



## Deceased Organ Donor Potential in Canada

Report

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Factors Influencing Health



Canadian Institute  
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# Deceased Organ Donor Potential in Canada

## Overview

Organ donation saves lives, but in Canada and around the world, the demand for solid organs—such as kidneys, livers, lungs and hearts—continues to outpace supply. In 2012, 230 Canadians<sup>1</sup> with end-stage organ failure died while on a transplant wait list.

While Canada has seen a modest increase in the number of organ donors over the past decade, our deceased donor rate has been described as “unacceptably low”<sup>2</sup>—it is about half the rates of the best-performing countries. Deceased donors are a critical source of organs, because each donor can provide up to 8 organs for transplantation.

To better understand Canada’s performance in organ donation, it is important to consider the potential for deceased donation in Canadian hospitals. Only a small proportion<sup>3, 4</sup> of all people who die are clinically suitable candidates for organ donation. Traditionally, a deceased organ donor is a person with otherwise healthy organs<sup>5</sup> who experiences severe brain damage (e.g., from a stroke, aneurysm or traumatic event) that leads to death in a hospital’s intensive care unit. However, the measure most commonly used to compare performance among countries and provinces—the deceased donor rate per million population—does not account for regional differences in the types of death that can lead to successful donation. For this reason, countries such as the United Kingdom,<sup>6</sup> as well as the provinces of Quebec and Ontario,<sup>3</sup> have begun to measure organ donor potential among deceased hospital patients to assess how well their donation programs are working and to identify ways to increase the number of organ donors.

The purpose of this study is to estimate how many patients who die in Canadian hospitals are clinically eligible to be organ donors, and how effectively health systems across the country recognize and convert these potential donors into actual donors. The study also examines how donor profiles vary across the country and explores some of the factors associated with successful conversion at the patient, hospital and health system levels.

The study uses discharge abstract data submitted to the Hospital Morbidity Database (HMDB) at the Canadian Institute for Health Information (CIHI) to estimate donor potential. The information contained in the abstract data is not as complete for assessing donor suitability as that in the patient’s original medical chart; therefore, this study likely overestimates the true number of potential donors. Estimates from full chart reviews conducted in 3 different jurisdictions came in with numbers that were 26% to 54% lower than the figures identified in this report.<sup>7–9</sup> However, further analyses of Ontario and British Columbia data also show that while the study method overestimates potential donors, it includes most of the deceased patients who became actual organ donors.<sup>8</sup>

In addition, as this study captures all hospital deaths in Canada and is comparable across the country, it can serve as a useful tool to help understand variations in deceased donation rates and target improvement efforts based on best practices.

## Glossary of Terms

### **Actual Donors**

In Canada, actual organ donors are those with at least 1 organ successfully transplanted into a donor recipient.

### **Potential Donors**

For the purposes of this study, potential donors are patients who died in Canadian hospitals and who were clinically eligible to be organ donors. To be clinically eligible, patients typically died after experiencing severe brain damage (leading to brain or cardiocirculatory death), were mechanically ventilated at or near the time of death and had no medical contraindications to donation.

### **Conversion Rate**

This measures how effectively health systems make use of deceased donor potential by looking at how many potential donors become actual donors.

### **Donation After Brain Death**

Most deceased organ donation in Canada occurs after brain death. In most provinces, at least 2 physicians must determine brain death based on a standard list of neurological criteria.

### **Donation After Cardiocirculatory Death**

This involves donation from a patient with a severe brain injury or other terminal condition who does not meet the criteria for brain death but who has no chance of recovery and is removed from life-sustaining therapy with the consent of his or her family. According to Canadian guidelines,<sup>10</sup> death is declared 5 minutes after the heart stops beating. Donation after cardiocirculatory death (DCD) is also known as donation after a non-heart beating death.

### **Donors per Million**

This is the number of actual or potential donors per million people. It allows for more comparable measurement by province and/or country by adjusting for differences in population sizes.

### **Exclusion Criteria**

These are medical contraindications that would prevent a person with a brain death or cardiocirculatory death from being considered for organ donation. 2 sets of criteria were used for this analysis: strict criteria, based on Canadian standards,<sup>11</sup> and updated criteria, to reflect evolving practice.

## Key Findings

- Overall, **there is room to improve on the number of deceased organ donors in Canada.**

A review of Canadian hospital discharge records identified many deceased patients who were clinically eligible to be organ donors on paper but who never became actual donors in practice. The study found that in 2012<sup>i</sup> there were 3,088 potential donors younger than 70 among patients who died in Canadian hospitals.<sup>ii</sup> However, only 520 of these potential donors became actual donors—donors with at least 1 organ successfully transplanted.

This translates to a conversion rate of 1 in 6 potential donors into actual donors, or 17%. Identifying potential donors using widened medical criteria that are less restrictive and more reflective of current practices (e.g., including potential donors between the ages of 70 and 79) drops the conversion rate to 10%.

Even when considering the upper end of possible overestimation in the number of eligible donors (based on chart review comparisons), these results suggest that Canada is not realizing its full potential in deceased organ donation.

For example, after adjusting for overestimation, there were 1,544 potential donors in 2012 younger than 70, with about one-third becoming actual organ donors. Since each deceased donor in Canada provides on average 3.4 organs, tapping unused potential could in theory have provided an additional 3,577 organs—enough to improve or save the lives of the majority of Canadians on the transplant wait list.<sup>12</sup>

- **There is an opportunity to increase donation among patients with cardiocirculatory deaths.** The study found that (unadjusted) conversion rates were 6 times greater for patients with brain death (30%)<sup>iii</sup> than for potential donors with cardiocirculatory death (5%). While DCD is a relatively new practice in Canada, it has become an important source of procurement in other countries, such as the U.K., where DCD accounted for more than 40% of all deceased donors in 2012.<sup>6</sup> In comparison, about 17% of Canadian deceased donors had cardiocirculatory deaths in that year, with wide variation in DCD practice across the country.
- **Older donors also represent a potential growth area for donation.** The study found significant variation across Canada in the use of organs from older donors. At the country level, conversion rates for potential donors younger than 50 (30%) were twice as high as rates for those age 50 to 59 (15%) and more than 4 times as high as those for patients age 60 to 69 (7%). As the criteria for organ donation widen to meet rising demand, and with more older Canadians on wait lists for organs, older donors are becoming increasingly accepted as a source of solid organs, both here at home and internationally.<sup>6</sup>

i. Includes 2011 data from Quebec, the most recent year available for that province.

ii. Based on strict exclusion criteria.

iii. Based on strict exclusion criteria, patients younger than 70.

- **Conversion rates vary widely among the provinces.** The study shows a more than two-fold difference in deceased donor conversion, with the highest rates seen in Quebec and Nova Scotia (21% and 18%, respectively) and the lowest rates in Manitoba and Saskatchewan (10% each). Significant differences were also observed in the profiles of deceased donors, such as the types of death considered for organ donation and the average age of donors. These differences at least partly reflect variations in practice among provinces (e.g., Manitoba and Saskatchewan have not yet implemented DCD programs).
- **Other factors associated with donation include how hospital care is organized.** Using data from Ontario to conduct a logistic regression analysis, the study found that teaching hospitals were 60% more likely to convert potential donors into actual donors than community hospitals. However, a large proportion (about half) of estimated potential donors died in Ontario community hospitals. At the country level, the study also found that about half of patients who died in Canadian hospitals from the types of deaths associated with organ donation (i.e., brain and cardiocirculatory deaths) did not become potential donors because they were not mechanically ventilated while in acute care.

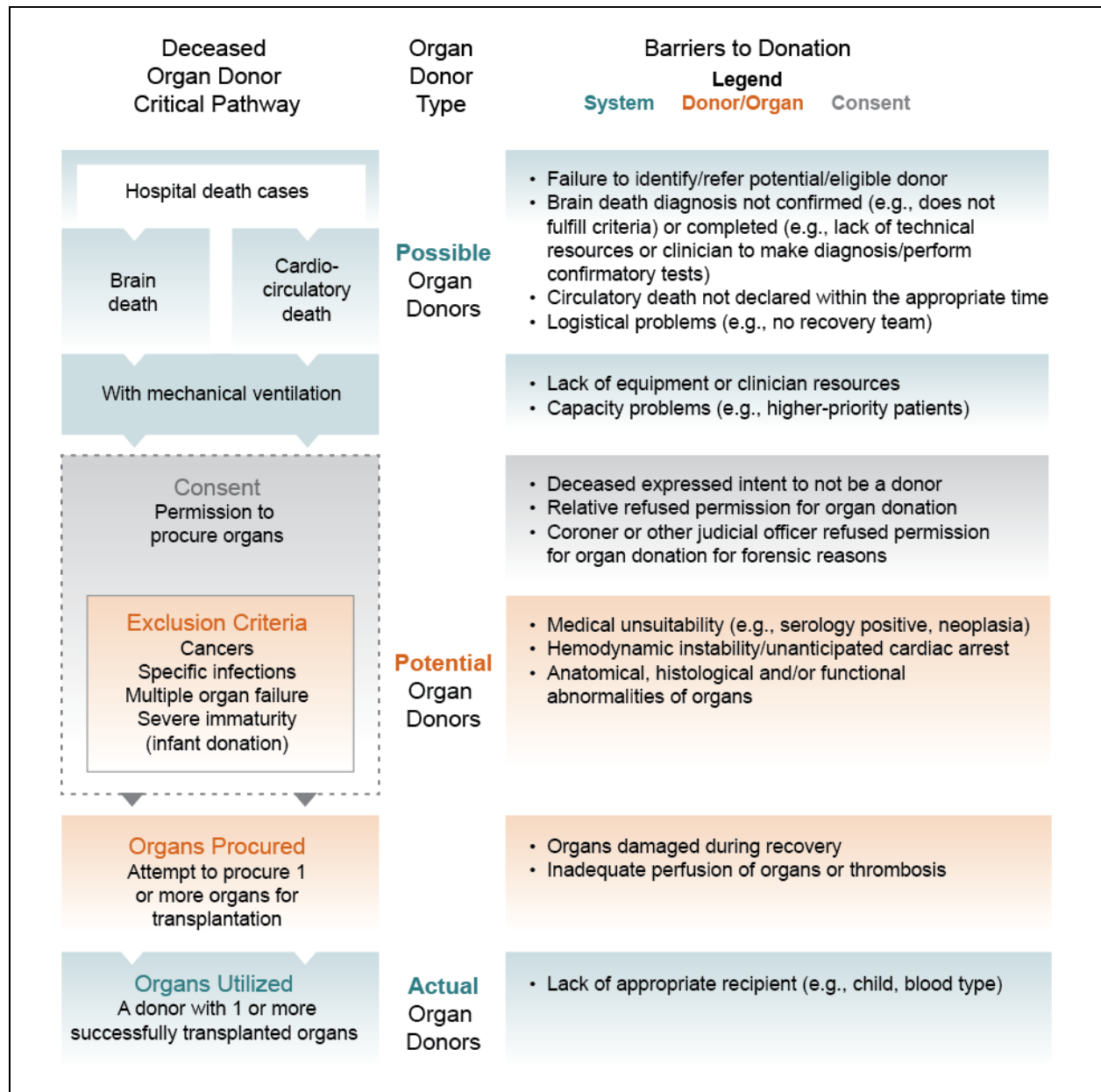
## About This Study

Successful deceased organ donation requires a complex set of factors and a specific chain of events, from identifying and referring potential donors, to securing patient consent, to managing donors during the dying process, to ensuring hospital resources are in place for organ recovery and that a suitable match is found for transplantation.<sup>2</sup>



Figure 1 illustrates the waterfall of events leading to donation and potential barriers along the way. It is adapted from the World Health Organization's critical pathway<sup>13</sup> for deceased donation.

Figure 1: Organ Donation Pathway and Barriers to Donation



**Source**

Dominguez-Gil B, et al. The critical pathway for deceased donation: reportable uniformity in the approach to deceased donation. *Transpl Int.* 2011;24:373-378.



As the figure illustrates, potential donors represent a subset (less than 3%)<sup>3, 4</sup> of all deaths that occur in hospital. According to international guidelines,<sup>13</sup> 2 main types of patient deaths should be considered for possible organ donation: declared brain death, as confirmed by neurological testing, and cardiocirculatory death, which involves patients who don't meet neurological death criteria but who are removed from life support with the consent of their families because they have no chance of recovery. To ensure organs remain viable for transplant, a patient must be mechanically ventilated at or near the time of death. For this reason, virtually all deceased organ donation comes from people who die in a hospital setting.

In addition, deceased patients must not have underlying diseases or conditions that could potentially endanger the life of the person receiving the organ. Using Figure 1 as a framework of reference, this study examines how efficiently health systems in Canada maximize deceased donor potential by looking at what proportion of potential donors become actual donors of solid organs. In Canada, actual donors are those with at least 1 organ successfully transplanted. Since patient or family consent is critical to organ donation and is not captured in CIHI's data, estimates of potential donors are based strictly on other patient characteristics (e.g., age, type of death, underlying conditions or diseases).

## Methodology

This study uses 4 years of data (from 2008 to 2011) for Quebec and 5 years of data (from 2008 to 2012) for all other Canadian provinces except Prince Edward Island to examine deceased organ donor potential and to estimate conversion rates. Presentations of the latest available year of results feature 2011 data from Quebec and 2012 data from the remaining provinces. P.E.I. and the territories were excluded from analyses due to low numbers of donors and the absence of transplant programs in these jurisdictions.

The 2 main data sources for this work are from CIHI:

- The **Canadian Organ Replacement Register (CORR)** collects data from provincial organ transplant and procurement organizations to provide comparable information on solid organ donation, transplants, wait lists and dialysis trends.
- The **Hospital Morbidity Database (HMDB)** captures clinical and administrative data on hospital separations from all Canadian acute care hospitals. The HMDB combines data from CIHI's Discharge Abstract Database (DAD) with MED-ÉCHO data from Quebec.

## Calculating Organ Donor Conversion Rates

Conversion rates were calculated by dividing the number of actual donors by the number of potential (or eligible) donors observed in Canadian hospitals.

$$\text{Conversion rate} = \frac{\text{Actual donors}}{\text{Potential donors}}$$

CORR data was used to identify actual deceased donors. In Canada, actual donors are those with at least 1 organ successfully transplanted into a recipient. (In many other countries, actual donors are those with at least 1 organ retrieved, regardless of transplantation results.) Acute care discharge data from the HMDB was used to identify potential donors from the more than 100,000 deaths recorded in Canadian hospitals every year.

This conversion method is based on earlier CIHI reports<sup>15, 16</sup> and is aligned with a Canadian study of organ donor potential using clinical administrative data.<sup>8</sup>

More information on the methods used to calculate donor potential is available in Appendix 1.

## Data Linkage

To better understand which potential donors became actual donors in Canada and the factors associated with successful conversion, the analysis linked acute care discharge records with donor register records from CORR. This linkage was possible in Ontario only, as more detailed and linkable acute care data from this province is available to CIHI.

## Study Limitations

The methods used for this study have the benefit of being comprehensive (i.e., they capture all patients in all Canadian facilities), economical and repeatable over time. However, the hospital discharge abstract data used to estimate potential donors in this study is not as complete as the data found in a direct analysis of original hospital patient charts; therefore, it may not capture all of the clinical information required to accurately assess donor suitability. For example, mechanical ventilation is required at or near the time of a patient's death to ensure organs are viable for transplant. However, discharge abstracts do not specify when ventilation was provided during the course of the patient's hospital stay. In addition, discharge abstracts do not contain information on social risk factors that may be considered as part of donor suitability assessment (e.g., whether the patient had a history of alcoholism, smoking or drug abuse) and may not capture whether organs were damaged during the dying process or during organ recovery. As a result, the method proposed in this study likely overestimates true donor potential.

Estimates from medical chart reviews conducted in 3 jurisdictions resulted in potential donor numbers that were 26% to 54% lower than those reported in this study.<sup>7-9</sup> As a result, conversion rates presented in this report—the percentage of potential donors who became actual donors—are likely underestimated by a similar scale. Differences in data collection across the country may also influence regional results.

Among other limitations, the study does not account for differences in suitability criteria by organ type. For example, someone who dies a cardiocirculatory death cannot in most cases become a heart donor, and age cut-offs for lung donors are traditionally much lower than for kidney donors. However, the majority of organ demand (75%) in Canada is for kidneys, and this organ has relatively fewer restrictions around age and type of death.

In addition, the study does not capture information on some of the barriers to the organ donation process, such as whether the potential donor was referred to a provincial organ procurement organization and whether consent was sought or obtained from the patient or his or her family. This type of information is collected in some provinces; however, it is not collected or reported consistently across the country.

## How the Criteria for Organ Donation Are Rapidly Evolving

Many people who consent to donate organs after their death are unable to become successful organ donors because the type of death they experience does not allow for the retrieval of a viable organ or because they have a disease or a condition that makes them medically unsuitable. However, thanks to process improvements, and in response to growing demand for organs, the criteria to determine who is medically suitable for organ donation are evolving and expanding in Canada and around the world.<sup>17</sup>

Canadian regulations<sup>11</sup> refer to a long list of contraindications<sup>15</sup> to organ donation—including many types of infections, malignancies and neurological disorders—while allowing for exceptions to be made on a case-by-case basis by local medical teams. Our study found that about one-third of actual deceased donors observed in Ontario were exceptions—they had a disease or condition on the list of contraindications. Other countries have significantly shortened their published lists of contraindications,<sup>6, 18</sup> partly to encourage as many people as possible to register as donors.

Age is another criterion that has been expanding over time. While there are no explicit age restrictions for organ donation in Canada, donors older than 75 were almost unheard of a decade ago. However, as the population ages, including the population on wait lists for organ transplants, older patients are increasingly being accepted and used as donors. The U.K. recently increased the age cut-off from 75 to 80 years when estimating donor potential and conversion rates.<sup>6</sup>

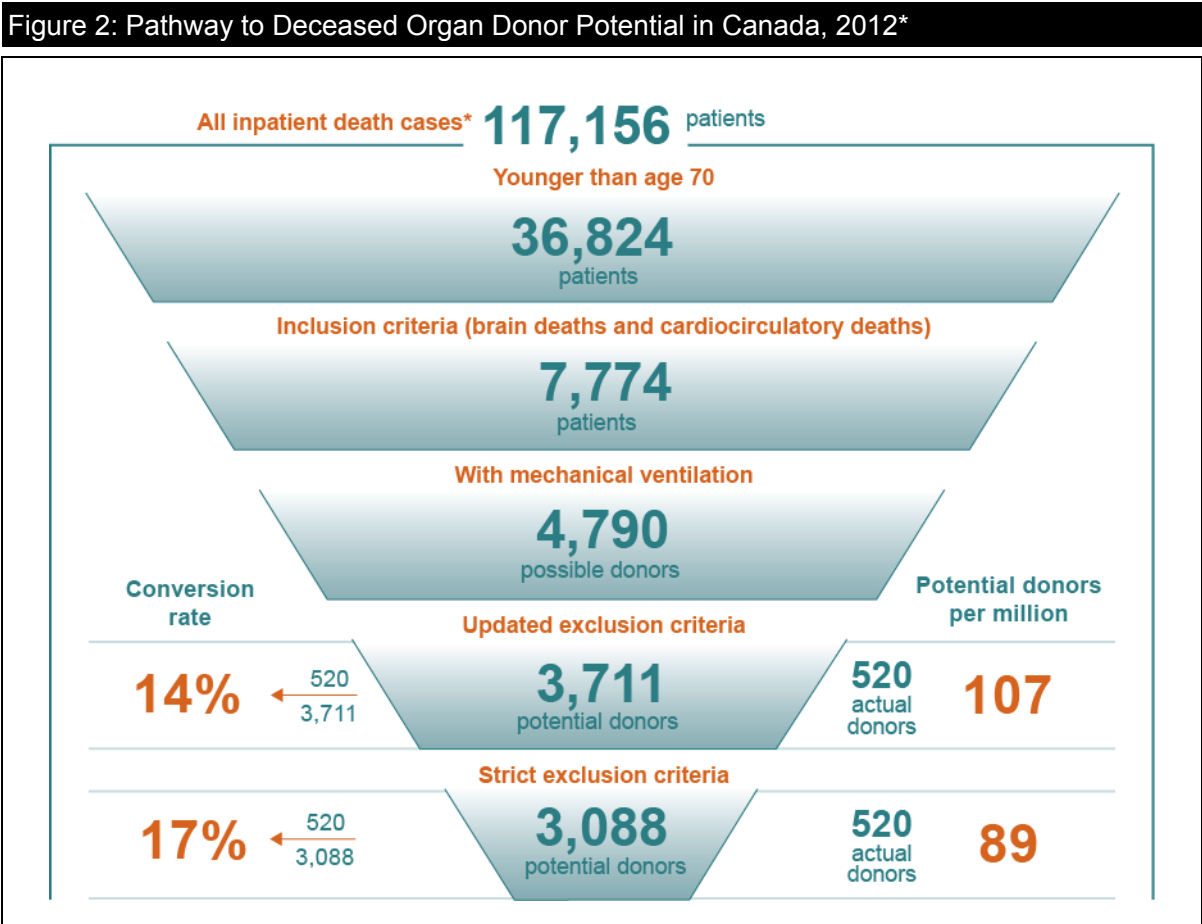
## Estimating Potential and Actual Conversion Rates in Canada

Due in part to an aging population, the burden of chronic disease and advances in keeping patients with end-stage organ disease alive,<sup>19</sup> the demand for solid organs is growing, both in Canada and around the world.<sup>12, 20</sup>

Maximizing the potential of deceased donors—under strict legal and ethical considerations—is a critical strategy to meet the needs of patients on the transplant wait list.<sup>13</sup> While Canada compares relatively well with other countries in donation rates from live donors, deceased donation rates are approximately half of what is observed in top-performing countries, such as Spain and the United States.<sup>21</sup>

With shortages in available organs both at home and abroad, developed countries have been looking at ways to narrow the gap between supply and demand,<sup>2, 17</sup> and they are using performance measurement as a tool to identify potential barriers to donation and to target improvement efforts. In Canada, comparable measurement is important for provincial health systems to assess how effectively organ donor potential is being realized across the country, identify best practices and understand where improvements can be made.

Figure 2 illustrates the critical pathway to deceased organ donation, beginning with all Canadian acute care hospital deaths observed in 2012. The figure presents different estimates of deceased donor potential and conversion rates to reflect evolving criteria around medical exclusions.



**Note**

\* Rates presented are for 2011 for Quebec and 2012 for the remaining provinces.

**Sources**

Hospital Morbidity Database and Canadian Organ Replacement Register, 2011 (Quebec) and 2012 (remaining provinces), Canadian Institute for Health Information.

Medical contraindications prevent some deceased hospital patients with brain or cardiocirculatory deaths from becoming potential organ donors. To reflect evolving practice, 2 sets of exclusion criteria were used for this analysis:

- **Strict criteria:** These reflect a long list of infections and conditions based on Canadian standards published in 2007.<sup>11, 15</sup>
- **Updated criteria:** Based on widening eligibility criteria in Canada and internationally,<sup>17, 18</sup> contraindications are limited to active and metastatic cancers, a history of melanoma, premature infants and some systemic infections (e.g., HIV, Creutzfeldt-Jakob disease).

See Appendix 3 for more information.

## Key Findings

- When using strict criteria, the study estimates there were 3,088 potential deceased donors in Canada younger than 70 in 2012. About 1 in 6 of these potential donors (or 17%) were converted into actual organ donors. These estimated conversion rates are considerably lower than those publicly reported in the provinces of Ontario and Quebec—52%<sup>3</sup> and 32%,<sup>7</sup> respectively, using different years of data and different methods of calculation.<sup>3</sup> The reasons for these differences can be explained as follows:
  - In Ontario, conversion rates (reported at 52% in 2012) are calculated based on the identification and referral of potential donors from 42 hospitals with organ donation coordinators, out of a total of 91 acute care hospitals with mechanical ventilation capacity in the province. The model in this report captures all patient deaths from all hospitals and includes potential cases that were not identified and referred to provincial organ procurement agencies. Quebec's reported conversion rate of 32% in 2009 is based on all hospital deaths in the province and aligns more closely with results for the province reported in this study, even though there are important methodological differences in the calculation.
  - Hospital discharge data used for this analysis does not contain all of the information necessary to make a final assessment of donor suitability and overestimates the number of potential donors, particularly among older patients. This is due in part to the large number of deaths of patients older than 60; these account for nearly 100,000 deaths a year (or 85% of all hospital deaths).
  - When limiting the analysis to hospital deaths younger than 60, the number of potential donors aligns more closely with estimates from previous Canadian studies<sup>15, 22</sup> and translates into a conversion rate closer to 25%.
- When using less-restrictive exclusion criteria that are more reflective of current practice in organ donation, the number of estimated potential donors younger than 70 increases by 620 additional potential donors a year.

### Could Canada Meet the Needs of People on Wait Lists?

Considering that every deceased donor in Canada provides an average of 3.4 organs, the following shows how many additional organs could be transplanted if full deceased organ donor potential was realized in this country. Potential numbers of donors reported in Figure 2 were adjusted<sup>iv</sup> here to account for possible overestimation by the study methods. While obtaining 100% conversion of donor potential is not a realistic target, the numbers nevertheless suggest there is room to make gains.

#### *Donor potential, younger than 70 with strict criteria*

89 deaths per million ► 3,088 potential donors ► 1,052 additional donors (adjusted) ► 3,577 additional organs for transplant ► 4,612 people on wait list (2012)

#### *Donor potential, younger than 70 with updated criteria*

107 deaths per million ► 3,711 potential donors ► 1,364 additional donors (adjusted) ► 4,640 additional organs for transplant ► 4,612 people on wait list (2012)

## Conversion of Potential Donors Younger Than 80

While there are technically no age restrictions for people to register as organ donors, the proportion of eligible donors decreases dramatically with advanced age relative to the number of hospital deaths among older patients. For this reason, an age cut-off is often used in calculations of donor potential.<sup>6, 23</sup>

However, since older people represent an important potential source of donation, conversion rates were also calculated using 80 as the maximum age. Using strict criteria, an estimated 12%<sup>v</sup> of potential donors younger than 80 became actual donors in 2012; the conversion rate fell to 10% using updated criteria. The risk of overestimating potential increases with age, however, which may partly explain the large drop in conversion rates.

## Opportunities for Increased Donation

Further analysis of donor potential and conversion data shows significant variation in a number of areas related to deceased organ donation in Canada, which may help identify opportunities for improvement. The areas examined were

- Donation after cardiocirculatory death;
- Donation among older donors;
- Provincial conversion rates and deceased donor profiles; and
- Organization of hospital care.

iv. Numbers adjusted by 50% to account for possible overestimation.

v. Unadjusted estimates.

## 1. Donation After Cardiocirculatory Death

Most organ donors are patients who have been declared brain dead based on standard neurological tests.<sup>2</sup> However, brain death from brain injury has been declining in Canada and in other developed countries, due in part to fewer deadly road collisions<sup>24, 25</sup> and the success of other injury prevention programs.

To increase deceased donation, many countries have established the practice of donation after cardiocirculatory death in addition to donation after brain death. DCD involves patients with a devastating brain injury or other terminal condition who do not meet the criteria for brain death but who are removed from life-sustaining therapy with the consent of their families because they have no chance of recovery (see sidebar on page 17). DCD has been practised in Canada since 2006 and is offered in only some provinces. However, as illustrated in Table 1, it offers an important source of potential new donors that is equivalent to or greater than potential donation after brain death.

**Table 1: Estimation of Donor Potential and Conversion Rates by Type of Death, 2012,\* for Those Younger Than 70**

Exclusion Criteria	Measure	DBD	DCD
<b>Strict</b>	Potential Donors per Million	43	46
	Conversion Rate	30%	5%
<b>Updated</b>	Potential Donors per Million	49	59
	Conversion Rate	27%	4%

### Notes

\* Rates presented are for 2011 for Quebec and 2012 for the remaining provinces.

DBD: Donation after brain death.

DCD: Donation after cardiocirculatory death and other.

### Sources

Hospital Morbidity Database and Canadian Organ Replacement Register, 2011 (Quebec) and 2012 (remaining provinces), Canadian Institute for Health Information; Statistics Canada, population estimates, 2008 to 2012.

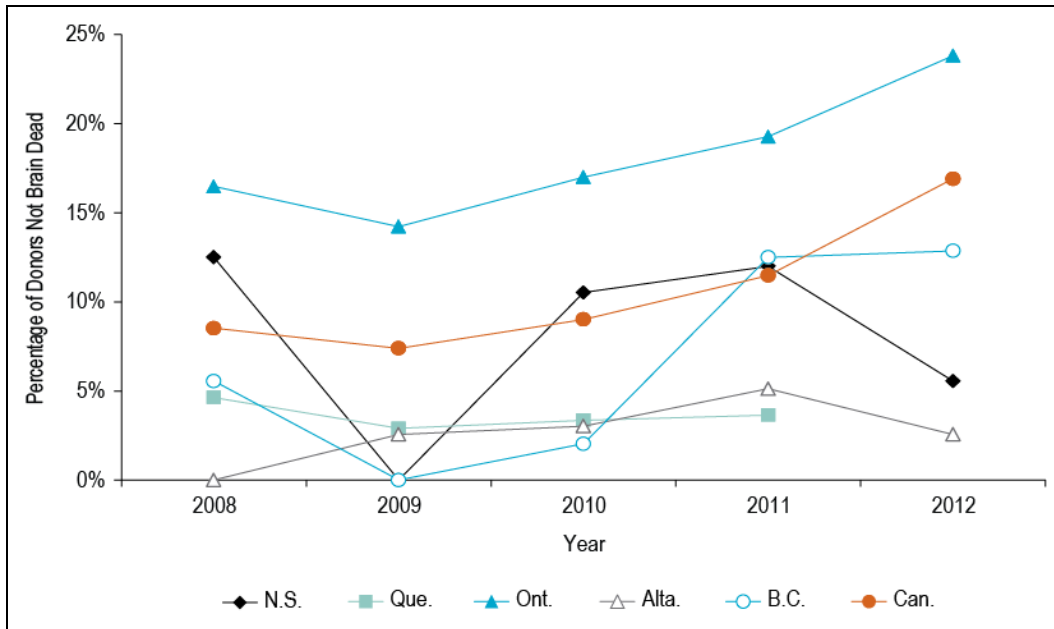
## Key Findings

- Using strict exclusion criteria, the conversion of potential donors into actual donors younger than 70 is 6 times greater for patients with a brain death (30%) than for those with a cardiocirculatory death (5%). However, the estimated number of potential donors is greater after cardiocirculatory death than after brain death, particularly when considering updated criteria. This is consistent with estimates from chart audits in the U.K. that show higher potential numbers among cardiocirculatory death patients.<sup>6</sup>
- While the percentage of DCD donors is on the rise in Canada, increasing from 9% of actual donors in 2008 to 17% in 2012, it remains relatively low when compared with other countries. In the U.K., for example, where targeted efforts have been made to increase donation after cardiocirculatory death, DCD now accounts for more than 40%<sup>6</sup> of all deceased donors. Since 2007, the U.K. has seen significant improvements in its overall deceased donation rate as well as its relative performance internationally.<sup>21</sup>



- The practice of DCD varies considerably across Canada, with the province of Ontario accounting for the majority of activity since 2006, as illustrated in Figure 3. Implementation has been incremental in other parts of the country, with DCD programs initiated in Nova Scotia, Quebec, Alberta and B.C.

**Figure 3: Cardiocirculatory Death Donors as a Percentage of Total Deceased Donors by Province, 2008 to 2012**



**Source**

Canadian Organ Replacement Register, 2008 to 2011 (Quebec) and 2008 to 2012 (remaining provinces), Canadian Institute for Health Information.

## Back to the Future: Donation After Cardiocirculatory Death

In the very early days of organ transplantation, all organs from deceased donors were recovered after a cardiocirculatory death, also known as a non-heart beating death. The practice stopped, however, after criteria to determine brain death were developed in the 1960s, and donation after brain death became international standard practice. Since the brain dies before the heart, blood continues to flow to the organs of a brain dead patient, which prevents damage to the organs and makes them ideal for transplantation.

Over the last 2 decades, organ shortages around the world, coupled with medical advances to preserve organs, have led to a re-emergence of DCD in many countries, including the U.S., the U.K., the Netherlands and Australia.<sup>25</sup> DCD involves a donation from a patient with a severe brain injury or other terminal condition who does not meet the criteria for brain death but who has no hope of recovering and is removed from life-sustaining therapy with the consent of his or her family. In Canada, new ethical and clinical practice guidelines introduced in 2005<sup>10</sup> paved the way for the introduction of DCD programs, notably by clarifying the determination of death after cardiac arrest: 5 minutes after the heart stops beating.

However, implementation of DCD programs has been restricted or delayed in some provinces and Canadian hospitals due to insufficient hospital resources, lack of clinical expertise and, more infrequently, ethical considerations. Some critics question whether DCD respects the “dead donor” rule or the proper determination of a patient’s death.<sup>26</sup> The practice is still not undertaken in some countries (e.g., Germany, Portugal). International studies suggest that, due to a greater risk of damage to the organs during a cardiocirculatory death, there are 1.5 fewer transplanted organs per cardiocirculatory death donor than per brain death donor, as well as a higher risk of complications for some types of organs.<sup>27</sup>

However, for kidneys—the organs in greatest demand in Canada—long-term outcomes for transplant patients are comparable for organs retrieved from both cardiocirculatory and brain death donors.<sup>25, 28, 29</sup> Early results are also promising for lung and liver transplants from DCD.<sup>30, 31</sup> With fewer brain deaths because of improvements in injury and stroke prevention, DCD has become an effective means in many countries of offering organ donation to more families and increasing the supply of organs for transplantation.<sup>25</sup>

## 2. Donation Among Older Donors

As criteria widen for organ donation to meet rising demand, older people are becoming increasingly accepted as a source of solid organs in Canada<sup>4,15</sup> and internationally<sup>20, 32, 33</sup>—particularly since many people on the wait lists for organs are older themselves.<sup>14</sup>

Table 2 illustrates the number of potential donors per million population by age group and how effectively they are converted into actual donors.

**Table 2: Estimation of Donor Potential and Conversion Rates by Age Group, 2012\***

Exclusion Criteria	Measure	Age <10	Age 10–19	Age 20–49	Age <50	Age 50–59	Age 60–69	Age 70–79
<b>Strict</b>	Potential DPM	2	3	25	30	23	36	42
	Conversion Rate	19%	44%	29%	30%	15%	7%	2%
<b>Updated</b>	Potential DPM	3	3	29	35	29	44	53
	Conversion Rate	14%	41%	25%	26%	13%	6%	2%

### Notes

\* Rates presented are for 2011 for Quebec and 2012 for the remaining provinces.

DPM: Donors per million.

### Sources

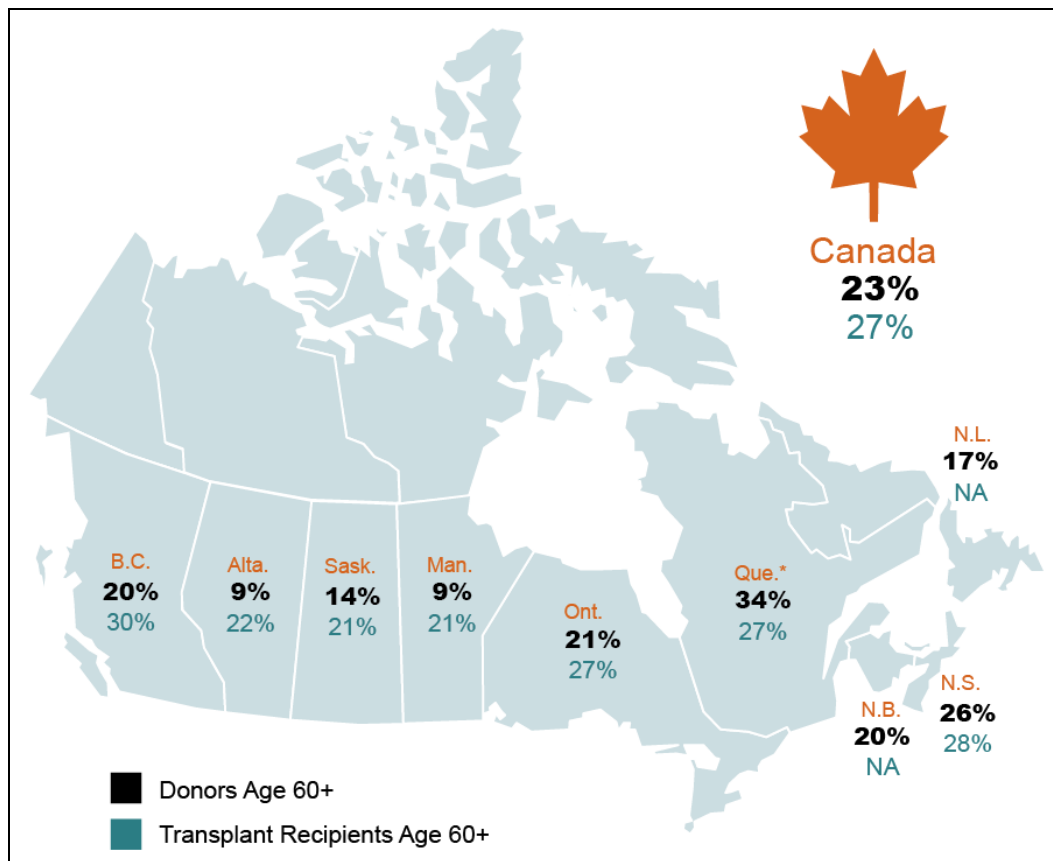
Hospital Morbidity Database and Canadian Organ Replacement Register, 2011 (Quebec) and 2012 (remaining provinces), Canadian Institute for Health Information; Statistics Canada, population estimates, 2011 (Quebec) and 2012 (remaining provinces).

Analysis by age group shows that health systems are more successful at identifying and procuring organs from younger potential donors than from older potential donors.

- Almost a third (30%) of estimated potential donors younger than 50 became actual donors, compared with only 15% of donors age 50 to 59. Conversion rates were more than 4 times higher for those younger than 50 than for potential donors age 60 to 69 (7%). These observed differences by age group are consistent with other Canadian analyses of conversion rates.<sup>7, 8</sup>

The number of potential donors also becomes much higher with increasing age. The study methods likely overestimate the true number of potential donors among seniors in particular, due in part to the larger volume of hospital deaths in this age group and data limitations around risk factors that may prevent safe donation from older Canadians. However, there is important variation across the country in the actual procurement of organs from Canadians age 60 and older, as illustrated in Figure 4.

Figure 4: Percentage of Donors Age 60 and Older, 2008 to 2012\*

**Notes**

\* Rates presented exclude Quebec in 2012.

Multiple years were combined for this figure to account for year-to-year fluctuations among smaller jurisdictions.

**Source**

Canadian Organ Replacement Register, 2008 to 2011 (Quebec) and 2008 to 2012 (remaining provinces), Canadian Institute for Health Information.

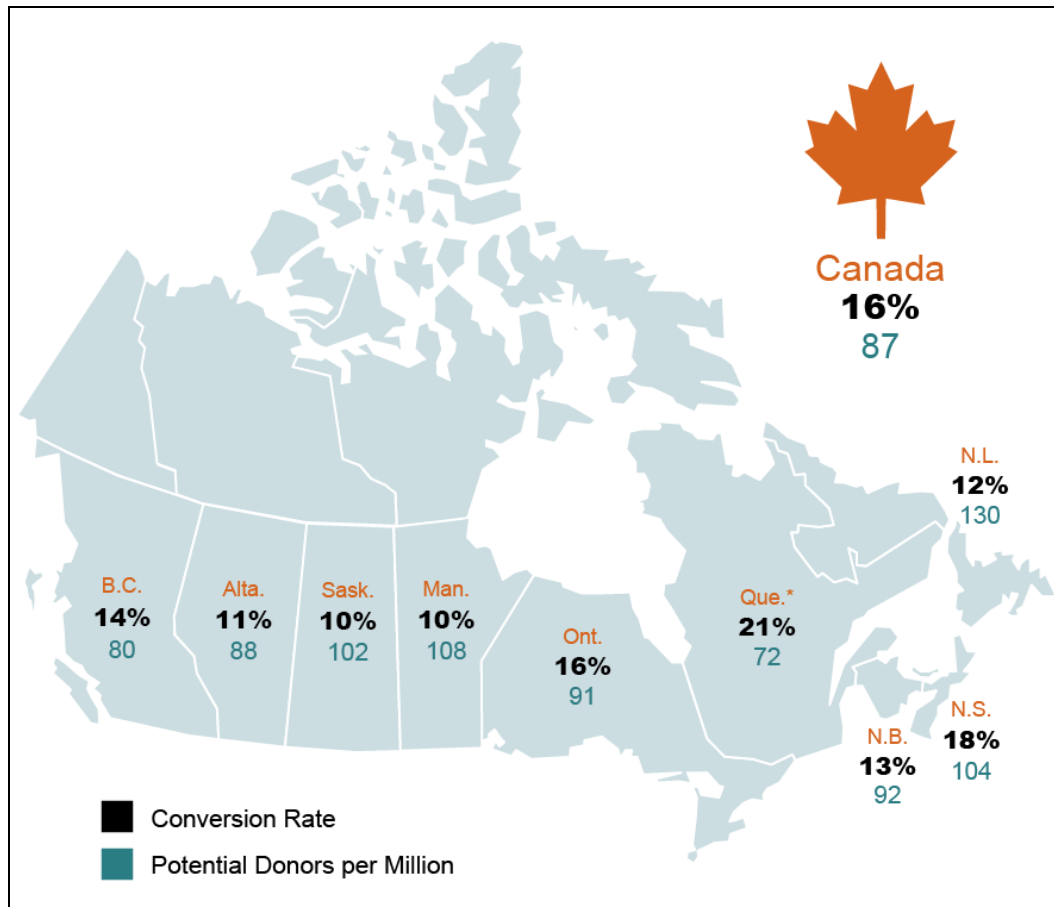
**Key Findings**

- There is a more than three-fold variation across the country in the utilization of older donors. Quebec had the highest percentage of actual donors 60 and older, accounting for more than one-third (34%) of its total donor pool, followed by Nova Scotia (26%). In contrast, fewer than 10% of deceased donors in Alberta and Manitoba were 60 and older.
- Other countries have higher proportions of older deceased donors. Less than one-quarter (23%) of Canadian donors were 60 and older between 2008 and 2012. In contrast, up to 45% of deceased donors in Spain were 60 and older in 2009.<sup>17</sup> Spain is considered a world leader in deceased organ donation<sup>2, 17, 19</sup> and has made concerted efforts to increase supply from older donors as part of an allocation strategy for older organ transplant recipients.
- The proportion of organ transplant recipients age 60 and older varies from province to province (from 21% to 30%). However, it does not vary as much as the proportion of older donors. This suggests that differences in clinical practice, not patient needs, are likely the largest drivers of variations in the use of older donors.

### 3. Provincial Variation in Donor Conversion

The provinces and territories are responsible for the delivery of health services in Canada, including the organization and management of organ donation, procurement and transplantation programs. Analysis by province (Figure 5) shows important variation across the country, in both the number of potential donors per million and corresponding conversion rates of potential donors into actual donors.

Figure 5: Conversion Rates and Potential Donors per Million by Province, 2008 to 2012\*



#### Notes

\* Rates presented exclude Quebec in 2012.  
 Using strict exclusion criteria for donors younger than 70.

#### Sources

Hospital Morbidity Database and Canadian Organ Replacement Register, 2008 to 2011 (Quebec) and 2008 to 2012 (remaining provinces), Canadian Institute for Health Information; Statistics Canada, population estimates, 2011 (Quebec) and 2012 (remaining provinces).

When looking at how effectively health systems across Canada convert potential donors into actual donors, the study found a two-fold variation among provinces. Quebec's conversion rate was more or less twice as high as those observed in the prairie provinces of Saskatchewan, Manitoba and Alberta. As small differences from year to year in the number of donors can cause wide fluctuations in smaller provinces, years were combined to provide a more stable means of comparison. (More detailed tables by year are available for free download as a companion product to this report.)

The study also found important differences in the number of potential donors among provinces. This may be due to provincial variation in the types of death that lead to organ donation. For example, there are significant differences in injury rates across the country, as well as in stroke incidence and mortality rates.<sup>34</sup> Hospitalizations for trauma vary nearly two-fold among provinces,<sup>35</sup> and cerebrovascular deaths are more common in Newfoundland and Labrador than in Quebec.<sup>34</sup>

To better understand differences in conversion rates, Table 3 examines differences in donor profiles by province.

**Table 3: Provincial Variation in Actual Donors, 2008 to 2012\***

Donor Measure	N.L.	N.B.	N.S.	Que.*	Ont.	Man.	Sask.	Alta.	B.C.	Canada
<b>Number of Donors</b>	42	46	93	545	1064	68	58	191	261	2368
<b>Organs Retrieved (Mean)</b>	3.9	4.2	4.0	3.2	3.4	4.3	4.2	4.2	4.6	3.6
<b>Organs Transplanted (Mean)</b>	3.6	4.0	3.7	3.2	3.2	3.9	3.9	3.9	3.7	3.4
<b>% DBD</b>	100%	100%	91%	96%	82%	100%	100%	97%	92%	89%
<b>% DCD</b>	0%	0%	9%	4%	18%	0%	0%	3%	8%	11%
<b>Median Age</b>	45	50	51	51	48	42	42	35	46	48
<b>% Age 60+</b>	17%	20%	26%	34%	21%	9%	14%	9%	20%	23%
<b>% Male</b>	71%	39%	49%	53%	57%	51%	50%	59%	55%	55%
<b>% Caucasian+</b>	95%	98%	91%	97%	90%	75%	97%	88%	88%	91%

#### Notes

\* 2008 to 2011 data used for Quebec.

DBD: Donation after brain death.

DCD: Donation after cardiocirculatory death and other.

Caucasian+: The category Caucasian was collapsed with unspecified responses to address inconsistencies in reporting racial origin among provinces.

#### Source

Canadian Organ Replacement Register, 2011 (Quebec) and 2012 (remaining provinces), Canadian Institute for Health Information.

## Key Findings

- Small differences were observed across the country in the number of organs collected and successfully transplanted from each deceased donor. A deceased donor can provide up to 8 organs for transplant, though some medical conditions or injuries may prevent utilization of all of the donor's organs. Maximizing solid organ and tissue retrieval from a single donor is a strategy used by many jurisdictions to increase organ supply.
- During the study period, 5 Canadian provinces practised DCD. Ontario far exceeded other provinces in the proportion of DCD donors used in its transplant program; these donors accounted for 24%—close to 1 in 4—of actual donors in 2012 and 18% over the 5 years combined (2008 to 2012).
- There is an important 16-year difference among the provinces in the median age of donors. (The median is the age at which half of all donors are older and half are younger.) Median ages tend to be higher in Quebec and the Maritime provinces and lower in the Prairies. Quebec and Nova Scotia had the highest median donor age (51) in Canada, and in 2013, Quebec successfully transplanted an organ from an 88-year-old donor.<sup>4</sup>
- Differences in the proportion of male and female donors may reflect regional differences in the causes of death that lead to donation. For example, injury and stroke rates vary significantly across the country and, statistically, men are more likely to die from injury, whereas more women die of stroke<sup>34</sup> in Canada. However, more research is required to better understand regional differences in donation by sex and whether there are opportunities to improve either identification of potential donors on a gender basis or consent rates based on sex.
- The data also shows that the vast majority of actual organ donors (91%) in Canada are Caucasian. This is higher than their proportion in the Canadian population at large (81%).<sup>36</sup> Studies suggest consent rates for organ donation tend to be higher among Caucasians and lower among visible minorities.<sup>6, 37</sup> When comparing provinces, Manitoba had the highest proportion of donors (25%) who were not Caucasian, with the majority being of Aboriginal descent.

## 4. Organization of Hospital Care

Deceased donation requires organization, coordination and planning at the system level to manage donor registries and wait lists for transplants and to allocate resources most effectively. It also requires trained staff and resources on the front lines of hospital care to identify potential donors, seek consent of families, conduct suitability tests and coordinate with transplant authorities in order to find an organ donor match to save a life.

To better understand some of the factors associated with successful donor conversion, a logistic regression analysis was conducted using linked acute care and donor registry records in Ontario. This analysis was possible in Ontario only, as record linkage is permitted and there is more detailed (and mandatory) reporting of organ donor procurement in the province's acute care hospital records. Ontario is Canada's most populous province, with almost 40% of the total Canadian population. Table 4 illustrates factors at the hospital level associated with organ donor conversion.



More information on the methodology is available in Appendix 1 of this report, and a more detailed table that includes other patient- and system-level factors associated with deceased donation is available for free download as a companion product to this report.

**Table 4: Hospital Factors Associated With Organ Donation in Ontario, 2008 to 2012**

Measure	Odds Ratio	Confidence Interval
<b>Death Time of Day: Work Day (6 a.m.–6 p.m.) Versus Evening</b>	1.5*	1.3–1.8
<b>Death Day of Week: Weekend (Friday 6 p.m.–Monday 6 a.m.) Versus Weekday</b>	0.9	0.8–1.1
<b>Peer Group: Teaching Versus Community</b>	1.6*	1.4–1.9

**Notes**

\*  $p < 0.01$ .

Using strict exclusion criteria for donors younger than 70.

**Sources**

Hospital Morbidity Database and Canadian Organ Replacement Register, 2011 (Quebec) and 2012 (remaining provinces), Canadian Institute for Health Information.

## Key Findings

- **Hospital type:** Teaching hospitals in Ontario were 60% more likely to convert potential donors into actual donors than community hospitals in the province. This is consistent with findings from other Canadian<sup>23</sup> and international studies.<sup>19</sup> In addition to having more resources, these facilities are also more likely to see the positive outcomes of transplantation and to establish a culture that supports organ donation. However, more than half (54%) of potential donors identified in the study died in community hospitals. Similarly, a Quebec study found that close to one-third of potential donors in that province died in non-teaching hospitals without trauma units or in hospitals without donor coordinators, and that these people were less likely to become actual donors.<sup>7</sup> This suggests an opportunity to improve organ donor conversion at the community hospital level.
- **Daytime death:** Potential donors who died during daytime hours were about 50% more likely to become actual donors than those who died in the evening. This could indicate a need for more round-the-clock availability of organ donation support staff. However, weekend deaths were not found to be a significant factor associated with donor conversion.
- **Access to mechanical ventilation:** Figure 2 shows that about 40% to 50% of acute care patients with a brain or cardiocirculatory death did not become possible donors because they were not mechanically ventilated in an intensive care unit while in hospital. Mechanical ventilation is necessary to keep oxygen flowing to the organs in order to facilitate a successful transplantation. While ventilation may not be indicated in all circumstances of end-of-life care, appropriate access to mechanical ventilation may be an area for further exploration. For example, intensive care units may be operating at full capacity and may not have the room or resources to accept a potential deceased donor.<sup>37</sup>

## Barriers to and Opportunities for Deceased Solid Organ Donation

Successful organ donation involves many players and a complex chain of events—from care at the patient bedside to coordination of wait lists and resources at the health system level. In 2011, Canadian Blood Services released *Call to Action: A Strategic Plan to Improve Organ and Tissue Donation and Transplantation Performance for Canadians* on behalf of Canada's organ transplantation communities.

The following table highlights some of the key challenges identified in the report, as well as opportunities and efforts to address them based on international best practices.

Barrier	Opportunity
Potential donors are not always identified by hospital staff and referred to provincial organ procurement organizations in a timely fashion.	Following the Spanish model, embed donation physicians within hospitals to integrate donation as part of end-of-life care, and ensure the quick identification and referral of potential patients.
Families are not always given an opportunity to donate, because staff are not sure how to approach them.	Train staff in how to initiate discussions with families and approach them in a culturally sensitive manner.
Families do not always consent to donation.	
Donation activities can be costly and must often compete with other services for access to intensive care unit beds and mechanical ventilation.	Implement provincial programs to reimburse hospitals for the cost of maintaining deceased donors on mechanical ventilation until organs are recovered.
There is slow and inconsistent adoption of leading practices across the country.	Follow the leading practice guidelines developed by Canadian Blood Services and ensure a coordinated approach to training health professionals.
There is vague and uncoordinated accountability for organ donation.	Implement a formal accountability framework with clear roles and responsibilities—as well as performance targets—for an integrated organ donation and transplantation system.
There is incomplete and inconsistent information to measure and monitor performance across the country.	Develop mandatory data reporting requirements: high-performing countries and jurisdictions have made quality performance monitoring a key component of their donation programs.

## Conclusions and Discussion

Not only does transplantation provide better outcomes for patients, it is often more cost-effective for the health system. For example, over a 5-year period, a kidney transplant patient costs approximately \$250,000 less than a patient on dialysis.<sup>38</sup> Like most other developed countries, Canada is facing a shortage of available organs for transplantation. Multiple strategies have been put into place across the country to encourage organ donation. These include efforts to improve donor registration (consent) at the individual level, and also to improve hospital success in identifying potential donors and coordinating successful transplants.

Strengthening the measurement of organ donation is also considered an important strategy to drive improvements across Canada.<sup>2</sup> By estimating potential and actual conversion rates, this study provides health systems with comparable information that accounts for regional differences in hospital deaths and complements more detailed organ donation reports released by some provinces.

Methods used in this study have important limitations and are not intended to supplant full patient medical chart reviews, which are considered the gold standard in identifying potential donors. However, there are several advantages to this approach:

- All hospital deaths in all Canadian acute care facilities were captured.
- Estimates are comparable across the country.
- The approach is reproducible and easily trended.
- The approach is also more economical and much less resource intensive than full patient chart reviews.

The study found there is potential to increase the number of deceased donors in Canada—about 1 in 6 potential donors younger than 70 became actual donors (using strict exclusion criteria). Even when considering overestimation by the study methods, there is still an important gap between potential and actual utilization of organ donors. While this report cannot measure why the potential is not being realized, a Quebec report suggested that up to a half of all potential donors may be lost due to a lack of consent from patients or their families, while 1 in 5 were not identified in time by hospital staff.<sup>7</sup>

Key findings from this study also raise the following points for discussion:

- **There is wide variation among provinces in the practice of deceased organ donation.** Variation among jurisdictions in both conversion rates and actual deceased donor profiles suggests there is room for improvement and an opportunity to learn from best practices across the country. The variations are particularly important when it comes to the use of older donors or DCD. Other countries have successfully targeted older donors or DCDs to increase their supply of available organs.

- **Organization of care can influence organ donation.** The study found that in Ontario, teaching hospitals are more successful at converting potential donors into actual donors than community hospitals, even though about half of potential donors die in community hospitals. At the Canada-wide level, the study also found that about half of patients with hospital deaths amenable to organ donation did not become potential donors because they had no recorded mechanical ventilation during their hospital stay. This finding suggests there may be an opportunity to increase donor potential by increasing ventilation capacity in smaller community facilities.
- **More comparable information is required to better understand performance in organ donation.** While summary data on organ donation activity is available in CIHI's CORR, there is a lack of comparable data across Canada on donor identification, referral rates and consent rates. Referral and patient consent are critical factors for successful donation, and more detailed and comparable information about them could help shed light on best practices in these areas. In addition, capturing organ donation procurement in hospital discharge abstracts is not mandatory in most provinces. This information would allow for a more comprehensive analysis of the factors associated with successful donation across the country.
- **Eligibility criteria for organ donation in Canada are not consistent across the country.** In Canada and around the world, eligibility requirements are evolving to meet the growing need for solid organs. However, unlike other countries (e.g., Australia, New Zealand, the U.K.) where suitability criteria for organ donors are regularly updated and publicly reported, there is no standard reporting mechanism in Canada. Each province determines its own set of criteria based on Canadian standards that are several years old and open to interpretation. These criteria are not publicly shared (e.g., via websites) and may vary among provinces as well as among individual clinicians.

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## Appendix 1: Estimating Donor Potential

To estimate the number of potential donors, the study examined all patients who died in Canadian hospitals who were mechanically ventilated and who had a recorded stay in an intensive care unit. In addition, the following criteria were used to further limit the potential donor pool:

- **Inclusion criteria:** Brain deaths and cardiocirculatory deaths were identified based on a standard list of medical conditions associated with these types of deaths and used in domestic and international studies on organ donation.<sup>15</sup> A list of medical criteria is available in Appendix 2.
- **Exclusion criteria:** Patients were excluded from the estimate if they had medical contraindications to donation. To reflect evolving practice, 2 sets of exclusion criteria were used for this analysis:
  - **Strict criteria:** A long list of infections and conditions based on Canadian standards published in 2007.<sup>11, 15</sup>
  - **Updated criteria:** Based on widening eligibility criteria in Canada and internationally,<sup>17, 18</sup> contraindications are limited to active and metastatic cancers, a history of melanoma, premature infants and some systemic infections (including sepsis, tuberculosis, hepatitis B and C, West Nile virus, HIV and Creutzfeldt-Jakob disease). The updated criteria were validated using linked data to determine the medical characteristics of actual donors.

See Appendix 3 for a list of conditions included in the strict and updated criteria.
- **Age limits:** While there are technically no age restrictions for people to register as donors, the proportion of eligible donors decreases dramatically with advanced age relative to the number of hospital deaths among older patients. For this reason, 2 age limits were used to estimate potential donors:
  - **Younger than 70**, in alignment with methods used in past Canadian<sup>15</sup> and international studies;<sup>39, 40</sup> and
  - **Younger than 80**, to reflect evolving practice and growing acceptance of older donors.<sup>6</sup>

## Factors Associated With Conversion

A hierarchical logistic regression (main fixed effects model without random effects) was used to determine factors associated with becoming an organ donor. The model was fitted to predict actual deceased organ donors from potential donors in Ontario using strict exclusion criteria and including only those younger than 70. Variables available in the clinical administrative data and identified in the literature as being influential to successful organ donor conversion were included. These included both hospital-level factors (hospital size and type, daytime versus evening deaths, weekday versus weekend deaths) and patient-level factors (rural residence, neighbourhood income quintile, age, gender, admitted by ambulance, inclusion/exclusion diagnosis). The full logistic regression results are available in the data tables associated with this product.

## Appendix 2: Potential Solid Organ Donor Inclusion Diagnoses

- Head injury
- Fracture of vault of skull with intracranial injury or hemorrhage
- Fracture of base of skull with intracranial injury or hemorrhage
- Other skull fractures with intracranial injury or hemorrhage
- Multiple fractures of skull or face with intracranial injury or hemorrhage
- Cerebral laceration and contusion
- Subarachnoid, subdural and extradural hemorrhage following injury
- Other intracranial hemorrhage following injury
- Intracranial injury of other and unspecified nature
- Cerebrovascular accident (CVA)
- Subarachnoid hemorrhage
- Intracerebral hemorrhage
- Other intracranial hemorrhage
- Occlusion or stenosis of precerebral arteries
- Occlusion of cerebral arteries
- Acute but ill-defined cerebrovascular disease
- Other
- Central nervous system tumours
- Anoxic brain damage
- Compression of brain
- Cerebral edema
- Ventricular tachycardia
- Ventricular fibrillation and flutter
- Cardiac arrest
- Status asthmaticus
- Asphyxia
- Respiratory arrest
- Asphyxiation and strangulation



## Appendix 3: Potential Solid Organ Donor Exclusion Criteria

Strict Exclusion Criteria	Updated Exclusion Criteria
Death from unknown cause	
Tuberculosis	Tuberculosis
Active septicemia	Active septicemia
HIV/human T-lymphotropic virus	HIV/human T-lymphotropic virus
Acute poliomyelitis	
Creutzfeldt-Jakob disease	Creutzfeldt-Jakob disease
West Nile virus	West Nile virus
Subacute sclerosing panencephalitis	
Progressive multifocal leukoencephalitis	
Active encephalitis	
Herpetic septicemia	
Viral hepatitis B	Viral hepatitis B
Viral hepatitis C	Viral hepatitis C
Rabies	
Malaria	
Active syphilis	
Active gonorrhea	
Systemic mycosis	
Malignant neoplasms	Malignant neoplasms
Melanoma	Melanoma
Active disseminated lymphomas, including Hodgkin's, non-Hodgkin's, Sézary	Active disseminated lymphomas, including Hodgkin's, non-Hodgkin's, Sézary
Leukemia	Leukemia
Myelodysplastic syndromes, including refractory anemia	
Meningitis (bacterial/viral)	
Alzheimer's disease	
Parkinson's disease	
Amyotrophic lateral sclerosis	
Multiple sclerosis	
Active endocarditis	
Mixed connective tissue disease	
All conditions affecting newborns, including immaturity/low birth weight	Prematurity (gestational age less than 32 weeks) or weight less than 500 grams
Chemotherapy for cancer	
Teleradiotherapy	
Pituitary dwarfism	
Previous tissue/organ transplant	

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