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### Authors

McGuire, Joseph F

Piacentini, John

Storch, Eric A

et al.

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## Defining Tic Severity and Tic Impairment in Tourette Disorder

**Joseph F. McGuire, PhD,**

Department of Psychiatry and Behavioral Sciences, Johns Hopkins University School of Medicine

Semel Institute of Neuroscience and Human Behavior, University of California Los Angeles

**John Piacentini, PhD,**

Semel Institute of Neuroscience and Human Behavior, University of California Los Angeles

**Eric A. Storch, PhD,**

Department of Psychiatry, Baylor College of Medicine

**Emily J. Ricketts, PhD,**

Semel Institute of Neuroscience and Human Behavior, University of California Los Angeles

**Douglas W. Woods, PhD,**

Marquette University

**Alan L. Peterson, PhD,**

Department of Psychiatry and Behavioral Sciences, University of Texas Health Science Center at San Antonio

Research and Development Service, South Texas Veterans Health Care System

Department of Psychology, University of Texas at San Antonio

**John T. Walkup, MD,**

Ann and Robert H. Lurie Children's Hospital of Chicago

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**Corresponding Author:** Joseph F. McGuire, Ph.D., Department of Psychiatry and Behavioral Sciences, Johns Hopkins University School of Medicine, Baltimore, Maryland. 1800 Orleans St, Baltimore, MD 21287. [jfmcguire@jhmi.edu](mailto:jfmcguire@jhmi.edu).

Author Statement

Joseph F. McGuire PhD: Conceptualization, methodology, data analysis, writing-original draft, reviewing, and editing.

John Piacentini PhD: Methodology, writing-original draft, reviewing, and editing, and funding acquisition.

Eric A. Storch PhD: Methodology, writing-original draft, reviewing, and editing, and funding acquisition.

Emily J. Ricketts PhD: Writing-original draft, reviewing, and editing, and funding acquisition.

Douglas W. Woods PhD: Writing- reviewing and editing, and funding acquisition.

Alan L. Peterson PhD: Writing- reviewing and editing, and funding acquisition.

John T. Walkup MD: Writing- reviewing and editing, and funding acquisition.

Sabine Wilhelm PhD: Writing- reviewing and editing, and funding acquisition.

Kesley Ramsey PhD: Data curation, writing- reviewing and editing.

Joey K.-Y. Essoe PhD: Data curation, writing- reviewing and editing.

Michael B. Himle PhD: Data curation, writing- reviewing and editing.

Adam B. Lewin PhD: Writing- reviewing and editing.

Susanna Chang PhD: Writing- reviewing and editing.

Tanya K. Murphy MD: Data curation, writing- reviewing and editing.

James T. McCracken MD: Data curation, writing- reviewing and editing.

Lawrence Scahill PhD: Conceptualization, methodology, writing-original draft, reviewing, and editing, supervision, and funding acquisition.

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**Sabine Wilhelm, PhD,**

Massachusetts General Hospital and Harvard Medical School

**Kesley Ramsey, PhD,**

Department of Psychiatry and Behavioral Sciences, Johns Hopkins University School of Medicine

**Joey K.-Y. Essoe, PhD,**

Department of Psychiatry and Behavioral Sciences, Johns Hopkins University School of Medicine

**Michael B. Himle, PhD,**

Department of Psychology, University of Utah

**Adam B. Lewin, PhD,**

Departments of Pediatrics, Psychiatry and Behavioral Neuroscience, University of South Florida

**Susanna Chang, PhD,**

Semel Institute of Neuroscience and Human Behavior, University of California Los Angeles

**Tanya K. Murphy, MD,**

Departments of Pediatrics, Psychiatry and Behavioral Neuroscience, University of South Florida

All Children's Hospital, Johns Hopkins Medicine

**James T. McCracken, MD,**

Semel Institute of Neuroscience and Human Behavior, University of California Los Angeles

**Lawrence Scahill, PhD**

Marcus Autism Center, Emory University School of Medicine

**Abstract**

**Objective:** Treatment guidelines for Tourette's Disorder (TD) are based on patients' degree of tic severity and impairment. However, clear benchmarks for determining tic severity and impairment have not been established. This study examined benchmarks of tic severity and tic impairment using the Yale Global Tic Severity Scale (YGTSS) and the Clinical Global Impression of Severity (CGI-S).

**Method:** Individuals with TD or another Tic Disorder ( $N = 519$ ) recruited across nine sites were administered a diagnostic interview, the YGTSS, and the CGI-S. Correlations and trend analyses contrasted YGTSS scores across CGI-S ratings. A logistic regression model examined predictive benchmarks for tic severity, tic impairment, and global severity. Model classifications were compared against CGI-S ratings, and agreement was examined using kappa.

**Results:** Spearman correlations between the CGI-S and YGTSS scores ranged from 0.54 to 0.63 ( $p < 0.001$ ). Greater CGI-S ratings were associated with a linear stepwise increase in YGTSS Total Tic scores, Impairment scores, and Global Severity scores. Despite moderate-to-strong associations ( $\rho = 0.45\text{--}0.56$ ,  $p < 0.001$ ) between the CGI-S and predictive logistical regression models, only fair agreement was achieved when applying classification benchmarks ( $\kappa = 0.21\text{--}0.32$ ,  $p < 0.001$ ).

**Conclusions:** CGI-S ratings are useful to characterize benchmarks for tic severity, tic impairment, and global severity on the YGTSS. Logistic regression model benchmarks had only

fair agreement with the CGI-S and underscore the heterogeneity of TD symptoms. Collectively, findings offer guidance on the delineation of tic severity categorizations to apply evidence-based treatment recommendations.

## Keywords

Tourette Disorder; YGTSS; tic severity; impairment; clinical severity; assessment

Tourette's Disorder and persistent tic disorders (collectively referred to as TD) are neuropsychiatric conditions with a childhood onset (Bloch and Leckman, 2009), which affect about 1% of the pediatric population (Knight et al., 2012; Scahill et al., 2014; Scharf et al., 2015). Individuals with TD exhibit a wide range of symptoms that include simple motor tics (e.g., repetitive eye-blinking, quick head jerk), complex motor tics (e.g., combination of movements, writing tics, whole body tics), simple vocal tics (e.g., coughing, throat clearing), and complex vocal tics (e.g., words, short phrases). Tics tend to emerge in early school-aged years and peak in severity during early adolescence (Bloch and Leckman, 2009). Although tic severity often declines in early adulthood, some individuals with TD exhibit tics throughout adulthood (Bloch and Leckman, 2009). In addition to tics, the clinical picture of TD is often complicated by co-occurring psychiatric conditions, including anxiety disorders, attention-deficit hyperactivity disorders (ADHD), and obsessive-compulsive disorder (OCD) (Freeman et al., 2000). Tics and co-occurring conditions are associated with functional impairment (Conelea et al., 2013; Storch et al., 2007a) and contribute to decreased quality of life (Eddy et al., 2011; Storch et al., 2007b).

There are two empirically supported treatment options for individuals with TD: pharmacotherapy (e.g., antipsychotic and alpha-2 agonist medications) (Weisman et al., 2013) and behavior therapy (e.g., habit reversal training, exposure with response prevention, comprehensive behavioral intervention for tics) (McGuire et al., 2014; McGuire et al., 2015c; Piacentini et al., 2010; Wilhelm et al., 2012). Decisions to pursue treatment for TD should be made collaboratively with patients and families, and incorporate multiple factors (e.g., tic severity, tic impairment, patient preference, and accessibility of treatments). However, patients and families often rely upon clinicians for guidance and in turn, clinicians rely on professional treatment guidelines. These treatment guidelines universally recommend incorporating tic severity and tic impairment in treatment planning (Murphy et al., 2013; Pringsheim et al., 2019, 2012; Roessner et al., 2011; Steeves et al., 2012; Verdellen et al., 2011). For tics that are "mild" in severity, psychoeducation is often the recommended intervention (Murphy et al., 2013). Behavior therapy is typically recommended for tics of "moderate" severity or greater; and pharmacotherapy recommended when tics are "severe" (Murphy et al., 2013). While nuanced differences exist from guideline to guideline (Murphy et al., 2013; Pringsheim et al., 2019, 2012; Roessner et al., 2011; Steeves et al., 2012; Verdellen et al., 2011), the commonality across all guidelines is that increasing levels of severity require increasing levels of clinical intervention. Unfortunately, the delineation of these descriptive severity categories is unclear and likely influenced by a clinician's level of experience with TD. This can result in differences in tic severity classification among clinicians and consequently different treatment recommendations. A clear consensus on criteria that constitute "mild", "moderate", and

“severe” severity in TD can guide clinicians (and allied care providers) to recommend appropriate levels of clinical intervention.

Tic severity and tic impairment are commonly measured using the Yale Global Tic Severity Scale (YGTSS) (Leckman et al., 1989; McGuire et al., 2018). Although the YGTSS is the gold standard for assessing tic severity and impairment (McGuire et al., 2012), there are no established benchmarks for distinguishing mild, moderate, or severe levels of illness. The Clinical Global Impression-Severity (CGI-S) scale is a general measure of disorder severity often used in research studies (Guy, 1976). This clinician-rated scale has been applied to measure global severity in TD, and incorporates tic severity and tic impairment into a single ordinal rating (e.g., mild, moderate, severe) (Guy, 1976; Leckman et al., 1989). Because the CGI-S considers tic severity and tic impairment into a single rating, it represents an ideal index to determine YGTSS benchmarks that correspond with descriptive severity categories used in treatment guidelines. To date, only one study has examined the relationship benchmarks between the CGI-S and the YGTSS (Leckman et al., 1989). Leckman and colleagues (1989) found a stepwise increase in the Global Severity score for each increasingly severe CGI-S category (Leckman et al., 1989). Although informative, this report only examined YGTSS Global Severity score (Total Tic score + Impairment score) and was limited to a single recruitment site that included only 90 youth and adults (Leckman et al., 1989). Given that the YGTSS Total Tic score is the primary outcome in most clinical trials (Murphy et al., 2017; Piacentini et al., 2010; Scahill et al., 2001; Wilhelm et al., 2012), benchmarks for this scale can inform the application of treatment guidelines and recommendations. Here, we examined benchmarks of tic severity, tic impairment, and global severity using the YGTSS and CGI-S in a large multi-site sample of well-characterized patients with TD.

## Methods

### Participants

Participants were 519 individuals with TD (465 Tourette Disorder, 41 Chronic Motor Tic Disorder, 5 Chronic Vocal Tic Disorder, and 8 Transient Tic Disorder) who were recruited across nine U.S. academic Tourette and Obsessive-Compulsive Disorder specialty clinics. These participants were ascertained as part of multiple independent studies either focusing on phenomenological research or clinical trials (University of California Los Angeles,  $n = 170$ ; University of South Florida,  $n = 99$ ; University of Wisconsin-Milwaukee,  $n = 76$ ; Massachusetts General Hospital and Harvard Medical School,  $n = 47$ ; Johns Hopkins University,  $n = 41$ ; University of Texas Health Science Center at San Antonio,  $n = 40$ ; Yale Child Study Center,  $n = 35$ ; University of Utah,  $n = 8$ ; Weill Cornell Medical College,  $n = 3$ ) (Bennett et al., 2020; Himle et al., 2012; Johnco et al., 2016; McCracken et al., 2008; McGuire et al., 2015a; McGuire et al., 2016; Piacentini et al., 2010; Ricketts et al., 2016; Storch et al., 2017; Wilhelm et al., 2012).

### Measures

**Psychiatric Diagnoses.**—In most cases, psychiatric diagnoses were determined using an age-appropriate structured diagnostic interview administered by a trained clinician [i.e.,

Anxiety Disorder Interview Schedule-Parent and Child Version (ADIS-C/P; Silverman et al., 2001; Silverman and Albano, 1996),  $n = 175$ ; the Structured Clinical Interview for DSM-IV (SCID; First et al., 2002),  $n = 122$ ; Kiddie-Schedule for Affective Disorders (KSADS),  $n = 98$ ; Mini International Neuropsychiatric Interview-KID (MINI-KID; Sheehan et al., 2010),  $n = 25$ ]. In 99 patients, psychiatric diagnoses were based on a clinical interview conducted by a board certified child psychiatrist or psychologist followed by a best estimate procedure conducted by two doctoral-level clinicians using all available information (Leckman et al., 1982).

**Yale Global Tic Severity Scale (YGTSS) (Leckman et al., 1989).**—The YGTSS is a clinician-rated interview that measures current tic severity and impairment. It has a stable factor structure (Storch et al., 2007c), as well as excellent reliability and validity (Leckman et al., 1989; McGuire et al., 2018; Storch et al., 2005). Motor and phonic tics are rated separately across five dimensions. Ratings are summed to produce a Total Tic score (range: 0–50), which serves as the gold standard measure of tic severity. The Impairment score is separate from tic severity and reflects overall tic impairment (range: 0–50). The Total Tic score and Impairment score are summed to produce a Global Severity score (range: 0–100).

**Clinical Global Impression-Severity (CGI-S) Scale (Guy, 1976).**—The CGI-S is a 7-point clinician-rating designed to measure overall illness severity in TD. Although co-occurring conditions are often present in TD, clinicians were trained to focus on TD symptom severity when rating the CGI-S using tic-specific anchors. Scores on the CGI-S range from: (1) “Normal presentation/no illness,” (2) “Borderline illness severity,” (3) “Mild illness severity,” (4) “Moderate illness severity,” (5) “Marked illness severity,” (6) “Severe illness severity,” and (7) “Extreme illness severity.”

## Procedures

Local institutional review boards approved all study procedures for each individual research protocol. Study data were collected after adult participants provided consent, parents provided permission for minors, and minors provided assent. Prior to the administration of the YGTSS and CGI-S, raters were trained to reliability. Supervision on assessments varied slightly across individual protocols. However, all raters received regular supervision on assessments either via regular meetings with local study investigators who had extensive experience with TD assessments, or monthly teleconference calls led by study investigators with extensive TD assessment experience. De-identified data were aggregated across the studies for the secondary analyses here.

## Analytic Plan

First, sample characteristics and distribution of YGTSS and CGI-S scores were examined (see Table 1). T-tests and Mann-Whitney U tests compared differences in tic severity (YGTSS, CGI-S) and impairment between youth (7–17 years of age) and adults (18+ years of age). Spearman correlations ( $\rho$ ) examined the association between CGI-S and the YGTSS Total Tic score, YGTSS Impairment score, and YGTSS Global Severity score. Second, YGTSS Total Tic scores, YGTSS Impairment scores, YGTSS Global Severity scores, and counts of co-occurring psychiatric diagnoses were indexed by CGI-S categories (see Table 2

and Figure 1). Third, to examine the influence of co-occurring psychiatric conditions on CGI-S ratings, chi-square tests examined differences in the counts of anxiety disorders, ADHD, OCD, and depressive disorders between CGI-S categories. Fourth, a trend analysis compared the YGTSS Total Tic score, YGTSS Impairment score, and YGTSS Global Severity score across CGI-S ratings using an analysis of variance (ANOVA). Polynomial contrasts and Bonferroni post-hoc tests determined significant trends. Finally, a logistic regression model was applied using the PLUM function in SPSS 25.0 to determine tic severity, tic impairment, and global severity benchmarks on the YGTSS using CGI-S ratings. Spearman correlations ( $\rho$ ) examined the relationship between the logistic regression model classifications and CGI-S classifications. Mutual classification of proposed tic severity, tic impairment, and global severity benchmarks were compared with the original CGI-S rating using Cohen's kappa ( $\kappa$ ): 0 as no agreement, 0.01–0.20 as none to slight agreement, 0.21–0.40 as fair agreement, 0.41–0.60 as moderate agreement, 0.61–0.80 as substantial agreement, and 0.81–1.00 as almost perfect agreement (Landis and Koch, 1977).

## Results

### Participant Characteristics.

Table 1 presents demographic and clinical characteristics of the 418 youth and 101 adults in the combined sample. The average YGTSS Total Tic score, Impairment score, and Global Severity score were  $24.03 \pm 7.19$ ,  $24.37 \pm 9.30$ , and  $48.40 \pm 14.25$ , respectively (see Table 1). There were no differences by age group on Total Tic score ( $t_{517} = 1.82$ ,  $p = 0.07$ ,  $d = 0.20$ ), Impairment score ( $t_{517} = 0.00$ ,  $p = 0.99$ ,  $d = 0.00$ ), and Global Severity Score ( $t_{517} = 0.91$ ,  $p = 0.36$ ,  $d = 0.10$ ). The distribution of CGI-S ratings are presented in Table 2. Mann-Whitney U tests found no significant difference between the mean rank of youth and adults on the CGI-S ( $Z = -0.17$ ,  $p = 0.86$ ). Given these small, non-significant differences in YGTSS and CGI-S scores, youth and adults were examined together. Across all participants, positive associations were observed between CGI-S ratings and YGTSS Total Tic score ( $\rho = 0.54$ ,  $p < 0.001$ ), YGTSS Impairment score ( $\rho = 0.54$ ,  $p < 0.001$ ), and YGTSS Global Severity score ( $\rho = 0.63$ ,  $p < 0.001$ ).

### The Influence of Concomitant Psychiatric Disorders on CGI-S Ratings.

The frequencies of anxiety ( $\chi^2 = 4.50$ ,  $p = 0.34$ ,  $V = 0.09$ ) and depressive disorders ( $\chi^2 = 6.61$ ,  $p = 0.16$ ,  $V = 0.11$ ) were not significantly different across CGI-S categories. However, there were differences in the frequency of ADHD ( $\chi^2 = 12.23$ ,  $p = 0.02$ ,  $V = 0.15$ ) and OCD ( $\chi^2 = 13.73$ ,  $p = 0.008$ ,  $V = 0.16$ ) across CGI-S categories. Participants with Marked severity had a higher co-occurrence of ADHD ( $\chi^2 = 9.91$ ,  $p = 0.002$ ,  $V = 0.15$ ) and OCD ( $\chi^2 = 11.42$ ,  $p < 0.001$ ,  $V = 0.16$ ) compared to those with Moderate severity. No other significant difference between CGI-S categories was present for either ADHD ( $\chi^2 = 0.11$ – $3.53$ ,  $p = 0.06$ – $0.74$ ,  $V = 0.02$ – $0.17$ ) or OCD ( $\chi^2 = 0.01$ – $3.33$ ,  $p = 0.07$ – $0.96$ ,  $V = 0.01$ – $0.14$ ). Taken together, these results suggest that concomitant psychiatric disorders did not have a large effect on CGI-S ratings.

### Tic Severity, Impairment, and Global Severity Across CGI-S Ratings.

Scores on the CGI-S ranged from Borderline to Severe, with no participants classified as Extreme. The average and standard error for YGTSS Total Tic scores, Impairment scores, and Global Severity scores across CGI-S ratings are presented in Figure 1. There were clear stepwise increases in the mean YGTSS Total Tic scores, Impairment scores, and Global Severity scores for each incremental CGI-S rating (see Figure 1). This visual impression was supported by an ANOVA contrasting YGTSS Total Tic scores ( $F_{4,514} = 60.55, p < 0.001$ ), Impairment scores ( $F_{4,514} = 60.67, p < 0.001$ ), and Global Severity score ( $F_{4,514} = 94.44, p < 0.001$ ) across CGI-S categories (see Table 2). Polynomial contrasts revealed a significant linear trend in YGTSS Total Tic scores across CGI-S categories ( $p < 0.001$ ), but no significant quadratic ( $p = 0.11$ ) or cubic trends ( $p = 0.24$ ). Post-hoc tests showed significantly lower YGTSS Total Tic scores for each incremental CGI-S category. Borderline severity had lower YGTSS Total Tic Scores than Mild severity ( $d = 1.09, p < 0.003$ ), Mild lower than Moderate ( $d = 0.50, p < 0.005$ ), Moderate lower than Marked ( $d = 0.94, p < 0.001$ ), and Marked lower than Severe ( $d = 1.09, p < 0.001$ ). The average stepwise difference for each CGI-S category ranged from 3 to 7 points. The largest stepwise increases in YGTSS Total Tic scores were between the Borderline to Mild group and Marked to Severe group (7-point increases). Comparatively, the increases from Mild to Moderate to Marked groups was smaller and relatively consistent across categorical steps (4 to 5 points, see Table 2 and Figure 1).

A similar pattern of greater impairment on the YGTSS Impairment Scale was observed across increasing CGI-S ratings. Polynomial contrasts found a significant linear trend in YGTSS Impairment scores ( $p < 0.001$ ) across CGI-S categories, but no significant quadratic ( $p = 0.15$ ) or cubic trends ( $p = 0.52$ ). Post-hoc tests confirmed that Borderline severity had significantly lower impairment than Mild ( $d = 1.46, p < 0.001$ ), Mild less than Moderate ( $d = 0.76, p < 0.001$ ), and Moderate less than Marked ( $d = 0.93, p < 0.001$ ). However, no significant difference in YGTSS Impairment scores was found between Marked and Severe ratings on the CGI-S ( $d = 0.40, p = 0.49$ ). There was an average change of 3 to 10 points on the YGTSS Impairment score for each increase in CGI-S category. The largest stepwise increase was between the Borderline to Mild group (9-point increase), with the increase between Mild to Moderate to Marked being smaller (6 to 7 points, see Table 2 and Figure 1). The smallest increase was between Marked and Severe categories on the CGI-S (4 points).

Finally, the YGTSS Global Severity score also displayed greater severity across increasing CGI-S ratings. Polynomial contrasts found a significant linear trend in YGTSS Global Severity scores ( $p < 0.001$ ) across CGI-S categories, but no significant quadratic ( $p = 0.88$ ) or cubic trends ( $p = 0.85$ ). Post-hoc tests confirmed that Borderline severity had lower YGTSS Global Severity scores than Mild severity ( $d = 1.66, p < 0.001$ ), Mild lower than Moderate ( $d = 0.81, p < 0.001$ ), Moderate lower than Marked ( $d = 1.17, p < 0.001$ ), and Marked lower than Severe ( $d = 0.87, p < 0.001$ ). This resulted in an average difference of 8 to 17 points on the YGTSS Global Severity score for each increase in CGI-S category. The largest stepwise increase was between the Borderline and Mild groups (16 points, see Table 2 and Figure 1), followed by the increase between the Moderate to Marked groups (13

points). The distinction between other stepwise categories (Mild to Moderate, and Marked to Severe) was smaller (8 to 10 points).

### **Determining Clinical Severity Based on YGTSS.**

Logistic regression models for tic severity, tic impairment, and global severity are displayed in Table 3. There was a moderate association between CGI-S and tic severity benchmarks identified by the logistic regression model ( $\rho = 0.45$ ,  $p < 0.001$ ), which mutually classified 296 cases with the CGI-S (57%) and had fair agreement ( $\kappa = 0.24$ , 95% CI: 0.18, 0.31,  $p < 0.001$ ). For tic impairment, there was also a moderate association between the CGI-S and the benchmarks predicted by the logistic regression model ( $\rho = 0.43$ ,  $p < 0.001$ ), which mutually classified 279 cases with the CGI-S (54%) and exhibited fair agreement ( $\kappa = 0.21$ , 95% CI: 0.15, 0.27,  $p < 0.001$ ). Finally for global severity, there was a strong association between the CGI-S and the benchmarks identified by the logistic regression model ( $\rho = 0.56$ ,  $p < 0.001$ ), which mutually classified 312 cases with the CGI-S (60%) and displayed fair agreement ( $\kappa = 0.32$ , 95% CI: 0.25, 0.38,  $p < 0.001$ ). Although the predictive logistic regression models and the CGI-S classified similar counts of participants for tic severity, tic impairment, and global severity, agreement on the participants placed in those categories was generally unimpressive (kappas ranging from .21 to .32). Given the level of observed agreement, we looked at a model that considered YGTSS Impairment scores  $> 10$  as having Moderate severity on the CGI-S (in line with YGTSS guidance). However, it did not substantially improve accuracy of predictive classification.

## **Discussion**

This study used a large, well-characterized, treatment-seeking sample to develop objective benchmarks of tic severity, tic impairment, and global severity classifications using the YGTSS and CGI-S. Positive associations were observed between CGI-S ratings and the YGTSS scores with minimal influence of co-occurring psychiatric conditions on CGI-S categories. These findings suggest that CGI-S ratings were primarily driven by tic severity and tic impairment in this sample and not affected by the presence of common psychiatric comorbidities.

Trend analyses found a linear progression of increasing YGTSS scores across CGI-S ratings. Indeed, the average tic severity (3 to 7 points), tic impairment (3 to 10 points), and global severity (8 to 17 points) scores on the YGTSS increased for each severity level on the CGI-S. The global severity scores across CGI-S ratings were comparable to those reported by Leckman and colleagues (Leckman et al., 1989), and the differentiation of tic severity and tic impairment scores across CGI-S ratings delineated the contribution of each component to overall severity (see Figure 1). The confluence of YGTSS scores and CGI-S categories underscores the importance of balancing both tic severity and an individuals' level of tic impairment in an evidence-based clinical assessment (McGuire et al., 2012).

While the current sample provides descriptive benchmarks and ranges to differentiate between severity categories using the YGTSS (see Figure 1), the logistic regression model encountered challenges when seeking to establish optimal categorical cut-points. Although the predicted benchmarks had moderate-to-strong associations with up to 60% mutual case

classification with the CGI-S, agreement on the specific participants placed into the same severity categories was only fair. The limited overall agreement between the logistic regression model categorizations and CGI-S categorizations raises concerns about the generalizability and precision of benchmarks identified for tic severity, tic impairment, and global severity. Although predictive regression models have identified severity benchmarks in OCD (Lewin et al., 2014; Storch et al., 2015), it may be that tic severity and impairment alone are not the only determining factors in severity as measured by the CGI-S. Consider a child who has a frequent and intense “eye poking tic” but few other tics. This child might have a low YGTSS Total Tic score, but this tic could be associated with considerable social and medical consequences and contribute to a Marked CGI-S rating. In comparison, another child with several frequent simple tics of mild intensity that go unnoticed by peers may contribute to a moderate YGTSS Total Tic score, a low YGTSS Impairment score and culminate in a Mild severity rating on the CGI-S. Thus, the degree to which specific tics are perceived as bothersome and contribute to disability across functional domains may be an important consideration in rating overall severity on the CGI-S that is not fully captured by YGTSS ratings. The modified Hopkins Motor/Vocal Tic Scale that measures the severity of most bothersome tics may be a useful complement to the YGTSS in clinical research (McGuire et al., 2015b; Walkup et al., 1992).

Several study limitations warrant consideration. First, this was a sample of outpatient treatment-seeking youth and adults. There were no cases in the Extreme CGI-S category and few in the Borderline ( $n = 12$ ) and Severe categories ( $n = 25$ ). The few cases on either end of the severity spectrum may have influenced the regression models’ accuracy in determining optimal benchmarks. Second, although consistent with clinical practice, the ratings of the YGTSS and the CGI-S were conferred by the same clinician. Third, assessments were conducted by trained clinicians, but we did not evaluate inter-rater reliability across sites and raters. The item anchors on the YGTSS dimensions offer clinicians guidance on scoring the measure. However, the YGTSS is not a self-report scale. Eliciting the information needed to rate the motor and vocal tic dimensions on the YGTSS requires training and experience. Finally, although the YGTSS is the gold-standard measure of tic severity, its limitations have been described and the revised version of the scale offers some, albeit modest, improvements (McGuire et al., 2018). Nonetheless, the YGTSS is the most commonly used measure in research and clinical practice. These YGTSS benchmarks are offered to help clinicians characterize TD severity and apply treatment guidelines.

Although definitive benchmarks remain elusive, the current findings have implications for research and clinical practice. In research, these results can assist with the classification of overall severity across TD treatment trials to permit greater comparability. In clinical practice, findings may help translate results from clinical trials that use the YGTSS and promote appropriate implementation of evidence-based treatment guidelines. Consider the case of a child with a YGTSS Total Tic score of 15 and Impairment score of 20 consistent with Mild rating on the CGI-S. Although concerned parents may advocate for immediate intervention, the clinician could appropriately offer reassurance and psychoeducation about the severity of tics. If tic severity later increased by 5 points on the YGTSS Total Tic score, then an appropriate level of intervention would be recommended (in collaboration with the patient/family) due to moderate severity of TD. In response to a more dramatic and sustained

increase in tic severity and tic impairment (e.g. an increase of 10 points on YGTSS Total Tic score and 20 points on YGTSS Impairment score), a greater level of intervention would warrant consideration due to a presentation consistent with a Marked rating on the CGI-S. While the CGI-S balances tic severity and tic impairment into a single rating, it is influenced by the clinician's overall experience with TD. Expert clinicians may intuitively apply these guidelines due to years of clinical experience. However, the development of benchmarks can help treatment recommendations be consistently applied across treatment centers, even among clinicians who are less experienced with TD populations. When doing so, individual patient treatment recommendations properly consider patient and family preference, tic severity, related distress and impairment, and access to treatment.

In summary, treatment recommendations for TD should properly consider tic severity and tic impairment. In the current study, a stepwise increase was observed on YGTSS Total Tic score, Impairment score, and Global Severity score across CGI-S ratings. Although predictive models using YGTSS scores produced only moderate agreement with CGI-S ratings, our findings provide general guidance for YGTSS scores that characterize overall severity and are not influenced by common psychiatric comorbidities. In doing so, this report offers direction for determining severity categorizations that underlie tic treatment algorithms developed by leading experts. While clinicians with considerable experience with TD may intuitively rely on the CGI-S to guide treatment, the YGTSS is less influenced by clinician experience due to its standardized administration and anchor points that guide severity ratings. Thus, the YGTSS scoring framework presented here can help guide clinicians less experienced with TD to appropriately interpret treatment algorithms in real-world clinical practice.

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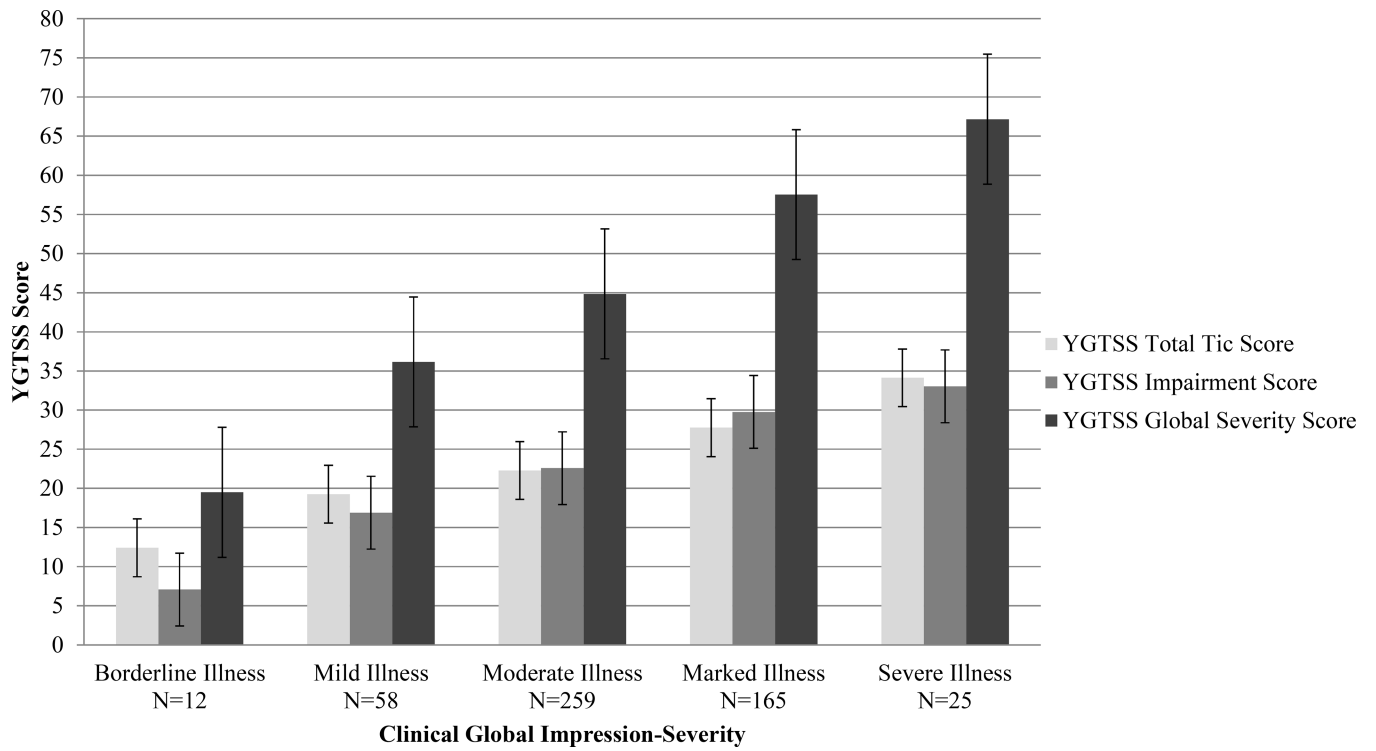
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**Figure 1.** The distribution of tic symptom severity, tic impairment, and global severity on the Yale Global Tic Severity Scale (YGTSS) for each Clinical Global Impression of Severity (CGI-Severity) category from the original ratings (N = 519).

**Table 1.**

## Demographic and Clinical Characteristics of the Sample (N = 519)

<b>Gender</b>	<b>N (%)</b>
Male	371 (71.5%)
<b>Race &amp; Ethnicity</b>	
Caucasian	402 (77.5%)
Hispanic	63 (12.1%)
Asian American/Pacific Islander	22 (4.2%)
African American	8 (1.5%)
Other Race (e.g., biracial)	13 (2.5%)
Unknown Race/Ethnicity	11 (2.1%)
<b>Medication Status</b>	
Antipsychotic	80 (15.4%)
Alpha-2 agonist	105 (20.2%)
Any tic medication	165 (31.8%)
<b>Co-Occurring Psychiatric Diagnoses</b>	
Any attention deficit hyperactivity disorder (ADHD)	162 (31.2%)
Any obsessive-compulsive disorder (OCD)	120 (23.1%)
Any anxiety disorders <sup>a</sup>	118 (36.2%)
Any depressive disorders <sup>b</sup>	25 (4.8%)
Participants with one or more co-occurring psychiatric diagnosis	314 (60.5%)
<b>Mean (SD) [Range]</b>	
Age	15.92 (11.13) [5–69]
YGTSS Total Tic Score	24.03 (7.19) [7–46]
YGTSS Impairment Score	24.37 (9.30) [0–50]
YGTSS Global Severity Score	48.40 (14.25) [7–96]

**Note:** YGTSS = Yale Global Tic Severity Scale

<sup>a</sup>Anxiety disorders included separation anxiety, social phobia, generalized anxiety, specific phobia, panic disorder, agoraphobia, and anxiety disorders not otherwise specified.

<sup>b</sup>Depressive disorders included major depressive disorder, dysthymia, or depressive disorder not otherwise specified.

**Table 2.**

Tic Symptom Severity, Tic Impairment, and Current Co-occurring Psychiatric Conditions for CGI-Severity scores (N = 519)

CGI-Severity		YGTSS Total Tic Score	YGTSS Impairment Score	YGTSS Global Severity Score	ADHD	OCD	Anxiety Disorders <sup>a</sup>	Depressive Disorders <sup>b</sup>
	N	Mean (SD)	Mean (SD)	Mean (SD)	N (%)	N (%)	N (%)	N (%)
Borderline Illness	12	12.42 (4.52)	7.08 (6.90)	19.50 (8.40)	6 (50%)	4 (33%)	5 (42%)	2 (17%)
Mild Illness	58	19.26 (6.54)	16.90 (6.70)	36.16 (10.32)	16 (28%)	11 (19%)	21 (36%)	4 (7%)
Moderate Illness	259	22.28 (5.94)	22.57 (7.66)	44.85(10.89)	66 (25%)	45 (17%)	83 (32%)	8 (3%)
Marked Illness	165	27.76 (5.73)	29.78 (7.97)	57.54 (10.84)	66 (67%)	52 (32%)	69 (42%)	9 (5%)
Severe Illness	25	34.12 (6.62)	33.04 (8.63)	67.16 (12.84)	8 (47%)	8 (47%)	10 (40%)	2 (8%)
Extreme Illness	0	---	---	---	---	---	---	---

**Note:** YGTSS = Yale Global Tic Severity Scale, ADHD = Attention-Deficit Hyperactivity Disorder, OCD = Obsessive-Compulsive Disorder.

<sup>a</sup>Anxiety disorders included separation anxiety, social phobia, generalized anxiety, specific phobia, panic disorder, agoraphobia, and anxiety disorders not otherwise specified.

<sup>b</sup>Depressive disorders included major depressive disorder, dysthymia, or depressive disorder not otherwise specified.

**Table 3.**

Potential Models for Benchmarks of Tic Severity, Impairment, and Global Severity on the Yale Global Tic Severity Scale (YGTSS)

CGI-Severity	Logistic Regression Model		
	Total Tic Score <sup>a</sup> n (%)	Impairment Score <sup>b</sup> n (%)	Global Severity Score <sup>c</sup> n (%)
Normal	0 (0%)	0 (0%)	0 (0%)
Borderline Illness	0 (%)	0 (0%)	2 (0.4%)
Mild Illness	14 (2.7%)	10 (1.9%)	30 (5.8%)
Moderate Illness	346 (66.7%)	295 (56.8%)	330 (63.6%)
Marked Illness	156 (30.1%)	210 (40.5%)	151 (29.1%)
Severe Illness	3 (0.6%)	4 (0.8%)	6 (1.2%)
Extreme Illness	0 (%)	0 (0%)	0 (0%)

**Note:**

<sup>a</sup>YGTSS Total Tic Score: 0 = normal (inferred), 1–6 = borderline (inferred), 7–10 = mild, 11–27 = moderate, 28–43 = marked, 43–46 = severe, 47–50 = extreme (inferred).

<sup>b</sup>YGTSS Impairment Score: not included = normal and borderline, 0–7 = mild, 8–29 = moderate, 30–42 = marked, 43–50 = severe, not included = extreme.

<sup>c</sup>YGTSS Global Severity Score: 0–9 = borderline, 10–25 = mild, 26–55 = moderate, 56–81 = marked, 82–96 = severe, not included = extreme.