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FINAL PROGRESS REPORT

Project Title:	**DIAGNOSTIC ERROR IN DYSTONIA**
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2. Structured Abstract

PURPOSE. Investigate the frequency, characteristics, and consequences of incorrect or delayed diagnosis in primary dystonia
SCOPE. Primary dystonia, thought to be the third most common movement disorder, is a chronic neurological disease affecting all age groups and racial groups. Estimates of the frequency of incorrect initial diagnosis range from 50% to 90%. This study extends an ongoing parent study of incident primary dystonia in the Northern California Kaiser Permanente Medical Care Plan.
METHODS. Diagnostic error was assessed using computerized health utilization review and patient questionnaires in incident primary dystonia cases. Controls for the utilization review were frequency-matched 10:1 on age, gender, and health plan membership duration. Unconditional logistic regression was used, adjusted for these matching factors.
RESULTS. In 625 cases of primary dystonia and 6250 controls, utilization data show that cases had more medical visits than controls in the year preceding correct diagnosis of dystonia; 78% of cases and 55% of controls had four or more visits to Kaiser ($p < 0.001$). Questionnaire data available for 218 cases indicate that 57% had an initial incorrect diagnosis and over 10% had three or more incorrect diagnoses. Mean time from symptom onset to dystonia diagnosis was 5 years (median 2 years). Initial misdiagnoses as a psychiatric disorder and recommendations for antidepressants or mental health treatment were common. These data are consistent with the common observation—never before assessed systematically—that multiple contacts with healthcare professionals occur before patients receive the correct diagnosis of dystonia.
KEY WORDS. Dystonia, primary dystonia, misdiagnosis

3. Purpose

The long-term goal of this research is to investigate diagnostic error in primary dystonia. Building on an ongoing study identifying incident cases of primary dystonia in the Northern California Kaiser Permanente Medical Care Plan—the largest population-based sample of dystonia patients ever ascertained, we are quantifying the frequency of misdiagnosis and duration of diagnostic delay, characterizing systematic healthcare- and patient-related factors associated with delayed diagnosis, and documenting the negative consequences of misdiagnosis of primary dystonia. We have three primary aims. Aim 1 seeks to identify the frequency of incorrect diagnosis of dystonia. Aim 2 seeks to describe the characteristics of diagnostic error associated with primary dystonia. Aim 3 seeks to estimate the personal and economic consequences of misdiagnosis.

4. Scope

Primary dystonia, thought to be the third most common movement disorder, is a chronic neurological disease affecting all age groups and racial groups. Common subtypes of primary dystonia include dystonic blepharospasm, spasmodic torticollis, oromandibular dystonia, spasmodic dysphonia, and focal hand dystonia (writer's cramp). Primary dystonia has adverse effects on health, employment, and quality of life. There is no cure, but many forms can be effectively treated. Incorrect diagnosis at the time of presentation with dystonia is common, with estimates ranging from 50% to 90%. Correct diagnosis is often delayed for years, causing unnecessary morbidity, suffering, and greater healthcare and societal costs. Moreover, persons with dystonia are frequently misdiagnosed as malingering or as suffering from a psychiatric disorder. This serious issue has not been studied systematically.

The epidemiology of dystonia also is not well studied. Estimates of prevalence for generalized dystonia ranged from $0.3/10^6$ in a German service-based study (based on three cases) to $50/10^6$ in a Chinese community-based door-to-door study (based on three cases). For focal and segmental dystonia, estimated prevalence ranged from $30/10^6$ in the same Chinese study to $2250/10^6$ in a population sample of older adults in Italy. Even less data is available regarding the incidence of dystonia. Apart from our work, described below, our total knowledge of the incidence of primary dystonia is based on only 41 cases from two populations observed between 1950 and 1982. There is at a minimum a fivefold difference in the incidence estimates for generalized dystonia between these two studies, ranging from $0.42/10^6$ to $2/10^6$ person-years. The distribution and onset age of the focal dystonias may vary by race, gender, or age, but this may in part reflect biased ascertainment.

Comparisons among any of the published studies are difficult, as most studies used different case ascertainment and diagnostic methods. The lack of adequate population-based studies precludes definitive conclusions.

In this study, we took advantage of our parent study in the Northern California Kaiser Permanente Medical Care Plan, which identified the world's largest population-based cohort of incident cases of primary dystonia (R01 NS046340), and used computerized health utilization review and direct patient interviews to address our aims.

5. Methods

Overview

We identified incident cases of primary dystonia and interviewed them to assess the consequences of previous misdiagnoses. We also analyzed cases' healthcare contacts prior to diagnosis with dystonia and compared them to those of matched controls.

Population

Individuals with dystonia were identified within Kaiser Permanente Northern California Region (KPNC) from among the cases identified in the ongoing parent epidemiologic study of incident dystonia for the period from 2003 to 2008. KPNC is the largest and one of the oldest health maintenance organizations in the United States. Approximately 25-30% of the general population located in a 14-county region in Northern California belongs to the health plan. The sociodemographic characteristics of KPNC members are generally representative of the underlying population. KPNC has about three million members.

Case ascertainment

Cases in the parent study were ascertained through a multi-step review process using the comprehensive clinical and administrative databases of KPNC. These databases are used by providers for direct clinical care and record each outpatient and inpatient visit, all laboratory and radiographic studies, and all medication use as well as administrative data on residence and membership. Potential cases of dystonia were identified by automated searches of the inpatient and outpatient utilization databases. ICD-9 codes were used to search for potential cases within hospital discharge databases for the 17 KPNC hospitals, and Kaiser-specific outpatient diagnostic codes were used to search within the utilization databases. Examples of outpatient codes of interest include generalized dystonia, focal dystonia, spasmodic torticollis, blepharospasm, and oromandibular dystonia. The search strategy also included examination of the pharmacy database to identify treatment with botulinum toxin, a therapy commonly used in some dystonias.

A control group was assembled in a 10:1 ratio, matching by age, gender and duration of membership in KPNC. For controls, healthcare contacts were assessed prior to an index date determined by matching cases' date of dystonia diagnosis.

Cases were contacted and invited to complete the diagnostic error survey if they were 18 years of age or older, were living, were English speaking with a working address at time of contact, and had their physician's approval to participate.

Measures

Socioeconomic status (SES) was defined based on participants' self-reported education. Participants with less than or equal to a high school degree were considered low SES; those with vocational, technical, or business training or some college or junior college were considered medium SES; and those with a college or graduate school degree were considered high SES.

Data from utilization reports were used to compare antecedent conditions (e.g., history of visits for depression) in dystonia cases and matched controls. Antecedent conditions were defined as KPNC-related coded events occurring prior to index date. A subset of these conditions was then classified according to whether they represent diagnostic error, as described below.

Definition of Diagnostic Error. Two major types of diagnostic errors can be made, incorrect diagnoses and diagnostic delays, and the first often contributes to the second. Below, we define how each of these types of diagnostic errors is defined and operationalized in our study. We focused on erroneous diagnoses in the period from first seeking medical care for dystonia until the time of correct diagnosis**.** Dystonia misdiagnosis was defined as symptoms and signs ultimately recognized as dystonia that were initially diagnosed as another disorder. Misdiagnosis of dystonia was assessed by two methods: (1) Utilization database review and (2) direct patient interview.

(1) Utilization-based Characterization of Diagnostic Error
For each patient with incident dystonia, a complete listing of all healthcare interactions was generated, including outpatient, inpatient, emergency room, pharmacy, and telephone contacts. Utilization records were reviewed by study expert physicians (Drs. Tanner, Goldman, Fross, Klingman) in order to classify each healthcare interaction as related or unrelated to dystonia prior to its correct diagnosis. Criteria defining incorrect diagnoses were developed for each dystonia subtype; examples are shown below. During the period prior to the first diagnosis of dystonia, each of these incorrect diagnoses was identified as a misdiagnosis event if listed as the primary diagnosis for a healthcare visit during which care was sought for dystonic symptoms.

Dystonia Subtype	**Selected diagnoses consistent with dystonia misdiagnosis**
Blepharospasm	Stress; Anxiety; Depression; Malingering; Conversion; Infection; Allergy; Eye strain; Muscle spasm; Bell's palsy
Oromandibular	Stress; Anxiety; Depression; Malingering; Conversion; Infection; Allergy; Drug reaction; TMJ syndrome; Muscle spasm; Bell's palsy; Dental problems
Cervical (spasmodic torticollis)	Stress; Anxiety; Depression; Malingering; Conversion; Sprain/strain; Arthritis; Cervical disk disease; Muscle spasm; Drug reaction
Laryngeal (spasmodic dysphonia)	Stress; Anxiety; Depression; Malingering; Conversion; Sinus infection; Upper respiratory Infection; Vocal cord polyps; Chronic hoarseness; Allergy; Laryngitis; Acid reflux/esophagitis
Upper limb	Stress; Anxiety; Depression; Malingering; Conversion; Sprain/strain; Tendonitis; Epicondylitis; Arthritis; Carpal tunnel syndrome

For each misdiagnosis event, the following characteristics were recorded: incorrect diagnosis; date of event; patient age; provider type, including physician or non-physician specialty; and type of interaction (inpatient, outpatient, ER, telephone).

Characteristic	**Variable**
Patient Age	Date of interaction
Provider type	Physician, specialty: family practice, internal medicine, ENT, orthopedics, pediatrics, physiatry, ophthalmology, psychiatry, emergency medicine, occupational medicine, neurology, other
	Non-physician: physical therapist, speech therapist, acupuncturist, psychologist or other mental health professional, any other healthcare-affiliated professional
Type of interaction	Inpatient; Outpatient; Emergency room/Urgent care; Pharmacy; Telephone
Incorrect Diagnosis	Utilization diagnostic code and description
Diagnostic Test	X-ray; MRI/other imaging; Biopsy; Blood draw/laboratory test; Allergy testing; EMG
Treatment Modalities	Medications, by type; Physical therapy; Acupuncture; Psychotherapy; Trigger point/epidural injections
Adverse Event	Drug reaction; Infection

(2) Direct patient interview
We developed a survey instrument to assess cases' perceptions of how long it took for their dystonia to be correctly diagnosed and the consequences of the preceding misdiagnoses. Self-report questionnaires were developed *de novo* and by adapting previously published dystonia survey instruments.

Analyses
All analyses were performed using SAS® version 9.3 (Cary, NC, USA).

Utilization data:
Antecedent conditions prior to dystonia diagnosis (or index date in controls) were compared in cases with primary dystonia and matched controls using logistic regression adjusted for age at diagnosis, gender, and membership duration before diagnosis.

Logistic regression was similarly used in comparisons of number and type of visits prior to index date between dystonia cases and matched controls. Because the correct diagnosis may require multiple visits, we compared the visit frequency in the year prior to index date.

Questionnaire data:
Descriptive analyses (mean, median, range) were used to summarize cases' responses to the case survey questions.

6. Results
Data collection activities for this study are complete. Except when specified below, results are from the diagnostic error survey given to cases. Preliminary results were presented at the Fifth International Dystonia Symposium in October 2011 and at the American Neurological Association Annual Meeting in October 2012.

Subject characteristics
After screening individuals with new diagnostic codes or write-in diagnoses that may be used for dystonia, 625 cases of primary dystonia were compared with 6250 controls matched on age, gender, and KPNC membership duration prior to index date. Cases were 71% women and had a mean age of 55 +/- 16 years at the start of the parent incidence study in 2003.

Of these cases, 520 incident dystonia cases were contacted regarding the diagnostic error survey; 218 cases completed the survey. Cases who participated (71% women, mean age 55 +/- 12 years) were similar to the overall pool contacted. Dystonia subtypes among the cases included laryngeal dystonia (n=53), cervical dystonia (n=47), limb dystonia (n=40), blepharospasm (n=39), segmental dystonia (n=20), oromandibular dystonia (n=9), Meige's syndrome (n=7), and generalized dystonia (n=3). Cases were predominantly non-Hispanic White people (n=161), with smaller numbers of Hispanic White people (n=22), Asians (n=20), African Americans (n=11), and Hispanics of other races (n=4); results are shown below for categories with at least 10 members.

6.1. Specific Aim 1: To identify the frequency of incorrect diagnosis of dystonia. What is the frequency of misdiagnosis, and does it vary by gender, race/ethnicity, or socioeconomic status?

Of 211 respondents to this question, 121 (57%) were given one or more incorrect diagnoses prior to the correct diagnosis of dystonia (see table below). Of these, almost half (45%) had their symptoms attributed to stress, anxiety, or depression, but misdiagnoses ran the gamut from acid reflux to (less commonly) bacterial infections and viral illnesses. Over 10% of cases had three or more incorrect diagnoses before being diagnosed with dystonia.

Incorrect diagnoses reported by >= 5% of cases	Frequency (%) among misdiagnosed cases
Stress	39
Anxiety	38
Allergy	14
Other: Dry eyes	13
Sprain/Strain	12
Other: Acid reflux	11
Depression	10
Arthritis	8
Laryngitis	7
Tendonitis	6

Patterns of misdiagnosis varied by dystonia subtype; several examples are given below. Thirty-two (70%) cervical dystonia cases, 25 (66%) blepharospasm cases, 31 (61%) laryngeal dystonia cases, and 15 (39%) limb dystonia cases were given one or more incorrect diagnoses prior to the correct diagnosis of dystonia.

	Frequency among cases given an incorrect diagnosis			
Incorrect diagnoses reported by >= 5% of primary dystonia cases (overall)	**Misdiagnosed cervical dystonia (%)**	**Misdiagnosed blepharo-spasm (%)**	**Misdiagnosed laryngeal dystonia (%)**	**Misdiagnosed limb dystonia (%)**
Stress	34	28	32	20
Anxiety	31	32	26	33
Allergy	0	24	19	0
Other: Dry eyes	0	40	0	0
Sprain/Strain	13	8	13	7
Other: Acid reflux	0	0	29	0
Depression	9	0	6	7
Arthritis	13	0	3	13
Laryngitis	0	0	19	0
Tendonitis	3	0	3	13

(a) Variation by gender, race/ethnicity, or socioeconomic status.

Gender. The frequency of misdiagnosis was strikingly similar in men and women; 55% of men and 58% of women reported one or more incorrect diagnoses before being diagnosed with dystonia, and 13% of men and 11% of women reported initially receiving three or more incorrect diagnoses.

Race/ethnicity. Self-reported frequency of misdiagnosis was also similar across categories of race/ethnicity. The proportion of cases reporting misdiagnosis ranged from 52% (11/21) among Hispanic White patients to 64% (7/11) among African Americans. Among those misdiagnosed, frequency of three or more misdiagnoses ranged from 9% (1/11) among Hispanic White patients to 24% (21/89) among non-Hispanic White patients.

Number of other diagnoses given for symptoms before dystonia diagnosed	Caucasian (non-Hispanic) (n=155)	Caucasian (Hispanic) (n=21)	African American (n=11)	Asian (n=20)
0	66 (43%)	10 (48%)	4 (36%)	9 (45%)
1	53 (34%)	6 (29%)	4 (36%)	7 (35%)
2	15 (10%)	4 (19%)	2 (18%)	2 (10%)
3+	21 (14%)	1 (5%)	1 (9%)	2 (10%)

Socioeconomic status. Patterns of misdiagnosis varied with socioeconomic status. Lower-SES cases were more likely to report a misdiagnosis: Over 75% (23/30) of cases with lower SES (less than or equal to a high school degree) reported misdiagnosis compared to 61% (53/89) of cases with vocational training or some college and 49% (41/84) of cases with a college or graduate school degree ($p < 0.04$ for lower- vs mid-/higher-SES). However, among those misdiagnosed, higher-SES cases were more likely to report three or more incorrect diagnoses before being diagnosed with dystonia: 34% vs 9% for lower- and 17% for mid-SES cases ($p < 0.02$ for higher- vs lower-/mid-SES).

6.2. Specific Aim 2: To describe the characteristics of diagnostic error associated with primary dystonia. (a) What was the length of time from symptom onset to correct diagnosis and initiation of appropriate treatment? (b) How many and what types of providers were seen prior to correct diagnosis? (c) How many and what types of inappropriate diagnostic tests and treatments occurred due to misdiagnosis? (d) How many misdiagnoses as a psychiatric disorder or as a malingerer occurred? (e) Do the answers to (a)-(d) vary by gender, race/ethnicity, or socioeconomic status?

(a) Time to correct diagnosis and treatment. Cases reported a mean time from symptom onset to being diagnosed with dystonia of 4.8 years (median 1.7 years, range 1 day – 50 years).

(b) Number and types of providers seen. Cases reported a mean of 4.1 doctor visits (median 2, range 0 to 90) before being correctly diagnosed. Over 50% of cases reported seeing more than one type of specialist before being diagnosed with dystonia; 25% saw three or more.

(c) Inappropriate tests and treatments. Forty-three percent of cases (91/212) reported undergoing symptom-related tests before being correctly diagnosed with dystonia, with 15% of cases reporting two or more types of tests.

Selected tests prior to dystonia diagnosis	Frequency among cases who had symptom-related tests (%)
MRI	49
X-ray	35
Blood tests	24
EMG	18
Other: CAT/CT scan	4

Reported frequency of tests varied with clinical subtype. For example, half (23/47) of cervical dystonia cases, 35% (18/51) of laryngeal dystonia cases, 24% (9/38) of blepharospasm cases, and 39% (15/38) of limb dystonia respondents underwent symptom-related tests before receiving a correct diagnosis.

Frequency of symptom-related treatments also varied with clinical subtype. Overall, half (104/208) of all cases reported being treated for an incorrect diagnosis (see table below). Symptom-related treatments were more common among cervical and generalized dystonia cases and less commonly reported among Meige's syndrome cases.

Sixty-seven percent of cervical dystonia cases (31/46) and generalized dystonia cases (2/3), and 0% (0/6) of Meige's syndrome cases reported receiving symptom-related treatment before being diagnosed with dystonia. Inappropriate treatments were also reported by 55% (28/51) of laryngeal dystonia cases, 36% (14/39) of blepharospasm cases, and 41% (14/34) of limb dystonia cases.

Treatments prescribed for incorrect diagnoses	Frequency among cases treated for an incorrect diagnosis				
	All cases (%)	Misdiagnosed cervical dystonia (%)	Misdiagnosed blepharo-spasm (%)	Misdiagnosed laryngeal dystonia (%)	Misdiagnosed limb dystonia (%)
Muscle relaxant	45	65	15	16	46
Acupuncture	30	34	36	12	50
Physical therapy	27	53	0	8	33
Anti-inflammatory	26	33	0	13	45
Speech therapy	26	0	0	79	0
Antidepressant	22	20	8	13	0
Allergy medications	15	0	43	28	0
Mental health referral	15	10	14	12	9
Trigger point or epidural injections	15	19	21	0	27
Steroids	11	0	23	20	0

(d) Misdiagnoses as psychiatric disorder or malingering. As shown above in 6.1 and 6.2.c, misdiagnoses as a psychiatric disorder (e.g., stress, anxiety, or depression) and recommendations for antidepressants or mental health treatment were common among dystonia cases.

(e) Variation by gender, race/ethnicity, or socioeconomic status.

Gender. Mean reported time from first symptom to a correct diagnosis of dystonia was similar in men and women (5.2 vs 4.7 years). Men and women typically saw the doctor twice about their symptoms before being correctly diagnosed and had a similar probability of symptom-related tests (48% vs 51%) and inappropriate treatments (40% vs 44%). Misdiagnosis as a psychiatric disorder were similar in men and women.

Race/ethnicity. Non-Hispanic White patients reported the longest average time from first symptom to diagnosis (mean 6 years, median 2 years). Median self-reported time to diagnosis was 1 year among African Americans and 1.5 years among Asians and Hispanic White patients, though the number of respondents was small for these racial/ethnic categories. However, African Americans reported the highest median number of doctor visits before being correctly diagnosed (n=4 visits vs 2 visits for the other racial/ethnic groups).

	White (non-Hispanic)	White (Hispanic)	African American	Asian
Median days from first symptom to diagnosis of dystonia	730 (n=123)	547.5 (n=14)	365 (n=8)	547.5 (n=16)
Median number of doctor visits for symptoms before diagnosis of dystonia	2 (n=142)	2 (n=20)	4 (n=9)	2 (n=15)

Socioeconomic status. Average time reported from first symptom to a diagnosis of dystonia was twice as long in lower- vs higher-SES cases (mean 8 vs 4 years, median 2 vs 1 years), though the difference did not reach statistical significance. Lower- and higher-SES cases reported a similar number of doctor visits before being correctly diagnosed (mean 4.0 vs 4.6 visits, median 3 vs 2 visits) and a similar probability of symptom-related tests (43% vs 49%) and inappropriate treatments (52% vs 45%).

(d, Utilization-based) Misdiagnoses as psychiatric disorder or malingering (utilization-based). Cases with dystonia were more likely than controls to have been diagnosed at KPNC with conditions coded as various psychiatric disorders prior to the correct diagnosis of dystonia (or index date in controls). For example, cases were almost twice as likely to have been seen for "post-traumatic stress disorder" (OR 1.81, $p < 0.04$) or "anxiety" (OR 1.81, $p < 0.001$). Physical rehabilitation visits were also more common among cases. Dystonia cases overall were more likely than controls to be seen for "disc disease" (OR 1.72, $p < 0.001$), an observation more pronounced among cases with cervical dystonia (OR 3.83, $p < 0.001$).

Visit type	Clinical Subtype	Cases		Controls		OR	Lower 95% CL	Upper 95% CL	p-value
		N	%	N	%				
Rehabilitation									
Sprain/Strain	Overall	363	58.1%	3316	53.1%	1.21	1.02	1.44	0.027
Sprain/Strain	Cervical	117	18.7%	943	15.1%	1.64	1.19	2.26	0.002
Sprain/Strain	Upper limb	77	12.3%	636	10.2%	1.59	1.07	2.38	0.023
Disc disease	Overall	175	28.0%	1154	18.5%	1.72	1.42	2.07	<0.001
Disc disease	Cervical	86	13.8%	341	5.5%	3.83	2.8	5.24	<0.001
Tendinitis	Upper limb	51	8.2%	376	6.0%	1.66	1.12	2.47	0.012
Carpal tunnel syndrome	Upper limb	23	3.7%	89	1.4%	3.03	1.82	5.05	<0.001
Psychiatric									
Stress	Overall	183	29.3%	1488	23.8%	1.31	1.09	1.58	0.004
Anxiety	Overall	190	30.4%	1220	19.5%	1.81	1.5	2.17	<0.001
Depression	Overall	169	27.0%	1290	20.6%	1.42	1.18	1.72	<0.001
Somatoform disorder	Overall	19	3.0%	142	2.3%	1.34	0.82	2.18	0.242
Acute stress	Overall	144	23.0%	1012	16.2%	1.55	1.27	1.89	<0.001
Post-traumatic stress disorder	Overall	16	2.6%	88	1.4%	1.81	1.05	3.1	0.033
Other									
Eye allergy	Blepharospasm	21	3.4%	82	1.3%	2.78	1.67	4.63	<0.001
Laryngitis	Laryngeal	6	1.0%	3	0.0%	21.5	5.29	87.5	<0.001

6.3. Specific Aim 3: To estimate the personal and economic consequences of misdiagnosis. We seek to estimate the consequences of misdiagnosis (a) on patients' relationships, mood, self-esteem, activities of daily living, economics, and livelihood; (b) expressed as number and type of adverse events due to inappropriate treatments provided to patients as a result of dystonia misdiagnosis; and (c) expressed as an estimate of excess health costs due to diagnostic error.

(a) Consequences of misdiagnosis on relationships, mood, self-esteem, activities of daily living, economics, and livelihood. Overall, 102/162 (63%) of cases whose diagnoses of dystonia were delayed reported unpleasant or harmful effects from the delay. Among those reporting ill effects, the consequences included problems with family relationships (59%) and friendships (50%); recreational or community activities (69%); and their jobs (75%). Almost everyone who reported ill effects from earlier misdiagnosis reported problems with personal worry or anxiety (94%) and emotional well-being (92%).

In addition, 81/207 (39%) of cases reported changing their job duties or activities as a result of dystonia symptoms. However, upon being correctly diagnosed with dystonia, approximately 77% of these cases who reported receiving treatment were able to resume some or most of their prior work activities.

(b) Adverse events due to inappropriate treatments resulting from misdiagnosis. Almost a quarter (23%) of cases who were treated for incorrect diagnoses reported unpleasant or harmful effects from the treatments, ranging from frustration and anxiety to difficulty focusing, unnecessary surgery, an ulcer, and muscle weakness and loss of sensation.

(c) Excess health costs due to diagnostic error (utilization-based).
Patients eventually diagnosed with dystonia had 50% more doctor visits than controls in the year prior to diagnosis (or index date in controls; median 7 vs 4 visits, mean 9.9 vs 6.6 visits, $p < 0.001$); 78.0% of cases and 54.5% of controls had four or more visits ($p < 0.001$). In particular, cases had over five times as many neurologist visits (mean 0.33 vs 0.06 visits for controls), one and a half times as many psychiatric visits (mean 0.52 vs 0.35 visits), and almost twice as many rehabilitation-related visits (mean 0.91 vs 0.54).

Excess medical visits were not limited to the year preceding diagnosis. In the 5 years prior to diagnosis, the typical dystonia case had 27 visits compared to 21 for controls (mean 37 vs 30, $p < 0.001$). Excess visits primarily occurred in the 5 years prior to diagnosis; no further excess was observed when the time window was extended to 10 years (median 41 vs 38 visits, mean 58 vs 51).

Conclusions:
Dystonia is commonly misdiagnosed; more than half of cases received one or more misdiagnoses before being correctly diagnosed. Almost half of misdiagnosed cases are initially classified as stress, anxiety, or depression. It typically takes over a year and a half and visits to multiple specialists before the correct diagnosis is reached, often involving expensive and sometimes harmful diagnostic tests and therapies. The delay in correct diagnosis also can have grave personal and economic consequences. Almost half of initially misdiagnosed cases reported that it caused problems with their jobs, and about a third reported that it adversely affected relationships with family and friends.

Interpretation:
These data are consistent with the common observation—never before assessed systematically—that multiple contacts with healthcare professionals occur before patients receive the correct diagnosis of dystonia.

Significance:
This investigation is the first systematic characterization of diagnostic error in dystonia and, indeed, one of the first to investigate diagnostic error in any neurological disorder. Identifying the types of incorrect diagnoses that are made, and by whom, provides a foundation for developing future effective interventions that can ultimately minimize this problem. If successful, this approach could be applied in other medical care settings as well as for other rare disorders to improve medical care and efficiency and reduce suffering.

7. Publications/Products to Date

Presentations
Tanner CM. Epidemiology of dystonia: questions and challenges. Fifth International Dystonia Symposium; 2011 Oct 20-22; Barcelona, Spain.

Posters
Caroline M. Tanner, Stephen K. Van Den Eeden, Samuel Goldman, et al. Diagnostic error in primary torsion dystonia. Presented at the American Neurological Association Meeting 2012 Oct 09; T1759.