



Original Article

# The Many Care Models to Treat Thoracic Aortic Disease in Canada: A Nationwide Survey of Cardiac Surgeons, Cardiologists, Interventional Radiologists, and Vascular Surgeons

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## ABSTRACT

**Background:** Several specialties treat thoracic aortic disease, resulting in multiple patient care pathways. This study aimed to characterize these varied care models to guide health policy.

**Methods:** A 57-question e-survey was sent to staff cardiac surgeons, cardiologists, interventional radiologists, and vascular surgeons at 7 Canadian medical societies.

**Results:** For 914 physicians, the response rate was 76% (86 of 113) for cardiac surgeons, 40% (58 of 146) for vascular surgeons, 24% (34 of 140) for radiologists, and 14% (70 of 515) for cardiologists. Several

## RÉSUMÉ

**Contexte :** La prise en charge de la maladie de l'aorte thoracique peut faire appel à plusieurs spécialités, ce qui a pour effet de multiplier les trajectoires de soins des patients. Cette étude visait à caractériser ces différents modèles de soins afin d'éclairer l'élaboration des politiques de santé.

**Méthodologie :** Un sondage électronique de 57 questions a été envoyé aux chirurgiens cardiaques, aux cardiologues, aux radiologistes interventionnels et aux chirurgiens vasculaires membres de 7 associations médicales canadiennes.

Thoracic aortic dissections and thoracic aortic aneurysms are a challenge for any healthcare system. Morbidity and mortality associated with these conditions are substantial,<sup>1</sup> and treatment is resource intensive.<sup>2</sup> Management is lifelong and draws

upon the expertise of several specialties. Diagnostic and surveillance imaging, optimal medical management (lifestyle modifications, blood pressure control, genetic testing and counselling), endovascular interventions, and complex surgical operations are all part of the care continuum for many patients. Cardiac surgeons, cardiologists, interventional radiologists, and vascular surgeons all have prominent roles in the treatment of thoracic aortic disease (TAD). Many synergistic and complimentary skillsets are provided by these specialties, but these skillsets also have a degree of overlap. This overlap, in conjunction with local variance in specialty interest, aortic expertise, and infrastructure, has culminated into multiple care models for providing thoracic aortic care. A spectrum ranging from solitary specialty independence to

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See page 799 for disclosure information.

services admitted type B dissections (vascular 37%, cardiology 31%, cardiac 18%, other 7%), and care was heterogeneous. Ownership of disease management was overestimated relative to the perspective of the other specialties. Type A dissection admissions and treatment were more uniform, but emergent call coverage varied. A 24/7 aortic specialist on-call schedule was present only 4% of the time. "Aortic" case rounds promoted attendance by a broader aortic specialty contingency relative to rounds that were specialty specific. Although 89% of respondents felt an aortic team was best for patient care, only 54% worked at an institution with an aortic team present, and only 28% utilized an aortic clinic. Questions designed to define an aortic team derived 63 different combinations.

**Conclusions:** Thoracic aortic disease follows a network of undefined and variable care pathways, despite its high-risk population in need of complex treatment considerations. Multidisciplinary aortic teams and clinics exist in low volume, and the "aortic team" remains an obscure construct. A multispecialty initiative to define the aortic team and outline standardized navigation pathways within the health systems hospitals is advocated.

multidisciplinary aortic team interdependence now exists, with hybridized models between these extremes. Having a high-risk patient population managed by a multitude of care models fosters a nonstandardized health policy for the disease of interest. This lack of standardization may have an adverse impact on patient outcomes and the cost-effective delivery of care for TAD. To investigate these uncertainties, baseline data characterizing current care models are required. We created a multidisciplinary nationwide survey to determine present-day management strategies for TAD, across Canada.

## Methods

### Survey development

A 12-member working group with equal representation of disciplines (3 cardiac surgeons, 3 cardiologists, 3 interventional radiologists, and 3 vascular surgeons), and Canada-wide geographic representation, developed a 57-question online survey tool ([Supplemental Appendix S1](#)). Development of the questionnaire consisted of a multi-round Delphi process completed by the 12-member working group, with unanimous consensus on the final version.<sup>3,4</sup> Thereafter, the survey was pretested and vetted by 33 aortic specialists across the United States, Europe, and New Zealand ([Supplemental Appendix S2](#)). The primary objective of the survey was to provide a descriptive analysis of present-day care models to treat TAD in Canada. The web-based application SurveyMonkey (SurveyMonkey, Inc., SanMateo, CA) was used to

**Résultats :** Sur un total de 914 médecins, le taux de réponse a été de 76 % (86 sur 113) chez les chirurgiens cardiaques, de 40 % (58 sur 146) chez les chirurgiens vasculaires, de 24 % (34 sur 140) chez les radiologistes et de 14 % (70 sur 515) chez les cardiologues. Plusieurs services avaient admis des cas de dissection aortique de type B (chirurgie vasculaire 37 %, cardiologie 31 %, chirurgie cardiaque 18 %, autre 7 %) et les soins étaient hétérogènes. Les spécialistes surestimaient leur responsabilité de la prise en charge des cas par rapport à celle des autres spécialistes. Les admissions de cas de dissection de type A et leur traitement étaient plus uniformes, mais la présence de spécialistes de garde pouvant traiter les cas urgents était variable. La présence continue d'un spécialiste de l'aorte de garde n'était observée que pendant 4 % du temps. Les séances de discussion de cas « aortiques » favorisaient la participation par une gamme plus large de spécialistes de l'aorte que les discussions axées sur une spécialité donnée. Si 89 % des répondants estimaient qu'une équipe « aortique » était la meilleure option pour les soins aux patients, ils n'étaient que 54 % à travailler dans un établissement disposant d'une telle équipe et 28 % à utiliser les services d'une clinique de l'aorte. En réponse aux questions portant sur les éléments constitutifs d'une équipe aortique, 63 combinaisons différentes de spécialités ont été proposées.

**Conclusions :** La prise en charge de la maladie de l'aorte thoracique emprunte un dédale de trajectoires de soins non définies et variables, alors que sa population à haut risque a besoin de traitements complexes. Les équipes multidisciplinaires et les cliniques spécialisées dans le traitement de l'aorte sont rares, et la notion d'« équipe aortique » demeure un concept obscur. Nous préconisons une initiative réunissant des spécialistes de différents domaines pour définir les éléments constitutifs d'une équipe aortique et établir des trajectoires de navigation normalisées au sein des hôpitaux du système de santé.

upload the survey to the Internet. The Checklist for Reporting Results of Internet E-Surveys (CHERRIES) was used as a framework to guide survey methods.<sup>5</sup> The survey could be taken in English or French. An adaptive algorithm was incorporated into the questionnaire to simplify respondent experience. Between 32 and 39 questions were asked of respondents, depending on their specialty and their involvement in TAD treatment. For the subset of participants having no involvement in TAD management, only 8 demographic questions were required. The survey was divided into 5 sections: (i) demographics, (ii) hospital infrastructure and specialty availability, (iii) treatment models, (iv) multidisciplinary aortic teams, and (v) outpatient clinics. Research ethics for the study were approved by the University of Calgary Conjoint Research Ethics Board (REB18-1483).

### Sampling frame

The target population consisted of staff physicians in Canada practicing within 1 of the 4 specialties typically involved in the medical, endovascular, or surgical management of the thoracic aorta—cardiac surgery, cardiology, interventional radiology, and vascular surgery. The sampling frame was derived from staff physician membership in any of 7 Canadian medical societies most representative of the target population: the Canadian Adult Congenital Heart Network, the Canadian Association of Interventional Cardiology, the Canadian Association of Interventional Radiology, the Canadian Society for Cardiovascular Magnetic Resonance, the Canadian Society for Vascular Surgery, the Canadian Society

of Cardiac Surgeons, and the Canadian Society of Echocardiography. Invitations to participate in the 20-minute study were sent through the e-mail directories of each medical society to its membership, with an accompanying link to the survey, on October 1, 2019. Two reminder e-mails were sent at consecutive 30-day intervals, with the study closing on December 31, 2019. Invitations to participate in the survey were sent by the administrative staff of the medical societies. Authors did not have access to these e-mail directories. Participation was voluntary, and consent was implied by participation. All responses were anonymous. No honoraria or incentives were given for completing the survey. Cookies were used to avoid duplicate entries.

### Pretest methodology

Invitations to pretest the questionnaire were based on (i) recognition as a preeminent international expert in TAD or (ii) having had physician training in Canada (hence familiarity with the Canadian healthcare system), but working outside of Canada with TAD as a significant part of their practice. Worksheets to evaluate the survey questions were sent to all pretest reviewers by e-mail (Supplemental Appendix S3). Using a Likert score (1 = strongly disagree, up to 6 = strongly agree), survey flow (average score 4.8, median 5) and study relevance (average score 5.2, median 5) were assessed. Commentary and data on time required to complete the survey (average time 19.3 minutes; 77% stated survey was an appropriate length), question comprehension (77% stated survey was clear and comprehensible), and question redundancy (87% stated no redundancy) were also collected. Suggestions on how to improve the survey and whether pertinent questions were felt to be missing also were solicited from the pretest cohort.

Several revisions were made based on the vetting process of the 33 specialists, focusing primarily on sentence structure and precise language for increased clarity to select question items. One question was revised to allow a rank-order response, and 2 questions were omitted to avoid redundancy in the final version.

### Statistical analysis

Categorical and dichotomous variables were presented as numbers and percentiles, respectively. For comparative analyses across specialties, *t* tests were used, with the Bonferroni correction when applicable. All analyses were 2-sided. A *P*-value of < 0.05 was considered to indicate statistical significance. The use of an adaptive algorithm meant that, aside from the demographics section of the survey, the denominator varied per question.

### Results

The survey was distributed to 914 physicians. The overall response rate was 27% (248 of 914). The response rate varied by specialty: cardiac surgeons 76% (86 of 113), vascular surgeons 40% (58 of 146), interventional radiologists 24% (34 of 140), and cardiologists 14% (70 of 515). Demographics are listed in Table 1. Specialty representation by province or territory is displayed in Figure 1. Of the

248 respondents, 35% were cardiac surgeons, 28% cardiologists, 23% vascular surgeons, and 14% interventional radiologists. Geographically, Ontario had the highest level of representation (33%), followed by Alberta (17%), Quebec (15%), and British Columbia (12%). All other provinces were represented by 8% or less, with no responses from Prince Edward Island or the 3 Territories (Table 1). Over 80% of the participants practice in an academic institution, and 70% have been in medical practice for 10 or more years.

Management of TAD was an active part of medical practice for 87% of survey respondents (a major focus for 21%, a minor focus for 66%). Each specialty was actively involved in treating TAD, although interventional radiologists were less likely to be involved (64%) relative to the respondents from the other specialties (cardiac surgeons, 93%; cardiologists, 91%; vascular surgeons, 87%; *P* < 0.05; Fig. 2). Moreover, although 62% of respondents stated that the majority of TAD was treated by select members within their division, when stratified by specialty, this approach to case distribution varied (cardiac surgeons, 83%; cardiologists, 58%; interventional radiologists 52%; vascular surgeons, 40%; *P* < 0.05]. Vascular surgeons were more likely than those in other specialties to distribute aortic cases evenly across division members (Fig. 3).

### Multidisciplinary aortic clinics and aortic case rounds

Conceptually, the use of a multidisciplinary aortic team was thought to be the best strategy for TAD management (multidisciplinary approach, 89%; specialty independence, 5%; undecided, 6%), but only 54% of respondents stated that a multidisciplinary aortic team was present at their hospital (no multidisciplinary aortic team presence, 37%; unsure, 8%). This perspective was similar across specialties (Fig. 4). Moreover, what constitutes a multidisciplinary aortic team appears to be an elusive concept, subject to local and personal interpretation. For respondents who stated that their institution had a multidisciplinary aortic team, when prompted to define the specialties directly involved from a list of 10 specialty options, 63 different combinations were derived (Table 2). The most common specialty combination selected to define a multidisciplinary aortic team was cardiac surgery + interventional radiology + vascular surgery (Table 2).

A multidisciplinary aortic clinic was utilized by 42% of respondents (no clinic, 49%; unsure if a clinic was present, 9%), but a defined collaborative clinic space was present only 28% of the time. The other 14% used a virtual clinic and maintained regular communication with personnel from other specialties without a shared physical space to assess or follow patients. For those without a multidisciplinary clinic, a rank order of reasons was as follows: first—being content with the current model (ranked first by 36% of respondents; average score 2.94); second—too low of an aortic case volume to justify a clinic (ranked first by 31% of respondents; average score 2.40); third—lack of funding (ranked first by 19% of respondents; average score 2.33); and fourth—lack of multidisciplinary interest (ranked first by 15% of respondents, average score 2.32).

**Table 1. Survey respondent demographics**

Demographic variable	Response	% (n) of 248
Medical specialty	Cardiac surgery	35 (86)
	Cardiology	28 (70)
	Noninterventional	20 (50)
	Adult congenital	24 [12/50]
	Cardiac MRI/CT imaging	8 [4/50]
	Echocardiography	34 [17/50]
	General cardiology	32 [16/50]
	Heart failure	0 [0/50]
	Other*	2 [1/50]
	Interventional	8 (20)
	Interventional radiology	14 (34)
	Vascular surgery	23 (58)
Type of hospital practice	Urban academic teaching hospital	83 (205)
	Affiliated with Canadian university	
	Urban non-teaching hospital	5 (13)
	Catchment area population > 500,000	
	Regional hospital	12 (30)
	Catchment area population 100,000-500,000	
Years in medical practice	Rural hospital	0 (0)
	Catchment area population < 100,000	
	< 5	14 (34)
	5-9	16 (39)
Personal involvement in the management of thoracic aortic disease	10-19	34 (84)
	≥ 20	36 (90)
	Thoracic aortic disease:	
	Is a major focus of my practice	21 (52)
	Is a minor part of my practice, but I do manage cases on occasion	66 (163)
Formal subspecialty fellowship training in “aortic surgery” beyond Royal College training	I do not manage thoracic aortic disease	13 (33)
	Cardiac surgeons that said “yes” to this statement	29 [25/86]
Province or territory of medical practice <sup>†</sup>	Vascular surgeons that said “yes to this statement	24 [14/58]
	Alberta	17 (43)
	British Columbia	12 (30)
	Manitoba	4 (10)
	New Brunswick	4 (11)
	Newfoundland and Labrador	2 (5)
	Nova Scotia	8 (19)
	Ontario	33 (83)
	Quebec	15 (37)
	Saskatchewan	4 (10)

CT, computed tomography; MRI, magnetic resonance imaging.

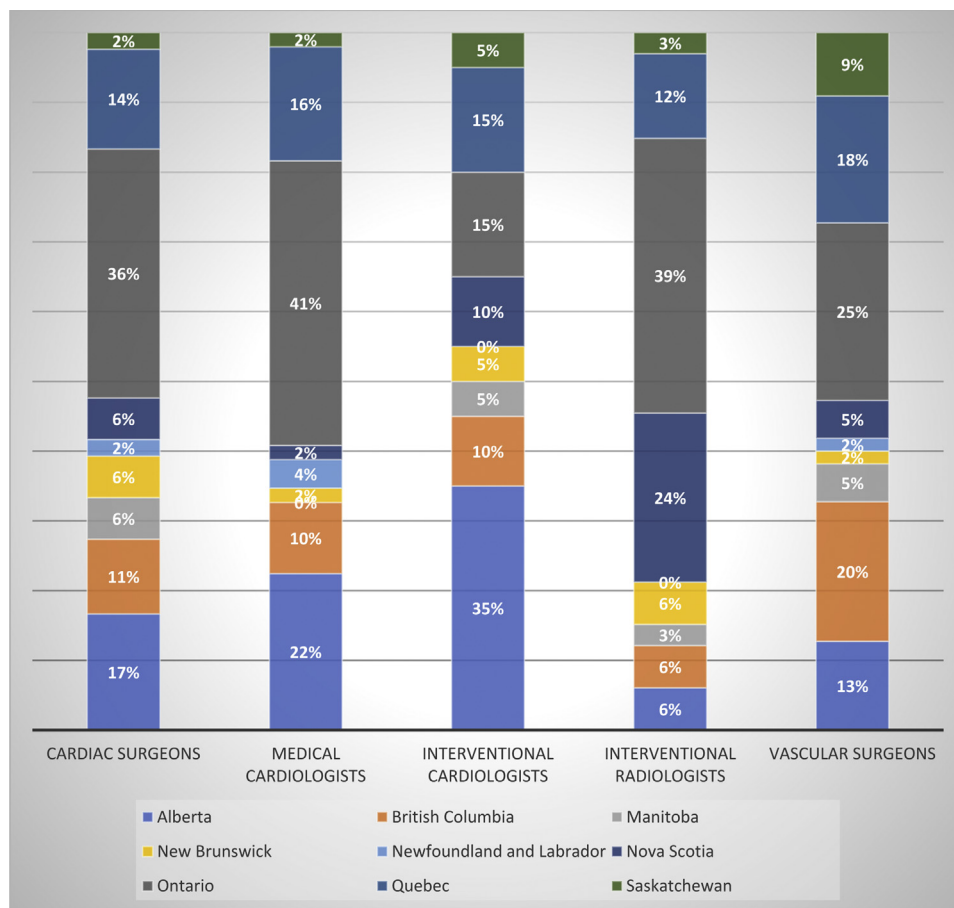
\*Pediatric cardiology was one “other” response.

<sup>†</sup>No persons resided in Prince Edward Island, Northwest Territories, Nunavut, or the Yukon.

Case rounds specific to TAD management were present at 37% of the respondents' hospitals, with an additional 27% noting that complex TAD was discussed at general case rounds. A point to note is that the distribution of specialty representation at case rounds varied greatly for those in attendance at formalized aortic rounds relative to general case rounds. For “aortic case rounds,” a large cardiac surgery (97%), vascular surgery (80%), and interventional radiology presence was noted (62%), and less of a presence for cardiology (medical cardiology 36%; interventional cardiology 15%). For general rounds, however, a clear dichotomy of representation for aortic management was observed. Cardiac surgeons and cardiologists met together and had a high level of attendance ( $\geq 80\%$ ) of each specialty at general cardiovascular rounds. There was a substantially lower level of attendance ( $\leq 25\%$ ) by interventional radiologists and vascular surgeons. Similarly, vascular surgeons and interventional radiologists met together and had high attendance ( $\geq 75\%$ ) at vascular rounds. Cardiac surgeons and cardiologists were in sparse attendance ( $\leq 30\%$ ).

## Aortic dissections

For aortic dissections, 78% of respondents practiced in a hospital that treated both type A and type B. A total of 5% percent were in a hospital that treated only type A, 11% in a hospital that treated only type B and 6% in a hospital that treated neither. Cardiac surgeons stated having an active role in 100% of type A aortic dissections, with 70% involved in type B aortic dissections as well. In a reciprocal manner, 100% of vascular surgeons stated having an active role in type B aortic dissections, with 14% also involved in type A aortic dissections. Interventional radiologists and cardiologists were also heavily invested, with 92% and 74% engaged in aortic dissection management, respectively (Fig. 5). For penetrating atherosclerotic ulcers and intramural hematomas arising at various segments within the thoracic aorta, 97% of respondents stated pathways for specialties to admit and manage such patients aligned with that of the hospital's aortic dissection pathways. For emergent aortic dissection management, only 4% (8 of 188) of respondents practiced in a



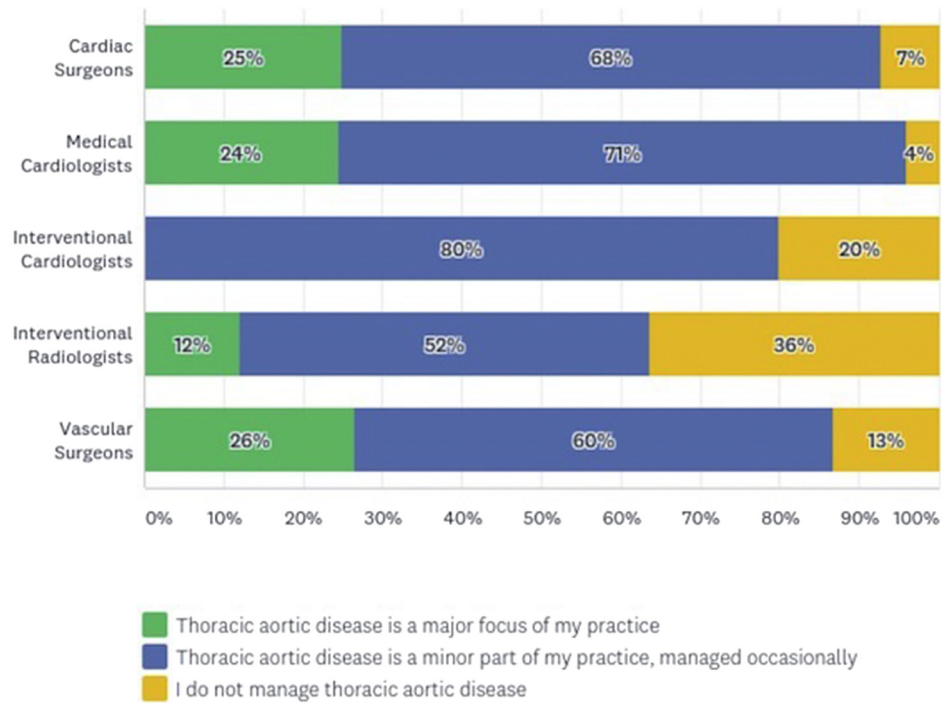
**Figure 1.** Percentage of specialty participation in Canada-wide survey stratified by province or territory of medical practice. No one who completed the survey resided in Prince Edward Island, Northwest Territories, Nunavut, or the Yukon.

hospital committed to 24/7 on-call coverage by an aortic specialist. Five of the 8 respondents were cardiac surgeons in Ontario. Two interventional radiologists in Nova Scotia, and 1 echocardiographer in Ontario, also noted 24/7 on-call coverage at their hospital by their respective specialties. For the remaining respondents, 46% used a general call system in which those on-call took full responsibility for care. An additional 49% worked in a similar general call system yet noted that an aortic specialist was always available to help if necessary.

For type B aortic dissections, patient care pathways were dispersed across several specialties, and management was heterogeneous. Medically managed uncomplicated type B aortic dissections were admitted and managed by vascular surgery 37% of the time, by cardiology 31%, and by cardiac surgery 18%. An additional 7% gave an answer of “other,” with half of this group stating that care was randomly distributed across the 3 specialties, depending on who happened to be called, or hospital bed availability. A leading role for internal medicine or the intensive care unit was mentioned by the remaining “other” respondents. The remaining 7% were unsure who managed these patients in their hospital but stated that their specialty was not involved. Physician perceptions toward care pathways for uncomplicated type B aortic dissections were skewed by their specialty

(Fig. 6). Whereas 60% of responding interventional radiologists and vascular surgeons felt the vascular surgery service managed such patients (cardiac surgery service, 13%; cardiology service, 10%), cardiologists had a very different perspective, with 58% of cardiologists stating that these patients were managed by the cardiology service (vascular surgery service, 17%; cardiac surgery service, 8%). Cardiac surgeons had a perception of management as being more evenly distributed, with the cardiac surgery service managing these patients 29% of the time, cardiology 32%, and vascular surgery 31%.

Initial therapy was consistent across specialties for uncomplicated type B aortic dissections, with 96% of institutions treating these patients for the first 24–48 hours in an intensive care or cardiac care setting. The use of thoracic endovascular aortic repair (TEVAR), on the other hand, as an adjunct to optimal medical therapy in select uncomplicated type B aortic dissection scenarios was not uniform. Only 51% of respondents stated that their hospital would use TEVAR in this scenario. A total of 31% said they do not use TEVAR for uncomplicated type B aortic dissections, and 18% were unsure. Outpatient follow-up and long-term surveillance for medically managed type B aortic dissections was predominantly managed by vascular surgery (44%). An aortic clinic (19%), cardiac surgery (15%), and cardiology (10%) were also involved to a lesser



**Figure 2.** Survey participant involvement in the management of thoracic aortic disease, stratified by specialty.

extent. A small subset was managed by internal medicine, and the remaining respondents were unsure.

For complicated type B aortic dissections, a model of varied pathways was again observed. When asked which of the 4 specialties were actively involved in the decision-making as to whether to proceed with endovascular or open surgical therapy for this patient cohort, 9 different specialty combinations were identified. Vascular surgery made the decision independent of other specialties 45% of the time, followed by teams of cardiac surgery + interventional radiology + vascular surgery (20%), cardiac surgery + interventional radiology (12%), interventional radiology + vascular surgery (12%), cardiac surgery + vascular surgery (10%), cardiac surgery independently (6%), cardiac surgery + interventional cardiology (1%), and cardiac surgery + interventional cardiology + vascular surgery (1%). Additionally, 2% of respondents were unsure, and 4% stated that complex cases of this nature were transferred to other institutions. Moreover, if such a patient proceeded with an endovascular treatment for a complicated type B aortic dissection, 42% stated that vascular surgery would do the procedure independently, 35% used a multidisciplinary team approach, 8% were done solely by interventional radiology, 6% were done by cardiac surgery independently, and 1% were done by interventional cardiology independently. Responses were again skewed by specialty (Fig. 7).

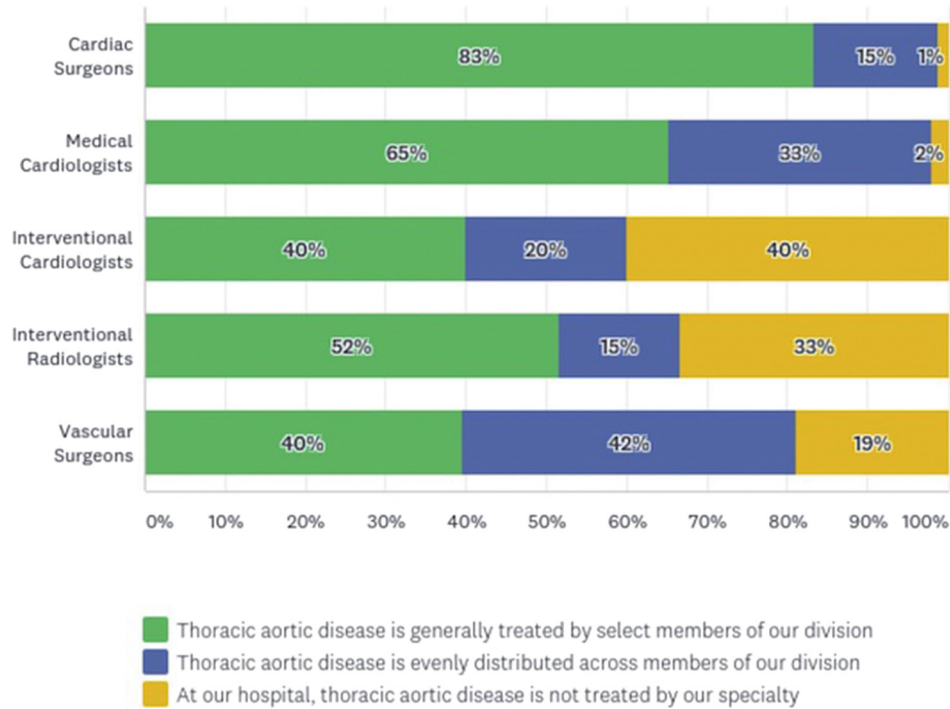
For complicated type B aortic dissections requiring open surgery but confined to the thorax (DeBakey IIIa), 31% stated that a multidisciplinary team from cardiac surgery and vascular surgery would treat this together (cardiac surgery independently, 35%; vascular surgery independently, 15%; transfer patient elsewhere, 19%). If the dissection extended below the thorax (DeBakey IIIb), the team approach to open

surgery increased to 41% (cardiac surgery independently, 22%; vascular surgery independently, 16%; transfer patient elsewhere, 22%). For aortic dissections traversing the arch, hybrid procedures (open arch surgery with adjunct TEVAR) were given consideration in select cases, with 78% of respondents stating that hybrid procedures were performed at their hospital (no, 6%; unsure, 7%; transfer elsewhere, 9%). A multispecialty team approach would provide this treatment 64% of the time, and cardiac surgery, independently, 36% of the time.

Of the adjunct interventional therapies to compliment open and endovascular treatment of chronic aortic dissections, stent grafting of adjacent branched vessels was used most widely, by 72% of the endovascular respondents. False lumen embolization was used by 46%, and intimal tear embolization by 38%. A total of 25% of endovascular respondents stated that none of the above techniques was utilized in their hospital.

### Aortic aneurysms

For thoracic aortic aneurysms, 74% of respondents practiced in a hospital that provided both open surgery and endovascular therapies for all segments of the thoracic aorta; an additional 15% practiced at institutions offering invasive therapies of varying degrees (surgery or endovascular) to select aortic segments (ascending, arch, descending, or thoracoabdominal). In all, 9% were at hospitals that did not offer invasive treatment options, and 2% were unsure. Interventional cardiologists had a more limited role in the invasive treatment for thoracic aortic aneurysms relative to that of other specialties ( $P < 0.05$ ; Fig. 8).

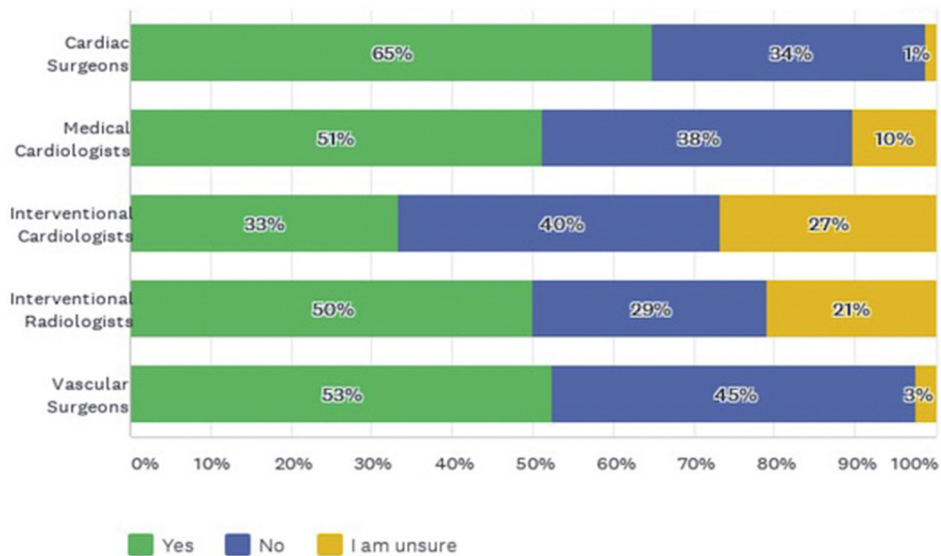


**Figure 3.** Survey participant response regarding divisional strategies for thoracic aortic disease management, stratified by specialty.

For thoracoabdominal aneurysms and dissections, an expected curve to surgical management was observed. Specialty independence decreased with increasing complexity of disease (Fig. 9). Beyond surgical management, similar to opinions regarding care for aortic dissections, opinions toward care pathways for aortic aneurysms showed variance based on specialty. Although 62% of all respondents stated that within their hospital, cardiac surgery would be the specialty consulted for assessment and outpatient follow-up of an incidentally identified ascending aortic aneurysm below the surgical

threshold (cardiology, 26%; vascular surgery, 2%; other, 5%; unsure, 5%), 77% of cardiologists stated that cardiology would manage this type of patient (16% of cardiologists selected cardiac surgery). On the other hand, 88% of cardiac surgeons, 67% of interventional radiologists, and 65% of vascular surgeons selected cardiac surgery as the most likely specialty to follow such patients. Similar patterns were also noted for aortic arch aneurysms.

For incidentally identified descending thoracic aneurysms below the surgical threshold and in need of assessment and



**Figure 4.** Survey participants' responses regarding a multidisciplinary aortic team presence at their hospital, stratified by specialty.

**Table 2. Specialty combinations that define multidisciplinary aortic teams at hospitals across Canada from the perspective of the physicians that responded to the survey stating that their hospital has a multidisciplinary aortic team**

Various compositions used to define a multidisciplinary aortic team, across Canada		
Specialties directly involved in multidisciplinary aortic team	Total responses per combination	Canadian provinces where respondents reside
Cardiac surgery + interventional radiology + vascular surgery	13	AB, BC, MB, NB, NS, ON, QC
Anesthesia + cardiac surgery + general cardiology + diagnostic radiology + genetics + ICU + interventional cardiology + interventional radiology + vascular surgery	9	AB, NB, ON
Cardiac surgery + general cardiology	5	AB, NS
Cardiac surgery + general cardiology + interventional radiology + vascular surgery	5	BC, NB, NS
59 additional aortic team combinations were submitted (not listed)		

AB, Alberta; BC, British Columbia; ICU, intensive care unit; MB, Manitoba; NB, New Brunswick; NS, Nova Scotia; ON, Ontario; QC, Quebec.

outpatient follow-up, again, specialty influenced perception. Overall, 52% of respondents stated that vascular surgery would manage this particular patient cohort (cardiac surgery, 25%; cardiology, 12%; other, 6%; unsure, 5%). Yet, when stratified by specialty, 90% of vascular surgeons stated that vascular surgery would manage this patient. Only 57% of interventional radiologists, 44% of cardiac surgeons, and 35% of cardiologists stated that vascular surgery was the primary service consulted for such patients in their hospital.

Perspectives toward specialty involvement with complex endovascular treatment of aortic arch aneurysms (Fig. 10), descending thoracic aortic aneurysms (Fig. 11), and thoracoabdominal aneurysm utilizing branched or fenestrated devices (Fig. 12) were also quite variant depending on one's specialty.

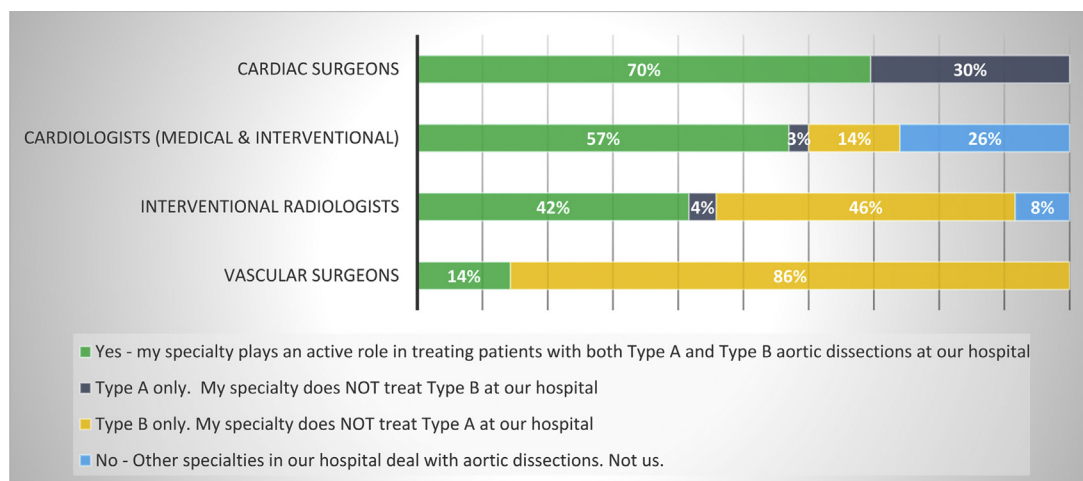
### Focused aortic outreach clinics

The presence of outpatient aortic clinics specific to select aortic populations is more prominent for some institutions. The establishment of an aortopathy or adult congenital clinic has had good penetrance, with 65% of respondents stating that patients within their region have access to such facilities. However, only 55% of respondents felt that their referral aortopathy clinic was equipped to provide genetic testing. As expected, cardiology had a significant presence at these clinics,

with 81% of respondents stating that cardiology was involved. Medical genetics was the second most prevalent specialty at 58%, cardiac surgery at 55%, vascular surgery at 30%, and diagnostic radiology at 20%. Various other specialties such as ophthalmology and orthopedic surgery were present at some clinics but to a lesser degree. Much less common or accessible for patient care were high-risk aortic pregnancy clinics. Only 24% of respondents suggested such a clinic was available for their patients. Cardiac surgery, vascular surgery, and cardiology outpatient clinics with a primary focus on aortic disease were modest in presence, at 55%, 45%, and 18%, respectively.

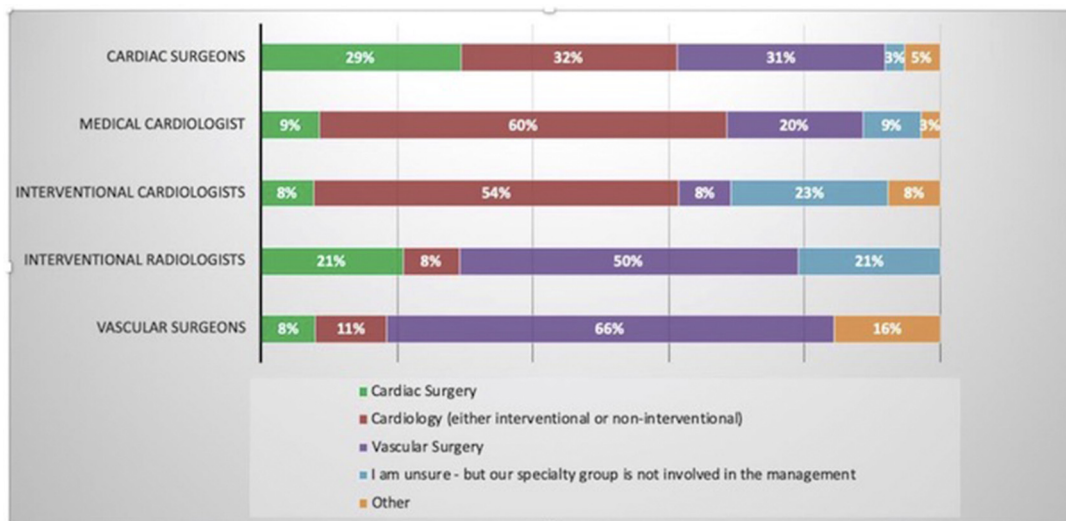
### Discussion

The current study provides a comprehensive description of the various care models used within the Canadian healthcare system to manage TAD. It is the first multispecialty collaborative effort to assess the nationwide workforce of cardiac surgeons, cardiologists, interventional radiologists, and vascular surgeons as a collective unit, facilitating specialty perspectives relative to one another with respect to TAD involvement and treatment responsibilities. Several key findings were identified.



**Figure 5.** Specialty involvement in the management of type A and type B aortic dissections in any significant capacity, be it with medical, endovascular, or surgical therapies.





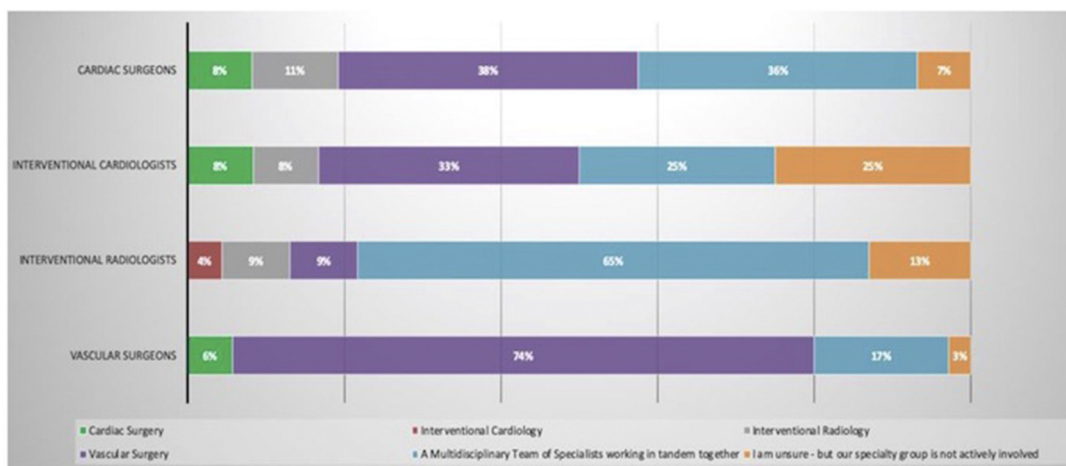
**Figure 6.** Survey participants' perception toward the specialty that will admit and medically manage uncomplicated type B aortic dissection patients in their hospital, stratified by specialty.

First, the potential benefits of a multidisciplinary aortic team are widely accepted as a theoretical construct, but actual establishment of a multidisciplinary aortic team is underutilized across the nation. Almost 90% of respondents felt multidisciplinary aortic teams were the best way to manage TAD patients. Despite this, 45% reported that a multidisciplinary aortic team was not present at their hospital. National and international medical societies now explicitly advocate for multidisciplinary aortic teams when managing TAD.<sup>6,7</sup> Given the persistent advances in endovascular technologies to complement and, at times, supersede the well-established surgical therapies to treat TAD, in addition to the acquisition of percutaneous and surgical skills by more than one specialty, early involvement of the available aortic specialists from all specialties makes sense. Moreover, studies have shown that, among aortic specialists, discordant viewpoints toward TAD management are not uncommon for select aortic conditions.<sup>8,9</sup> Such differences further justify the need for early

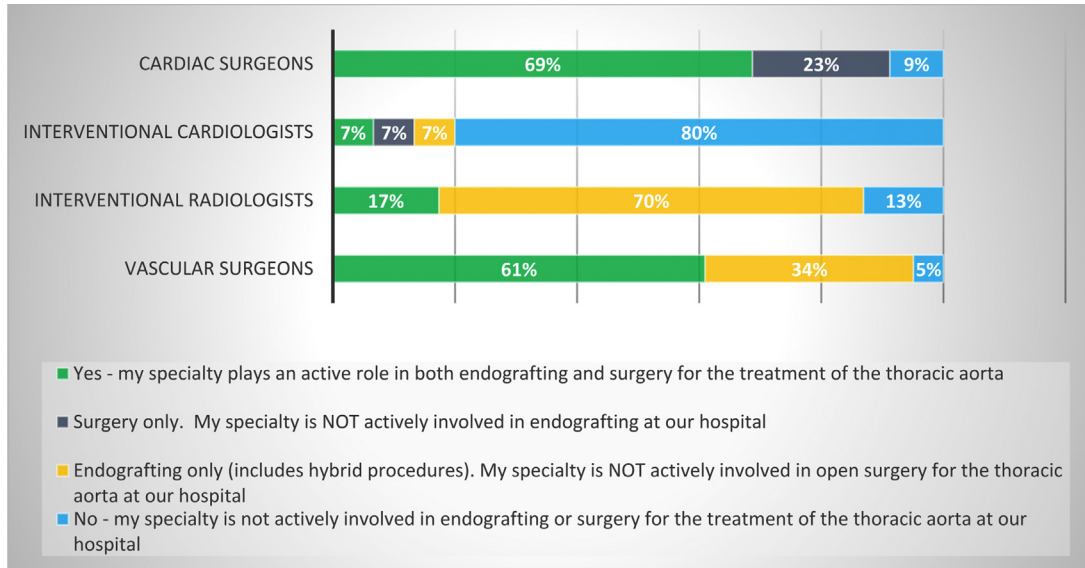
engagement of the various specialties in the decision-making process prior to initiating treatment.

Second, a structured definition to guide and define a “multidisciplinary aortic team” is lacking in Canada. Although a degree of flexibility is recognized as being necessary to accommodate local variance, the fact that 63 different combinations were reported to define a multidisciplinary aortic team suggests that the conceptual idea is in need of more precisely defined parameters. A multispecialty consensus to outline such parameters would be advantageous, as it would enable hospital stakeholders to create aortic teams with set goals and objectives in mind. Defining the multidisciplinary aortic team may catalyze the dissemination of aortic teams to hospitals across the country, as it would give some structure and direction on how to build such teams.

Third, as in the case of aortic teams, multidisciplinary aortic clinics and multidisciplinary aortic case rounds are underutilized. Despite the endorsement of multidisciplinary



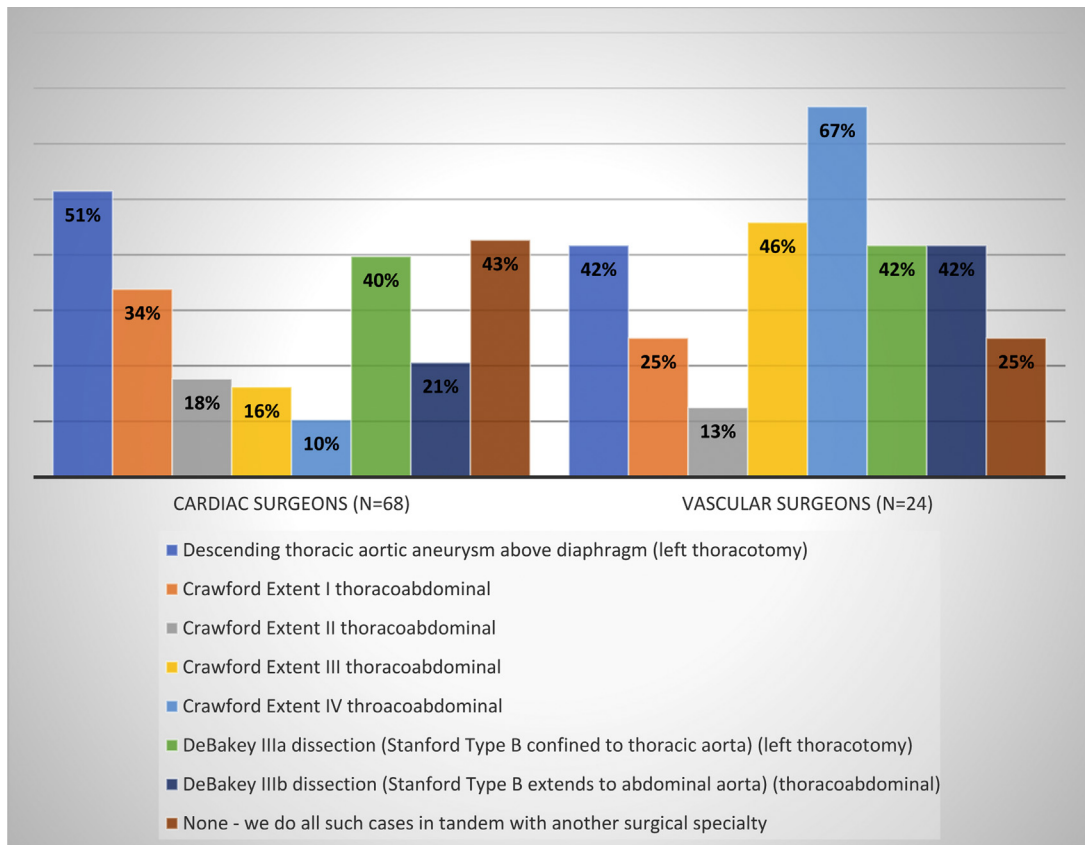
**Figure 7.** Survey participants' perceptions toward the specialty that performs endovascular treatment for complicated type B aortic dissections in their hospital, stratified by specialty.



**Figure 8.** Specialty involvement in the invasive treatment (endovascular or open surgery) of thoracic aortic aneurysms.

aortic clinics by major medical societies,<sup>6,7</sup> and persuasive arguments in the literature to suggest that multidisciplinary aortic clinics should be standard of care in Canada,<sup>10</sup> less than 30% of respondents had a defined physical space for

multidisciplinary patient assessments. Multiple factors are likely responsible for this observation. Although the most highly ranked reason for not having a multidisciplinary clinic was comfort with the status quo, the lowest ranked reason was



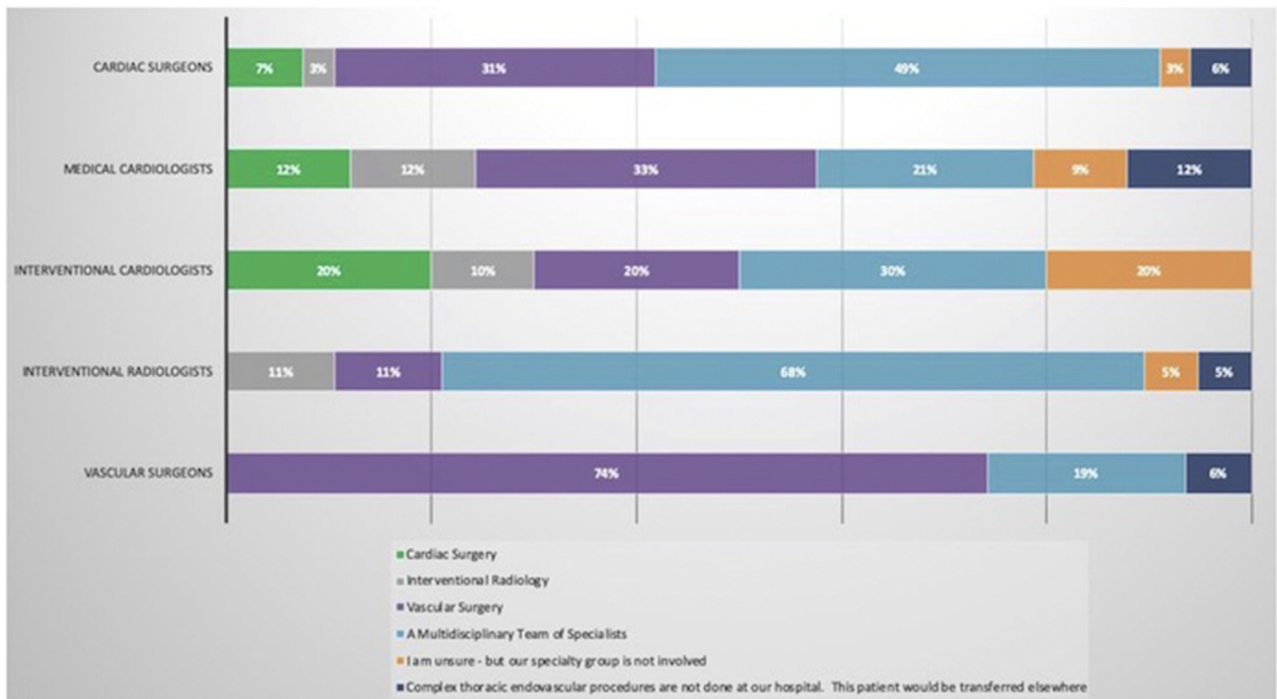
**Figure 9.** The percentage of cardiac surgeons and vascular surgeons performing INDEPENDENT surgical management of thoracoabdominal aneurysms and descending thoracic aortic dissections at hospitals across Canada.



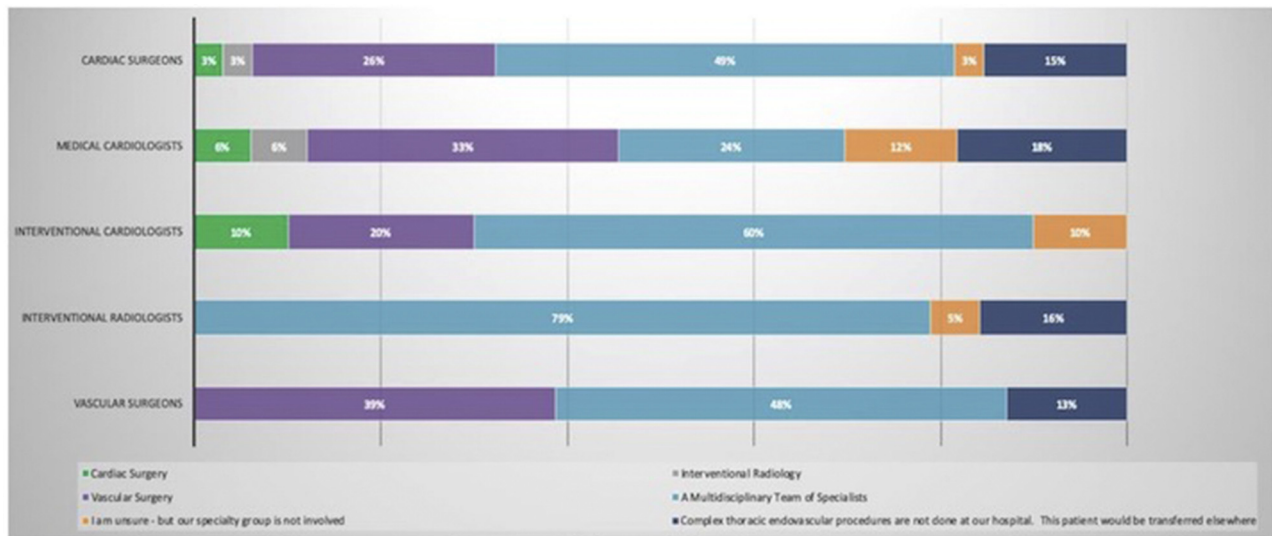
**Figure 10.** Survey participants' perceptions toward the specialty that performs endovascular treatment for aortic arch aneurysms in their hospital, stratified by specialty.

a lack of interest. This finding suggests that physicians are receptive to establishing multidisciplinary aortic clinics but are in need of personnel to champion the initiative. A lack of capital investment for the needed clinic space could also be a

contributing factor,<sup>11</sup> but lack of funding was not reported to be a major obstacle by respondents. On the other hand, despite the low penetrance of multidisciplinary aortic clinics to date, focused outpatient aortopathy/adult congenital clinics



**Figure 11.** Survey participants' perceptions toward the specialty that performs endovascular treatment for descending thoracic aortic aneurysms in their hospital, stratified by specialty.



**Figure 12.** Survey participants' perceptions toward the specialty that performs endovascular treatment for thoracoabdominal aortic aneurysms with branched or fenestrated devices in their hospital, stratified by specialty.

for the management of connective tissue disorders have a strong presence across the country. Broadening the scope of well-established aortopathy clinics to encompass degenerative aortic disease or alternatively using the aortopathy model as a framework for the establishment of stand-alone multidisciplinary aortic clinics are the 2 avenues most likely to promote a more multidisciplinary presence to treating complex aortic patients.

Fourth, care pathways to treat TAD are poorly defined and quite variable. Although they are most evident for pathologies of the descending thoracic aorta, treatment for the ascending aorta also showed variance. The disparity among models for emergent surgical on-call coverage of type A aortic dissections is noteworthy. With the high mortality rate of this patient subset, an opinion held by an increasing number within the broader aortic community is that type A aortic dissections should be treated by a limited number of aortic-focused surgeons within a hospital's larger cardiac surgery group.<sup>12</sup> Several large tertiary centers have reported success with this approach.<sup>13-15</sup> To date, however, this model has had little traction in Canada, as only 6% of cardiac surgeons stated that they work in such a system. The vast majority work within a general call system or a general call plus aortic specialty back-up model. A consensus policy on best practice may prove beneficial to guide hospital initiatives with such protocols.

The descending thoracic aorta proves most challenging. For type B aortic dissections, vascular surgery, cardiology, and cardiac surgery all take an active role in admitting these patients to their service. Reassuringly, early management protocols were consistent, with nearly all respondents monitoring uncomplicated patients within an intensive-care setting. Thereafter, however, with the role of TEVAR evolving in this sphere,<sup>16</sup> if patients are not managed within a multidisciplinary construct, potential exists for divergent pathways and

heterogeneity in patient care models. The same holds true for descending thoracic aneurysms and thoracoabdominal aortic disease. Endovascular options to treat these patient subsets are constantly in flux, and determining when best to utilize endovascular techniques is not always clear.<sup>17,18</sup> Achieving a balance between TEVAR under-utilization and over-utilization relative to long-established medical and surgical treatments requires collective oversight. Specialties less adept at endovascular techniques may have a tendency to under-refer patients for such therapies, whereas specialties heavily invested in endovascular care may inadvertently overuse the technology in select situations. The fragmented distribution of descending thoracic pathology patients to various specialties fosters discordant pathways of care. A framework within the health system to guide and safeguard against such missteps is in the patients' best interest.

Last, specialties appear to have a poor understanding of their true impact on the management of TAD. Specialties overestimated their true level of ownership of both inpatient referrals and outpatient follow-up. Thus, outside the construct of a multidisciplinary team, specialties may believe they have more involvement in the management of thoracic aortic disease than they actually do. The survey reflects the attitudes or perspectives of the respondents (with respect to involvement of their specialty) and does not necessarily correlate to absolute statistical truth, but this variance is of interest and warrants further study.

### Limitations

With the first nationwide multispecialty survey to characterize care pathways for TAD in Canada, important insights into present-day management practices have been acquired. Still, as a cross-sectional survey, it has limitations. The data depict a point in time and are not representative of past or

future processes. Still, with endovascular therapy now well established and uniformly adopted within the aortic armamentarium,<sup>19</sup> assuming no other major disruptive influences occur to alter current care models, it is reasonable to assume that the present report is relevant for a wide timeline, both pre- and post-survey.

Another potential limitation is the response rate of 27%, indicating that the results could be subject to a degree of bias. However, for the greater cohort, active participation in TAD treatment by nearly 30% of all physicians from the 4-specialty sampling frame is likely representative of real-world practice. Moreover, the distribution of the response rate by specialty is also reflective of the real world. Cardiac surgery (76% response rate) is inherently involved in TAD treatment due to type A aortic dissection responsibilities. Vascular surgery (40% response rate) is equally involved in TAD treatment at tertiary centers, yet with many vascular surgeons working at peripheral sites, there is a portion of their workforce that is less invested. Finally, both interventional radiology (24% response rate) and cardiology (14% response rate) have many subspecialty areas of niche expertise, of which TAD is a small subset. Those involved in TAD treatment from interventional radiology and cardiology are equally invested relative to their cardiac and vascular surgery counterparts, but the overriding stake in TAD treatment by their specialties is proportionally smaller. Taken together, it is quite reasonable to assert that most invested personnel across the nation participated and that the results are indicative of current care practices. Finally, some questions and scenarios within the survey may not be transferrable to healthcare systems in other countries, limiting the external validity beyond that for a single-payer healthcare system.

## Conclusion

Thoracic aortic disease follows a mesh of variable care pathways, despite its high-risk patient population in need of complex treatment considerations. Multidisciplinary aortic teams and clinics exist in low volume and the “aortic team” remains an obscure construct. A multispecialty initiative to define the aortic team and outline standardized navigation pathways within the health system’s hospitals is advocated.

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## Disclosures

The authors have no conflicts of interest to disclose.

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### **Supplementary Material**

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