



Original Research

Canadian Physicians' Use of Perioperative Botulinum Toxin Injections to Spastic Limbs: A Cross-sectional National Survey



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KEYWORDS

Botulinum toxins;
Muscle spasticity;
Perioperative care;
Rehabilitation

Abstract *Objective:* To investigate the practice patterns of Canadian physicians who use perioperative botulinum toxin (BoNT) injections to improve surgical outcomes on spastic limbs. *Design:* A cross-sectional national survey composed of an invitation email and an 18-item questionnaire was disseminated by a national physical medicine and rehabilitation (PMR) society to 138 physician members involved in spasticity management. *Setting:* Not applicable. *Participants:* Twenty-five percent of the participants (N=34) fully completed the survey. *Interventions:* Not applicable. *Main Outcome Measures:* Participants completed an online questionnaire that examined the practice patterns and surgical outcomes associated with perioperative BoNT injections. *Results:* The majority (n=21; 84%) of Canadian physicians who inject BoNT perioperatively to improve outcomes of surgeries performed on spastic limbs are specialists in PMR practicing in

List of abbreviations: BoNT, botulinum toxin; CANOSC, Canadian Advances for Neuro-Orthopedics for Spasticity Congress; CAPMR, Canadian Association of Physical Medicine and Rehabilitation; MS, multiple sclerosis; PMR, physical medicine and rehabilitation; SCI, spinal cord injury. This study did not receive any grants or funding from public, commercial, or not-for-profit sectors.

Disclosures: Dr Finlayson has received honoraria and participated in advisory boards for Allergan/Abbvie, Merz, and Ipsen. Dr Winston has received honoraria and unrestricted educational grants, as has his institution, from Abbvie, Merz, and Ipsen; he has also participated on advisory boards for all 3 companies. Dr Reebye has received honoraria and institutional funding and participated in advisory boards for Allergan/Abbvie, Merz, and Ipsen.

The other authors have nothing to disclose.

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academic settings. Most respondents (74%) used BoNT injections for perioperative treatment for patients with limb spasticity undergoing surgery. Of those surveyed, 65% of physicians used BoNT preoperatively, 21% used BoNT intraoperatively, and 24% used BoNT postoperatively.

Of the physicians who performed BoNT injections preoperatively, 6% performed BoNT injections 7 to 12 weeks preoperatively, 32% performed BoNT injections 4 to 6 weeks preoperatively, 47% performed BoNT injections 2 to 3 weeks preoperatively, and 15% performed BoNT injections 0 to 1 week preoperatively. The majority of physicians (85%) responded that injecting BoNT perioperatively may improve a patient's surgical outcome and all of the participants (100%) stated that BoNT did not contribute to any perioperative complications or adverse effects. Qualitative responses emphasized that successful outcomes from the perioperative BoNT were linked to enhanced collaboration with surgeons and that more research is needed to determine the optimal timing of perioperative BoNT.

Conclusion: Canadian physicians, mostly PMR specialists, administer perioperative BoNT to improve outcomes of surgeries performed on spastic limbs. The optimal timing for perioperative BoNT was suggested to be 2 to 3 weeks before the surgery by 47% of survey respondents. All participating physicians responded that perioperative BoNT did not contribute to any known perioperative complications or adverse events. This study highlights the importance of conducting more robust research to better understand optimal timing for perioperative BoNT injection, enhancing collaboration between physicians and surgeons, and increasing awareness of perioperative BoNT when planning for surgeries on spastic limbs.

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Spasticity is a sensorimotor disorder characterized by intermittent or sustained involuntary muscle activation, which is a common and potentially problematic consequence of upper motor neuron disorders.¹ Spasticity is commonly associated with disorders such as stroke, traumatic brain injury, cerebral palsy, spinal cord injury (SCI), and multiple sclerosis (MS). Multimodal spasticity management aims to improve patients' symptomatology and functionality and involves nonpharmacological, pharmacological, and surgical interventions.²

Patients with spasticity may undergo surgical procedures (eg, tendon lengthening, neurectomy, tenotomy, wound flap surgery) to help with spastic deformities or complications from underlying spasticity that are not sufficiently managed by more conservative strategies. They may also undergo surgical procedures unrelated to their spasticity (eg, joint replacement, cervical fusion).³⁻¹⁰

Spasticity may predispose patients to increased surgical complications in the perioperative period, which includes the pre-, intra- and postoperative stages.¹¹ Surgery itself may act as a noxious stimulus that increases spasticity in the intra- and postoperative periods, which could adversely affect tissue repair, joint anatomy, and wound healing processes resulting in poor surgical outcomes and surgical failure.¹¹⁻¹³ Optimizing spasticity management before surgery may therefore help decrease surgical complications.¹¹⁻¹³

Previous animal and human studies have assessed the role of perioperative botulinum toxin (BoNT) injections to enhance surgical outcomes. Preoperative BoNT administration was found to decrease passive tension in the muscle-tendon unit, which can facilitate intraoperative manipulation and rehabilitation, and may lower the risk of rupture of tendon repairs.¹⁴⁻¹⁶

Perioperative BoNT injection has also led to a reduction of pain and spasticity and a decrease in analgesic use in

patients undergoing surgery on their spastic limbs.¹⁷⁻²¹ Perioperative BoNT injections can also optimize surgical outcomes of patients with spasticity undergoing orthopedic procedures not directly related to their preexisting spasticity.^{11,17-22} Perioperative BoNT could therefore help improve surgical outcomes, alleviate postoperative pain, and facilitate rehabilitation participation.¹¹

A recent case series suggested potential benefits from perioperative BoNT administration for patients with spasticity owing to upper motor etiologies, including SCI, stroke, or MS. This case series highlighted that the use of perioperative BoNT may be effective in improving surgical outcomes in the 3 perioperative periods for patients undergoing unrelated surgery to their spasticity such as hip arthroplasty in a spastic limb, spasticity-related surgery such as tendon lengthening, and wound healing post wound-flap surgery from spasticity related pressure ulcers.¹¹

A systematic review regarding the role of perioperative BoNT administration suggested that BoNT injection preoperatively can improve surgical outcomes, including postoperative pain, spasticity, and analgesic use. More research is warranted to further demonstrate the efficacy, benefits, and risks associated with this modality.¹³

There has been an increase in publications over the past 2 years regarding the use of perioperative BoNT to enhance outcomes of surgeries on spastic limbs,^{10,11,13,17,21,23} but to date, there have not been any cross-sectional surveys to assess how frequently perioperative BoNT treatment is performed by physicians involved in spasticity management or physicians' practice patterns regarding the timing of perioperative BoNT. Given the paucity of literature and absence of guidelines regarding perioperative BoNT injection to enhance outcomes of surgeries on spastic limbs, we organized a cross-sectional study to assess whether physicians are performing perioperative BoNT, with an ultimate goal to plan for the future development of Canadian guidelines. The

primary aim of this study was to assess how commonly perioperative BoNT is administered to patients undergoing surgical procedures to their spastic limbs. The secondary aims of this study were to gather practice patterns regarding the timing of perioperative BoNT injections and to assess barriers in the use of perioperative BoNT.

Methods

Study design and survey

Physicians involved and having a special interest in the treatment of spasticity were identified using a national database provided by the Canadian Association of Physical Medicine and Rehabilitation (CAPMR), the national organization representing specialists in physical medicine and rehabilitation (PMR), as well as the Canadian Advances for Neuro-Orthopedics for Spasticity Congress (CANOSC), a non-profit suborganization under CAPMR for physicians (not limited to PMR) and surgeons interested in the advancement of spasticity treatment. An anonymous online survey tool was developed by project team members and used for all data collection. Our team created survey questions de novo and performed multiple robust revisions. This study was approved by the local research ethics board. The final version comprised 18 questions directed to physicians involved in spasticity management with experience in the perioperative use of BoNT injections used specifically to address outcomes of surgeries performed on spastic limbs. This included the demographics of the patients injected for perioperative BoNT, injection techniques (eg, electromyography, electrical stimulation, ultrasound-guided), physician demographics, any observed side effects or complications, and the physicians' viewpoints regarding opportunities and barriers for the use of perioperative BoNT. Survey questions sought both quantitative and qualitative responses. Participants were invited to complete the survey using the SurveyGizmo^a web-based platform, and all data collection occurred electronically via this online survey. The CAPMR secretariat holds an enterprise license for this software. The survey is shown in [supplemental appendix S1](#) (available online only at <http://www.archives-pmr.org/>).

Participant recruitment

We surveyed Canadian physician and surgeon members of CAPMR involved in spasticity management and its spasticity-related organization CANOSC, to assess whether they have experience with perioperative BoNT injections to improve outcomes of surgeries performed on spastic limbs. We included fully licensed specialist physicians involved in spasticity management for this survey. We excluded resident physicians or other physician trainees. We forwarded an invitation email containing information about our study, obtaining consent, privacy and ethics statements, and the link to the anonymized survey platform. We provided the contact information of the principal investigator in case the study participants had any questions or concerns.

Upon submission, all questionnaires were thoroughly reviewed by 2 study coauthors; any disagreements were resolved through consensus. Surveys were either filled

partially or completely. Partially responded surveys were excluded. The descriptive data from the completed surveys were meticulously extracted. The survey platform was kept open between May 2020 and October 2020.

Study participants

A total of 138 invitations were sent via the CAPMR survey platform to members of CANOSC and CAPMR involved in the use of BoNT for spasticity management ([fig 1](#)). This number of approximately 138 Canadian PMR physicians involved in spasticity management was similar to that in previous studies by Ip et al²⁴ and Kassam et al²⁵ that evaluated practice patterns of Canadian physicians involved in spasticity management regarding the administration of BoNT and adjunctive therapy and BoNT injection for spasticity management in the anticoagulated patient.

Results

Demographics and participant characteristics

A total of 167 members within the CAPMR and CANOSC organizations were identified as physicians having a special interest in spasticity management; 82% were Canadian and 18% were international members. We excluded resident physicians and international members, and a total of 138 physicians was identified for survey distribution ([fig 1](#)).

A total of 138 invitation emails were sent to the practicing Canadian physicians involved in spasticity management. Sixty-seven participants (49%) opened and viewed the questionnaire. Forty-nine responses were received over the 5 months the survey platform was open; 15 partially completed surveys (<50% completion) were excluded. Thirty-four participants fully completed the survey, resulting in a survey response rate of 25%. The demographics of study participants are demonstrated in [table 1](#).

The majority of respondents were PMR specialists. A 2019 survey by the Canadian Medical Association revealed that approximately 500 Canadian PMR specialists were in clinical practice.²⁶ Our survey was therefore completed by approximately 6% of active PMR specialists in the country.

All physicians (N=34) included in this study used BoNT injections for spasticity management. The majority of these physicians (68%) have been using BoNT injections to treat spasticity for at least 10 years. The majority of physicians surveyed treated patients with diverse upper motor neuron etiologies contributing to spasticity including patients with stroke (88%), traumatic brain injury (88%), cerebral palsy (88%), MS (88%), or SCI (91%). Of the physicians surveyed, 71% used BoNT in an academic hospital or medical center, 12% conducted the procedure in a nonacademic hospital or medical center, and 18% used it in a community or private practice setting.

Intervention timing

The majority of physicians (74%) administered perioperative BoNT injections for patients with limb spasticity undergoing surgery. Fifty-four percent of physicians used perioperative

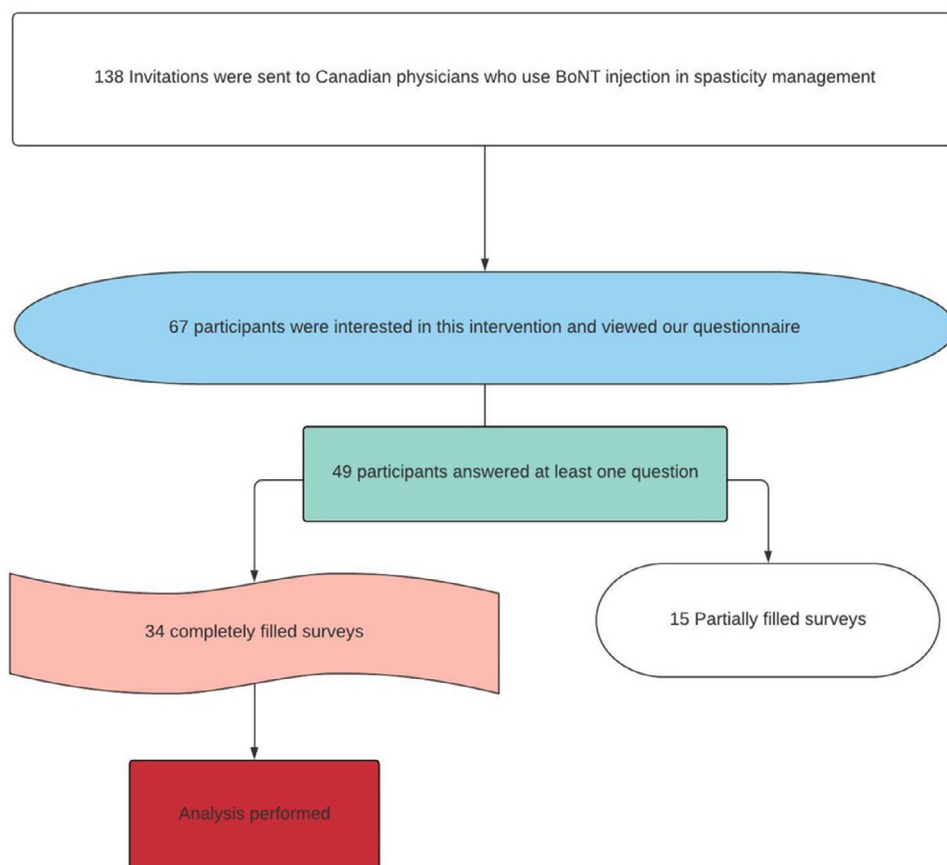


Fig 1 Flow chart for surveys completed.

Table 1 Demographics of participants and intervention outcomes

Physician Demographics	n (%)	Intervention Demographics	n (%)
Specialty		BoNT use, y	
Physical medicine and rehabilitation	31 (91)	0-9	11 (32)
Orthopedic surgery	2 (6)	10-19	16 (47)
Plastic surgery	1 (3)	20-29	6 (18)
		>30	1 (3)
Province		BoNT conditions treated	
British Columbia	15 (44)	Stroke	30 (88)
Ontario	10 (29)	Traumatic brain injury	30 (88)
Quebec	5 (15)	Cerebral palsy	30 (88)
Alberta	1 (3)	Multiple sclerosis	30 (88)
Saskatchewan	1 (3)	Spinal Cord Injury	31 (91)
Manitoba	1 (3)		
New Brunswick	1 (3)	Perioperative BoNT use, y	
		0-4	7 (20.5)
		5-9	5 (15)
		10-14	4 (12)
		15-19	8 (23.5)
		>20	1 (3)
		Do not use	9 (26)

Table 2 Perioperative use of BoNT

Perioperative Use of BoNT	n (%)	Perioperative Use of BoNT	n (%)
Perioperative use	25 (74)	BoNT toxins	
Preoperative	22 (65)	Onabotulinum toxin A	33 (97)
Intraoperative	7 (21)	Incobotulinum toxin A	24 (71)
Postoperative	8 (24)	Abobotulinum toxin A	18 (53)
Preoperative use, wk		Setting of perioperative use	
0-1	5 (15)	Academic hospital	24 (71)
2-3	16 (47)	Nonacademic hospital	4 (12)
4-6	11 (32)	Community/private practice	6 (18)
7-12	2 (6)		
Not notified of date	14 (41)		
Perioperative surgical outcomes		Perioperative adverse effects	
Improves	29 (85)	No adverse effects	34 (100)
Does not improve	3 (9)		
Unanswered	1 (3)		
Perioperative barriers to treatment		BoNT guidance techniques	
Time constraints	13 (38)	EMG	24 (71)
Lack of evidence	6 (18)	Electrical stimulation	30 (88)
		Ultrasound	21 (62)
		CT fluoroscopic guidance	3 (9)
Colleague perioperative treatment			
Similar	0 (0)		
Differs	19 (56)		
Unsure	14 (41)		
Unanswered	1 (3)		

Abbreviations: CT, computed tomography; EMG, electromyography.

BoNT treatments for at least 5 years. Sixty-five percent of physicians have performed BoNT injections to the spastic limb preoperatively, 21% have used BoNT intraoperatively, and 24% have used BoNT postoperatively. Forty-one percent of physicians experienced a time when they were not notified of their patient's surgery date. Physician perioperative use of BoNT is documented in [table 2](#).

Of the physicians who performed BoNT injections preoperatively, 6% performed BoNT injections 7 to 12 weeks preoperatively, 32% performed BoNT injections 4 to 6 weeks preoperatively, 47% performed BoNT injections 2 to 3 weeks preoperatively, and 15% performed BoNT injections 0 to 1 week preoperatively.

Intervention characteristics

Seventy-one percent of physicians performed the perioperative BoNT injections at an academic hospital, 12% of physicians performed the injections at a nonacademic hospital, and 18% of physicians performed the injections in the community or private practices. To target the correct muscles, most physicians used multiple forms of BoNT injection guidance techniques, including electromyography (71%), electrical stimulation (88%), ultrasound (62%), and computed tomographic-fluoroscopic guidance (9%).

Physicians surveyed used all 3 BoNT toxins available in Canada, with onabotulinumtoxin A (Botox^b) used by 97% of physicians, incobotulinumtoxin A (Xeomin^c) used by 71% of physicians, and abobotulinumtoxin A (Dysport^d) used by 53%

of physicians. The doses used for each toxin were variable. Physicians stated that the use of perioperative BoNT injections was not standardized among colleagues. Fifty-six percent of the physicians stated that their use of BoNT was different from their peers, and the remainder did not know how their colleagues treated their patients with perioperative BoNT.

Intervention outcomes

The majority of physicians (85%) stated that injecting BoNT perioperatively can improve a patient's surgical outcome. When asked an open-ended question, all physicians (100%) believed that BoNT did not contribute to any perioperative complications or adverse effects. Thirty-eight percent of physicians stated that the time constraints were a barrier for patients receiving perioperative BoNT, whereas 18% believed that lack of evidence in medical literature was a barrier.

Qualitative responses

Physician responses, summarized in [table 3](#), emphasized the benefits of perioperative BoNT and the importance of collaboration with surgeons. Physicians also described the reason as to why they started using perioperative BoNT and how surgical outcomes were improved by its use.

Table 3 Themes and responses**Tips and Pearls of Wisdom for Using Perioperative BoNT Injections**

- “Relationships with surgeon. Teach your surgical colleagues why it is helpful.”
- “Discuss with surgeon what is being done and what treatment options are available. Work with surgeons who have expertise in neurologic patients.”
- “Optimal timing can be difficult to coordinate with patient/surgeon/clinical time.”
- “Appears to reduce postoperative pain particularly in the leg with standing.”

How/Why Did You Start Injecting BoNT Into Spastic Limbs Perioperatively?

- “Excellent relationship with surgeons.”
- “Asked by surgeon colleague to do it.”
- “Clinical encounter—surgeon initiated the question.”
- “To help with pain and spasticity management.”

What Improved Surgical Outcomes Have You Noticed With BoNT Injections?

- “Improved pain control. Decreased tendon rupture.”
- “Improved pain control, better positioning for casting and bracing.”
- “Ease of postoperative positioning, immobilization, and healing of fractures.”
- “Improved tolerance of casting/bracing.”

Discussion

To our knowledge, this is the first cross-sectional study to examine Canadian physicians' practice patterns regarding perioperative BoNT injections to improve outcomes of surgeries performed on spastic limbs. The majority of physicians who responded to our survey were specialists in PMR. A small number were orthopedic and plastic surgeons. They used BoNT in the management of various patient populations with spasticity from conditions such as stroke, traumatic brain injury, cerebral palsy, MS, and SCI.

Although all respondents used BoNT injections for spasticity management, 74% of respondents also administered BoNT perioperatively. Academic hospitals were the most prevalent setting for perioperative BoNT injections for both cohorts. It is unclear if this is owing to the availability of multidisciplinary teams, such as those with dedicated orthopedic or plastic surgeons working with the spasticity team.

Physicians used all 3 available preparations of BoNT for spasticity management and perioperative BoNT injections. Our cross-sectional survey identified that physicians were not consistent in their dosing for upper and lower spastic limbs undergoing surgical interventions, and further investigations should be completed to determine the rationale for the use of each toxin and its recommended dosing for perioperative use. Similarly, more research is needed to explore the optimal timing of perioperative BoNT injections. Although each physician was able to select multiple choices, nearly half of the physicians (47%) stated that the optimal timing of BoNT injections was 2 to 3 weeks before the surgery, followed by 32% of physicians stating 4 to 6 weeks preoperatively as the optimal timing of perioperative BoNT.

Furthermore, 21% of participants injected BoNT intraoperatively and just under 24% did so postoperatively. We surmise that the preoperative time interval of 2 to 3 weeks was likely chosen because this is consistent with the known physiological actions of BoNT.^{13,27} A recent systematic review of perioperative BoNT¹³ suggested that preoperative, and not intraoperative, BoNT injection can improve surgical outcomes, and most Canadian physicians injected in this perioperative time frame.

Our survey also demonstrated that approximately 41% of the surveyed physicians were not typically notified of their patient's surgery date. This highlights the importance of collaboration with surgical colleagues to optimize the success of perioperative BoNT injections.

Barriers, opportunities, and challenges

The majority of physicians (85%) agreed that perioperative BoNT injections may improve a patient's surgical outcomes, and all physicians stated that there were no adverse effects from perioperative BoNT administration. We recommend collaborative education sessions between PMR specialists and surgeons early in their careers to improve collaboration with regard to identifying patients who would benefit from perioperative BoNT and ensuring optimal timing for the perioperative BoNT injections.

Qualitative responses also reflect the importance of collaboration with surgical colleagues. Responses when asked “Why did you start injecting BoNT into spastic limbs perioperatively?” included “Asked by surgeon colleague to do it” and “Clinical encounter—surgeon initiated the question.” When asked about the pearls of wisdom they've acquired in the time they've used perioperative BoNT injections, responses included “Work with surgeons who have expertise in neurologic patients,” and “Relationships with surgeon(s). Teach your surgical colleagues why it is helpful.”

Lack of adequate resources, such as clinicians' time constraints and high patient volume, as well as limited literature regarding perioperative BoNT injection, were noted as common barriers in implementing perioperative BoNT injections to improve outcomes of surgeries performed on spastic limbs. Orthopedic surgeons, neurosurgeons or plastic surgeons who are not involved in a multidisciplinary spasticity clinic and are conducting surgical procedures not directly related to the patient's spasticity (ie, hip arthroplasty secondary to osteoarthritis) may have more challenges in coordinating optimal referrals and discussions of the timing of the perioperative BoNT. This emphasizes the need to increase our surgical colleagues' awareness of the importance of presurgical identification of patients undergoing surgery to their spastic limbs and early collaboration with the spasticity team to plan for perioperative BoNT to optimize surgical outcomes. Our study likely takes into account that most patients in our country can access BoNT, but there may be barriers to reimbursement by insurers or the government, which need to be overcome before injection.²⁸

Study limitations

Since we implemented an email survey, we recognize that our results are susceptible to voluntary response bias. Our

survey had a small sample size; however, this likely reflected the Canadian landscape of PMR specialists involved in the treatment of spasticity and using perioperative BoNT in an academic or community-based clinic setting. The surgeons involved in the survey were from the CANOSC association and represented a minority of the CANOSC membership. In Canada, orthopedic and plastic surgeons are often involved in multidisciplinary spasticity clinics to help in the surgical management of patients requiring surgery for their limb spasticity. These surgeons would likely have the greatest ease of communication with the physicians to ensure optimal timing of the perioperative BoNT injections. We asked physicians to complete the survey if they were involved in the use of perioperative BoNT for surgical procedures directly related to the spastic limb or for patients undergoing surgical procedures unrelated to their spasticity. We did not ask the physicians the most common etiologies or common surgical procedures to spastic limbs requiring the use of perioperative BoNT. This information would have been valuable, and this needs to be addressed in future cross-sectional surveys or collected when developing perioperative BoNT treatment guidelines.

Recommendations for future studies

Our survey was disseminated to members of CAPMR and CANOSC who had a special interest in spasticity management. This convenience sample resulted in 34 fully completed surveys out of 138 physicians surveyed involved in spasticity management. This subgroup could be approached for future perioperative survey studies and the development of guidelines for the use of perioperative BoNT. Future survey-based studies should consider developing a cross-sectional national survey including surgeons not attached to a spasticity clinic and evaluating their awareness of the use of perioperative BoNT to optimize surgical outcomes on spastic limbs. This would better assess whether surgeons not attached to a spasticity clinic are aware of the use of perioperative BoNT. This survey has identified the need to conduct further research to develop guidance and guidelines in the timing for perioperative BoNT, strategies to improve collaboration between physicians and surgeons to ensure proper timing, patient selection, and delivery of perioperative BoNT. This survey can help in the development of robust questions when developing a Delphi process for the development of guidelines for the timing and patient selection for perioperative BoNT in the real-world clinical setting. Furthermore, future studies can also examine perioperative BoNT functional outcomes in conjunction with pain, analgesic use, and spasticity.

Conclusions

Our cross-sectional survey study has highlighted that Canadian physicians use BoNT for spasticity management in the perioperative period. Although our respondents have noted favorable postsurgical benefits and negligible risks, they are often not notified when their patient is scheduled for surgery and, as a result, this may affect the timely delivery or use of perioperative BoNT for patients undergoing surgery

on their spastic limbs. Collaboration between physicians and surgeons is key in enhancing education, national guideline development, and future research in the field of perioperative BoNT injections.

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Supplier

a. SurveyGizmo; SurveyGizmo. b. Onabotulinumtoxin A (Botox); Allergan/Abbvie. c. Incobotulinumtoxin A (Xeomin); Merz. d. Aboobotulinumtoxin A (Dysport); Ipsen.

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