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ORIGINAL RESEARCH

Identifying Symptoms of Distress in Youth Living with Neurofibromatosis Type 1 (NF1)

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Abstract Children and adolescents with Neurofibromatosis type 1 (NF1) are at increased risk for wide-ranging behavioral, developmental, and cognitive impairments and decreased quality of life. To date, no psychosocial screening tool has been developed to quickly assess the symptoms that 1) can be addressed during routine medical appointments in children with NF1, 2) can produce interpretable and actionable results, 3) can be integrated into medical care, and 4) can quickly identify patients at risk in order to better address that the provision of appropriate care are available. This study was conducted to test the overall usability of the Distress Thermometer (DT) and symptom checklist and concordance of DT ratings between pediatric patients, their caregivers and medical providers. Eighty youth (ages 7–21) living with NF1 completed the DT and an accompanying checklist. The findings of this study suggest the DT and symptom checklist was acceptable and feasible to complete in a clinic setting. A small subset reported high distress that required further assessment and intervention. Significant discordance between distress ratings of caregivers and children and healthcare providers was also found. Overall, the DT and accompanying symptom checklist provide important information to identify the presence of distress and contextualize the child's distress but is limited by not assessing whether these symptoms interfere with the child's daily life.

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Introduction

Neurofibromatosis type 1 (NF1) is one of the most common dominantly inherited genetic disorders, with an incidence of 1 in 3000 births (Evans et al. 2010). Diagnosis of NF1 is based on a clinical assessment; common signs include café au lait spots, neurofibromas on the skin, plexiform neurofibromas (PNs), Lisch nodules in the iris, optic gliomas, axillary freckles, and skeletal complications including scoliosis. Clinical expression of the disease is diverse and manifests variably in each patient, making the psychosocial impact of the disease hard to predict. The clinical manifestations of disease usually occur by age 3, and can be extensive, painful, and disfiguring as they progress. Typically, the frequency and severity of symptoms increase with age.

Children and adolescents with NF1 are at increased risk for wide-ranging behavioral, developmental, and cognitive impairments and decreased quality of life (Birch and Friedman 2012; Hyman et al. 2005; North et al. 2002; Oostenbrink et al. 2007; Williams et al. 2009). Increased rates of attention deficit hyperactivity disorder (ADHD), autism spectrum disorders, behavioral abnormalities and psychosocial issues have been described (Barton and North 2004; Huijbregts et al. 2010; Plasschaert et al. 2016; Williams et al. 2009).

When compared to their same aged peers and sibling controls, NF1-patients experience many social and behavioral problems. These problems are varied and include difficulties in interacting with peers, poorer social skills, and both internalizing and externalizing behavior problems (Barton and North 2004; Graf et al. 2006; Martin et al. 2012; Noll et al. 2007; Prinzie et al. 2003). Moreover, children and adolescents with

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NF1 whose NF1 is characterized by greater CNS involvement are at even higher risk for problems with psychosocial functioning, specifically, higher parental distress and more family conflict (Noll et al. 2007). Additionally, poor social skills reduce a young person's ability to manage the appearance-related challenges presented by NF1 since strong social skills are important in mediating the effects of an altered appearance (Rumsey and Harcourt 2012).

While PNs are benign tumors comprised of a proliferation of cells in the nerve sheath (Friedrich, Kluwe, Fünsterer C, & Mautner, 2005; Gutmann et al., 1997), they often cause significant pain that interferes with functioning (Kim et al., 2009; Wolters et al., 2015), and negatively impact quality of life (QOL) (Wolkenstein et al., 2001). More severe pain has been correlated with worse QOL in children and adolescents with NF1 and PNs, and more severe pain has been found among the children with at-risk or clinically significant levels of depression and anxiety (Burns et al., 2011).

Garwood et al. (2012) noted that the emotional functioning of adolescents with NF1 predicted overall QOL while physical challenges predicted ongoing physical dysfunction. These findings are further supported by a recent longitudinal natural history study at the National Institutes of Health in which both caregiver report (73%) and self-report (59%) of youth with NF1 suggest that pain interferes with their daily functioning, despite 33% taking prescribed pain medications (Wolters et al., 2015). Additionally, this study by Wolters and colleagues, emphasizes the important role that pain has with social emotional functioning and QOL. Specifically, the data suggests that the more symptoms of anxiety the greater the prediction of pain interference. Similarly, greater pain interference and social stress is predictive of poorer QOL. These findings highlight the importance of not only screening for overall distress, but also identifying the individual symptoms that cause distress for patients with NF1. Overall, the unpredictable, progressive and chronic nature of NF1, as well as the physical disfigurement, cognitive, and behavioral implications of the condition can have a profound negative impact on the psychological adjustment of these children and adolescents.

Despite the range of social, emotional and physical manifestations associated with living with NF1, to date, no psychosocial screening tool has been developed to quickly assess the symptoms that can be addressed during routine medical appointments in children with NF1. Studies have shown that most children who meet criteria for emotional or behavioral problems are not recognized by their medical team (Costello et al., 1988; Lavigne et al., 1993; Lavigne, Feldman, & Meyers, 2016; Sheldrick, Merchant, & Perrin, 2011). Given the well documented evidence for psychosocial risk in NF1 patients, a valid screening instrument that is easy to use, can produce interpretable and actionable results (Jones et al., 2007), can be integrated into medical care, and can quickly identify patients at risk would be useful to better address the provision of appropriate care (Kazak et al., 2015). The use of the pediatric Distress Thermometer (DT) has been described in outpatient pediatric cancer clinics with a DT rating of 4 or greater considered clinically elevated (Weiner et al., 2015). In this paper, we describe the overall usability of the Distress Thermometer and symptom checklist with youth (ages 7–21) living with NF1. This includes assessing the concordance of DT ratings between pediatric patients, their caregivers and medical providers. The information derived from this brief screen would assist genetic counselors in obtaining an overview of the patient's psychosocial needs as advised by the Recommendations of the National Society of Genetic Counselors (Radtke et al. 2007).

Methods

Patients, ages 7–21 years old, were recruited as part of a larger study on distress screening of outpatients with serious medical illness from one of 5 clinics in two institutions; methods for the larger study have been previously described (Wiener et al., 2015). Eighty patient participants from the larger sample had a diagnosis of NF-1 and are reported here. Participants were divided into three age categories: 7–12, 13–17 and 18–21 and measures were administered accordingly. Additional inclusion criteria included availability of a parent/guardian to participate, and the ability to speak English (primary outcome measure is not yet available in other languages). Exclusion criteria included the presence of psychotic symptoms or cognitive impairment, which in the judgment of the Principal or Associate Investigator, or consulting psychiatrist, would compromise the patient's ability to accurately complete the measures. This study was approved by the Combined Neuroscience Institutional Review Board at the National Institutes of Health.

Measures

The Distress Thermometer (DT)

The DT was designed as a brief screening tool to assess for distress in adult cancer patients (NCCN, 2015) and has been recognized as a good alternative to many of the longer measures commonly used to screen for distress in cancer patients (Jacobsen et al., 2005). Patel et al. (2011) conducted a study that investigated the validity and utility of an adapted DT to screen for distress in a pediatric oncology inpatient setting. Convergent validity was demonstrated by reasonable agreement between the pediatric distress rating tool and standardized pediatric measures (Patel et al., 2011); the adapted pediatric DT was used in this study for all ages, with the problem checklist administered to the 13–17 and 18–21 year old participants only. Another study described patients, aged 9–18 years with sarcoma, which found the pediatric DT to be

feasible and acceptable to young people to complete screening measures during a clinic visit' (Weiner, 2015).

Children's Depression Inventory (CDI-S and CDI-P)

The CDI–S (Kovacs, 1992) is a 10-item self-report measure for depression in children, ages 7 to 17 years. The CDI is widely used, reliable and valid. It has been noted to have a bias towards cognitive symptoms (Shemesh et al., 2005) and has few questions on physical symptoms, potentially making it more appropriate for children with medical illness whose illness symptoms can be confounded with physical manifestations of depression (Shemesh et al., 2005). The CDI was completed by all patients ages 7–17. The CDI Parent Version (CDI-P) is derived directly from the CDI, is scored identically and has similar psychometric properties (Kovacs, 1992). The CDI-P was completed by caregivers of all patients, ages 7–21.

The Brief Symptom Inventory 18 (BSI-18)

The BSI-18 (Derogatis and Fitzpatrick, 2004) is an 18-item self-report measure to screen for psychological distress and psychiatric disorders in individuals in the community or hospital settings. The BSI-18 assesses three dimensions of emotional functioning, depression, anxiety, and somatization. The Global Severity Index (GSI) is a measure of symptom severity. An individual is designated as meeting criteria for "caseness" on the BSI if they have a GSI score greater than or equal to a T-score of 63 or they meet "case" criteria on at least 2 subscales. Since the CDI-S was only designed for patients up to age 17, patients ages 18–21 were administered the Depression dimension of the BSI-18 (6 items). Caregivers were administered all 18 items on themselves. The BSI-18 has excellent psychometric properties (Zabora et al., 1990).

Lansky and Karnofsky Scores

Medical providers completed a Lansky score for patients 17 years and younger and a Karnofsky score for patients 18 years and older. These scores indicate the disease severity and functional capabilities of the patient (Lansky et al., 1987; Mor et al., 1984) and were obtained in order to assess the disease severity of the patients completing the DT. Lansky and Karnofsky scores range from 0 to 100 in increments of 10, with 0 indicating unresponsiveness/death to 100 indicating perfect health.

Distress Thermometer Acceptability and Feasibility Scales

Acceptability: Patients, primary caregivers, and the child's primary medical provider rated on a scale of 1–4 how easy or difficult the DT was to complete during an outpatient visit and also indicated, on a three point scale, to what extent completing the DT bothered them. Feasibility: After each administration of the DT to patients and caregivers, the data collector recorded how feasible the DT was to administer on a four-point scale. The DT Acceptability and Feasibility Scales were developed by the study investigators for the purpose of this study.

Other

Additional instruments to assess anxiety, pain and fatigue were given in order to validate the DT; summary validation results included patients with NF and are described in Wiener et al., 2015.

Procedure

All data collection was completed in a single clinic visit. After reviewing and signing the assent (children ages 7–17) and consent (ages 18–21), each patient was given a self-administered Distress Thermometer (DT) (and problem checklist for participants aged 13-21), either the Children's Depression Inventory (CDI) or the Brief Symptom Inventory (BSI-depression items), the DT Acceptability Scale, as well as other measures not reported in this study, by one of the investigators or trained data collectors. Parents also consented to the study for their minor children and themselves, and completed the DT (on the child), parent versions of the CDI (CDI-P), the DT Acceptability Scale and other measures not reported in this study. In addition, caregivers completed the BSI-18 about their own psychological symptoms. Patient and caregiver data were collected simultaneously but separately and each took 30 min or less. Primary medical providers (physicians or nurse practitioner) completed the DT, giving their estimation of the patient's distress on the same day the patient and primary caregiver completed the measure. Medical providers completed the DT Acceptability Scale and the Lansky-Karnofsky scales. Data collectors completed the DT Feasibility Scale after each administration of the DT.

Results

Eighty pediatric patients with NF1 and an accompanying caregiver completed a study evaluating pediatric distress screening. Sample characteristics are summarized in Table 1. Forty-one percent of patients were 7–12 years old, 39% were 13–17 years old and 20% were 18–21. The overall sample was fairly evenly divided by gender with 59% males, but was predominantly Caucasian (73%). Of the caregivers, 71% were mothers, 24% fathers, and 3% were 'other'. The caregiver respondents were predominantly married (70%). Twenty

Table 1. Characteristics of the Sample (n = 80)

Characteristics	N (%)
Child gender	
Female	33 (41.3)
Male	47 (58.8)
Child age	
7–12	33 (41.3)
13–17	31 (38.8)
18+	16 (20.0)
Relationship to child	
Mom	57 (71.3)
Dad	19 (23.8)
Other	2 (2.6)
Parent marital status	
Married/living with partner	60 (75.1)
Not married	18 (24.9)
"Lone Parent" when it comes to caring for child with NF	28 (35.0)
Child race	
White	58 (72.5)
Black or African American	5 (6.3)
Asian/Pacific Islander	1 (1.3)
Biracial	8 (10.0)
Missing	1 (1.3)
Child Ethnicity Latino	7 (8.8)
Child learning disorder/psychiatric dx	
Learning disorder	40 (50.0)
ADHD	27 (33.8)
Anxiety	13 (16.3)
Depression	11 (13.8)
Household Income	
Less than $1000 per month	5 (6.3)
$1000–$1999 per month	10 (12.5)
$2000–$2999 per month	13 (16.3)
$3000–$3900 per month	10 (12.5)
$4000–$4900 per month	10 (12.5)
$5000–$5999 per month	4 (5.0)
More than $6000 per month	78 (32.5)
Missing	2 (2.5)
Disease Severity	Mean (range)
Lansky (<18 years)	92.5 (60–100)
Karnofsky (18+ years)	85.9 (70–100)

percent of the sample earned less than $2000 per month, which is approximately the federal poverty level for a family of four (U.S. Federal Poverty Guidelines, 2015).

Half of the caregivers (50%) reported that their child had a learning disorder; 34 % reported their child had been diagnosed with Attention Deficit Hyperactivity Disorder (ADHD), 16% with anxiety and 14% with depression.

Distress Thermometer- Overall Distress

It has been suggested that a score of 4 or higher on the DT should be used to detect significant distress (Baken & Woolley, 2011). The overall mean distress ratings for each of the age groups was reported below the validated clinical cutoff of 4. The overall patient-reported distress rating was 3.4 (SD = 3.5, range = 0–10). The youngest age group had an average overall distress rating of 3.2 (SD = 3.0; range 0–10), the 13–17 year olds had an average rating of 3.8 (SD = .2.5; range 0–9), and the oldest age group had an average rating of 3.5 (SD = 2.9; range 0–10). Caregivers reported an overall higher perceived level of distress for their child with an average rating of 3.9 (SD: 2.2; range 0–10), while the patient's medical provider reported an overall lower level of perceived distress with a mean of 2.9 (SD: 2.2; range 0–8). Table 2 contains average DT scores by age and rater.

Caregiver/patient and provider/patient concordance were both quite poor. Only one age group (13–17 year olds) exhibited a significant, but modest, correlation in reported distress levels between the caregivers and their child (r = 0.41, $p < 0.05$). There was not significant provider/patient correlation for any of the three age groups.

When classified as 'low distress' (DT rating of 0–3), 'moderate distress' (DT Rating of 4–6), and 'high distress' (DT rating of 7–10), 44% of caregivers designated a different distress category than was reported by their child. Two caregivers (2.6%) reported that their child had a low level of distress, while the child's score was a reported 'high distress' value, while 4 (5.2%) reported the opposite (high distress when child reported low).

Distress Thermometer Problem Checklist - Sources of Distress

When asked about causes of distress across five domains: 1) emotional (worry/anxiety, nervousness, sadness/depression, loneliness/feeling isolated, boredom/apathy, irritability, anger), 2) physical (pain, nausea, fatigue, difficulty falling asleep, difficulty staying asleep), 3) practical (school, work, not taking or missing medications), 4) spiritual (feeling distanced from God) and 5) family/social (dealing with parents, dealing with siblings, family issues, dealing with old friends, dealing with new friends), some differences emerged between the age groups. Boredom, worry and nervousness/fear were

Table 2 Average Distress Thermometer Score by Age and Rater

Age	Patient (n)	Caregiver (n)	Medical Provider (n)
7–12	3.2 (32)	4.1 (33)	2.7 (33)
13–17	3.8 (31)	3.8 (31)	2.6 (31)
18+	3.5 (16)	3.8 (14)	4.0 (16)
Overall	3.4 (79)	3.9 (78)	2.9 (80)

endorsed by the 13–17 year olds and the young adults. In the physical domain, symptoms including pain, fatigue, and sleep issues were endorsed by both older youth groups; however, 56% of the oldest age group endorsed pain as a cause of distress versus only 37% of the adolescents. Both groups mentioned school as a source of distress (47% of 13–17 year olds and 25% of 18–21 year olds). Twenty three percent of the adolescents endorsed missing medications as a source of distress, while only 6% of the 18–21 year olds endorsed this item. Another difference emerged in the family and social domain; 47% of the 13–17 year olds endorsed problems with siblings as a source of distress, but only 13% of the 18–21 year olds endorsed this item ($X^2 = 5.4$, $p < .05$), and a higher proportion of the younger group endorsed problems with making new friends (23%) as compared to the older group (13%) (Table 3).

Caregiver-patient concordance was examined when looking at particular items that may cause distress in each of the domains. For the 13–17 year olds, there was significant caregiver/patient concordance within the physical domain including pain ($r = 0.71$, $p < 0.001$), difficulty falling asleep ($r = 0.45$, $p < 0.05$) and nausea ($r = 0.80$, $p < 0.001$). Within the emotional domain there was one item with significant concordance, sadness/depression ($r = 0.39$, $p < 0.05$). None of the other items in any of the domains were similarly endorsed by caregivers and their children.

For the 18–21 year olds, only three items had significant correlation between caregivers and their child. Two were in the physical domain: fatigue ($r = 0.55$, $p < 0.05$) and nausea ($r = .55$, $p < 0.05$), while the other was in the social domain, 'dealing with old friends' ($r = 0.65$, $p < 0.05$).

Suicidal Ideation

Of note, for clinical purposes we scored questions pertaining to suicidal ideation on the CDI and BSI immediately during the clinic visit. Among the children (ages 7–17), one child (1.3%) endorsed wanting to kill him/herself, and another 6.3% reported that they had thoughts about killing themselves. None of the 18–21 year olds expressed a desire to kill themselves; however, 1.3% had thought about it. The one person who wanted to kill

Table 3 DT Symptoms by Age and Rater

Symptom	13–17		18+	
	Patient ($n = 30$) n (%)	Caregiver ($n = 31$) n (%)	Patient ($n = 16$) n (%)	Caregiver ($n = 14$) n (%)
Emotional				
Worry/Anxiety	12 (40.0)	19 (61.3)	8 (50.0)	8 (57.1)
Nervousness	9 (30.0)	16 (51.6)	8 (50.0)	2 (14.3)
Sadness/Depression	5 (16.7)	8 (25.8)	6 (37.5)	2 (14.3)
Loneliness/Feeling Isolated	2 (6.7)	6 (19.4)	5 (31.3)	2 (14.3)
Boredom/Apathy	14 (46.7)	10 (32.3)	9 (56.3)	2 (14.3)
Irritability	5 (16.7)	10 (32.3)	4 (25.0)	5 (35.7)
Anger	6 (20.0)	5 (16.1)	2 (12.5)	1 (7.1)
Physical				
Pain	11 (36.7)	12 (38.7)	9 (56.3)	5 (35.7)
Nausea	3 (10.0)	6 (2.5)	2 (12.5)	2 (14.3)
Fatigue	9 (30.0)	9 (29.0)	5 (31.3)	2 (14.3)
Difficulty falling asleep	5 (16.7)	3 (9.7)	3 (18.8)	1 (7.1)
Difficulty staying asleep	4 (13.3)	4 (12.9)	4 (25.0)	2 (14.3)
Practical				
School	14 (46.7)	17 (54.8)	4 (25.0)	5 (35.7)
Work	2 (6.7)	2 (6.5)	2 (12.5)	2 (14.3)
Not taking or missing medications	7 (23.3)	2 (6.5)	1 (6.3)	1 (7.1)
Spiritual				
Feeling distanced from God	2 (6.7)	1 (3.2)	2 (12.5)	0 (0.0)
Family/Social				
Dealing with parents	6 (20.0)	6 (19.4)	2 (12.5)	3 (21.4)
Dealing with siblings	14 (45.7)	10 (32.3)	2 (12.5)	1 (7.1)
Family issues	5 (16.7)	5 (16.1)	3 (18.8)	1 (7.1)
Dealing with old friends	7 (23.3)	6 (19.4)	3 (18.8)	4 (28.6)
Dealing with new friends	7 (23.3)	3 (9.7)	2 (12.5)	1 (7.1)

him/herself had the highest CDI score and had a safety evaluation which resulted in a recommendation for outpatient mental health followup. Of the 5 people thinking about suicide, all caregivers rated them as low distress, 2 patients rated themselves low distress, 2 moderate and 1 high. For the one person that 'wanted to kill self', he/she rated himself as high distress while the caregiver rated him/her as moderate.

Lansky/Karnofsky Performance Status

The average performance status score was 92.5 for children under 18 and 85.9 for those 18 and over. Performance status scores were significantly correlated to DT scores for medical provider ratings and patient ratings, for patients under 18 ($r = -.27$, $p < .05$ for patient rating and $r = -.42$, $p < .001$ for medical provider rating). Ratings for patients over 18 were not significantly related to performance status, nor were caregiver ratings of either age group.

DT Acceptability/Feasibility

Nearly 80% of caregivers, 87.5% of medical providers and 65.8% of patients reported that the DT was very easy to complete, with another 12.8%, 11.3% and 30.4%, respectively, reporting that it was somewhat easy. Eight percent of caregivers, 1.3% of medical providers and 3.8% of patients reported that it was somewhat hard and none reported that it was very hard. When asked if they were bothered by having to complete it, 97.4% of caregivers, 96.3% of medical providers and 92.4% of patients reported that it 'didn't bother me at all', while 2.6%, 2.5% and 7.6%, respectively, reported that it 'bothered me a little bit'. One percent of medical providers and no caregivers or patients reported that it 'bothered me a lot'. Data collectors were asked how feasible it was to administer the DT to patients and providers. Eighty-eight percent reported that it was "very feasible" to administer to patients (8.8% "somewhat feasible", 2.5% "somewhat infeasible", 1.3% "very infeasible") and 93.8% reported that it was "very feasible" to administer to caregivers (2.5% "somewhat feasible", no one reported that it was "somewhat" or "very infeasible").

Lone Parenting and Caregiver Distress

Thirty-five percent of caregivers considered themselves to be 'lone parents' when it came to caring for their child with NF1. Lone parents are those parents defined as having self-report perceptions of feeling alone and caring for an ill child largely on his/her own rather referring to their demographic status (Brown et al., 2008). Of these, 50.0% were married/remarried and 3.6% were living with a partner; 46.4% were single/separated/divorced/widowed. Caregivers who endorsed perceiving themselves to be a lone parent were more likely to be a "case" on the BSI Somatization subscale.

Caregiver distress was identified on the BSI with 12.5% meeting criteria for a "case" (t-score greater or equal to 63) on somatization, 11.3% for anxiety, and 3.8% for depression and 8.8% for the Global Severity Index. Overall, 8.8% met "case" criteria on the BSI. There were no significant differences in BSI scores (subscales or overall) by child age group.

Discussion

While patients living with NF1 in our sample did not endorse significant overall distress on the numerical scale, over one-third of patients and caregivers rated these youth as having elevated distress (DT ≥ 4) and a small group of patients were highly distressed (i.e. expressed having suicidal thoughts). Our findings also show that caregiver and medical provider concordance with patient ratings is low, with caregivers reporting higher distress than patient self-report and medical providers reporting lower distress. The latter suggests that factors influencing a patient's emotional distress may not become apparent to medical providers until the child's symptoms have progressed significantly and emotional difficulties are acute. Furthermore, youth as young as 7 years old found completing the DT feasible, though feasibility ratings increased with age.

The NF1 population is known to often experience chronic pain, as well as social-emotional difficulties, including fewer friends, and increased social difficulties (Wolters, 2015). Within our study cohort, patients aged 13–21 most commonly endorsed symptoms of boredom, worry, nervousness/fear, and concerns about school as distressing. They also endorsed challenges with taking medications, problems with siblings, and difficulties making friends. While caregiver concordance was not high for the overall DT rating, caegivers of patients aged 13–17 were noted to more accurately identify symptoms of pain, sleep and nausea, as well as sadness/depression. Caregivers of young adults (age 18–21) were concordant with fatigue, nausea and the stress associated with dealing with old friends.

The current study supports previous findings that the NF1 patients experience a range of academic and emotional problems and physical symptoms, suggesting youth in this cohort have support needs in emotional, social, physical, and family domains. Rapid outpatient screening of these individuals is recommended in order to obtain further evaluation or referrals and assure the health care team is providing comprehensive care and support.

The literature suggests there is often discordance between a caregiver's and a medically ill child's report of distress (Upton et al., 2008; Lundberg et al., 2012). Our data, which demonstrates a lack of concordance in overall DT ratings among both caregivers/patients and providers/patients, is further indication that rapid screening should occur with the patient themselves, rather than rely solely upon caregiver report or medical provider's perception. The importance of patient self-report is also highlighted by the evidence that parent distress, when

elevated, may impact their perception of the patient's own distress. Similar patterns of discordance were noted between caregiver and child endorsement of distressing symptoms. Caregivers of adolescents were able to identify sadness/depression, but not any other symptom in the emotional, physical, social, spiritual or family domains, whereas caregivers of young adults were able to identify physical symptoms of fatigue and nausea and the social issue of dealing with old friends. These findings are consistent with the fact that caregivers are better at identifying externalizing physical symptoms than internalizing emotional symptoms (Bein et al., 2015; Canning et al., 1992; Canning et al., 1994; Coutinho et al., 2016; Pereira et al., 2015; Russell et al., 2016). Finally, one third of parents report feeling like a 'lone parent' and are more likely to report their own distress is elevated suggesting monitoring parent distress is important as well.

Limitations

Our study has several limitations. First, the study is limited by the cross-sectional nature of the data and the fact that caregivers are largely represented by mothers. Fathers (24%) and other types of caregivers (3%) were not highly prevalent in this sample. Second, approximately 73% of participants are Caucasian; replication in more diverse racial and ethnic populations would be important. Third, we did not require parents to report their own health status so we do not know whether parents who are themselves living with NF1 would report higher or lower distress scores for their child than parents who are not living with NF1. Fourth, only 20% of our sample were in the 18–21 age range. The association between performance status and distress may be different with a more robust sample size. Fifth, parents reported high rates of comordid psychiatric conditions such as ADHD, depression, and anxiety which were not corroborated in the medical chart but do suggest a subpopulation of children at risk likely to need further psychological interventions. Finally, the DT does not assess for suicidal ideation. Considering the endorsement of suicidal ideation reported on the CDI/BSI, suicidal ideation should be included in brief distress screening tools. Similarly, as noted in the larger study of the adapted DT (Wiener et al., 2015), while the accompanying problem checklist provides important additional information to contextualize the child's distress, future distress screens should assess whether these symptoms interfere with the child's daily life. Symptom interference cannot be inferred from the DT.

The study also has some important strengths. The children with NF1 enrolled in this study had different degrees of symptomatology, which helps to demonstrate the overall flexibility and utility of the DT across a number of different psychosocial implications. The wide pediatric age range represented in the sample (ages 7 to 21) encompasses a diverse set of developmental stages and potential psychosocial stressors.

Conclusion

Our findings suggest that the DT and problem checklist may be a useful screening tool for clinicians to implement within the NF1 setting. As recommeneded by the National Society of Genetic Counselors (2007), genetic counselors should obtain a psychosocial assessment which includes gathering information on physical factors of the disease that may overwhelm the patient, as well as their school and social situation. Understanding a patient's level of distress prior to providing genetic counseling can better allow for the counselor to target specific information or intervention needs. Patients living with NF1 experience a range of self-reported academic and emotional problems and physical symptoms. While most patients with NF1 did not endorse significant distress, a small subset report high distress that required further assessment and intervention. Importantly, as noted in previous literature, there is discordance between distress ratings of caregivers and children and healthcare providers. Each of these findings emphasize the importance of screening these youth for psychosocial distress routinely and obtaining input from multiple raters in order to obtain a more global view of the child's experience.

Compliance with Ethical Standards

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Conflict of Interest Authors LW, HB, SZB, AB, BCW, and MP declare that they have no conflicts of interest.

Human Studies and Informed Consent All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000 (5). Informed consent was obtained from all patients for being included in the study.

Animal Studies No animal studies were carried out by the authors for this article.

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