..4	5..14	15..24	25..34	35..44	45..54	55..64	65..74	75..84	85+
1	[001]	Do Not Use	0	0	0	0	0	0	0	0	0	0	0
2	[002]	Do Not Use	0	0	0	0	0	0	0	0	0	0	0
3	[003-009]	Do Not Use	0	1	0	0	0	0	0	0	0	0	6
4	[010-018]	Do Not Use	6	1	0	0	1	1	2	3	22	61	115
5	[033]	Class II	0	0	0	0	0	0	0	0	0	0	0
6	[036]	Do Not Use	1	4	0	1	0	0	1	1	1	0	0
7	[037]	Do Not Use	0	0	0	0	0	0	0	0	0	0	3
8	[038]	Do Not Use	32	9	2	1	2	3	12	26	93	264	813
9	[050]	Do Not Use	0	0	0	0	0	0	0	0	0	0	0
10	[055]	Do Not Use	0	0	0	0	0	0	0	0	0	0	0
11	[064]	Do Not Use	0	0	0	0	0	0	0	0	0	0	0
12	[070]	Do Not Use	8	0	0	1	2	7	11	14	25	27	22
13	[082-083]	Do Not Use	0	0	0	0	0	0	0	0	0	0	0
14	[084]	Do Not Use	0	0	0	0	0	0	0	0	0	0	0
15	[090-099]	Do Not Use	0	0	0	0	0	0	0	0	1	0	0
16	[122]	Do Not Use	0	0	0	0	0	0	0	0	0	0	0
17	[020-139 minus *5* to *16*]	Do Not Use	36	8	2	5	36	54	42	37	58	93	251
18	[140-209]	Do Not Use	1,958	32	27	44	93	358	1,227	3,805	8,265	14,150	19,971
19	[210-229]	Class I	5	2	0	0	2	1	3	6	16	39	98
20	[230-234]	Do Not Use	0	0	0	0	0	0	0	0	0	0	0
21	[235-239]	Do Not Use	31	3	3	1	3	6	13	33	89	261	592
22	[250]	Do Not Use	190	1	0	2	7	20	61	229	706	1,671	3,476
23	[260-269]	Do Not Use	7	1	0	0	0	1	1	4	14	47	316
24	[270-279]	Do Not Use	40	16	6	7	7	10	22	54	91	239	908
25	[240-246,251-259]	Do Not Use	7	1	0	0	1	2	1	4	15	57	235
26	[280-285]	Do Not Use	16	3	1	1	1	1	2	7	20	125	648
27	[286-289]	Do Not Use	11	1	0	1	2	2	4	16	36	92	156
28	[290]	Do Not Use	85	0	0	0	0	0	1	9	82	739	4,121
29	[291]	Class II	3	0	0	0	0	1	2	5	8	18	34
30	[303]	Class II	18	0	0	0	3	12	25	46	71	60	31
31	[292-302,304-319]	Class II	90	1	0	2	5	10	11	19	103	686	4,129
32	[320]	Do Not Use	1	1	0	0	0	1	1	2	2	7	3
33	[323]	Do Not Use	1	3	0	0	1	0	1	1	2	8	14
34	[332]	Do Not Use	42	0	0	0	0	0	1	8	100	550	1,064
35	[345]	Class II	9	2	2	5	5	11	10	10	15	28	50
36	[320-389 minus *32* to *35*]	Do Not Use	166	38	10	11	10	24	51	137	387	1,397	4,473
37	[390-392]	Do Not Use	0	1	0	0	0	0	0	0	2	1	0
38	[393-398]	Class II	16	0	0	0	1	1	9	16	56	147	302
39	[401-404]	Class II	45	0	0	0	0	2	10	26	115	391	1,442
40	[410]	Class II	732	1	0	1	7	63	281	900	2,495	6,643	13,961
41	[411]	Class II	19	0	0	0	0	4	11	26	65	128	369
42	[415-417]	Class II	31	1	1	1	3	7	20	43	103	260	475
43	[430-438]	Class I	535	6	2	1	11	40	112	328	1,198	4,846	17,286
44	[440]	Class II	46	0	0	0	0	1	3	12	68	335	2,246
45	[412-414,441-459]	Class II	1,224	21	5	12	24	81	273	1,020	3,344	10,242	36,634
46	[480-486]	Do Not Use	258	12	1	4	7	11	35	104	398	2,079	10,827
47	[487]	Do Not Use	10	1	0	0	0	0	1	2	9	80	489
48	[490-496]	Do Not Use	321	2	1	4	3	5	32	217	1,088	3,391	7,069
49	[460-478,500-519]	Do Not Use	80	11	1	2	2	7	24	63	249	658	2,068
50	[530-537]	Class II	19	0	0	0	1	2	6	18	61	156	500
51	[540-543]	Class II	1	0	1	0	0	0	2	1	4	11	25
52	[571]	Do Not Use	68	0	0	0	4	29	75	186	310	298	221
53	[520-579 minus *50* to *53*]	Class II	166	15	3	3	6	15	46	132	419	1,397	4,889
54	[580-589]	Do Not Use	89	2	0	1	2	6	14	64	247	835	2,422
55	[600]	Class II	2	0	0	0	0	0	0	1	4	21	53
56	[590-599,601-629]	Class II	30	0	0	1	1	2	5	15	50	263	1,171
57	[630-638]	Class II	0	0	0	0	0	0	0	0	0	0	0
58	[640-648]	Class II	0	0	0	0	1	0	0	0	0	0	0
59	[650-659]	Class II	0	0	0	0	0	0	0	0	0	0	0
60	[660-669]	Class II	0	0	0	0	1	1	0	0	0	0	0
61	[680-709]	Do Not Use	8	0	0	0	0	1	2	2	16	66	310
62	[710-739]	Class II	34	0	0	2	3	4	11	33	87	274	978
63	[740-759]	Class II	32	297	10	11	10	9	12	21	15	40	64
64	[767]	Class I	1	17	0	0	0	0	0	0	0	0	0
65	[760-766,768-779]	Do Not Use	29	446	1	0	0	0	0	0	0	0	0
66	[780-799]	Class II	198	175	8	42	70	105	144	237	449	926	3,652
67	[E800-E807]	Class I	2	0	1	2	1	2	2	1	2	2	0
68	[E810-E819]	Class I	96	30	32	186	102	78	75	90	120	185	131
69	[850-869]	Class II	23	1	1	10	35	49	35	19	14	16	28
70	[E880-E888]	Class I	87	3	1	10	8	11	18	40	126	628	3,613
71	[E890-E899]	Class I	9	8	3	4	8	7	9	14	18	25	42
72	[E800-E949 minus *67* to *71*]	Class II	71	45	25	58	54	53	61	77	121	239	531
73	[E950-E959]	Class II	123	0	13	137	144	172	180	142	120	125	137
74	[E960-E969]	Class II	14	12	5	19	23	14	15	12	9	13	14
75	[E970-E999]	Class II	10	5	1	5	12	18	14	13	11	9	6
76	All Causes		7,192	1,239	176	604	725	1,326	3,039	8,351	21,613	55,349	153,483
		Do Not Use	3,499	596	58	88	183	551	1,635	5,031	12,327	27,197	60,592
		Class I	735	66	40	204	132	139	217	478	1,480	5,724	21,170
		Class II	2,958	578	78	312	410	636	1,187	2,842	7,806	22,427	71,721
		Class I + II	3,693	643	118	516	542	775	1,404	3,320	9,286	28,151	92,890
	Total Deaths		215,669	2,383	716	2,450	3,381	6,777	11,947	21,577	45,600	65,904	54,934
	Population in millions		29.99	1.92	4.06	4.05	4.66	5.11	3.93	2.58	2.11	1.19	0.36

Table Five: Age Specific Mortality Rates (Deaths per Million), United States, 1998

			All Ages	0..4	5..14	15..24	25..34	35..44	45..54	55..64	65..74	75..84	85+
1	[001]	Do Not Use	0	0	0	0	0	0	0	0	0	0	0
2	[002]	Do Not Use	0	0	0	0	0	0	0	0	0	0	0
3	[003-009]	Do Not Use	4	13	0	0	0	0	1	2	7	25	76
4	[010-018]	Do Not Use	4	0	0	0	1	2	3	7	12	23	43
5	[033]	Class II	0	0	0	0	0	0	0	0	0	0	0
6	[036]	Do Not Use	1	3	1	1	1	0	1	0	1	1	2
7	[037]	Do Not Use	0	0	0	0	0	0	0	0	0	0	0
8	[038]	Do Not Use	86	16	1	3	7	15	35	91	239	610	1,722
9	[050]	Do Not Use	0	0	0	0	0	0	0	0	0	0	0
10	[055]	Do Not Use	0	0	0	0	0	0	0	0	0	0	0
11	[064]	Do Not Use	0	0	0	0	0	0	0	0	0	0	0
12	[070]	Do Not Use	17	0	0	1	3	20	38	32	46	54	37
13	[082-083]	Do Not Use	0	0	0	0	0	0	0	0	0	0	0
14	[084]	Do Not Use	0	0	0	0	0	0	0	0	0	0	0
15	[090-099]	Do Not Use	0	0	0	0	0	0	0	0	1	1	3
16	[122]	Do Not Use	0	0	0	0	0	0	0	0	0	0	0
17	[020-139 minus *5* to *16*]	Do Not Use	73	20	3	8	81	141	111	84	89	118	199
18	[140-209]	Do Not Use	1,966	23	25	45	111	375	1,298	3,766	8,255	13,016	17,180
19	[210-229]	Class I	6	2	0	1	1	2	3	7	17	38	92
20	[230-234]	Do Not Use	0	0	0	0	0	0	0	0	0	0	0
21	[235-239]	Do Not Use	23	4	2	2	3	6	11	27	63	155	378
22	[250]	Do Not Use	235	0	1	4	16	42	124	377	880	1,686	2,896
23	[260-269]	Do Not Use	15	1	0	0	0	1	2	5	18	96	560
24	[270-279]	Do Not Use	62	17	3	8	13	21	39	75	148	328	1,182
25	[240-246,251-259]	Do Not Use	9	3	0	1	1	2	3	7	17	56	210
26	[280-285]	Do Not Use	16	3	1	2	4	5	6	10	31	104	410
27	[286-289]	Do Not Use	22	5	1	2	2	5	10	24	68	173	320
28	[290]	Do Not Use	89	0	0	0	0	0	1	8	86	656	3,553
29	[291]	Class II	1	0	0	0	0	1	2	3	5	6	7
30	[303]	Class II	19	0	0	0	5	23	47	52	42	24	16
31	[292-302,304-319]	Class II	82	1	1	5	12	24	25	26	81	478	2,920
32	[320]	Do Not Use	2	5	1	1	0	1	2	2	3	3	3
33	[323]	Do Not Use	1	1	0	0	1	0	1	1	3	4	4
34	[332]	Do Not Use	48	0	0	0	0	0	1	10	104	526	1,103
35	[345]	Class II	5	2	1	2	5	5	6	7	9	11	16
36	[320-389 minus *32* to *35*]	Do Not Use	155	36	12	16	16	27	64	140	342	1,060	3,427
37	[390-392]	Do Not Use	0	0	0	0	0	0	0	1	1	2	3
38	[393-398]	Class II	17	0	0	1	2	4	9	23	56	123	242
39	[401-404]	Class II	161	1	0	1	7	29	87	200	416	1,041	3,544
40	[410]	Class II	739	1	0	2	12	77	318	962	2,333	5,443	13,575
41	[411]	Class II	11	0	0	0	0	2	7	17	30	63	189
42	[415-417]	Class II	46	11	1	3	9	16	32	67	142	289	571
43	[430-438]	Class I	575	18	2	5	17	58	162	418	1,275	4,469	14,729
44	[440]	Class II	55	0	0	0	0	1	5	24	90	362	2,034
45	[412-414,441-459]	Class II	1,826	35	7	24	60	195	599	1,719	4,770	12,946	44,068
46	[480-486]	Do Not Use	327	30	3	5	13	30	61	164	579	2,327	10,223
47	[487]	Do Not Use	6	0	0	0	0	0	1	3	8	42	224
48	[490-496]	Do Not Use	409	5	4	6	8	19	80	440	1,659	3,590	5,591
49	[460-478,500-519]	Do Not Use	125	24	3	4	6	15	34	105	338	975	2,689
50	[530-537]	Class II	29	2	0	1	2	4	12	28	70	201	694
51	[540-543]	Class II	2	1	0	0	0	1	1	2	4	10	19
52	[571]	Do Not Use	91	1	0	1	13	74	163	228	302	304	216
53	[520-579 minus *50* to *53*]	Class II	166	20	2	4	12	35	84	179	446	1,147	3,295
54	[580-589]	Do Not Use	95	8	1	1	4	10	26	78	255	744	2,132
55	[600]	Class II	1	0	0	0	0	0	0	1	1	13	50
56	[590-599,601-629]	Class II	79	2	0	1	3	8	21	56	178	587	2,115
57	[630-638]	Class II	0	0	0	0	0	0	0	0	0	0	0
58	[640-648]	Class II	0	0	0	1	1	1	0	0	0	0	0
59	[650-659]	Class II	0	0	0	0	0	0	0	0	0	0	0
60	[660-669]	Class II	1	0	0	1	2	1	0	0	0	0	0
61	[680-709]	Do Not Use	12	0	0	0	1	2	4	9	27	79	308
62	[710-739]	Class II	37	1	1	3	6	11	23	45	103	230	652
63	[740-759]	Class II	43	350	9	12	11	12	15	22	35	82	157
64	[767]	Class I	1	10	0	0	0	0	0	0	0	0	0
65	[760-766,768-779]	Do Not Use	48	680	1	0	0	0	0	0	0	0	1
66	[780-799]	Class II	94	200	4	15	27	43	55	75	155	379	1,741
67	[E800-E807]	Class I	2	0	0	3	3	3	2	1	1	1	3
68	[E810-E819]	Class I	153	41	45	259	176	150	137	143	176	274	308
69	[850-869]	Class II	39	2	1	23	54	93	63	23	15	23	34
70	[E880-E888]	Class I	59	3	1	6	9	15	24	39	100	381	1,599
71	[E890-E899]	Class I	12	15	8	5	6	9	10	13	21	39	60
72	[E800-E949 minus *67* to *71*]	Class II	90	77	27	56	56	63	74	97	160	325	777
73	[E950-E959]	Class II	111	0	8	109	136	151	146	128	139	193	210
74	[E960-E969]	Class II	65	37	11	143	113	76	48	33	25	26	37
75	[E970-E999]	Class II	15	6	2	11	22	31	22	10	6	8	22
76	All Causes		8,484	1,737	195	807	1,076	1,959	4,156	10,115	24,483	55,970	148,470
		Do Not Use	3,941	898	63	111	306	815	2,119	5,695	13,580	26,756	54,695
		Class I	808	90	56	279	212	237	339	621	1,592	5,203	16,791
		Class II	3,735	749	76	417	558	907	1,698	3,799	9,311	24,011	76,985
		Class I + II	4,543	839	133	696	771	1,144	2,037	4,420	10,903	29,214	93,776
	Total Deaths		2,337,256	33,622	7,791	30,627	42,516	88,866	146,479	233,724	458,982	681,663	612,986
	Population in millions		275.50	19.36	39.93	37.94	39.50	45.36	35.25	23.11	18.75	12.18	4.13