Dystonia treatment

Patterns of medication use in an international cohort

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ABSTRACT

Objective: To determine the frequency of medication use in patients with dystonia enrolled in an international biorepository study.

Methods: In a cross-sectional analysis, we included 2,026 participants enrolled at 37 sites in the United States, Canada, Europe, and Australia through Project 1 of the Dystonia Coalition, an international biorepository study. The primary aim was to assess the frequency of medication classes recommended for treating patients with dystonia, and the secondary aim was to compare characteristics (disease type, age, sex, duration of disease, comorbid conditions, severity).

Results: Querying the database for the presence of any medication for dystonia used (includes both injectable and oral therapy), we found 73% using medications (n = 1,488) and 27% using no dystonia medications (n = 538). Furthermore, 61% of the total sample used botulinum toxin (BoNT) therapy alone or in combination. Differences were found in medication use patterns by dystonia type, with the lowest oral medication use in focal dystonia and highest use in generalized dystonia; by region, with highest BoNT therapy rate reported in Italy and the lowest in the Northeast region of the United States; and by focal dystonia subtype, with highest BoNT therapy alone in blepharospasm and spasmodic dysphonia (49%) and lowest in other cranial dystonia (32%).

Conclusions: The majority of patients with dystonia enrolled in the Dystonia Coalition Project 1 were using medications to treat their dystonia. Overall, a complex picture of medication use patterns emerged, with factors such as region, disease duration, type of dystonia, disease severity, and psychiatric comorbidities all playing a significant role. *Neurology*® 2017;88:543–550

GLOSSARY

BoNT = botulinum toxin; **DBS** = deep brain stimulation; **GDRS** = Global Dystonia Rating Scale.

Although botulinum toxin (BoNT) injections are the gold standard therapy for patients with focal dystonia, oral medications such as anticholinergics and GABAergic classes are typically recommended in published treatment reviews on dystonia.[1] We currently do not know the range or type of oral medications actually used in patients with dystonia (alone or combined with BoNT).

In a study performed as an online survey, most patients (86%) with a self-reported diagnosis of cervical dystonia had used BoNT, and the majority of patients (53%) also reported oral medication for their dystonia symptoms.[2] This study supports that many patients with dystonia use oral medications, but we do not know the type or class of medication used in this population.

We conducted a cross-sectional study in an international cohort to better characterize and understand medication use in the dystonia population. This study provides an opportunity to explore the potential therapeutic gap in the treatment of dystonia and whether this gap might differ among the subtypes of dystonia, requiring a precision medicine approach.

METHODS **Study participants.** We reviewed data collected from 2,131 individuals across 37 enrolling sites in the United States, Canada, Europe, and Australia participating in Project 1 of the Dystonia Coalition (http://clinicaltrials.gov/show/NCT01373424).

Supplemental data at Neurology.org

The full inclusion and exclusion criteria for the Dystonia Coalition Natural History and Biorepository studies can be found at http://www.rarediseasesnetwork.org/cms/dystonia/Get-Involved/Research-Studies/6301-Natural-History and http://www.rarediseasesnetwork.org/cms/dystonia/Get-Involved/Research-Studies/6301-Biorepository. In general, the inclusion criteria consisted of having isolated dystonia (cervical dystonia, blepharospasm or craniofacial dystonia, oromandibular dystonia, spasmodic dysphonia, limb dystonia, segmental dystonia, or generalized dystonia) and being ≥18 years of age. Of the 2,131 participant records provided, we maintained the same inclusion criteria but extended the exclusionary criteria to include participants with muscle tension dysphonia who were enrolled in the cohort with the intention of serving as controls in a completed project within the biorepository (n = 50); participants taking medications known to lead to dystonic symptoms (e.g., dopamine antagonists, n = 21); and participants with duplicate data entries, in which case we used the earliest initial encounter date (n = 34). After applying the exclusionary criteria, we included data collected from 2,026 individuals for analysis (figure e-1 at Neurology.org).

Standard protocol approvals, registrations, and patient consents. This study was approved by the University of New Mexico Health Sciences Center Institutional Review Board, and the Dystonia Coalition Executive Committee provided access to the database for analysis. All patients were examined, videotaped, and enrolled in either the natural history arm (if disease onset was ≤5 years previously) or the biorepository arm (for disease duration >5 years) following a standardized protocol after written informed consent was obtained from all patients participating in the study.

Dystonia. Data used in the analysis included dystonia type (e.g., focal, generalized, hemidystonia, multifocal, segmental), region where the patient participated (e.g., Australia, Canada, England, France, Germany, Italy, United States [Northeast, Midwest, South, West]), and severity of disease determined by total score of the Global Dystonia Rating Scale (GDRS).[3]

Medications. Medication use was recorded by the enrolling site and entered into the database either by dropdown menu of frequently used medications or by free-text entry if "other" was selected. BoNT use was also noted by date of last injection given. Medications recorded included medications that could be used for the treatment of dystonia symptoms and medications used for other conditions.

We categorized the medications into classes typically recommended for treatment of dystonia based on expert review.[4] The treatment classes included in the analysis as medications used to treat dystonia were the following: (1) muscle relaxant (cyclobenzaprine, tizanidine, carisoprodol, orphenadrine, metaxalone, dantrolene); (2) benzodiazepine (clonazepam, lorazepam, diazepam, alprazolam, temazepam, bromazepam); (3) dopaminergic (levodopa, pramipexole, amantadine [low-dopaminergic properties], bromocriptine); (4) anticholinergic (trihexyphenidyl, benztropine, diphenhydramine); (5) antidopaminergic (tetrabenazine, clozapine); (6) baclofen; (7) non–benzo-hypnotic (zolpidem); and (8) BoNT (onabotulinumtoxin A, abobotulinumtoxin A, incobotulinumtoxin A, rimabotulinumtoxin B). In the United States, the above oral agents do not have a Food and Drug Administration (FDA)–approved indication for dystonia and are used in an off-label manner. Because we used data collected at sites outside the United States, some of the medications listed have not received FDA approval for any indication.

Statistical analyses. We performed a cross-sectional analysis using SAS (version 9.4; SAS Institute Inc, Cary, NC). We looked at prevalence of medication use by demographic characteristics (age, sex, region), by dystonia characteristics (type, severity, duration), and by comorbidities (e.g., anxiety/depression). We then looked further at the type of medication (oral vs BoNT vs both oral and BoNT vs none) using the same demographic and dystonia characteristics. Missing data elements (i.e., sex) were handled by excluding that participant for that particular analysis. For each result below, the total number included in the analysis is disclosed. We used χ^2 and Fisher exact tests (for sample size <5) to analyze these associations, with values of $p < 0.05$ considered significant. Multivariate logistic regression was used to test for regional differences while controlling for dystonia type, presence of anxiety/depression, disease severity, and disease duration.

RESULTS **Study participants.** We studied a total of 2,026 participants (1,437 [71%] female and 587 [29%] male) who were enrolled into the Dystonia Coalition Biorepository and Natural History Projects from January 4, 2011, to July 22, 2015 (with 2 missing values for sex). Participant mean age was 59.4 years (SEM 0.3 year) with mean age at onset of 45.3 years (SEM 0.3 year) and mean disease duration of 14.1 years (SEM 0.3 year). Mean severity score on the GDRS was 9.0 (SEM 0.2). A total of 1,588 participants were enrolled in the United States (9.1% in the Northeast region, 30.0% in the Midwest region, 49.2% in the South region, and 11.6% in the West region). The international site enrollment consisted of 438 participants, with 16.4% in Canada, 4.3% in Australia, 0.7% in England, 29.7% in France, 36.1% in Germany, and 12.8% in Italy.

Dystonia characterization. We determined the frequencies of dystonia syndrome by type in the database. Focal dystonia was the most common type of dystonia at 76.4% (n = 1,528) of the population, followed by segmental dystonia at 16.4% (n = 328), generalized dystonia at 3.8% (n = 76), multifocal dystonia at 3% (n = 61), and hemidystonia at 0.4% (n = 8). For the focal dystonia subtypes, cervical dystonia was the most prevalent at 60.9% (n = 930) of the focal dystonia sample, followed by laryngeal at 11.9% (n = 182), limb at 10.3% (n = 157), cranial (includes oromandibular, lingual, and Meige) at 8.7% (n = 132), and blepharospasm at 8.3% (n = 127) (total n = 2,001 with 25 missing values for dystonia type).

Medication use. Querying the whole database for the presence of any medication for dystonia used (includes both injectable and oral therapy), we found 73% using medications (n = 1,488) and 27% using no dystonia medications (n = 538) (total n = 2,026).

By dystonia type. The same trend continued for dystonia type. We found 74% using medications (n = 1,481) and 26% using no dystonia medications (n = 520). Of those using medications, 48% (n = 712)

Figure 1   Medication use by dystonia type and subtype
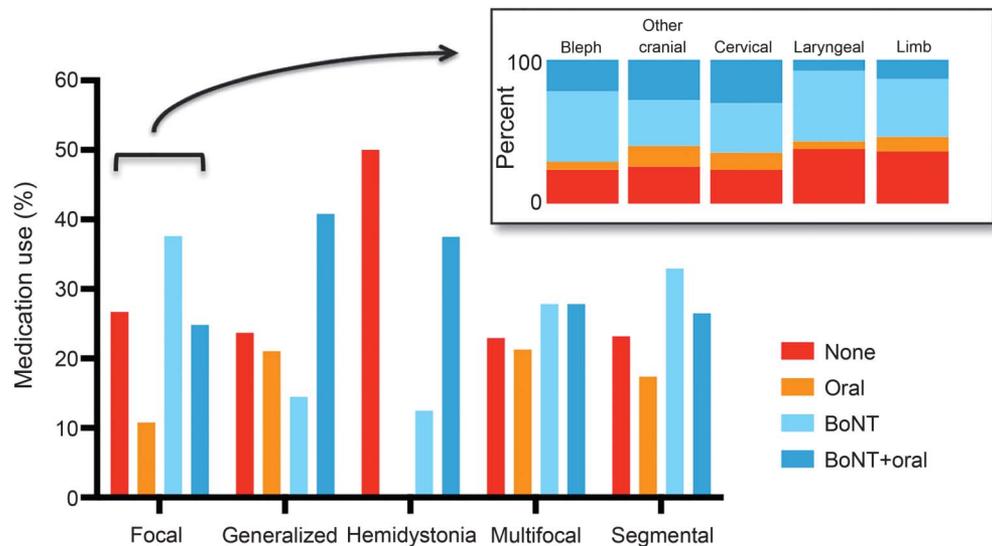
Main graph shows medication use by dystonia type (n = 2,001 with 25 missing values) with percentage used along the y-axis. Inset shows percentage of no medication use and medication use by class for each subtype of focal dystonia (n = 1,528 with 473 nonfocal dystonia and 25 missing). Other cranial includes lower cranial dystonia and Meige syndrome. For each focal dystonia subtype, percentages for none, oral, botulinum toxin (BoNT), and BoNT plus oral: blepharospasm, 23.6%, 5.5%, 48.8%, and 22.1%, respectively; other cranial, 25.8%, 14.4%, 31.8%, and 28.0%; cervical, 23.4%, 12.2%, 34.3%, and 30.1%; laryngeal, 37.9%, 5.5%, 48.9%, and 7.7%; and limb, 36.3%, 10.2%, 40.1%, and 13.4%.

used BoNT therapy alone, 17% (n = 251) used oral medications alone, and 35% (n = 518) used both BoNT therapy and oral medications (total n = 2,001 with 25 missing values for dystonia type).

Analyzing by dystonia type showed that the frequencies of no medications, BoNT therapy, oral medications, and combination therapy were different among the dystonia types (*p* < 0.0001, figure 1). Hemidystonia had the highest rate of no medication use. Generalized dystonia and hemidystonia had the lowest rates of BoNT alone use but had BoNT and oral medication combination use at 41% and 38%, respectively. Oral medication use was highest in generalized dystonia.

By focal dystonia subtype. Dystonia medication use varied by focal dystonia subtype (*p* < 0.0001). The prevalence of no medication use, BoNT use, oral medication use only, and use of BoNT plus oral medications was analyzed for each focal dystonia subtype (figure 1). The highest prevalence for no dystonia medication use was seen in laryngeal dystonia (38%) and limb dystonia (36%) and the lowest in cervical dystonia (23%), blepharospasm (24%), and other cranial dystonia (26%). For BoNT alone, highest use was in laryngeal dystonia (49%) and blepharospasm (49%).

By region. Looking at medication use by region, we found that the frequency of dystonia medication use varied by region (*p* < 0.0001). We examined this by no medication use, oral medication use only, BoNT use only, and use of BoNT plus oral medications

(figure 2). No medication use ranged from a high of 57% in the Northeast to a low of 13% in Canada. This regional difference in medication use (i.e., taking dystonia medications vs not taking dystonia medications) persisted when adjusted for dystonia type, presence of anxiety/depression, disease severity, and disease duration (*p* < 0.0001, table e-1). Two hundred fourteen patients were excluded because of missing values for at least one variable used in the analysis (n = 1,812).

By demographic and clinical variables. We analyzed the frequency of no medication use and medication use by class using demographic, dystonia disease–specific, and comorbid variables. To analyze age, age at onset, disease duration, and disease severity (measured by total GDRS score), we divided the population into quartiles. For age, there were differences in medication use patterns, with patients in the oldest quartile less likely to be using oral medications (*p* < 0.0001). Disease duration and severity varied both in frequency of medication use and by type of medication class (*p* < 0.0001). Longer disease duration was associated with lower oral medication use; however, higher disease severity scores were associated with higher rates of oral medication and combination therapy (BoNT plus oral) use. Finally, if anxiety/depression was present, patients were twice as likely to be taking oral medications. Complete results are presented in table 1.

By medication class. For the 8 classes of medication used to treat dystonia symptoms, we plotted each

Figure 2 Dystonia medication use plotted by region
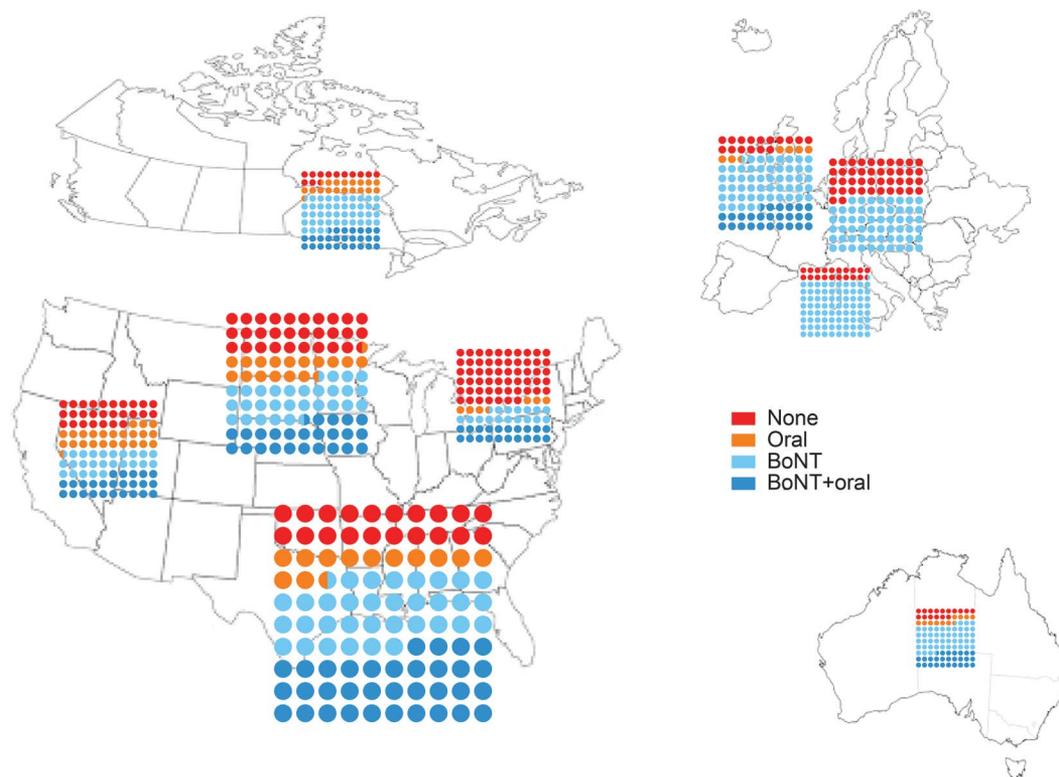
The individual region plots are approximately scaled to reflect number of participants in each region (actual numbers: Northeast n = 145; Midwest n = 477; South n = 782; West n = 184; Canada n = 72; Australia n = 19; France n = 130; Germany n = 158; Italy n = 56; England excluded because of small number [n = 3]; p < 0.0001). BoNT = botulinum toxin.

Legend:
- None
- Oral
- BoNT
- BoNT+oral

medication class individually (figure 3). Overall, the most frequently used medication was BoNT, followed by benzodiazepines and muscle relaxants (excluding baclofen). The least frequently used class was the antidopaminergic class. Of note, in this analysis, participants could be using more than one class of medication. The use of medication classes varied significantly by dystonia type, by focal dystonia subtype, and by the presence of anxiety/depression (figure 3 and table 2).

Surgical therapy. One hundred eighteen participants reported prior surgical therapy for dystonia symptoms. Of those, 67 patients reported non–deep brain stimulation (DBS) surgery, with selective denervation for cervical dystonia being the most common at 31%, followed by myectomy for blepharospasm at 18%.

Fifty-one patients had DBS: 34 (83%) in the globus pallidus interna, 3 (7%) in the subthalamic nucleus, and 2 (5%) in the thalamus and unknown categories each. Half of the DBS patients had generalized dystonia (51%), and 27% had focal dystonia (primarily cervical dystonia). Most patients who had DBS had a younger age at onset (<35 years of age, 53%), longer disease duration (20–74 years, 55%), and more severe disease (GDRS total 10–102, 75%;

table e-2). Forty-four of the 51 patients reported current dystonia medication use, with 28 patients (55%) using BoNT alone or in combination with oral medications (table e-2).

DISCUSSION In the largest cross-sectional study ever undertaken in patients with dystonia, we showed that 73% of patients with dystonia reported using medications that have been recommended for the treatment of dystonia. The lowest oral medication use was found in focal dystonia and the highest in generalized dystonia, and within focal dystonia subtype, the BoNT alone rate was highest in blepharospasm and spasmodic dysphonia (49%) and lowest in other cranial dystonia (32%). Although BoNT has FDA approval for dystonia symptoms, many patients were using off-label oral medications, highlighting potential limitations to our gold standard therapy for complete symptom control. However, even more interesting is how many patients were not on medications used for dystonia. We looked at the effect of surgical treatment, specifically DBS, on medication use patterns in this population. Despite receiving DBS, these patients were more likely to be using medications (both BoNT and

Table 1 Demographic, dystonia disease-specific, and comorbid variables analyzed by treatment method

	Treatment method, %				
	None	Oral	BoNT	BoNT+oral	p Value
Demographic variables					
Sex					
Male	26.8	14.1	36.1	23.0	0.25
Female	26.4	12.0	34.8	26.8	
Age,[a] y					
18–51	29.4	18.1	29.4	23.1	<0.0001
52–60	24.0	13.4	37.9	24.8	
61–67	24.2	10.5	36.6	28.8	
68–87	27.9	8.8	37.1	36.3	
Dystonia variables					
Age at onset, y					
0–35	25.6	14.1	35.1	25.2	0.42
36–46	23.7	13.5	37.1	25.7	
47–56	25.5	11.2	37.5	25.9	
57–82	30.0	11.9	31.9	26.2	
Disease duration,[a] y					
0–4	37.6	19.4	20.0	23.1	<0.0001
5–10	20.1	12.4	42.4	25.1	
11–19	24.4	10.2	37.6	27.8	
20–74	23.5	9.3	39.7	27.4	
GDRS[a]					
0–3	32.6	11.5	38.1	17.8	<0.0001
4–6	27.3	10.1	40.3	22.3	
7–9	23.5	13.8	35.6	27.1	
10–102	22.6	15.5	28.2	33.7	
Comorbid variable					
Anxiety/depression[a]					
Yes	20.2	20.1	26.2	33.5	<0.0001
No	29.1	9.6	38.8	22.5	

Abbreviations: BoNT = botulinum toxin; GDRS = Global Dystonia Rating Scale.
[a] Total number used in analysis listed for each variable due to exclusion of missing values: sex (n = 2,024), age (n = 2,022), age at onset (n = 2,015), disease duration (n = 1,871), GDRS total score (n = 1,977), and anxiety/depression (n = 2,019).

common oral medication classes identified in these reviews are anticholinergics, dopaminergics, GABAergics, and muscle relaxants, as included in our study. We acknowledge the limitations and lack of evidence-based prescribing strategies due to an absence of large, controlled studies, highlighted in systematic evidence-based reviews.[7,8]

There is no clear order for the introduction of medications in an individual patient with dystonia because of a lack of substantial comparative-effectiveness studies due to small population size (i.e., 4 patients) or to study design issues.[9,10] For anticholinergics, however, the recommendation for use comes from a double-blind placebo-controlled trial, which showed benefit of high-dose anticholinergic medication in improving generalized dystonia.[11] However, the practical use is limited by side effects such as impaired recall and slowing of cognition, especially in the older patient population.[12] In a prospective, randomized, blinded trial, BoNT vs the anticholinergic medication trihexyphenidyl was tested, with blinding achieved by saline injection.[13] BoNT was shown to be more effective than trihexyphenidyl in this trial and had fewer adverse effects than the anticholinergic medication. In our population, we found that overall only 5% of patients reported anticholinergic use, primarily in the generalized dystonia group representing 15.7% of the total anticholinergic use.

BoNT is the gold standard for the treatment of focal dystonia.[14] Although a clear breakthrough in the treatment of focal dystonia, it has limitations, including that the injections themselves are painful. Expected adverse events include weakness and swallowing difficulty with neck injections. Finally, many patients report a decline in effect at 9.5 weeks after injection despite a typical 12-week-long injection cycle.[15] Despite these limitations, BoNT was the most common medication used in this population, either alone or in combination with oral medications. For the subtypes of focal dystonia, BoNT use (either alone or in combination with oral medications) varied on the basis of the particular subtype, ranging from a high of 71% of patients with blepharospasm to 54% of patients with limb dystonia. No differences were seen in BoNT use by sex or by age at onset. Younger age was associated with more oral medication use, and conversely, older age was associated with higher oral medication plus BoNT use. Patients with disease duration <4 years were more likely to not be using any medications than those with longer disease duration or to be using oral medications alone than those with disease duration >4 years. Disease severity was related to medication use most clearly in the most severely

oral medications) than the population as a whole, with only 14% of DBS patients reporting no medication use. Other factors such as the cost of medications, especially of BoNT, and the side effects of oral medications (e.g., the anticholinergics) may play a role in the results seen in this study. These results raise many questions about gaps in our current treatment portfolio and future opportunities to close this treatment gap.

Multiple publications summarize and list treatment options for dystonia.[4–6] Generally, the most

Table 2 Use of medication classes varied significantly by dystonia type and comorbid factors

	Medication classification, n (%)							
	BoNT	Benzodiazepine	Muscle relaxant	Baclofen	Anticholinergic	Dopaminergic	Non–benzo hypnotic	Antidopaminergic
Dystonia type								
Focal	955 (62.5)	397 (26.0)	88 (5.8)	67 (4.4)	62 (4.1)	56 (3.7)	47 (3.1)	4 (0.3)
Generalized	42 (55.3)	26 (34.2)	7 (9.2)	9 (11.8)	17 (22.4)	12 (15.8)	1 (1.3)	1 (1.3)
Hemidystonia	4 (50)	2 (25.0)	0 (0.0)	1 (12.5)	1 (12.5)	0 (0.0)	0 (0.0)	0 (0.0)
Multifocal	34 (55.7)	22 (36.1)	4 (6.6)	4 (6.6)	6 (9.8)	4 (6.6)	3 (4.9)	0 (0.0)
Segmental	195 (59.5)	108 (32.9)	17 (5.2)	24 (7.3)	22 (6.7)	17 (5.2)	7 (2.1)	0 (0.0)
p Value	0.44	0.03[a]	0.66	0.01[a]	<0.0001[a]	<0.0001[a]	0.62	0.20
Dystonia subtype								
Cervical	599 (64.4)	293 (31.5)	72 (7.7)	51 (5.5)	49 (5.3)	30 (3.2)	28 (3.0)	2 (0.2)
Blepharospasm	90 (70.9)	27 (21.3)	3 (2.4)	2 (1.6)	2 (1.6)	4 (3.2)	3 (2.4)	0 (0.0)
Laryngeal	103 (56.6)	16 (8.8)	3 (1.7)	0 (0.0)	0 (0.0)	3 (1.7)	4 (2.2)	0 (0.0)
Limb	84 (53.5)	17 (10.8)	4 (2.6)	4 (2.6)	4 (2.6)	8 (5.1)	6 (3.8)	0 (0.0)
Lower cranial	79 (59.9)	44 (33.3)	6 (4.6)	10 (7.6)	7 (5.3)	11 (8.3)	6 (4.6)	2 (1.5)
p Value	0.008[a]	<0.0001[a]	0.001[a]	0.0002[a]	0.0009[a]	0.03[a]	0.73	0.20
Presence of anxiety/ depression								
No	880 (61.3)	319 (22.2)	70 (4.9)	71 (4.9)	65 (4.5)	59 (4.1)	31 (2.2)	4 (0.3)
Yes	348 (59.7)	238 (40.8)	47 (8.1)	36 (6.2)	43 (7.4)	31 (5.3)	27 (4.6)	2 (0.3)
p Value	0.51	<0.0001[a]	0.006[a]	0.26	0.01[a]	0.23	0.003[a]	0.81

Abbreviation: BoNT = botulinum toxin.
The raw number of participants taking the particular medication class is given first in each column, followed by the row percentage in parentheses. Participants could be taking more than one class of medication. Total number used in analysis listed for each variable due to exclusion of missing values: dystonia type (n = 2,001), dystonia subtype (n = 1,528), and anxiety/depression (n = 2,019).
[a] Significant.

affected patients, who were more likely to be using BoNT in combination with oral medications. The least severely affected patients more commonly reported BoNT use by itself or no medications at all. Overall, we found a large percentage of patients (39%) not using BoNT, the FDA-approved medication for most focal dystonias. This finding was unexpected and varied from the online survey results showing the majority of patients using BoNT in cervical dystonia.[2] A follow-up study may be required to understand the reasons for the lower BoNT use reported in this large, multicenter, international cohort.

There are limitations to these data. First, the majority of patients enrolling in the Dystonia Coalition studies are going to tertiary care medical centers for treatment, which may bias toward an overreporting of medication use in comparison to the dystonia population as a whole because our study population may be actively seeking out therapeutic options. However, an international web-based survey in patients with cervical dystonia reported a higher use of BoNT at 86% of respondents and oral medication

use at 53% than we found in our study.[2] The true prevalence of dystonia by type and subtype may not be reflected in our data (i.e., a relatively higher rate of laryngeal dystonia than reported in the general population) because specific projects within the Dystonia Coalition seek out these patients to develop diagnostic and measurement tools for spasmodic dystonia. The dystonia disease severity may be greater in our study than in the dystonia population as a whole, again because they are coming to specialty centers, and we cannot know the characteristics of patients who were not contacted to enroll in the Dystonia Coalition or patients who declined to enroll. We broke down the analysis by severity to try to identify whether this might be related to medication use, and this is described above. In terms of medication use patterns by region or by subtype, there were small samples for some of the regions and subtypes, so we tempered our conclusions because without a larger population size it is difficult to generalize. Finally, in a cross-sectional analysis, we cannot determine what medications patients might have tried in the past, nor can we determine reasons for

Figure 3 Medication use by class
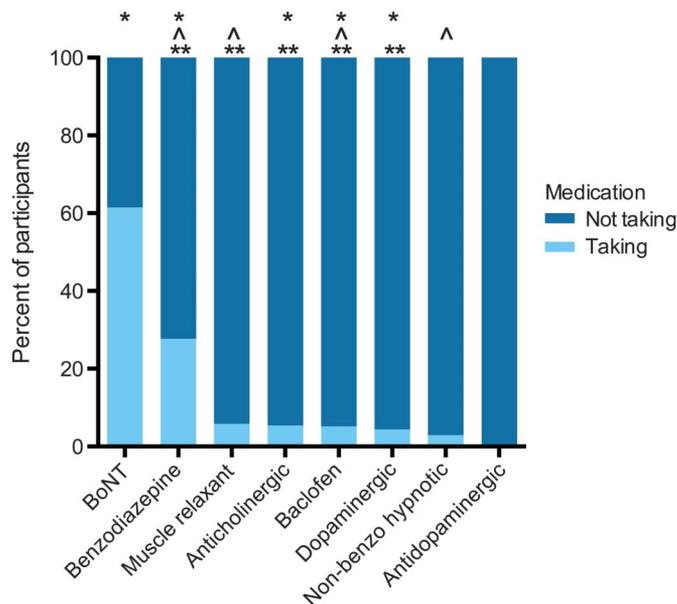
Percent of participants taking each class of medications. Participants may be taking more than one medication. Medication class use varied by dystonia type (*$p < 0.05$), by focal dystonia subtype (**$p < 0.05$), and by presence of anxiety/depression (^$p < 0.05$). BoNT = botulinum toxin.

discontinuation of medications tried. This would be an important next step.

Overall, we found that most patients with dystonia are using medications, both oral and injectable, to treat dystonic symptoms. Medication use patterns varied by region, dystonia type, focal subtype, disease severity, and the presence of comorbid conditions. We also found that a significant number of patients are not reporting current medication use for their dystonia. This persisted across demographic variables, dystonia variables, and comorbid variables, with more than a quarter of all patients not using medications. This clearly points to a potential therapeutic gap. Future directions in clinical therapeutic research in dystonia range from innovative drug therapy to neurorestorative approaches (both noninvasive and invasive). In addition, the development of coherent symptomatic treatment strategies and the identification of biologic markers to monitor treatment response are needed.[16] These future approaches should include patients with dystonia across the age span, across the spectrum of disease localization, and across the range of disease severity.

AUTHOR CONTRIBUTIONS

Dr. Pirio Richardson participated in the conception, study design, data analysis, interpretation of the results, and drafting of the manuscript and made a critical revision of the manuscript. A.R. Wegele participated in the conception, study design, data analysis, interpretation of the results, drafting of the manuscript, and revising the manuscript. Dr. Skipper contributed to the data analysis, interpretation of results, and drafting of the manuscript. Dr. Deligtisch and Dr. Jinnah contributed to the interpretation of the results and made a critical revision of the manuscript.

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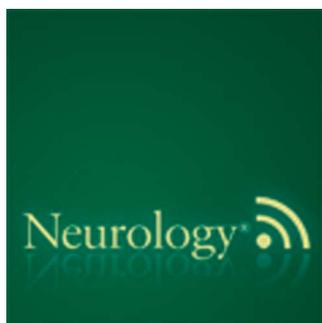
Dystonia treatment: Patterns of medication use in an international cohort (see p. 543)

This podcast begins and closes with Dr. Robert Gross, Editor-in-Chief, briefly discussing highlighted articles from the February 7, 2017, issue of *Neurology*. In the first segment, Dr. Jeff Ratliff interviews Dr. Sarah Pirio Richardson about her paper on patterns of medication use in dystonia treatment. Dr. Ted Burns talks with Dr. Gretchen Birbeck about the *Without Borders* global neurology site for our "What's Trending" feature of the week. In the next part of the podcast, Dr. Andy Southerland focuses his interview with Dr. Larry Wechsler on a *Neurology Today*® story about the expansion of teleneurology.

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