Many eligible patients never receive an organ transplant because of biological or psychological human factors that contribute to shortfalls in organ availability.1,2 Immune suppression and surgical complications, for example, require that transplant recipients receive centralized care at hospitals staffed by highly specialized clinicians.3,4 However, the subtleties of patient preferences, community support and maximizing available organs require that donors be identified from a wide range of general hospitals.2 Ultimately, these practices can mean that hospitals responsible for identifying potential donors do not always encounter the patients who received the successful transplantations.

A request for organ donation after death requires initiative, appropriate referral, consent, formal declaration of brain death and maintenance of donor viability at a time when other patients may also require attention.5,6 The time pressure is substantial, because incidents often arise on weekends or at night when clinicians are short staffed, sleep deprived and uncertain about diagnosing brain death.7,8 The diversity of cultural preferences and distraught emotions in relatives of potential donors can also cause well-intentioned requests to be misunderstood and followed by negative conflict.9,10 Hence, the ongoing rates of deceased organ donation represent substantial efforts both in the community and in hospitals.11

Decision science research suggests that clinical behaviour does not always follow the standard model of rational thought.12 Self-identity, for example, can sometimes influence decisions by shaping people’s preferences and defining institutional norms.13–15 We questioned whether the difference between hospitals that observe gratifying recipient outcomes and hospitals that initiate...
deceased organ donation might potentially contribute to lower donation rates owing to the lost transmission of information and the attitudes of hospitals that do not have transplant programs. To test this question, we assessed deceased organ donation rates and compared hospitals that have clinical services for transplant recipients to hospitals that do not have such services.

**Methods**

**Patients**

We identified all consecutive patients (children and adults) who died in any Ontario hospital between Apr. 1, 1994, and Mar. 31, 2011, from conditions associated with catastrophic brain injury. We chose this time frame because data were available for all hospitals, the coding system remained mostly unchanged (with the exception of one revision in 2002), and none of the hospitals changed their transplantation designation during this period. We excluded patients who did not have a valid health card identifier. The study was approved by the Sunnybrook Research Ethics Board, including a waiver of individual consent.

**Selected causes of death**

The patient’s cause of death was classified using the International Classification of Disease (ICD) codes (versions 9 and 10, as appropriate). We included 3 specific conditions that were common causes of brain death, consistently documented in available records and established in previous research.\textsuperscript{16–18} Traumatic brain injury was defined as cerebral laceration, contusion or other intracranial hemorrhage after trauma (ICD codes 800, 801, 804, 851–853 and S06–S09). Subarachnoid hemorrhage included events related to aneurysms or vascular malformations (ICD codes 430 and I60). Intracerebral hemorrhage included rupture of any cerebral blood vessel or unspecified nontraumatic hemorrhage (ICD codes 431, 432, I61 and I62).

**Additional causes of death**

We included 5 additional neurologic causes of death to provide a comprehensive assessment of potential donors: anoxic brain damage (ICD codes 348 and G931), cerebral edema (ICD codes 348 and G936), cerebral infarction (ICD codes 434 and I639), cerebral thrombosis (ICD codes 434, 436, I136, I138, I630–I635, I639 and I640) and asphyxiation (ICD codes 994 and T71).

**Patient characteristics**

We obtained patient age at death, sex and residence (urban or rural) through the official vital statistics registry.\textsuperscript{19} We derived patient socioeconomic status using the Statistics Canada algorithm.\textsuperscript{20} We determined previous admissions to hospital and outpatient visits in the year before death using linked databases validated in previous research (i.e., the Canadian Institute for Health Information hospital inpatient database and the Ontario Health Insurance Plan medical outpatient database).\textsuperscript{21,22} We determined comorbid conditions by any physician diagnosis in the...
We addressed referral patterns by classifying mode of hospital arrival into 3 groups: direct from the community, by ambulance or transferred from another hospital. The databases did not contain information on patient preferences, religion, race, ethnicity, vital signs, mental status, medications or formal declaration of brain death.

**Hospital characteristics**

We focused our attention on where the patient died and distinguished between hospitals that averaged more than 20 deaths per year (“larger hospitals”) and those that averaged fewer than 20 deaths per year (“smaller hospitals”). Larger hospitals were further divided into those that had clinical services for transplant recipients (“transplant hospitals”) and those that did not (“general hospitals”). Without exception, transplant hospitals announced transplantation services prominently as part of their identity, whereas general hospitals made no mention of such services on public websites or in community services. Otherwise, the hospitals operated under the same regulations, offered similar emergency services and obtained funding through identical fee structures.

**Actual organ donation**

We determined solid organ donation through the population-based physician billing database using a comprehensive set of billing codes for any combination of heart, lung, kidney, liver, pancreas or bowel procurement (codes E753, G347, G348, G411, M157, R872, S196, S201, S265, S274, S302 and S436). Some surgeons received funding from alternate payment programs and did not always use such codes; however, anesthesiologists and other clinicians without alternate funding used such codes in all relevant cases. These billing codes are specific (100%, 95% confidence interval [CI] 99%–100%), but not fully sensitive (75%, 95% CI 73%–78%) when validated through the Trillium Gift of Life Network registry (A.H. Li, Western University, unpublished data).

**Subgroup of eligible candidates**

We identified a subgroup of patients who would be the most eligible candidates for organ procurement based on a combination of demographic and clinical data. We used the data from this subgroup to check the robustness of our primary analysis after confining the sample based on objective criteria; specifically, patients with a diagnosis of any of the 3 specific conditions that were common causes of brain death, patients aged 59 years or younger, patients who received mechanical ventilation on their first day in hospital, patients who did not have a disqualifying condition (HIV, tuberculosis or cancer) and patients who survived for no longer than 1 week in hospital.

**Table 1: Characteristics of patients included in the study**

| Characteristic | Transplant hospitals, no. (%) | General hospitals, no. (%) |
|---------------|-----------------------------|---------------------------|
| Age, yr       |                             |                           |
| ≤ 19          | 1 032 (4.6)                 | 268 (0.5)                 |
| 20–44         | 2 036 (9.0)                 | 1 920 (3.3)               |
| 45–59         | 3 331 (14.8)                | 4 742 (8.3)               |
| 60–74         | 6 384 (28.3)                | 14 771 (25.8)             |
| ≥ 75          | 9 714 (43.1)                | 35 514 (62.0)             |
| Missing       | 18 (0.1)                    | 16 (0.0)                  |
| Sex           |                             |                           |
| Male          | 12 014 (53.4)               | 28 416 (49.6)             |
| Missing       | 18 (0.1)                    | 16 (0.0)                  |
| Residence     |                             |                           |
| Urban (v. rural) | 19 778 (87.8)        | 52 579 (91.9)             |
| Missing       | 26 (0.1)                    | 75 (0.1)                  |
| Income quintile |                             |                           |
| 5 (highest)   | 4 076 (18.1)                | 9 503 (16.6)              |
| 4             | 3 841 (17.1)                | 9 648 (16.9)              |
| 3             | 4 067 (18.1)                | 11 292 (19.7)             |
| 2             | 4 815 (21.4)                | 12 924 (22.6)             |
| 1 (lowest)    | 5 580 (24.8)                | 13 646 (23.8)             |
| Missing       | 136 (0.6)                   | 218 (0.4)                 |
| Previous care*|                             |                           |
| ≥ 7 visits to an outpatient clinic | 17 428 (77.4)        | 47 496 (83.0)             |
| ≥ 1 admission to hospital         | 8 849 (39.3)              | 23 426 (40.9)             |
| Arrival at hospital               |                             |                           |
| By ambulance                  | 14 961 (66.4)              | 42 597 (74.4)             |
| Direct (no ambulance)           | 5 037 (22.4)               | 11 652 (20.4)             |
| Hospital-to-hospital transfer    | 2 517 (11.2)               | 2 982 (5.2)               |
| Season of admission             |                             |                           |
| Winter                        | 5 678 (25.2)               | 15 356 (26.8)             |
| Spring                       | 5 704 (25.3)               | 14 646 (25.6)             |
| Summer                       | 5 433 (24.1)               | 13 264 (23.2)             |
| Autumn                       | 5 700 (25.3)               | 13 965 (24.4)             |
| Day of admission              |                             |                           |
| Weekday                       | 16 091 (71.5)              | 41 166 (71.9)             |
| Weekend                       | 6 424 (28.5)               | 16 065 (28.1)             |
| Diagnosis                     |                             |                           |
| Traumatic brain injury         | 2 794 (12.4)               | 3 892 (6.8)               |
| Subarachnoid hemorrhage        | 1 200 (5.3)                | 1 458 (2.5)               |
| Intracerebral hemorrhage       | 3 999 (17.8)               | 10 777 (18.8)             |
| Other neurologic death         | 9 431 (41.2)               | 27 725 (48.4)             |
| Combination of above           | 5 091 (23.6)               | 13 379 (23.4)             |

*Identified during year before death.
Control procedure
We examined cornea donation as another type of donation that follows a different procurement procedure. In contrast to organ donation, cornea donation (code E108) is subject to much less time pressure and can be scheduled hours after death. The person initiating the request for cornea donation tends to be affiliated with a central agency in Ontario and is not directly attached to the particular hospital involved. Finally, the request for cornea donation usually occurs when a donor is no longer receiving life-sustaining therapies and all physiology has ended.

Statistical analysis
Our primary analysis evaluated rates of actual organ donation among patients who were potential donors and compared transplant hospitals to general hospitals. We used hierarchical logistic regression to account for patient clustering in hospitals of different sizes. Our secondary multivariable analyses accounted for demographic factors including patient age, sex, residence, socioeconomic status and time of death (year, season, day). We performed additional stratified analyses to repeat the primary comparison using only data from the subgroup of patients who would be most eligible for donation. We conducted all analyses using the privacy safeguards of the Institute for Clinical Evaluative Sciences.

Results
We identified a total of 87 129 patients who died during the study period, of whom 1930 were identified as actual organ donors, (i.e., about 9 donors per million population annually). The number of actual donors increased with time so that the number of donors in the final year of the study was about twice that of the first year (Figure 1). The median upper quartile of age of actual organ donors also increased with time, with an increase in median age of about 11 years (40 v. 51 yr) and an increase in upper quartile age of about 10 years (51 v. 61 yr). The 87 129 deaths were distributed across 140 hospitals, of which a total of 84 hospitals averaged fewer than 20 deaths annually. After excluding these small general hospitals, we obtained a sample of 56 hospitals (40%), 79 746 deaths (92%) and 1898 (98%) actual organ donors.

A total of 22 515 patients died at transplant hospitals and the remaining 57 231 died at large general hospitals. Those who died in transplant hospitals had a distribution of demographic characteristics similar to that of patients who died at large general hospitals (Table 1). Patients who died generally lived in an urban area, had diverse characteristics and had a diagnosis of intracerebral hemorrhage or some other catastrophic neurologic condition. The main differences between the 2 settings were that patients who died in large general hospitals tended to be older and more likely to have a diagnosis of a miscellaneous catastrophic neurologic condition than those who died at a transplant hospital. Socioeconomic status was well balanced, albeit with a lower representation of people with high socioeconomic status in both groups.

Overall, 1898 of the 79 746 patients included in our primary analysis became donors, for a procurement rate of about 1 in 40. Transplant hospitals accounted for 1118 donors and 22 515 deaths, for a procurement rate of 5.0 per 100 deaths. Large general hospitals accounted for 780 donors and 57 231 deaths, for a procurement rate of 1.4 per 100 deaths (Figures 2 and 3). This difference between hospitals was equal to a relative reduction in donation rates of about 74% (odds ratio [OR] 0.26, 95% confidence interval [CI] 0.24–0.29), was evident in both the first and second halves of the dataset (before and after Jan. 1, 2003) and amounted to an absolute reduc-
tion of about 121 actual organ donors each year in large general hospitals. Comparisons based on data from all hospitals (including small general hospitals) showed a relative reduction of 76% (OR 0.24, 95% CI 0.22–0.27). Restricting analyses to the 13 largest hospitals (> 2000 total deaths) showed a relative reduction of 73% (OR 0.27, 95% CI 0.24–0.31).

We identified patients who would be the most eligible donors by determining those with a diagnosis of traumatic brain injury, subarachnoid hemorrhage or intracerebral hemorrhage and who were younger than 59 years, were free of disqualifying clinical conditions, received mechanical ventilation starting on their first day in hospital and survived in hospital no longer than 1 week. A total of 3961 patients met these criteria, of whom 1035 were actual donors, for an overall procurement rate of about 1 in 4. Transplant hospitals accounted for 652 donors and 2205 deaths (procurement rate 29.6/100 deaths), large general hospitals accounted for 383 donors and 1756 deaths (procurement rate of 21.8/100 deaths), for a relative reduction in donation rates of about 34% (OR 0.66, 95% CI 0.57–0.77).

Basic patient characteristics were additional predictors of actual organ donation. Patients aged 59 years or younger were about 10 times more likely to be actual donors than patients aged 60 years or older (Table 2). Patients with lower socioeconomic status were about 30% less likely to be actual donors than patients with higher socioeconomic status. Cause of death was a good predictor of organ donation, with the highest rates of donation among patients who died after subarachnoid hemorrhage. Accounting for all predictors yielded a relative reduction in donation rates of about 42% (OR 0.58, 95% CI 0.36–0.92) at large general hospitals compared with transplant hospitals.

Our control analysis showed no large differences in cornea donation when comparing different hospitals. Overall, 2104 of the 79 746 patients who died became cornea donors. Transplant hospitals accounted for 688 cornea donors (procurement rate 3.1/100 deaths); large general hospitals accounted for 1416 cornea donors (procurement rate 2.5/100 deaths). This difference was equal to a relative reduction in donation rates of about 20% (95% CI 12%–27%). The subgroup analyses restricted to the 3961 patients who were the most eligible donors showed a procurement rate of about 1 in 8 and a 14% relative (but nonsignifi-
Research

†History of HIV, tuberculosis or cancer.
*Coded as a continuous variable.

Note: CI = confidence interval, OR = odds ratio, ref = reference group.

Table 2: Predictors of organ procurement in 56 hospitals in Ontario

| Predictor                        | OR (95% CI)                       | Univariate analysis | Multivariate analysis |
|----------------------------------|-----------------------------------|---------------------|-----------------------|
| **Age, yr**                      |                                   |                     |                       |
| ≤ 44                             | 1.00 (ref)                        | 1.00 (ref)          |                       |
| 45–59                            | 0.50 (0.44–0.56)                  | 0.50 (0.44–0.56)    |                       |
| 60–74                            | 0.11 (0.09–0.12)                  | 0.13 (0.11–0.15)    |                       |
| ≥ 75                             | 0.01 (0.01–0.01)                  | 0.01 (0.01–0.02)    |                       |
| **Sex**                          |                                   |                     |                       |
| Male                             | 1.00 (ref)                        | 1.00 (ref)          |                       |
| Female                           | 0.99 (0.90–1.09)                  | 1.39 (1.25–1.54)    |                       |
| **Residence**                    |                                   |                     |                       |
| Urban                            | 1.00 (ref)                        | 1.00 (ref)          |                       |
| Rural                            | 1.78 (1.55–2.05)                  | 1.11 (0.96–1.30)    |                       |
| **Income quintile**              |                                   |                     |                       |
| 5 (highest)                      | 1.00 (ref)                        | 1.00 (ref)          |                       |
| 4                                | 1.11 (0.96–1.28)                  | 0.89 (0.76–1.04)    |                       |
| 3                                | 0.97 (0.84–1.13)                  | 0.81 (0.69–0.95)    |                       |
| 2                                | 0.77 (0.66–0.89)                  | 0.63 (0.54–0.74)    |                       |
| 1 (lowest)                       | 0.78 (0.68–0.91)                  | 0.63 (0.53–0.73)    |                       |
| **Prior care**                   |                                   |                     |                       |
| Visits to outpatient clinics*    | 0.25 (0.22–0.27)                  | 0.66 (0.59–0.74)    |                       |
| Admissions to hospital*          | 0.36 (0.32–0.41)                  | 0.66 (0.57–0.76)    |                       |
| **Arrival**                      |                                   |                     |                       |
| By ambulance                     | 1.00 (ref)                        | 1.00 (ref)          |                       |
| Direct (no ambulance)            | 0.60 (0.53–0.69)                  | 0.81 (0.70–0.93)    |                       |
| Hospital-to-hospital transfer    | 0.81 (0.68–0.96)                  | 1.06 (0.86–1.30)    |                       |
| **Season**                       |                                   |                     |                       |
| Winter                           | 1.00 (ref)                        | 1.00 (ref)          |                       |
| Spring                           | 0.92 (0.81–1.05)                  | 0.91 (0.79–1.05)    |                       |
| Summer                           | 1.05 (0.92–1.20)                  | 0.94 (0.81–1.08)    |                       |
| Autumn                           | 1.10 (0.96–1.25)                  | 1.06 (0.92–1.21)    |                       |
| **Day**                          |                                   |                     |                       |
| Weekday                          | 1.00 (ref)                        | 1.00 (ref)          |                       |
| Weekend                          | 0.97 (0.87–1.07)                  | 0.94 (0.84–1.05)    |                       |
| **Diagnosis**                    |                                   |                     |                       |
| Traumatic brain injury           | 1.00 (ref)                        | 1.00 (ref)          |                       |
| Subarachnoid hemorrhage          | 1.99 (1.70–2.34)                  | 1.55 (1.29–1.86)    |                       |
| Intracerebral hemorrhage         | 0.51 (0.44–0.59)                  | 0.90 (0.76–1.06)    |                       |
| Other neurologic death           | 0.21 (0.18–0.25)                  | 0.31 (0.27–0.37)    |                       |
| Combination of above             | 0.53 (0.46–0.61)                  | 0.72 (0.61–0.84)    |                       |
| **Exclusions**                   |                                   |                     |                       |
| Disqualifying condition†         | 0.06 (0.03–0.11)                  | 0.06 (0.03–0.12)    |                       |
| **Hospital**                     |                                   |                     |                       |
| Transplant                       | 1.00 (ref)                        | 1.00 (ref)          |                       |
| Large general                    | 0.17 (0.09–0.34)                  | 0.58 (0.36–0.92)    |                       |

Note: CI = confidence interval, OR = odds ratio, ref = reference group.
*Coded as a continuous variable.
†History of HIV, tuberculosis or cancer.
assigned in a controlled experiment. One explanation for our results could be that some hospitals that are inherently enthusiastic about organ donation are early adopters of clinical services for transplant recipients. Alternatively, communities with positive attitudes toward donation might be the most successful at obtaining clinical transplant services at their own hospitals. Regardless of the explanation, our research suggests that actual organ donation may not be an accurate reflection of individual patient wishes.

We used codes for organ donation that were specific rather than sensitive, and they may have missed unidentified cases of organ donation; however, fallible coding is unlikely to explain the size of the discrepancy we saw between transplant hospitals and large general hospitals. In addition, we evaluated a region distinguished by universal health care and public awareness campaigns about transplantation; hence, shortfalls in donation for other regions may be larger. Finally, the ideal rate of organ donation is not known given the importance of patient preferences and community circumstances.

Conclusion

Our research suggests a lower frequency of deceased organ donation at large general hospitals than at transplant hospitals. In particular, we found a substantial age gradient underlying the shortfall in organ donation. This gradient may be partly explained by appropriate medical judgment, given that older organs are sometimes unsuitable for transplantation to young recipients.29-31 However, unfair age discrimination may be an additional explanation.32,33 Indeed, there is no age limit for organ donation, and successful organ procurement can occur from patients older than 80 years of age.34,35

The practice patterns in large hospitals are a reflection of identity, education, incentives and myriad other factors. Thus, addressing the shortfall in organ donation rates could include training, encouragement, regulations, policies, consent procedures and academic detailing campaigns targeting large general hospitals. Any of these approaches would require tact, is prone to misinterpretation and is rarely included in national campaigns for organ donation. The current data suggest, however, that prevailing practices lead to missed potential opportunities for solid organ donation in large general hospitals.

References

1. Gottmacher SL, Beasley CL, Brigham LE, et al. Organ donor potential and performance: size and nature of the donor shortfall. Crit Care Med 1996;24:432-9.
2. Sheehy E, Conrad SL, Brigham LE, et al. Estimating the number of potential organ donors in the United States. N Engl J Med 2003;349:667-74.
3. Scales DC, Granton JT. Care of the critically ill transplant patient. In: Principles of critical care. Hall JB, Schmidt GA, Wood LDH, editors. 3rd ed. New York (NY): McGraw-Hill; 2005.
4. Hauptman PJ, O’Connor KJ. Procurement and allocation of solid organs for transplantation. N Engl J Med 1997;336:422-31.
5. Shemie SD, Ross H, Pagliarello J, et al. Organ donor management in Canada: recommendations of the Forum on Medical Management to Optimize Donor Organ Potential. CMAJ 2006;174:513-32.
6. Wood KE, Becker BN, McCartney JG, et al. Care of the potential organ donor. N Engl J Med 2004;351:2730-9.
7. Bell CM, Redelmeier DA. Mortality among patients admitted to hospitals on weekends as compared with weekdays. N Engl J Med 2001;345:663-8.
8. Greer DM, Varelas PN, Haque S, et al. Variability of brain death determination guidelines in leading US neurologic institutions. Neurology 2008;70:284-9.
9. Siminoff LA, Gordon N, Hewlett J, et al. Factors influencing families’ consent for donation of solid organs for transplantation. JAMA 2001;286:71-7.
10. Ghorbani F, Khoddami-Vishite HR, Gholibadi O, et al. Causes of family refusal for organ donation. Transplant Proc 2011;43:405-6.
11. Simpkin AL, Robertson LC, Barber VS, et al. Modifiable factors influencing relatives’ decision to offer organ donation: systematic review. BMJ 2009;338:b691.
12. Kahneman D. Thinking, fast and slow. New York (NY): Farrar, Straus and Giroux; 2011.
13. Ross L, Nisbet RE. The person and the situation: perspectives of social psychology. New York (NY): McGraw-Hill; 1991.
14. LeBoeuf RA, Shafir E, Bayuk JB. The conflicting choices of alternating selves. Organ Behav Hum Decis Process 2010;111:48-61.
15. Rachlin H, Locey M. A behavioral analysis of altruism. Behav Processes 2011;87:25-33.
16. Cloutier R, Baran D, Morin JE, et al. Brain death diagnoses and evaluation of the number of potential organ donors in Quebec hospitals. Can J Anaesth 2006;53:716-21.
17. Kompanje EJ, Bakker J, Stieker FJ, et al. Organ donations and unused potential donations in traumatic brain injury, subarachnoid haemorrhage and intracerebral haemorrhage. Intensive Care Med 2006;32:217-22.
18. Opdam HL, Silvester W. Identifying the potential organ donor: an audit of hospital deaths. Intensive Care Med 2004;30:1390-7.
19. Williams JL, Young W. Inventory of studies on the accuracy of Canadian health administrative databases. Ottawa (ON): Institute for Clinical Evaluative Sciences; 1996.
20. Wilkins R, Peters PA. Automated geographic coding based on the Statistics Canada Postal Code Conversion Files. Ottawa (ON): Health Statistics Division, Statistics Canada; 2004.
21. Iron K, Godd V, Williams J, Concordance with hospital discharge abstracts and physician claims for surgical procedures in Ontario. North York (ON): Institute for Clinical Evaluative Sciences; 1995.
22. CIHI data quality study of emergency department visits for 2004-2005. Vol. 2: Main study findings. Ottawa (ON): Canadian Institute for Health Information; 2008.
23. Schull MJ, Hatcher CM, Guttmann A, et al. Development of a consensus on evidence-based quality of care indicators for Canadian emergency departments. North York (ON): Institute for Clinical Evaluative Sciences; 2010.
24. Ross L, Nisbet RE. The person and the situation: perspectives of social psychology. New York (NY): McGraw-Hill; 1991.
25. Barber K, Falvey S, Hamilton C, et al. Potential for organ donation in the United Kingdom: audit of intensive care records. BMJ 2006;332:1124-7.
26. Kennedy I, Sells RA, Duar AS, et al. The case for “presumed consent” in organ donation. International Forum for Transplant Ethics. Lancet 1998;351:1650-2.
27. Horvat LD, Cuerden MS, Kim J, et al. Informing the debate: rates of kidney transplantation in nations with presumed consent. Ann Intern Med 2010;153:641-9.
28. Chavalitdhamrong D, Gill J, Takemoto S, et al. Patient and graft outcomes from deceased kidney donors age 70 years and older: an analysis of the Organ Procurement Transplant Network/United Network of Organ Sharing database. Transplantation 2008;85;1573-9.
29. Remuzzi G, Cravedi P, Perua A, et al. Long-term outcome of renal transplantation from older donors. N Engl J Med 2006;354:343-52.
30. Moreno F, Soron D, Gil-Vernet S, et al. Donor age and delayed graft function as predictors of renal allograft survival in rejection-free patients. Nephrol Dial Transplant 1999;14:930-5.
31. Lai Q, Melandro F, Levi Sandri GB, et al. Use of elderly donors for liver transplantation: Has the limit been reached? J Gastrointestin Liver Dis 2011;20:383-7.
32. Jassal SV, Krahn MD, Naglie G, et al. Kidney transplantation in the elderly: a decision analysis. J Am Soc Nephrol 2003;14:187-96.
33. Young A, Kim SJ, Speechley R, et al.; Donor Nephrectomy Outcomes Research Network. Accepting kidneys from older living donors: Impact on transplant recipient outcomes. *Am J Transplant* 2011;11:743-50.

34. Singhal A, Sezginsoy B, Ghuloom AE, et al. Orthotopic liver transplant using allografts from the geriatric population in the United States: Is there any age limit? *Exp Clin Transplant* 2010;8:196-201.

35. Hubbard WJ, Dashti N. Age and transplantation — A topic for biomedicine or bioethics? *Aging Dis* 2011;2:181-5.

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