

Physician Approaches to the Pharmacologic Treatment of Dystonia in Cerebral Palsy

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Abbreviations: AACPD – American Academy of Cerebral Palsy and Developmental Medicine; CP – Cerebral Palsy; CNS – Child Neurology Society; SIG – Special Interest Group; GMFCS – Gross Motor Function Classification System

Article summary: Dystonia is common and debilitating in people with CP, with little data on pharmacologic treatments. We describe physicians' current approaches to using these treatments.

What's known on this subject: Comparing the effectiveness of existing pharmacologic treatments for dystonia in CP is a research priority shared by clinicians and the community. However, current pharmacologic treatment practices are unknown.

What this study adds: Physicians in the US and Canada primarily prescribe a subset of six medications for the treatment of functionally limiting and generalized dystonia in CP: baclofen, trihexyphenidyl, gabapentin, carbidopa/levodopa, clonazepam, and diazepam.

Contributors Statement

Emma Lott helped design the study, carried out data analyses, and critically reviewed and revised the manuscript.

Darcy Fehlings, Rose Gelineau-Morel, Michael Kruer, Jonathan Mink, Sruthi Thomas, and Steve Wisniewski helped design the study and critically reviewed and revised the manuscript.

Bhooma Aravamathan conceptualized and designed the study, supervised data collection and analysis, drafted the initial manuscript, and critically reviewed and revised the manuscript.

Abstract

Objective: To determine how physicians approach pharmacologic dystonia treatment in people with CP and assess physician readiness to participate in a randomized trial comparing existing pharmacologic dystonia treatments.

Methods: We administered a REDCap survey to physician members of the American Academy of Cerebral Palsy and Developmental Medicine and of the Child Neurology Society to assess which pharmacologic agents they use to treat dystonia in CP and their preferred indications and dosing.

Results: Of 479 physicians surveyed, 240 (50%) responded. Respondents treated functionally limiting (95%) and generalized (57%) dystonia and most commonly used six medications: baclofen (95%), trihexyphenidyl (79%), gabapentin (67%), carbidopa/levodopa (55%), clonazepam (55%), and diazepam (54%). Baclofen was preferred in people with co-existing spasticity (81%), gabapentin was preferred in people with co-existing pain (49%), and trihexyphenidyl was avoided in people with constipation (34%) or urinary retention (42%). Preferred dosing regimens followed published regimens for dystonia, when available, but otherwise followed published regimens for other CP symptoms (spasticity and seizures). Baclofen was preferred by 64% of respondents as first line treatment, but there was no clear consensus on second or third-line medications. Most respondents (51%) were comfortable randomizing their patients to receive any of the six most commonly used medications used to treat dystonia in CP.

Conclusions: This study summarizes current indications and dosing for the six most commonly used medications to treat dystonia in CP as per treating physicians in the US and Canada and also demonstrates physician support for a randomized trial comparing the effectiveness of these treatments.

1 **Introduction**

2 Cerebral palsy (CP) is the most common childhood-onset motor disability and the most common
3 condition associated with dystonia in young people.¹⁻³ Dystonia is an often painful and
4 debilitating movement disorder characterized by overflow muscle activation triggered by
5 attempted voluntary movement.⁴⁻⁶ Up to 80% of people with CP are affected by dystonia.⁷
6 Though multiple pharmacologic agents are available to treat dystonia in people with CP, it is
7 unclear which, if any, are effective.⁸ Therefore, it is necessary to compare the effectiveness of
8 existing treatments, a top research priority that emerged in a recent collaborative effort between
9 clinicians, researchers, and the community to identify areas of research need for dystonia in CP.⁹
10 Current guidance for treatment of dystonia in people with CP is based largely on expert opinion.
11 The American Academy of Cerebral Palsy and Developmental Medicine (AACPD) Care
12 Pathway for Dystonia in Cerebral Palsy recommends baclofen first line and trihexyphenidyl
13 second line as pharmacologic treatment.¹⁰ Specific indications for other medications included
14 consideration of gabapentin for people with dystonia and pain and clonidine for people with
15 dystonia and poor sleep.¹⁰ The data supporting these recommendations are of low certainty.⁸
16 To compare the effectiveness of existing pharmacologic treatments for dystonia in CP, we must
17 first establish how pharmacologic treatments are currently used. In this study, we queried how
18 physicians in the US and Canada approach pharmacologic dystonia treatment in people with CP
19 and assessed physician readiness to participate in a randomized trial comparing the efficacy of
20 these medications. We hypothesized that physicians would have variable treatment approaches
21 and would generally support a trial comparing their efficacy to treat dystonia in CP.

22 **Methods**

23 Standard Protocol Approvals, Registrations, and Patient Consents: Human Subjects Research
24 exemption was granted by the Washington University Institutional Review Board (IRB ID#
25 201910233, 11/04/2019).

26 Surveyed population: We surveyed the physician memberships of the AACPD and select
27 Special Interest Groups (SIGs) within the Child Neurology Society (CNS): the CP SIG and the
28 Movement Disorders SIG. Physicians primarily practicing outside the US or Canada were
29 excluded. Medical specialty data of non-responders was abstracted through society membership
30 data.

31 Survey development and administration: The survey was developed in REDCap via iterative
32 discussions between medical specialists in child neurology (BRA, RGM, JWM), developmental
33 pediatrics (DF), psychiatry (ST), and an epidemiologist and clinical trialist (SW). Respondents'
34 approaches to using the following 10 medications were queried explicitly with the opportunity to
35 write in other medications: baclofen, trihexyphenidyl, gabapentin, carbidopa/levodopa,
36 clonazepam, diazepam, clonidine, tetrabenazine, clobazam, and cannabidiol. Question formats
37 included multiple choice, checkbox, and open-ended responses (see Supplementary Methods for
38 Survey PDF). The survey was emailed to potential respondents weekly between 5/31/2023 and
39 7/19/2023.

40 Qualitative analysis: Open-ended responses were analyzed using a conventional content analysis
41 approach.¹¹ Two investigators coded all responses and resolved discrepancies via discussion.

42 Data availability: Anonymized data will be shared by request from any qualified investigator.

43

44 **Results**

45 Respondent demographics

46 In total, 479 physicians were eligible to take the survey (360 from AACPDPM plus 135 from the
47 CNS Movement Disorders and CP SIGs minus 16 practicing outside the US or Canada). Of these
48 479 physicians emailed the survey, 240 responded (response rate of 50%) of whom 219
49 confirmed they currently cared for people with CP (91%). Most cared primarily for children
50 (166/217, 76%) in an academic setting (172/218, 79%) in the US (196/218, 90%) independently
51 for more than 5 years (165/218, 76%). Most respondents were physiatrists (83/216, 38%) or
52 neurologists (66/216, 31%) with at least 25% of their clinical practices comprised of people with
53 CP (142/214, 66%) (Table 1). Medical specialty representation was similar between survey
54 respondents and non-respondents (Supplementary Table 1).

55 Most respondents relied on physical exam (210/219, 96%) and history (175/219, 80%) to
56 diagnose dystonia in people with CP. Less common approaches included video review (39/219,
57 18%) or a validated tool or scale (46/219, 21%), most commonly the Hypertonia Assessment
58 Tool (Table 2).

59 Most respondents prescribed medications (172/217, 79%), the majority of whom also confirmed
60 that they prescribed medications to treat dystonia (154/172, 90%). These 154 physicians were
61 asked to describe their prescribing practices further. The demographics of these physicians were
62 comparable to those of the entire respondent group, except for a slightly higher representation of
63 physiatrists (74/154, 48%) and neurologists (56/154, 37%) (Table 1).

64 Factors affecting whether medications are prescribed at all to treat dystonia in people with CP

65 Over 50% of respondents prioritized at least one of three factors when deciding whether to
66 prescribe medications for dystonia in people with CP: 1) dystonia severity (defined in the survey
67 as “severity based on my assessment in the clinic”), 2) functional impact (defined as “whether a
68 person’s dystonia prevents their ability to do a task that they deem is important to them, causes
69 significant pain, interferes with sleep, or creates challenges associated with ease of caregiving”),
70 and 3) whether the dystonia is focal or generalized (Table 3). Almost all physicians considered
71 dystonia severity (144/154, 94%) and functional impact (146/154, 95%) when deciding whether
72 to prescribe medications at all. Of the 61 people who provided written explanations for how they
73 considered dystonia severity when deciding to prescribe medications, the majority (40/61, 66%)
74 cited reasons having to do with functional impact:

75 *“will prescribe depending on level of distress or dysfunction caused to the patient.”*

76 *“Must have a life impact”*

77 When elaborating on why functional impact affected their decision to prescribe medications,
78 some respondents indicated that it was the primary driver of their decision to prescribe:

79 *“Main deciding factor”*

80 *“This is the key question I think”*

81 The next most common factor governing respondents’ decision to prescribe medications was
82 whether dystonia was focal vs. generalized (cited by 101/154, 66%). Of the 44 people who
83 elaborated on how they applied this factor clinically, the majority (38/44, 86%) noted that they
84 tended to prescribe enteral or “systemic” medications if dystonia was generalized, but preferred
85 to use injectables like botulinum toxin if dystonia was focal.

86 Other factors were less commonly cited (by <50% of respondents). Interestingly, though etiology
87 was relatively infrequently noted to affect the choice to prescribe medications (32/154, 21%), 6
88 respondents of the 12 who provided explanations stated that a genetic or suspected genetic
89 etiology would make them more likely to prescribe a medication. Three more respondents
90 suggested that basal ganglia injury would make them more likely to prescribe a medication.

91 *“dopamine trial for all children with dystonia and CP to eval for [Dopa-responsive*
92 *dystonia]”*

93 *“May be more likely to try oral meds for dystonia if basal ganglia involvement”*

94 Of the 23 respondents who explained why age was a factor affecting their decision to prescribe
95 medications, 8 noted simply that they would not prescribe medications below a certain age,
96 ranging from newborns to 2 years old. Eleven people noted that age limited their choice of
97 medications. Interestingly, 3 people noted that dystonia could not yet be functionally impactful at
98 young ages which is why they would not treat:

99 *“I might be more careful with oral medications such as baclofen in very young children as*
100 *they seem to experience more side effects “*

101 *“age determines functional impairment “*

102 Factors affecting choice of medication prescribed to treat dystonia in people with CP

103 The most common factor that respondents cited as governing their choice of medications (Table
104 3) was dystonia being focal vs. generalized (103/154, 67%). Almost all of those explaining
105 further (28/30, 93%) reiterated that they would use injectables for focal dystonia and enteral
106 medications for generalized dystonia. The next most cited factors were functional impact

107 (95/154, 62%) and severity (94/154, 61%). Respondents factoring in severity (n=17) stated that
108 greater severity dystonia would make them consider surgical interventions (4/17, 24%) or
109 injectables together with enteral medications (3/17, 18%):

110 *“consider [intrathecal baclofen pump] if generalized/severe and/or significant spasticity*
111 *also, sometimes will do combo meds and injections if severe”*

112 Pain management (6/17, 36%) and sleep (3/17, 18%) were prioritized by the 17 respondents
113 explaining how they factor in functional impact:

114 *“If sleep is issue - may reach for gabapentin or clonazepam as first line. If pain is issue, may*
115 *use valium as first line.”*

116 Age of the patient affected medication choice for 58% of respondents (89/154). Of the 32
117 respondents elaborating further, the most common single explanation was that age governed
118 medication formulation or dose (7/32, 22%). When discussing specific medications, age was
119 factored in most commonly for trihexyphenidyl (6/32, 19%), dopaminergic agents (5/32, 16%),
120 and baclofen (4/32, 13%), but variably so:

121 *“in littlest patients would not use [trihexyphenidyl] or dopa”*

122 *“Anticholinergics are better tolerated in the young. Dopamine supplementation is more*
123 *likely to be efficacious in the young, in my opinion.”*

124 *“...I also avoid baclofen in those younger than 1.5 years old”*

125 *“In a younger child I...have been using baclofen more with good response and tolerance.*

126 Medical complexity (clarified in the survey as “e.g. need for G-tube, tracheostomy, or other
127 specialty-based medical care”) was also cited as a factor governing medication choice (84/154,

128 55%). Respondents explaining further (n=29) avoided medications whose side effects might
129 worsen co-existing conditions (13/29, 45%) and chose medications whose side effects may
130 improve co-existing conditions (5/29, 17%):

131 *“pick meds that might help with another concern as well (eg trihexyphenidyl if drooling is a*
132 *big problem) or avoid worsening another condition (eg baclofen and seizure threshold)”*

133 *“Example, if they have sialorrhea, I may use trihexyphenidyl for anticholinergic effects in*
134 *addition to helping with dystonia...”*

135 Concerns about polypharmacy (5/29, 17%) and available formulations (4/29, 14%) were also
136 noted when prescribing enteral medications to people with high medical complexity:

137 *“depends if other complex neurologic needs may not want to prescribe another medication in*
138 *similar class”*

139 *“if all [G-tube fed] sometimes I'll start with meds easily available as liquid or dissolvable*
140 *tabs, if lots of AEDs/benzos may be more/less likely to start with [clonazepam]”*

141 Other factors were cited by less than a third of respondents. Notably, respondents who cited
142 etiology as a factor affecting medication choice (44/154, 29%) went on to explain that genetic or
143 idiopathic etiologies may prompt them to use carbidopa/levodopa (7/13, 54%):

144 *“I do not find [carbidopa/levodopa] effective but if sometimes if the exam shows NO*
145 *Spasticity and only dystonia, the etiology is unclear and the child has a normal brain MRI I*
146 *may offer a quick [carbidopa/levodopa] trial”*

147 Medication management

148 Almost all respondents gauged medication efficacy by asking the person with CP or their
149 caregivers if there had been any improvement (150/154, 97%). The vast majority also gauged
150 medication efficacy by establishing a shared functional goal before treatment and assessing
151 progress toward achieving that goal (113/154, 73%), assessing changes in dystonia severity on
152 physical exam (124/154, 81%), and side effect burden (124/154, 81%). A minority of
153 respondents used validated dystonia scales (16/154, 10%), most commonly the Barry-Albright
154 Dystonia Scale (7/16, 44%) or the Burke-Fahn-Marsden Scale (7/16, 44%).

155 If a medication was found to be ineffective, respondents were equally likely to add a second
156 medication to the first medication (38/154, 25%), wean off the first medication before starting a
157 second medication (37/154, 24%), or simultaneously wean the first medication while up-titrating
158 the second medication (43/154, 28%). Thirty-three of 154 respondents (21%) indicated that they
159 will utilize any of the above options depending on the specific patient situation.

160 Most common medications used, indications, and dosing

161 The six most used medications were baclofen (147/154, 95%), trihexyphenidyl (122/154, 79%),
162 gabapentin (103/154, 67%), carbidopa/levodopa (84/154, 55%), clonazepam (85/154, 55%), and
163 diazepam (83/154, 54%). Overall, 80% of respondents (123/154) used a subset of only these six
164 medications as their first through third-line pharmacologic treatments for dystonia in CP. Fifty-
165 seven percent of respondents (88/154) used five of these six medications as their first through
166 fifth-line treatment choices. These top six medications, including baclofen as the most commonly
167 used medication, did not differ between neurologists and physiatrists or differ based on number
168 of years in practice (Supplementary Table 3). Other medications (clonidine, tetrabenazine,
169 clobazam, cannabidiol, and single write-in entries for amantadine and benzotropine) were each

170 used by less than 20% of all respondents to treat dystonia and are not described further due to the
171 relative paucity of respondent data (Table 4).

172 Most respondents used baclofen first-line to treat dystonia (98/154, 64%), but there was no clear
173 consensus on the choice of 2nd or 3rd line medications. The indications and dosing regimens
174 preferred by respondents for each of the top six medications used to treat dystonia in CP are
175 shown in Table 5 and 6, respectively. Preferred dosing regimens for trihexyphenidyl¹²⁻¹⁴,
176 gabapentin¹⁵, and carbidopa/levodopa¹⁶ were in line with published pediatric dosing regimens for
177 dystonia, except for the maximum dose of carbidopa/levodopa. Published regimens use
178 maximum doses of levodopa as high as 400 mg/day for the treatment of dystonia in CP¹⁶, but the
179 most common maximum daily dose used by respondents was 100 mg/day. Noting that dystonia-
180 specific dosing information is lacking for baclofen¹⁷⁻¹⁹, clonazepam²⁰, and diazepam^{18,21},
181 respondents used dosing regimens in line with those published for spasticity or seizure
182 management.

183 The co-existing symptoms most frequently affecting medication choice were spasticity, pain,
184 urinary retention, and constipation. Eighty-one percent (124/154) of respondents would be more
185 likely to prescribe baclofen in the setting of co-existing spasticity. Forty-nine percent (76/154) of
186 respondents would be more likely to prescribe gabapentin in the setting of co-existing pain.

187 Forty-two percent (65/154) and 34% (53/154) of respondents would be less likely to prescribe
188 trihexyphenidyl in the setting of co-existing urinary retention or constipation, respectively.

189 Noting that the above co-existing symptoms were explicitly queried as a part of the survey, the
190 single most common co-existing symptom written-in by respondents was sialorrhea: 10% of

191 respondents (15/154) would be more likely to prescribe trihexyphenidyl in the setting of

192 sialorrhea. A summary of these preferred indications and dosing regimens is provided in Table 7.

193 Half of respondents would be comfortable randomizing their patients to receive any of the six
194 most commonly used medications as a part of a clinical trial comparing their effectiveness for
195 treating dystonia in CP (79/154, 51%). A large minority (56/154, 36%) would be comfortable
196 randomizing their patients to receive any of the 10 explicitly queried medications (baclofen,
197 trihexyphenidyl, gabapentin, carbidopa/levodopa, clonazepam, diazepam, clonidine,
198 tetrabenazine, clobazam, and cannabidiol).

199 Of the respondents who provided additional comments at the end of the survey, 39% (14/36)
200 noted the value of establishing current treatment practices to inform a clinical trial comparing the
201 efficacy of these medications:

202 *“Much more information is needed on treatment, efficacy and standard practices for treating*
203 *dystonia. I appreciate the time spent on this study.”*

204 *“Important work. There is need for clarity here.”*

205 *“I would be comfortable randomizing to almost anything with guidance and support.”*

206 **Discussion**

207 Dystonia in CP is a common condition lacking clear data to support enteral pharmacologic
208 treatment. The current AACPD treatment guideline, based largely on expert opinion, suggests
209 the use of baclofen first line, trihexyphenidyl second line, gabapentin in people with pain, and
210 clonidine in people with poor sleep.¹⁰ We demonstrate that physicians who treat dystonia in
211 people with CP in the US and Canada prioritize functional impact and whether the dystonia is
212 generalized when deciding whether to prescribe medications to treat dystonia in CP. They most
213 commonly use a subset of six medications: baclofen, trihexyphenidyl, gabapentin,
214 carbidopa/levodopa, clonazepam, and diazepam. Respondents prefer baclofen in people with co-

215 existing spasticity, gabapentin for those with co-existing pain, carbidopa/levodopa for those with
216 genetic or idiopathic dystonia etiologies, and they avoid trihexyphenidyl in people with
217 constipation or urinary retention. They largely follow published dosing regimens for dystonia,¹³⁻
218 ¹⁶ when available, but otherwise follow published regimens for other symptoms that are often
219 present in people with CP (e.g. spasticity and seizures).¹⁷⁻²¹ Though there appears to be some
220 consensus on the preferred first-line medication (baclofen), there is no clear consensus on the
221 choice of second or third-line medications. Finally, though respondents noted preferences for
222 medications, indications, and dosing, they were still largely comfortable randomizing their
223 patients to receive any of the commonly used medications used to treat dystonia in CP, with
224 some noting the clear need for such a trial.

225 The lack of evidence supporting these treatment practices remains glaring.⁸ Though our results
226 show that baclofen is the most commonly used first line medication to treat dystonia in CP, there
227 are no controlled or prospective studies supporting baclofen's use for this purpose.⁸ To provide
228 the CP population with an evidence-based treatment paradigm for dystonia, it is necessary to do
229 a placebo-controlled trial assessing the efficacy of enteral baclofen as a first line treatment of
230 dystonia in CP. Furthermore, the lack of consensus regarding second- or third-line treatments
231 necessitates a clinical trial comparing the effectiveness of these medications directly.

232 Limitations of this study center around the survey design. There was just over a 50% response
233 rate, which may limit generalizability of the survey. Despite surveying a broad population of
234 physicians who treat people with CP across two professional organizations, respondents were
235 largely limited to 2 subspecialties: neurology and physiatry. This may, however, accurately
236 reflect the physician populations most commonly prescribing these medications. We assessed
237 only what physicians said were their prescribing practices, not their actual prescribing practices.

238 This work would be complemented by a study examining a large electronic medical record
239 (EMR) database. However, it is important to note that an EMR-based study would indicate
240 which medications are most commonly prescribed to people with ICD-10 diagnoses of dystonia
241 and CP but would not be reliable in generating the preferred dosing regimens and indications for
242 these medications, including whether a given medication was truly prescribed for dystonia or to
243 treat another co-existing symptom.

244 In conclusion, this study summarizes the current indications and dosing for the six most
245 commonly used medications to treat dystonia in people with CP according to physicians who
246 treat this population in the US and Canada (Table 7). The survey also demonstrates physician
247 support for a trial comparing the effectiveness of pharmacologic treatments for dystonia in CP.
248 This data may serve as a rough guide for trainees or other physicians interested in treating
249 dystonia in this population and may also inform a rational dosing guide for assessing the
250 comparative effectiveness of these medications in a clinical trial.

	Respondents who currently care for people with CP (N=219)	Respondents who currently prescribe medications for dystonia (N=154)
	n, %	n, %
Patient age		
Children	166, 76%	117, 76%
Adults	4, 2%	4, 3%
Both	47, 22%	32, 21%
Total respondents	217, 100%	153, 100%
Practice setting		
Academic	172, 79%	122, 79%
Private	19, 9%	13, 8%
Both	27, 12%	19, 12%
Total respondents	218, 100%	154, 100%
Practice location		
US	196, 90%	138, 90%
Canada	22, 10%	16, 10%
Total respondents	218, 100%	154, 100%
Years in practice		
In training	9, 4%	3, 2%
0 to 5	44, 20%	34, 22%
6 to 10	47, 22%	33, 21%
11 to 15	28, 13%	19, 12%
>15	90, 41%	65, 42%
Total respondents	218, 100%	154, 100%
Specialty		
Physiatry	83, 38%	74, 48%
Neurology	66, 31%	56, 37%
Orthopedics	38, 18%	5, 3%
Developmental Pediatrics	13, 6%	8, 5%
Neurodevelopmental Disabilities	6, 3%	6, 4%
Complex Care Pediatrics	3, 1%	2, 1%
General Pediatrics	2, 1%	1, 1%
Other	5, 2%	1, 1%
Total respondents	216, 100%	153, 100%
% of patients with CP		
<5	9, 4%	6, 4%
5 to 25	63, 29%	42, 28%
26 to 50	52, 24%	32, 21%
51 to 75	54, 25%	40, 27%
>75	36, 17%	30, 20%
Total respondents	214, 100%	150, 100%

Table 1. Physician Respondent Demographics

Specialty	Respondents		Non-respondents	
	n,	%	n,	%
Physiatry	83,	35%	72,	30%
Neurology/Neurodevelopmental Disabilities	74,	31%	82,	34%
Orthopedics	38,	16%	39,	16%
Developmental Pediatrics	13,	5%	18,	8%
Pediatrics - Other	5,	2%	15,	6%
Other	5,	2%	13,	5%
Not currently in clinical practice	20,	8%	unknown	--
Unspecified	2,	1%	0,	0%
TOTAL	240,	100%	239,	100%

Supplementary Table 1. Medical specialties of survey respondents and non-respondents.

	n, % (Total N=219)
Do not diagnose dystonia	6, 3%
History	175, 80%
Physical Exam	210, 96%
Video Review	39, 18%
Alone	26, 12%
Group	28, 13%
Validated Tool/Scale	46, 21%
HAT	36, 16%
BADS	13, 6%
BFM	10, 5%
MD-CRS	3, 1%
D-FIS	1, 0%
Other Tool*	1, 0%
Other**	8, 4%

Table 2. Methods used to diagnose dystonia. HAT – Hypertonia Assessment Tool, BADS – Barry Albright Dystonia Rating Scale, BFM – Burke-Fahn-Marsden Rating Scale, MD-CRS – Movement Disorders – Childhood Rating Scale, D-FIS – Dyskinetic Cerebral Palsy Functional Impact Scale. *Other tool – written in response for Unified Dystonia Rating Scale. **Other – respondents indicated they used other methods to diagnose dystonia but did not clarify further.

Medical or demographic consideration	Affects whether to prescribe a medication at all	Affects the choice of which medication to prescribe
	n, % (Total N=154)	n, % (Total N=154)
Age	55 36%	89, 58%
Severity	144 94%	94, 61%
Focal versus Generalized	101 66%	103, 67%
Arms versus Legs	44 29%	44, 29%
Functional Impact	146 95%	95, 62%
GMFCS	39 25%	32, 21%
Etiology	32 21%	44, 29%
Medical Complexity	58 38%	84, 55%
Prevention of secondary MSK complications	76 49%	42, 27%
Peri-operative tone management	61 40%	41, 27%
Other	8 5%	23, 15%

Table 3. Factors affecting whether to prescribe a medication and which medication to prescribe.

	Overall (n=154)	Neurology (n=56)	Physiatry (n=74)	<5 yrs in practice (n=37)	6-15 yrs in practice (n=52)	>15 yrs in practice (n=66)
Medications	n, %	n, %	n, %	n, %	n, %	n, %
Baclofen	147, 95%	52, 93%	72, 97%	33, 89%	51, 98%	64, 97%
Trihexyphenidyl	122, 79%	44, 79%	65, 88%	26, 70%	43, 83%	53, 80%
Gabapentin	103, 67%	34, 61%	52, 70%	28, 76%	37, 71%	38, 58%
Clonazepam	85, 55%	32, 57%	43, 58%	23, 62%	32, 62%	31, 47%
Carbidopa/Levodopa	84, 55%	32, 57%	44, 59%	15, 41%	29, 56%	41, 62%
Diazepam	83, 54%	26, 46%	44, 59%	23, 62%	26, 50%	34, 52%
Clonidine	30, 19%	16, 29%	8, 11%	11, 30%	6, 12%	13, 20%
Tetrabenazine	27, 18%	14, 25%	11, 15%	2, 5%	11, 21%	14, 21%
Clobazam	11, 7%	9, 16%	1, 1%	4, 11%	4, 8%	3, 5%
Cannabidiol	7, 5%	2, 4%	2, 3%	0, 0%	2, 4%	5, 8%
Other*	2, 1%	0, 0%	2, 3%	0, 0%	1, 2%	1, 2%

Supplementary Table 2. Medications used to treat dystonia in CP and frequency of use: comparison by specialty and by number of years in practice. Medications are listed by descending frequency of use based on the results from all respondents. *Other – only 2 respondents wrote in medications they used that were different from the 10 medications explicitly queried: amantadine and bztropine.

	At all	1st line	2nd line	3rd line	4th line	5th line
Medications	n, % (Total N=154)	n, %	n, %	n, %	n, %	n, %
Baclofen	147, 95%	98, 64%	18, 12%	17, 11%	10, 6%	4, 3%
Trihexyphenidyl	122, 79%	21, 14%	35, 23%	31, 20%	21, 14%	14, 9%
Gabapentin	103, 67%	9, 6%	25, 16%	27, 18%	19, 12%	23, 15%
Clonazepam	85, 55%	11, 7%	23, 15%	20, 13%	14, 9%	17, 11%
Carbidopa/Levodopa	84, 55%	9, 6%	18, 12%	20, 13%	20, 13%	17, 11%
Diazepam	83, 54%	6, 4%	23, 15%	15, 10%	25, 16%	14, 9%
Clonidine	30, 19%	0, 0%	7, 5%	7, 5%	8, 5%	8, 5%
Tetrabenazine	27, 18%	0, 0%	2, 1%	6, 4%	8, 5%	11, 7%
Clobazam	11, 7%	0, 0%	3, 2%	2, 1%	3, 2%	3, 2%
Cannabidiol	7, 5%	0, 0%	0, 0%	3, 2%	2, 1%	2, 1%
Other*	2, 1%	0, 0%	0, 0%	2, 1%	0, 0%	0, 0%

Table 4. Medications used to treat dystonia in CP and frequency of use. Medications are listed by descending frequency of overall use. *Other – only 2 respondents wrote in medications they used that were different from the 10 medications explicitly queried: amantadine and benztropine.

Co-existing symptoms affecting medication use	Baclofen	Trihexyphenidyl	Gabapentin	Carbidopa/Levodopa	Clonazepam	Diazepam
	n, %*	n, %*	n, %*	n, %*	n, %*	n, %*
Spasticity	124, 81%	15, 10%	25, 16%	12, 8%	41, 27%	41, 27%
More likely	124, 100%	4, 27%	24, 96%	0, 0%	39, 95%	41, 100%
Less likely	0, 0%	11, 73%	1, 4%	12, 100%	2, 5%	0, 0%
Anxiety	6, 4%	7, 5%	22, 14%	3, 2%	34, 22%	30, 19%
More likely	4, 67%	2, 29%	21, 95%	1, 33%	33, 97%	30, 100%
Less likely	2, 33%	5, 71%	1, 5%	2, 67%	1, 3%	0, 0%
Depression	6, 4%	4, 3%	5, 3%	2, 1%	6, 4%	11, 7%
More likely	1, 17%	1, 25%	3, 60%	2, 100%	1, 17%	3, 27%
Less likely	5, 83%	3, 75%	2, 40%	0, 0%	5, 83%	8, 73%
Poor sleep	44, 29%	7, 5%	50, 32%	6, 4%	42, 27%	35, 23%
More likely	44, 100%	5, 71%	49, 98%	2, 33%	41, 98%	35, 100%
Less likely	0, 0%	2, 29%	1, 2%	4, 67%	1, 2%	0, 0%
Constipation	42, 27%	53, 34%	10, 6%	14, 9%	10, 6%	9, 6%
More likely	4, 10%	0, 0%	9, 90%	8, 57%	6, 60%	4, 44%
Less likely	38, 90%	53, 100%	1, 10%	6, 43%	4, 40%	5, 56%
Urinary retention	38, 25%	66, 43%	3, 2%	6, 4%	5, 3%	6, 4%
More likely	1, 3%	1, 2%	2, 67%	4, 67%	2, 40%	1, 17%
Less likely	37, 97%	65, 98%	1, 33%	2, 33%	3, 60%	5, 83%
Reflux	13, 8%	8, 5%	4, 3%	3, 2%	1, 1%	3, 2%
More likely	6, 46%	1, 13%	4, 100%	2, 67%	0, 0%	1, 33%
Less likely	7, 54%	7, 88%	0, 0%	1, 33%	1, 100%	2, 67%
Breathing concerns	25, 16%	6, 4%	8, 5%	1, 1%	38, 25%	36, 23%
More likely	5, 20%	3, 50%	2, 25%	1, 100%	0, 0%	0, 0%
Less likely	20, 80%	3, 50%	6, 75%	0, 0%	38, 100%	36, 100%
Pain	42, 27%	9, 6%	76, 49%	3, 2%	16, 10%	17, 11%
More likely	41, 98%	8, 89%	76, 100%	2, 67%	13, 81%	15, 88%
Less likely	1, 2%	1, 11%	0, 0%	1, 33%	3, 19%	2, 12%
Seizures	32, 21%	4, 3%	30, 19%	1, 1%	37, 24%	35, 23%
More likely	2, 6%	2, 50%	29, 97%	1, 100%	34, 92%	31, 89%
Less likely	30, 94%	2, 50%	1, 3%	0, 0%	3, 8%	4, 11%

Table 5. Co-existing symptoms affecting the choice to prescribe a medication. %* - Percentages are indicated in two ways: 1) Out of the total N of 154 (when giving the % of respondents stating that a specific co-existing symptom affects their choice to prescribe a medication), or 2) Out of the number of respondents stating that a given co-existing symptom affects their choice to prescribe a medication (when giving the % of respondents stating that they are more or less likely to prescribe a given medication in the presence of a given co-existing symptom). E.g. Spasticity affects the choice to prescribe baclofen for 124/154 respondents (81%). Of those respondents, 100% (124/124) stated that the presence of co-existing spasticity would make them more likely to prescribe baclofen.

	Baclofen	Trihexyphenidyl	Gabapentin	Carbidopa/ Levodopa	Clonazepam	Diazepam
Starting dose (median)						
mg/day	5	1	100	25	0.25	1.75
mg/kg/day	0.5	0.1	10	1	0.02	0.12
frequency/day	2	2	3	2	2	3
Starting dose (mode)						
mg/day	5	1	300	25	0.25	1
mg/kg/day	0.5	0.1	10	1	0.01	0.1
frequency/day	3	2	3	3	2	3
Maximum dose (median)						
mg/day	80	15	2400	150*	3	15
mg/kg/day	2	0.75	42.5	10	0.2	0.8
frequency/day	3	3	3	3	3	4
Maximum dose (mode)						
mg/day	80	60	3600	100*	2	15
mg/kg/day	2	0.75	50	10	0.2	0.8
frequency/day	3	3	3	3	3	4

Table 6. Respondent's preferred dosing for enteral medications used to treat dystonia in CP. Respondents were given a choice between providing mg/day dosing and mg/kg/day dosing with the assumption that mg/kg/day dosing would be the preferred dosing paradigm for younger children while mg/day dosing might be preferred for adolescents and young adults. *Dosing used by respondents largely paralleled published dosing regimens except for the maximum dose of carbidopa/levodopa, where published dosing regimens use maximum doses as high as 400 mg/day.¹⁶ Note: maximum prescribed mg/day doses in the table may exceed safe maximal doses for children.

	Baclofen	Trihexyphenidyl	Gabapentin	Carbidopa/ Levodopa	Clonazepam	Diazepam
Most commonly used*	1 st line	2 nd or 3 rd line	2 nd or 3 rd line	3 rd or 4 th line	2 nd or 3 rd line	3 rd or 4 th line
Potential indications**	Spasticity, poor sleep, pain	-	Poor sleep, pain	-	Spasticity, anxiety, poor sleep, seizures	Spasticity, poor sleep, seizures
Potential contraindications**	Constipation, urinary retention, seizures	Constipation, urinary retention	-	-	Respiratory difficulties	Respiratory difficulties
Starting dose#						
mg/day	5	1	300	25	0.25	1
mg/kg/day	0.5	0.1	10	1	0.01	0.1
dose frequency	TID	BID	TID	TID	BID	TID
Max dose#						
mg/day	80	60	3600	100##	2	15
mg/kg/day	2	0.75	50	10	0.2	0.8
dose frequency	TID	TID	TID	TID	TID	QID

Table 7. Summary of the indications and dosing cited by respondents for their six most frequently used enteral medications to treat dystonia in CP. *Most commonly used medications are indicated based on the relative frequency with which respondents stated they used each medication as 1st line, 2nd or 3rd line, or 3rd or 4th line treatment choices (Table 4). **Potential indications and contraindications refer to co-existing symptoms that met two criteria (Table 5): 1) at least 20% of respondents felt the co-existing symptom would affect their choice to prescribe a medication, and 2) More than 90% of those respondents stated that the co-existing symptom would make them more likely to prescribe the medication (indication) or less likely to prescribe the medication (contraindication). #Starting and maximum doses refer to the most common dosing regimens used by the respondents (Table 6). Respondents were given a choice between providing mg/day dosing and mg/kg/day dosing with the assumption that mg/kg/day dosing would be the preferred dosing paradigm for younger children while mg/day dosing might be preferred for adolescents and young adults. ##Dosing used by respondents largely paralleled published dosing regimens except for the maximum dose of carbidopa/levodopa, where published dosing regimens use maximum doses as high as 400 mg/day.¹⁶ Note: maximum prescribed mg/day doses in the table may exceed safe maximal doses for children by weight. BID – twice a day, TID – three times a day, QID – four times a day

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