



A Canadian survey of critical care physicians' hemodynamic management of deceased organ donors

Sondage canadien sur la prise en charge hémodynamique des donneurs d'organes décédés par les médecins des soins intensifs

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Abstract

Purpose We sought to characterize Canadian physicians' perspectives and stated practices regarding their hemodynamic care of deceased organ donors.

Methods We designed a 24-item electronic survey that was independently pretested for relevance, clarity, and intra-rater reliability by ten critical care clinicians. With the help of provincial organ donation organizations (ODO), we identified intensive care units (ICUs) with a

high volume of adult deceased donors (defined by the management of five or more donors per year for two consecutive years). Medical directors of these high-volume ICUs helped identify ICU physicians to whom our survey was emailed.

Results Of the 448 ICU physicians from 37 centres in nine provinces that were emailed, 184/448 (41.1%) responded to one or more survey questions. Respondents identified specialist nurses from ODOs as their primary source of guidance in donor care (107/165; 60%). They typically diagnosed an autonomic storm according to a rise in blood pressure (159/165; 96.4%) and/or heart rate (135/165; 81.8%); nevertheless, their stated management varied

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substantially. After termination of the autonomic storm, preferred first-line vasopressors were norepinephrine (93/164; 56.7%) and vasopressin (68/164; 41.5%). Twenty-one respondents (21/162; 13.0%) reported that they never administer inotropes to donors. Corticosteroid and thyroid hormone prescriptions for all donors was reported by 62/161 (37.6%) and 50/161 (31.1%) respondents, respectively. Respondents perceived an influence from ODO nurses or transplant physicians when prescribing corticosteroids (77/161; 47.8%) and/or thyroid hormones (33/161; 20.5%)

Conclusion We observed important variability in self-perceived practices of ICU physicians in the hemodynamic management of deceased donors, particularly in the treatment of the autonomic storm, in the prescription of hormone therapy, and in the administration of inotropes.

Résumé

Objectif Nous avons tenté de caractériser les perspectives et les pratiques déclarées des médecins canadiens concernant les soins hémodynamiques prodigués aux donneurs d'organes décédés.

Méthode Nous avons mis au point un sondage électronique comportant 24 éléments et l'avons préalablement testé pour déterminer sa pertinence, sa clarté et sa fidélité interobservateur par dix médecins de soins intensifs. Avec l'aide des organismes de dons d'organes (ODO) provinciaux, nous avons identifié les unités de soins intensifs (USI) prenant en charge un volume élevé de donneurs adultes décédés (prise en charge de cinq donneurs ou plus par an pendant deux années consécutives). Les directeurs médicaux de ces USI à haut volume nous ont aidé à identifier les médecins de l'USI à qui envoyer le sondage par courriel.

Résultats Parmi les 448 médecins de l'USI issus de 37 centres dans neuf provinces ayant reçu le sondage, 184/448 (41,1 %) ont répondu à une question ou plus de notre questionnaire. Les répondants ont identifié les infirmières spécialisées des ODO en tant que source principale de conseils quant aux soins à prodiguer aux donneurs (107/165; 60 %). Un diagnostic de tempête adrénérge était fréquemment posé suite à une augmentation de la tension artérielle (159/165; 96,4 %) et/ou de la fréquence cardiaque (135/165; 81,8 %); toutefois, la prise en charge déclarée variait considérablement. Après la fin de la tempête adrénérge, les vasopresseurs de première intention les plus utilisés étaient la norépinéphrine (93/164; 56,7 %) et la vasopressine (68/164; 41,5 %). Vingt-et-un répondants (21/162; 13,0 %) ont rapporté ne jamais administrer d'inotropes aux donneurs. Les prescriptions systématiques de corticostéroïdes et d'hormones thyroïdiennes à tous les donneurs ont été rapportées par 62/161 (37,6 %) et 50/161 (31,1 %) répondants, respectivement. Les répondants se sentaient influencés

par les infirmières des ODO et les médecins spécialisés en greffe lors de la prescription des corticostéroïdes (77/161; 47,8 %) et/ou des hormones thyroïdiennes (33/161; 20,5 %).

Conclusion Nous avons observé une variabilité considérable dans les pratiques perçues des médecins de l'USI quant à la prise en charge hémodynamique des donneurs décédés, particulièrement en ce qui a trait au traitement de la tempête adrénérge, à la prescription de thérapie hormonale et à l'administration d'inotropes.

Introduction

The main objective for the care of neurologically deceased patients who are potential organ donors in the intensive care unit (ICU) is to optimize the quality and availability of organs for life-saving organ transplantation.¹ In Canada, the vast majority of organs for transplantation stem from brain-injured patients with a neurological determination of death (NDD).² Consideration of the unique pathophysiology of brain death and its implications for deceased donor care is, therefore, important to enhance organ transplantability. Animal studies show that intracranial hypertension leading to brain herniation causes ischemia to the vagal motor nucleus; this in turn results in a surge of endogenous catecholamines and a constellation of hemodynamic changes commonly termed the *autonomic storm*.³ In models, associated tachycardia and hypertension may be abrupt and severe, lasting minutes to hours.^{4,5} Concurrent ischemia of the hypothalamo-pituitary axis leads to vasopressin, adrenal hormone, and thyroid hormone depletion, such that termination of the autonomic storm may result in profound vasoplegia and shock.^{3,4,6,7} Brain herniation is also associated with a systemic inflammatory response, characterized by elevated circulating levels of interleukin-1, interleukin-6, and tumour necrosis factor-alpha that contribute to distributive shock.^{7,8} Animal models of brain death and clinical research among NDD donors suggest that catecholamine toxicity may lead to heart cell apoptosis and necrosis, which limit cardiac transplant suitability.⁹⁻¹² Clinical research in NDD donor management is very limited, but supports these observations.¹⁰⁻¹² Moreover, severe inflammation and shock contribute to acute damage of all organs, threatening the transplantability of the kidneys, liver, lungs, heart, and pancreas.^{4,6,13-15}

Canadian Guidelines (2006) for the management of potential NDD donors highlight hemodynamic management and hormone therapy (Table 1).¹⁶ Since then, other groups have released guidelines on donor care.¹⁷⁻¹⁹ Recommendations on specific interventions (e.g.,

Table 1 2006 Canadian Guidelines' recommendations according to survey domains

Survey domains	2006 Canadian Guidelines' recommendations
Autonomic storm management	Hypertension is treated if <ul style="list-style-type: none"> • SBP > 160 mmHg • MAP > 90 mmHg First-line treatment : <ul style="list-style-type: none"> • Nitroprusside or • Esmolol
Hemodynamic monitoring and treatment	Hemodynamic targets: <ul style="list-style-type: none"> • MAP \geq 70 mmHg • SBP \geq 100 mmHg • Heart rate 60–120 beats·min⁻¹ • CVP 6–10 mmHg Agents for hemodynamic support <ul style="list-style-type: none"> • First-line: vasopressin • Alternatives: norepinephrine, epinephrine, phenylephrine Fluid resuscitation aims at maintaining normovolemia (CVP 6–10 mmHg) and normal urine output (0.5–3 mL·kg ⁻¹ ·hr ⁻¹)
Hormone therapy	Combined hormone therapy (thyroid hormone, vasopressin, and methylprednisolone) are recommended in: <ul style="list-style-type: none"> • Donors with LVEF \leq 40% • Hemodynamic instability But considered in all donors Corticosteroids are recommended to all donors for lung protection

CVP = central venous pressure; LVEF = left ventricular ejection fraction; MAP = mean arterial pressure; SBP = systolic blood pressure

hormone therapy) vary between guidelines and they still, more than ten years after the Canadian guidelines, rely mostly on animal and retrospective clinical studies, in the context of few published randomized trials.^{5,13,15,20}

Hemodynamic management is fundamental to the practice of critical care. Most Canadian critical care clinicians, however, have limited exposure to the management of potential NDD donors. Consequently, their approaches likely reflect their hemodynamic management of non-donor populations. While observational studies can elucidate actual practice patterns, we sought to determine self-perceived practices in the context of knowledge about, and experience with, neurologically deceased donor care. We hypothesized that stated knowledge and practices among Canadian critical care physicians are likely to vary, reflecting not only a lack of clinical research to guide practices, but also a potential opportunity for education and knowledge translation initiatives to improve donor care.

Methods

Sampling of survey participants and centres

We surveyed physicians from adult ICUs across Canada characterized by a high volume of adult NDD donors. To facilitate this study, provincial organ donation organizations (ODOs) identified centres that had cared for at least five adult organ donors annually for two consecutive years (2014 and 2015) in the ICU. In some centres, donors are initially managed on-site and then transferred to a designated organ referral centre for procurement surgery. This approach to deceased donation is common in the province of Quebec and since management of donors occurs on-site, high-volume centres using this approach were included. Provincial ODOs provided contact information for the ICU medical director in each centre. When authorized by their physician colleagues, the ICU directors provided an email address for each physician in their ICU. In the situation where ICU physicians declined to share their email addresses, ICU medical directors forwarded the survey link to their colleagues. The Research Ethics Board of Hôpital du Sacré-Coeur reviewed and approved this survey

(#20141072). All respondent names and email addresses were to remain confidential, as were individual responses.

Survey development

The development of this electronic self-administered survey followed current standards for item generation, item reduction, pre-testing, and administration.^{21,22}

Item generation and item reduction

The principal investigator (A.J.F.) generated a preliminary list of survey items within four specific domains of deceased donor care: general support; autonomic storm management; other hemodynamic monitoring and treatment; and hormone therapy. A focus group including ICU donation clinicians and survey methodologists (A.J.F., K.S., P.M., M.M., D.W., E.C., and F.D.A.) refined the survey and reduced the number of questions. The survey objectives, methods and all survey questions were presented at a scientific meeting of the Canadian Critical Care Trials Group (Lake Louise, Alberta, February 2015). Members in attendance provided group feedback on the target population, the relevance of survey questions, clarity, and length of the questionnaire. We removed items perceived as redundant, and those perceived as least relevant to the survey objectives, and we limited the target respondents to intensive care physicians in adult ICUs.

Questionnaire testing

Five intensive care physicians external to our group, with expertise in survey development reviewed an electronic version of the survey with the objective of evaluating the relevance and comprehensiveness of items (i.e., face-validity). After minor revisions, we assessed test-retest reliability. Ten volunteer ICU physicians from the group of target respondents, with representation from three Canadian provinces, completed the questionnaire twice each at a four-week interval. Survey items found to have low intra-rater validity (i.e., Cohen's kappa < 0.4) were either modified or removed. Since the questionnaire was modified following this pre-testing, questionnaires from those ten potential respondents were excluded from final analysis, as recommended.²³ Lastly, three ICU resident physicians subsequently tested time required to complete the questionnaire, which ranged from ten to 13 min.

Questionnaire formatting

We created an electronic English-language survey using SurveyMonkey® (Appendix, available as Electronic Supplementary Material). The final survey included 19

questions pertaining to four pre-specified domains and five demographic questions, giving a total of 24 questions. We used four-point Likert scales and multiple-choice questions. An option for textual responses was offered after every item. Electronic distribution of the questionnaire to target participants was preceded by a personalized email explaining the study purpose. We also informed potential respondents about the voluntary nature of the survey, our confidentiality policy, and the time required to complete the questionnaire.

Questionnaire administration

We distributed the electronic questionnaire to each target physician by email in September 2016. Two ICU medical directors, unable to provide contact information, forwarded an electronic link to the survey to their ICU physician colleagues. Four electronic reminders were sent over a three-month period.

Statistical analysis

Completed questionnaires were entered into an SPSS database (IBM SPSS Statistics v24.0 2018). We summarized descriptive data using means (standard deviation) and proportions.

Results

Participants

Provincial ODOs identified 44 centres with the requisite activity in deceased donation. The medical directors of four centres (three from Ontario and one from Saskatchewan) did not respond to email invitations to participate in this survey; therefore, 40 centres are included in this report (40/44; 90.9%). From these centres, we identified 448 potential respondents and contacted them by email. Ultimately, 184/448 (41.1%) participated. We classified the 19 respondents who answered fewer than four of the 19 questions as "partial respondents" and analyzed their responses separately.²³ Thus, a total of 165/448 (36.8%) potential respondents completed the questionnaire and are included in the final analysis as complete respondents. There was at least one respondent from each participating centre, and the number of respondents from each province generally reflects the distribution of organ donation activity in Canada (Table 2). The majority of responding ICU physicians had specialized training in internal medicine ($n = 94/165$; 57%) and many were responsible for care of four to six donors per year ($n = 75/165$; 45.5%) (Table 3).

Table 2 Demographics of respondents

Variable	Proportion of respondents, <i>n</i> (%)
Respondents by province <i>n</i> = 165	
British Columbia	14 (8.5)
Alberta	12 (7.3)
Saskatchewan	3 (1.8)
Manitoba	3 (1.8)
Ontario	59 (35.8)
Quebec	55 (33.3)
New Brunswick	4 (2.4)
Nova Scotia	5 (3.0)
Newfoundland	4 (2.4)
No response	6 (3.6)
Medical specialty of respondents <i>n</i> = 165	
Internal medicine	94 (57)
Family medicine	4 (2.4)
Emergency medicine	9 (5.5)
Surgery	17 (10.3)
Anesthesia	33 (20)
No response	8 (4.8)
Teaching hospital	
Yes	138 (83.6)
No	21 (12.7)
No response	6 (3.6)
Transplant centre	
Yes	77 (46.7)
No	83 (50.3)
No response	5 (3)
Organ retrieval centre*	
Yes	140 (84.8)
No	20 (15.2)
No response	5 (3)

*Responses to the question: “Does organ retrieval occur at your centre?”

General donor support

The majority of respondents (107/165; 64.8%) seek advice from ODO nurse specialists in most or all cases, with further advice occasionally sought from on-call ODO physicians (48/164; 29.1%) or physicians in other centres (34/164; 20.6%). Most reported consulting pharmacists rarely or never (99/164; 60.4%). The majority of respondents also always or usually (125/165; 75.8%) rely upon local protocols for donor care, and the 2006 Canadian Guidelines were strongly (84/165; 50.9%) or always (38/165; 23.0%) identified as a reliable source (Table 3).

The autonomic storm

Nearly all respondents (159/165; 96.4%) consider a “rise of blood pressure” and most consider a “rise of heart rate” (135/165; 81.8%) as a component criterion for the diagnosis of an autonomic storm. Opinions varied on the importance of the “duration and/or timing” of hypertension or tachycardia in this diagnosis. Most respondents (100/162; 61.7%) stated that they react to isolated hypertension in this setting by administering antihypertensive medication, while others stated that they do not treat isolated hypertension (29/162; 17.9%). Preferred medications for the management of symptoms of autonomic storm are presented in Fig. 1, showing that beta-blockers were generally a first choice.

Hemodynamic monitoring and treatment of hypotension

The survey inquired about common triggers for fluid administration and fluid responsiveness prediction in all donors. Results are presented in Fig. 2. In the specific situation of a hypotensive multi-organ donor without organ dysfunction and already fluid-resuscitated with 2 L of crystalloids, the stated preferred resuscitation fluid was Ringer’s lactate in 150/164 respondents (94.9%) or normal saline in 98/164 (66.2%). However, 68/164 respondents (47.2%) also perceived that they administer 5% albumin and 27/164 (20.0%) reported use of 25% albumin. Balanced crystalloid solutions (e.g., Osmolyte®, Plasmalyte®) were chosen by 47/164 (29.3%) of respondents. No respondents stated that they would administer starch solutions in organ donor resuscitation.

For a donor evaluated as hypotensive but euvoletic, 118/163 (71.5%) respondents would initiate vasopressor therapy even if no other signs of hypoperfusion were present. This number increased to 131/163 (80.4%) considering a donor with signs of hypoperfusion (e.g., oliguria) and to 134/163 (82.2%) considering a donor with associated hypoperfusion markers (e.g., elevated serum lactate, low central venous oxygen saturation).

When lung donation was considered, the majority of respondents would often or always refrain from additional fluids and, rather, initiate or optimize vasopressors (109/163; 66.9%). However, this number drops to 21/162 (13.0%) when the lungs were not considered for donation.

Mean arterial pressure targets in donors hypotensive and unresponsive to volume varied from 60 mmHg (26/162; 16.1%) to 70 mmHg (20/162; 12.4%), with the majority of respondents identifying 65 mmHg (*n* = 106/162; 65.4%) as their preferred target. For donors with no evidence of diabetes insipidus at the time of hypotension, norepinephrine was the preferred first-line vasopressor

Table 3 Sources of guidance for the medical management of neurologically deceased donors

Variable, n/N (%)	Complete respondents N = 165*	Partial respondents N = 19**
Number of donors managed per year by respondent		
> 12	9 (5.5)	0
10–12	13 (7.9)	0
7–9	29 (17.6)	2 (10.5)
4–6	75 (45.5)	7 (36.8)
0–3	39 (23.6)	10 (52.6)
Seeking advice from ODO nurse		
Always	81 (49.1)	8 (47.4)
Most of the time	26 (15.8)	3 (15.8)
Occasionally	22 (13.3)	1 (5.3)
Rarely	26 (15.8)	3 (15.8)
Never	10 (6.1)	3 (15.8)
No response	0	0
Seeking advice from ODO physician [§]		
Always	6 (3.6)	1 (5.3)
Most of the time	12 (7.3)	1 (5.3)
Occasionally	48 (29.1)	4 (21.1)
Rarely	60 (36.4)	9 (47.4)
Never	38 (23)	4 (21.1)
No response	1 (0.6)	0
Seeking advice from physician in another centre [§]		
Always	10 (6.1)	0
Most of the time	21 (12.7)	1 (5.3)
Occasionally	34 (20.6)	3 (15.8)
Rarely	45 (27.3)	5 (26.3)
Never	54 (32.7)	10 (52.6)
No response	1 (0.6)	0
Seeking advice from a pharmacist [§]		
Always	10 (6.1)	3 (15.8)
Most of the time	21 (12.7)	3 (15.8)
Occasionally	34 (20.6)	5 (26.3)
Rarely	45 (27.3)	7 (36.8)
Never	54 (32.7)	1 (5.3)
No response	1 (0.6)	0
Seeking advice in a local protocol ^{***}		
Always	80 (48.5)	12 (63.2)
Most of the time	45 (27.3)	3 (15.8)
Occasionally	15 (9.1)	0
Rarely	13 (7.9)	1 (5.3)
Never	12 (7.3)	3 (15.8)
No response	0	0

Table 3 continued

Variable, n/N (%)	Complete respondents N = 165*	Partial respondents N = 19**
Seeking advice in online resources [§]		
Always	9 (5.5)	2 (10.5)
Most of the time	16 (5.5)	3 (15.8)
Occasionally	40 (24.2)	7 (36.8)
Rarely	53 (32.1)	1 (5.3)
Never	39 (23.6)	6 (31.6)
No response	8 (4.8)	0
Seeking advice in Canadian Guidelines		
Always	38 (23)	6 (31.6)
Strongly	84 (50.9)	7 (36.8)
Fairly	35 (21.2)	2 (10.5)
Not at all	8 (4.8)	3 (15.8)
No response	0	1 (5.3)

*We report in the column the number of respondents that provided the answer from a total of 165 complete respondents, (%). **We report in the column the number of respondents that provided the answer from a total of 19 partial respondents, (%). *** Local protocol refers to hospital-specific protocols. [§]The reported proportions are adjusted to the number of respondents for the specific question (listwise values). ODO = organ donation organizations

(93/164; 56.7%). Vasopressin was also frequently reported for this indication (68/164; 41.5%). The use of alternative vasopressors (e.g., epinephrine, dopamine, or phenylephrine) was rare (1/164; 0.6%). A minority of respondents 21/162 (13.0%) answered that they would never administer inotropes (e.g., milrinone, dobutamine) to donors who are euvoletic and normotensive. Faced with a hypotensive donor with signs of hypoperfusion, use of inotropes appeared to differ according to whether the donor's heart was under consideration for transplantation: for potential cardiac donors, 78/162 respondents (48.2%) would administer an inotrope and for non-heart donors, 94/162 respondents (58.0%) would administer an inotrope.

Hormone therapy

The survey assessed three hormone therapies: corticosteroids, insulin, and thyroid hormones. ODO donation and transplant clinicians largely influenced the prescription of both corticosteroids and thyroid hormones. Specifically, 77/161 (47.8%) respondents reported that they prescribe corticosteroids and 33/161 (20.5%) thyroid hormones to donors specifically when requested by ODO clinicians.

Some respondents stated that they generally order corticosteroids specifically for hemodynamic instability (48/161; 29.8%) and in the setting of potential for

transplant of specific organs (43/161; 26.7%). One third (50/161; 31.1%) reported the prescription of corticosteroids to all donors, and few prescribe corticosteroids to no donors (6/161; 3.7%). Methylprednisolone was the preferred corticosteroid in 87/160 of respondents (54.4%). A stress dose of hydrocortisone (200–300 mg·day⁻¹) was the preferred regimen for 46/160 (28.8%) of respondents.

Thyroid hormones were reported as prescribed to all donors by 62/161 (37.6%) of respondents. Other most frequently reported indications included left ventricular dysfunction in potential heart donors (40/160; 25%) and hemodynamic instability regardless of heart dysfunction (25/161; 15.5%). Some respondents (64/160; 40.0%) indicated that they were unfamiliar with the administration of insulin as part of a combined infusion of glucose, insulin, and potassium (GIK). Still, 20/160 (12.5%) reported using GIK infusion in potential heart donors with left ventricular dysfunction or in donors with depressed left ventricular function regardless of the potential for heart donation (6/160; 3.75%).

Partial respondents

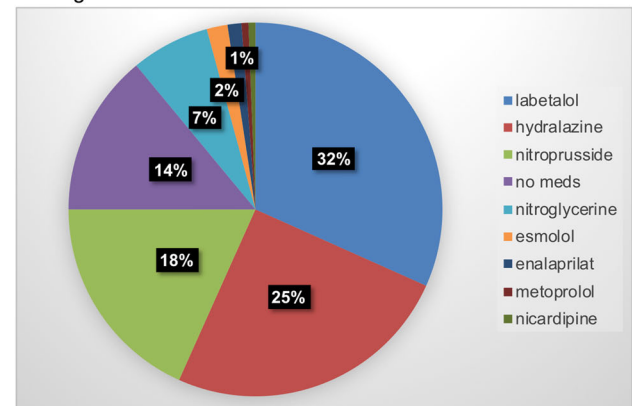
A group of respondents answered only the first four questions of the questionnaire ($n = 19/184$). We considered them as partial respondents and their available responses were analyzed separately (Table 3). Compared with complete respondents, partial respondents appeared to have less experience with the management of deceased organ donors. Their responses, however, were generally comparable with those of complete respondents

Discussion

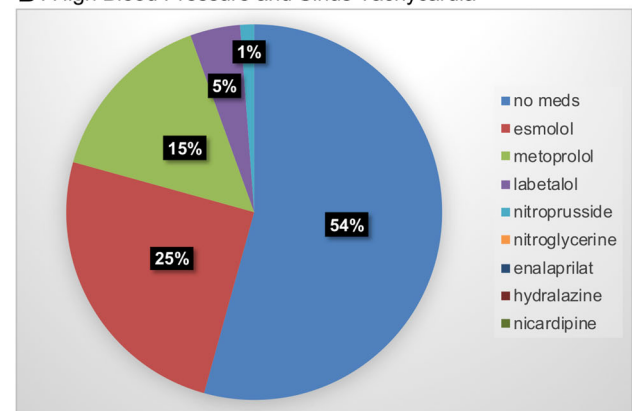
In this survey of self-reported clinical practices in the hemodynamic management of NDD donors, 41% of 448 ICU physicians responded, with a geographical distribution that generally reflects the epidemiology of deceased donation in Canada.² Forty of 44 major Canadian donation centres were included and represented in this survey.

The treatment of an autonomic storm in the setting of severe brain injury and potential organ donation is far from uniform. Physicians appear to apply varied diagnostic criteria and hemodynamic strategies, particularly when facing isolated hypertension. Variability in the self-perceived practice of autonomic storm management reflects the paucity of literature, which is limited to animal studies and one small retrospective clinical study.^{5,24,25} Many respondents indicated that they treat an autonomic storm with consideration of the potential for

A . High Blood Pressure and Normal Heart Rate



B . High Blood Pressure and Sinus Tachycardia



C . Normal Blood Pressure and Sinus Tachycardia

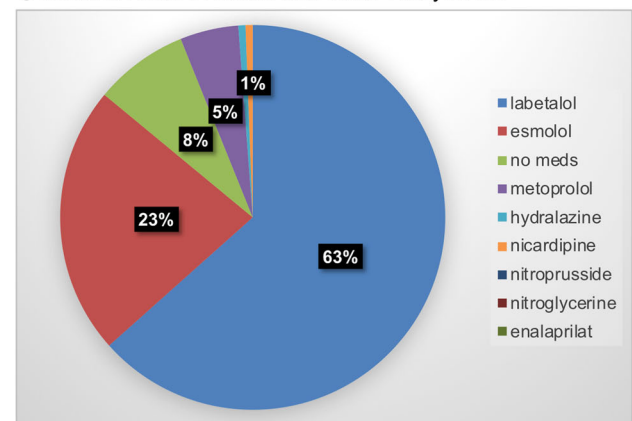


Fig. 1 Medication prescribed in the context of an autonomic storm. Drugs used for each diagnosis of an autonomic storm are ranked from the most to the least commonly prescribed

organ donation. Although not evaluated in a clinical study, the administration of a beta-blocker to a potential donor in the context of an autonomic storm could prevent end-organ damage caused by catecholamine-induced direct toxicity.⁵

The use of inotropes in NDD donors also varied, reflecting an existing controversy, particularly in the

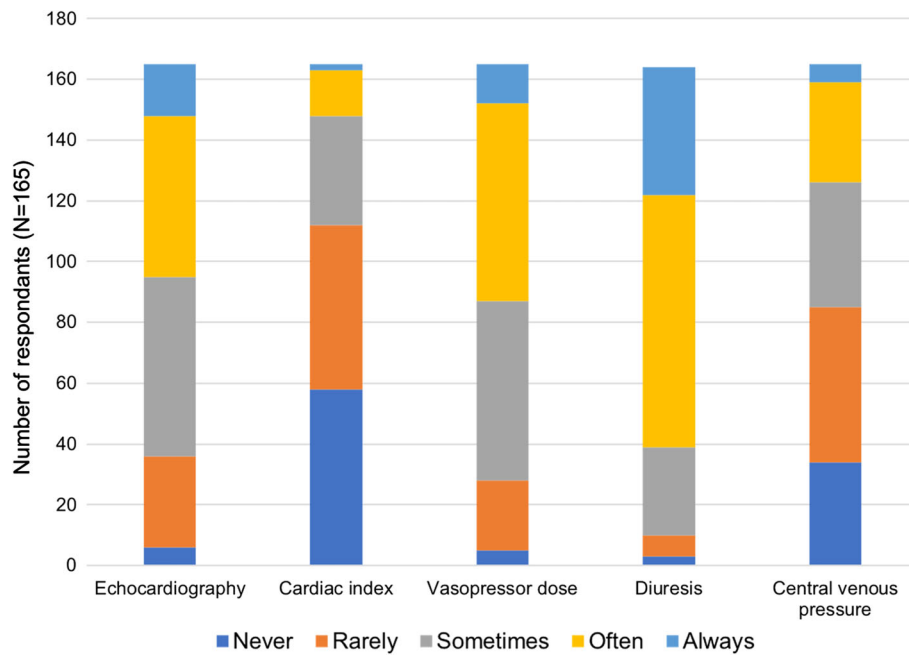


Fig. 2 Triggers for fluid administration and fluid responsiveness. Cardiac index measurement includes pulmonary artery catheter and other non-invasive measurements

context of potential heart donation. Many respondents were reluctant to administer inotropes to deceased donors, highlighting a possible concern to augment the hyperadrenergic state during and following an autonomic storm. Respondents have identified vasopressin as one of their preferred first-line vasoactive medications to treat hypotension in donors, likely reflecting the knowledge of central insufficiency of this hormone and of the 2006 Canadian Guidelines' recommendation on the treatment of hypotension.¹⁶ In animal models, the surge in catecholamines occurring during the autonomic storm was deemed responsible for direct cardiomyocyte damage.⁴ The administration of beta-agonist agents could theoretically contribute to further cardiac toxicity. To date, there are no investigations of milrinone or dobutamine in this setting to test this concern.²⁶

The frequent prescription of corticosteroids and/or thyroid hormones appeared largely influenced by ODOs and surgical teams. Since the publication of the guidelines, systematic reviews have concluded there is insufficient evidence to support (or refute) corticosteroid or thyroid hormone supplementation.^{16,17,27-29} Other retrospective studies showing potentially impressive benefits on organ recovery, particularly in lung donors, may be influential in current reported practices.^{14,15,20,30-33} Additionally, it is conceivable that the use of low-dose hydrocortisone is largely driven by the general ICU literature.^{34,35} Although the benefit of corticosteroids in general ICU patients with

shock remains controversial, they remain frequently prescribed by Canadian intensivists.^{36,37} The use of low-dose hydrocortisone might also reflect the impact of the CORTICOME study.^{16,38} In this non-randomized study of deceased potential donors, low-dose hydrocortisone was associated with reduced vasopressor doses and duration.³⁸

Glucose, insulin, and potassium (GIK) infusions appear to be used infrequently. One observational study suggested an inotropic benefit with the use of GIK in the NDD donor population, specifically among those with severe heart failure.³⁹ Nevertheless, the paucity of confirmatory literature likely explains the lack of apparent uptake of GIK infusions.

Although ICU physicians indicated that they see the 2006 Canadian Guidelines as a reliable source of information, self-reported practices suggest otherwise. For example, the Canadian Guidelines *suggest* combined hormone therapy (vasopressin, corticosteroids, and thyroid hormone) to all donors, but more strongly *recommend* combined hormone therapy to hemodynamically unstable donors, and corticosteroids specifically to lung donors.¹⁶ In contrast, respondents' self-perceived practice on the use of hormone therapy suggested variability in opinions, with about a third of respondents perceiving that they prescribe hormone therapy to all donors. Also, about 20% of respondents report that they do not treat hypertension in the context of an autonomic storm, a practice that does not comply with the 2006 Canadian

Guidelines where a treatment is recommended for a mean arterial pressure over 90 mmHg or a systolic blood pressure over 160 mmHg (Table 1).¹⁶ Moreover, nine different pharmacological agents were identified by our respondents as their preferred treatment for an autonomic storm, and yet the Canadian Guidelines' recommendation is limited to esmolol or nitroprusside infusions to treat hypertension.

Similar to our findings, a survey on self-reported practice of ODO clinicians when caring for pediatric donors reported variance in compliance with the most recent American guidelines.^{17,40} Varying compliance (ranging between 3% and 100%) with the American guidelines was also reported by an observational cross-sectional study in Belgium.^{17,41} Nevertheless, our survey was not designed to compare the self-reported practices with the Canadian Guidelines' recommendations. Therefore, we cannot conclude that ICU physicians do not find the guidelines a reliable source of information. In the context of this survey's objectives, the possible disparity between ICU physicians' self-reported practices in some areas and the Canadian Guidelines' recommendations generates hypotheses on the need for knowledge, translational educational tools, and on the importance of collaborating with stakeholders from transplantation and ODO teams in designing future clinical research.

We surveyed participants about the role of ODO specialists in the care of deceased organ donors. In Canada, on-site ODO nurses are generally responsible for organ compatibility testing and allocation, but their clinical involvement on direct donor care may vary from centre to centre. Survey results suggest that ODO nurses play a major role in counseling ICU physicians; consequently, their implicit involvement in knowledge translation deserves explicit recognition.⁴² Moreover, our findings of varied practices suggest that this is a suitable area for education and knowledge translation interventions and research. Consideration of the implicit or explicit roles of ODO specialists in such initiatives will be essential.⁴³

This survey also raised questions about the involvement of ICU pharmacists in deceased donor management since few respondents indicated relying on their expertise when caring for donors.⁴⁴ While this survey was not designed to explore specific activities of ICU pharmacists (protocols, counseling, teaching, clinical evaluation), our findings suggest that they may be an underutilized resource for education and knowledge translation.

Strengths and limitations

This survey meets the objective of exploring the variability in self-perceived practices for the management of NDD

donors in Canada. As an ongoing large observational study will describe donor care interventions in Canadian ICUs, this survey helps to understand and generate hypotheses about the rationale for current practices and underlying beliefs.⁴⁵ For example, understanding that the prescription of hormone therapy by ICU physicians is largely influenced by ODO and surgery teams was highly informative in that it suggests the need for more information related to donor care at the bedside. It also will guide important collaborations with stakeholder ODOs and transplant programs for future clinical trials.

Following current standards for the development of questionnaires to survey health professionals about their stated practices, we used focused groups and extensive pre-testing to ensure relevance, clarity, and ease of completion. Our survey response rate was low (41.1%), limiting generalizability; nevertheless, we felt it was important to survey broadly, including physicians with a spectrum of experience in donor care. Also, we successfully obtained information from almost all the major Canadian organ donation centres (40/440; 91.9%), although Alberta physicians appear under-represented. The results, even with low response rate, reveal the variability in management resulting from paucity of evidence. It is likely that survey respondents have a different level of interest and expertise in organ donor management than non-respondents. Corroborating this hypothesis, an analysis among the 19 partial respondents revealed that they had less experience in donor management than complete respondents. Based on empirical evidence found in unrelated surveys, the characteristics of survey non-respondents are generally similar to those of partial respondents.⁴⁶ The response rate in this survey is similar to recent surveys (30–40%) of Canadian ICU clinicians.^{47–50} In addition, a recent survey of health professionals on the need for education programs in organ donation reported a response rate of 15%.⁵¹ One notable difference between our survey and those that have reported higher response rates may be the sampling strategy. Many published surveys have used society membership lists or even research consortia, thus targeting more involved participants. However, we sought to survey a broader sample of critical care physicians.^{37,52}

Conclusion

In a national survey of ICU physicians, we found variability in self-perceived practice in the management of neurologically deceased organ donors, in a context where the impact of specific interventions on organ suitability or availability is uncertain. Differences in opinions may relate to the paucity of research in this

field and to the relative inexperience of many physicians in managing deceased donors, which make up a very small fraction of the clinical case load in most centres. Nevertheless, the survey also revealed the importance of clinical nurse specialists (from ODOs) in decision-making. Thus, this survey highlights the need for clinical research and education specific to the hemodynamic management of organ donors, and also specific to current models of knowledge dissemination in deceased donor care.

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