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European clinical guidelines for Tourette Syndrome and other tic disorders. Part I: assessment

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Abstract A working group of the European Society for the Study of Tourette Syndrome (ESSTS) has developed the first European assessment guidelines of Tourette Syndrome (TS). The available literature including national guidelines was thoroughly screened and extensively discussed in the expert group of ESSTS members. Detailed clinical assessment guidelines of tic disorders and their comorbidities in both children and adults are presented. Screening methods that might be helpful and necessary for specialists' differential diagnosis process are suggested in order to further analyse cognitive abilities, emotional functions and motor skills. Besides clinical interviews and physical examination, additional specific tools (questionnaires, checklists and neuropsychological tests) are recommended.

Keywords Tics · Tourette · Assessment · Guidelines

Introduction

Tics are defined as sudden, rapid, recurrent, non-rhythmic motor movements or vocalizations usually appearing in bouts while waxing and waning in frequency, intensity and

Members of the ESSTS Guidelines Group are given in Appendix.

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kind of tic [1]. Tic disorders including Gilles de la Tourette or Tourette Syndrome (TS) typically onset in childhood mostly at the age of 5 to 6 years [2, 3]. TS encompasses the combination of chronic (more than 1 year) motor and vocal tics. TS is often underdiagnosed and many patients do not receive adequate information and care [5, 6], and thus suffer from psychosocial impairment for a long time. On average, it takes more than 5 years from first onset of symptoms to diagnosis [7]. Patients and their families are frequently unable to correctly identify the symptoms and patients sometimes get stigmatised as a consequence of their tics. Therefore, they often experience a great relief to get a diagnosis because this allows them to better cope with the situation. There is no cure for TS, therefore, treatment aims to diminish tic severity and frequency. Often it is more important to manage the commonly comorbid conditions in order to improve psychosocial functioning and development. So far, to the best of our knowledge, only in Germany explicit guidelines for the diagnosis and treatment of TS exist (German Guidelines of child and adolescent psychiatry [8] and neurology [9]). In the past years, there has been an increasing interest in research on aetiology, pathophysiology, diagnosing and treatment of TS, leading to valuable new insights on many aspects of the syndrome. Therefore, experts of the European Society for the Study of Tourette Syndrome (ESSTS) have developed the first European guideline in four parts (this issue). This part deals with the assessment of tic disorders in children, adolescents and adults.

Epidemiology of tics

Prevalence

TS affects between 0.3 [10] and 1% [11] of the population, a.o. depending on age of the study group and rigorousness of the sampling method used. Tics occur predominantly in young people (before age 18), and tend to have a waxing and waning course [12]. Importantly, a TS diagnosis is twice more likely to occur in non-Hispanic white persons than in Black persons or in Hispanics [10]. There is a male to female preponderance of between 3:1 [10] and 4.3:1 [13, 14].

Course

The mean age at onset is around 5 years although lower ages at onset are reported in up to 40% of persons. Waxing and waning is the rule. Complex tics generally appear later than simple ones and phonic tics appear later than motor tics [15], usually after 1 or 2 years, with <5% of patients developing phonic tics first [16]. For most patients, the worst ever period of tics occurs between 8–12 years of age [17, 18].

The course of tics is relatively favourable over time. Clinical as well as population-based studies indicate that up to 80% of persons who have presented with a tic disorder before age 10 experience a significant tic decrease during adolescence, and by age 18 tic intensity and frequency has decreased to such an extent that the person no longer experiences any impairment from tics, although objective ratings indicate that most persons still have mild tics [19]. Yet, a small proportion of patients (20%) does not experience a decrease in tic intensity, and in this group some individuals not only experience tic worsening in adulthood but develop the most severe and debilitating forms of tic disorders. Reports on whether certain types of tics in childhood predict tics or comorbidity in adulthood are somewhat conflicting [20–26]. Frequency and severity of tics in childhood is hardly predictive of tic severity in adulthood [22]. However, children and adolescents with tics experience worse quality of life than healthy children (but better than psychiatric controls) [27], and poorer quality of life is related to increased tic severity [28]. Poor quality of life in adults with TS is associated with persistence of OCD [29]. Comorbid OC symptoms in children with TS onset at a somewhat later age (around 10 years) than tics and, in children with tics, tend to remit in only about 40% of patients [29]. Further new onset of OCD at a later age might occur [12]. Interestingly, persistence of OC symptoms into adulthood is particularly related to high IQ, and to smaller caudate volume measures in children [23, 30].

ADHD symptoms in TS children occur in the majority of cases before tic onset, and in one third of children after tic onset [31]. ADHD symptoms tend to decrease in 20% of children during adolescence but later than tics. Interestingly, OC symptoms in childhood predict OC symptoms and more ADHD symptoms in adolescence and adulthood, and ADHD in childhood predicts more OCD in adulthood [17, 26]. Finally, persistence of ADHD into adulthood is related to poorer psychosocial functioning. In conclusion, the following picture emerges: as tics in childhood hardly predict long-term outcome, comorbid OCD and ADHD are associated with poorer psychosocial functioning.

Pathogenesis

Family studies of TS consistently show a 10- to 100-fold increase in the rates of tics and TS in first degree relatives of TS patients compared to control families, indicating a strong genetic component to be operant in the disease [31–33]. Tic severity increases with bi-lineal transmission [34]. Further, independently of whether the proband has

concurrent OCD, first degree family members of TS patients have elevated rates of early-onset OCD, especially the female relatives, suggesting that—in TS—OCD is an alternate expression of the TS phenotype [32]. With respect to ADHD transmission, the picture is slightly different; although rates in first degree relatives of TS families are significantly elevated, ADHD is mostly comorbid with tics in the relatives, pointing into the direction of shared aetiology, i.e. associated but not comorbid in the strict sense [35], and not ADHD as an alternate expression of the disease [31]. In summary, these family studies strongly indicate a genetic component to be operant in TS, with shared genetic influences between tic and OCD, but it is unclear for ADHD. A large Genome Wide Association Study within the TSA genetic consortium is underway [36] (for a review on the genetics of TS: see O'Rourke et al. [37]).

MRI studies with different techniques [38–43] and electrophysiological investigations [44] on neuronal inhibition have identified alterations in brain areas of the cortico-striato-thalamo-cortical (CSTC) circuits. Finally, PET raclopride studies using amphetamine challenge to study D2 receptor availability in striatal circuits in TS patients have revealed increased phasic dopamine release in ventral striatal areas in TS patients after amphetamine challenge [45, 46] (Table 1).

Diagnosing

Tics can either be diagnosed according to the tenth International Classification of Disease (ICD)-10 criteria or according to criteria of the Diagnostic and Statistical Manual Text Revision, fourth edition (DSM-IV-TR) [47]. These classification systems are fully compatible. According to DSM-IV-TR criteria, tic disorders are grouped under the disorders that first occur in infancy, childhood or adolescence, and encompass four categories, i.e. Tourette's disorder (307.23), chronic motor or vocal tic disorder (307.22), transient tic disorder (307.21) and tic disorder not otherwise specified (307.20) (Table 2). In ICD 10, the same categories exist and the differences are minimal. In DSM-IV-TR [4] one item has been omitted that is mentioned for nearly all mental disorders and has previously been necessary for the diagnosis of TS: "*The disturbance causes marked distress or significant impairment in social, occupational or other important areas of functioning*". This modification was made in recognition of the fact that clinicians see patients who meet all the other criteria for TS, but do not have distress or impairment.

For DSM-V (expected in 2013), only minor changes have been recommended, designed to clarify and simplify the diagnostic criteria, and reduce the use of the tic disorder not otherwise specified category. A European commentary on recent DSM-V version can be found in this Journal [48]. Specific recommendations include a.o: (1) simplification of the duration criterion for the tic disorders; any person who has tic symptoms of less than 12 month duration but more than 4 weeks duration receives the diagnosis 'provisional tic disorder'; (2) establishing new tic disorder categories for substance induced tic disorder and tic disorder due to a general medical condition; (3) including a motor tic only and vocal tic only specifier for the chronic motor or vocal tic disorder category [49].

To establish a diagnosis of TS, a person must have (1) the combination of two or more motor tics and one (or more) phonic tic, that have been present at some time during the illness although not necessarily concurrently; (2) tics occur many times daily nearly every day through a period of more than 1 year; (3) onset before 18 years of age; and (4) are not directly caused by a general medical condition or by substance use.

Table 1 Clinical features of tic disorders to be distinguished from similar phenomena of other disorders; MED medication induced

Tic phenomena	Differential diagnosis
Eye rolling	Absences
Focussing on tic control	Attention problem
Tic repetition (after post-tic urge)	Obsessive–compulsive behaviour (OCB)
"Excessive" tic	Imitation/somatisation
Tripping	MED-akathasia, juvenile Parkinson desease/OCB
Neck jerking a.o.	Dystonia, MED-dyskinesia
Convulsive grimacing	Blepharospasmus/Facialis spasm
'Slinging' tics	Chorea
'Trembling' tics	Myoklonus
Monotone tic ('rhythmic')	Stereotypy
Tics during sleep	Restless legs/Rolandi epilepsia/ parasomnias
Excesive eye squeezing in adults	Blepharospasm

Table 2 Differences of motor symptoms in ADHD and tic disorders

Tic disorders	ADHD
Fragments of normal movements	Generally increased motor activity
Circumscribed functional muscle groups	General motor hyperactivity
Suddenly occurring (independent of waiting situation)	Slowly increasing (intensified by waiting situation)
Fixed pattern of quick actions	Disorganised, tempo change
Badly modulated	Badly modulated
Uniformly repeated (often in bouts)	Temporally irregular-intermittent (changing intensity)

Motor tics are described as brief, sudden, irresistible, inapposite and non-rhythmic recurrent movements in voluntary muscles or muscle groups [50]. Most common tics occur in the face, neck or shoulder musculature and encompass a.o.: eye blinking, nose and mouth twitches and shoulder jerks.

Vocal tics are defined as sounds elicited by a flow of air through the vocal cords, mouth or nose and the most common vocal tics are: throat clearing, grunts, high-pitched sounds and sniffing. Amongst the most well-known vocal tics is coprolalia (i.e. the uttering of socially inappropriate words), which occurs only in between 14 and 20% of patients [51]. Tics can be suppressed or inhibited depending on the situation. The suppression, however, causes an uncomfortable sensation.

Three essential 'tic' features can be recognised that are closely interwoven, i.e.: (1) temporary tic suppression [16]; (2) inner tension that accompanies tic suppression; (3) the feeling of active involvement in performing a tic, especially in adults. Although patients cannot permanently suppress the tic they might experience the tic as a conscious, intentional and self-directed movement executed to relieve a premonitory urge [52]. This feeling of intentionality is rarely present in children between age 4 and 8 but increases with age, and by age 12 the majority of patients recognises a premonitory urge preceding and exacerbating a tic [15]. This subjective perception is an important distinguishing feature from other hyperkinetic movement disorders [52].

Tics usually start in the face and tend to extend caudally, with a remaining preference for head, neck, shoulders and arms. Tics tend to significantly decrease during sleep, although—in contrast with previous notions—they often do not disappear [53]. Up to 60% of TS children and adults complain about disturbed sleep [54]. Polysomnography and simultaneous video recording during sleep in TS patients has revealed both an increased number of regular movements and more tics in all sleep stages but especially during REM sleep [53, 55, 56]. Patients show decreased sleep efficiency and slow wave sleep percentage, increased sleep latency, more awakeness and awakenings and more sleep stage changes during sleep. Severity of TS is positively associated with number of awakenings and sleep stage changes and negatively with sleep efficiency. Comorbid ADHD, a condition in which increased motor activity during sleep is found as well, seems to significantly add to the sleep problems in TS [56–58].

The intensity of tics depends in most cases on environmental cues, such as exciting or stressful events, although the nature of these environmental mediators has hardly been investigated systematically yet. In apparent contrast to this, tics can exacerbate during relaxation, for example whilst watching television. Situations or activities that require focused attention from the patient often diminish tics, both in children and adults [59].

Types of tics

Tics can be classified according to: type, complexity, whether they are isolated or multiple, and according to location, number, frequency and duration [6]. They also vary in terms of intensity or 'forcefulness' [69].

Type

Tics can be motor, vocal, sensory or cognitive [60].

Motor tics

Motor tics arise in the voluntary musculature and involve discrete muscles or muscle groups. Tics can be seen as fragments of normal motor movements that appear out of context [61]. The most frequent tic is eye blinking. [16].

Phonic (or vocal) tics

Phonic (or vocal) tics can consist of any noise produced by movement of air through the nose, mouth or pharynx. Tongue clicking is, therefore, not classified as a phonic, but a motor tic. The term 'phonic' should be preferred over 'vocal', since not all sounds (f.i. sniffing) are produced by the vocal cords. Less than 5% of patients with tics have phonic tics alone without associated motor ones [62], but motor tics without phonic tics are very common.

Sensory tics

Many adult patients (up to 90%), are aware of premonitory sensations preceding the tics, with a mean age of starting to become aware of 10 years, and depending on type of tic [15]. More automatic movements such as eye blinking are less often preceded by sensory urges. These sensations are experienced as unpleasant somatosensory sensations, either within the muscles of the upcoming tic or somewhere else in the body or the head (tiredness, itch, pressure, stabbing pain, abdominal discomfort, heat or cold) and sometimes difficult to articulate. They are often relieved by execution of the tic [52, 63]. Younger children are much less aware of premonitory urges; 37% of children between 8 and 19 years are able to report on premonitory urges, whereas 64% of these children were able to suppress their tics. Thus, tic awareness does not seem to be a prerequisite for the ability to suppress tics, and awareness seems to increase with age, and be closely associated with cognitive development [64]. Premonitory urges can be bound to small

localised areas, with 'hot spots' in the shoulder girdle, hands, feet and front of the thighs. They can also be more generalised, and described as a sense of 'inner tension' [61].

Cognitive tics

These tics have been described in adolescents and adults with TS and seem to occur predominantly in this age group [65–67]. They have been first described by Shapiro et al. [16] and termed 'impulsions' to delineate them from the anxiety-driven 'obsessions' that occur in 'pure' OCD patients. Thus, cognitive tics are described as repetitive thoughts that are not anxiety-driven but occur as a response to the excessive urge to give in or act upon provocative auditory, visual, tactile or inner stimuli [67]. Although exact frequencies are not known, cognitive tics encompass: echophenomena in thought, mental play [68], aimless counting and repetitive thoughts with sexual or aggressive content that produce no fear.

Complexity

Tics can be subdivided into simple and complex [62]. Simple tics are restricted to one muscle or a single muscle group. Examples of simple motor tics are: eye blinking, nose twitching, tongue protrusion, head jerks and shoulder shrugs, etc. Examples of simple phonic tic are grunting, throat clearing, coughing, sniffling and barking, etc.

Complex motor tics often have a repetitive and/or compulsive nature. Examples are: the repetitive touching of objects or people, making elaborate sequences of movements, repetitive obscene movements (copropraxia), mimicking others (echopraxia) or wounding oneself (self-injurious behaviour). Complex phonic tics occur when sounds are elaborate or have a semantic content, including for instance words or phrases, expressing obscenities (coprolalia), repeating others (echolalia) or repeating oneself (palilalia). In general, complex motor tics are aimless or in response to an excessive premonitory urge. However, when the tic sequences are complex and elaborate it can be difficult to distinguish them from compulsions as seen in 'pure' OCD, the latter being more cognitively driven, goal-directed and aimed at reduction of anxiety [15].

Isolated or multiple

One can have one tic that always originates from the same anatomical location (isolated) or many tics at multiple locations. Migration of tics from one location to another over longer periods of time is typical in chronic tic disorders. The tics wax and wane in intensity and complexity.

Duration

Tics are generally brief. They can be categorised as clonic (less than 100 ms) or dystonic and tonic (more than 300 ms). Dystonic tics are less common and are characterised by a repetitively abnormal posture of a kind that one may see in dystonia (e.g torticollis). In tonic tics, there is a relatively long duration of the contraction (in e.g. back muscles) without exhibiting abnormal postures.

Impairment

In children and in adults, it is paramount to assess degree of impairment due to tics or comorbid conditions, although as described here above, in DSM-IV-TR [4] and in future DSM-V [49], the distress item has been omitted that was obligatory to establish a tic diagnosis in previous classifications. Impairment entails that the disorder is time consuming, causes significant distress and interferes with major domains of daily life of both children and adults, such as school, work status and (social) relationships. Impairment can be reliably measured with various instruments, including the impairment item on the Yale Global Tic Severity Scale (YGTSS), which separately rates impairment due to motor or vocal tics, on 0–4 scales [69]. Alternatively, impairment can be assessed using a Global Assessment of Functioning, both in children (C-GAS) [70] and in adults according to axis five of DSM-IV TR (2002 [47]). The scale runs from 0–90, with 0 indicating complete dependence on care by others, and 90 being healthy and excellently functioning in all areas of development, school/work and psychosocial functioning. Further, in children as well as adults the Clinical Global Impression Scale (CGI-S [71]) can be rated by the clinician. The CGI-S assesses change in global daily functioning (between 0 = much deteriorated and, via 3 = no change, to 6 = very much improved). The CGI-S has shown good face validity and is extremely easy to use, although interrater reliability is somewhat low [72].

Recently, a Quality of Life scale has been developed specifically for tic disorder patients [73, 74]. This 27 item scale is based on the health-related quality of life scale (HR-QOL) [75] with response ranges between 0 and 4, and assesses quality of life in four domains: psychological problems, cognitive problems, physical/Activity of Daily Living problems and obsessive–compulsive themes. Internal consistency as well as test–retest reliability are excellent. TS patients report elevated scores, predominantly in the domains of psychological and cognitive problems [73].

Comorbidity

In clinical series, the large majority of cases (79%) have comorbid psychopathology, with attention deficit/hyperactivity disorder (ADHD) predominantly of the inattentive or combined subtype, being the most frequent comorbid disorder in up to 60% of the cases in both children and adults [31], followed by Obsessive–Compulsive Disorders (OCD), merely in adolescents and adults, anger control problems, sleep disorder, learning disorders, mood disorders, anxiety disorders and conduct and oppositional defiant disorders (CD/ODD). Sex differences occur with respect to this comorbidity, with predominance of males over females for ADHD, CD/ODD, anger control problems and learning disorders, and a female preponderance for OCD and self-injurious behaviour. Other comorbidities include impulsive, self-injurious and aggressive behaviour, autism spectrum disorders and sleep disorders [76]. Especially in adults, comorbidity often forms the main reason to seek help.

Differential diagnosis

Tics need to be differentiated from other hyperkinetic movement disorders and from psychogenic movement disorders (Table 3). The features that distinguish tics from other movement disorders—with the exception of akathisia and psychogenic movement disorders—are (1) the ability to suppress them for a while, and (2) the patient's experience of tics as a (partly) voluntary movement to relieve an inner tension or a premonitory focal sensory sensation [77]. These features can be used to help differentiate from other movement disorders which characteristically worsen with action and are not suppressible [78] (Fig. 1).

Table 3 Clinical differences and similarities of tic disorders and obsessive–compulsive disorders

Tic	Obsessive–compulsive disorder
Differences	
Sudden, short (jerking)	Ritualized
Fragmented movements	Goal-directed behaviour
Sensorimotor urges	Thoughts/imaginations (cognitive-emotional dissonance)
Not related to anxiety	Mostly related to anxiety
Ego-syntonic	Ego-dystonic
Involuntary (clustered sequence)	Voluntary (cyclic)
Onset in primary school (one peak)	Onset after primary school (two peaks)
Waxing and waning (from seconds to months)	Little changes over time
Also during sleep	Never during sleep
Similarities	
Decrease with concentration	Decrease with concentration
Increase with emotional excitement	Increase with emotional excitement
Suppressible (short-term)	Suppressible (long-term)

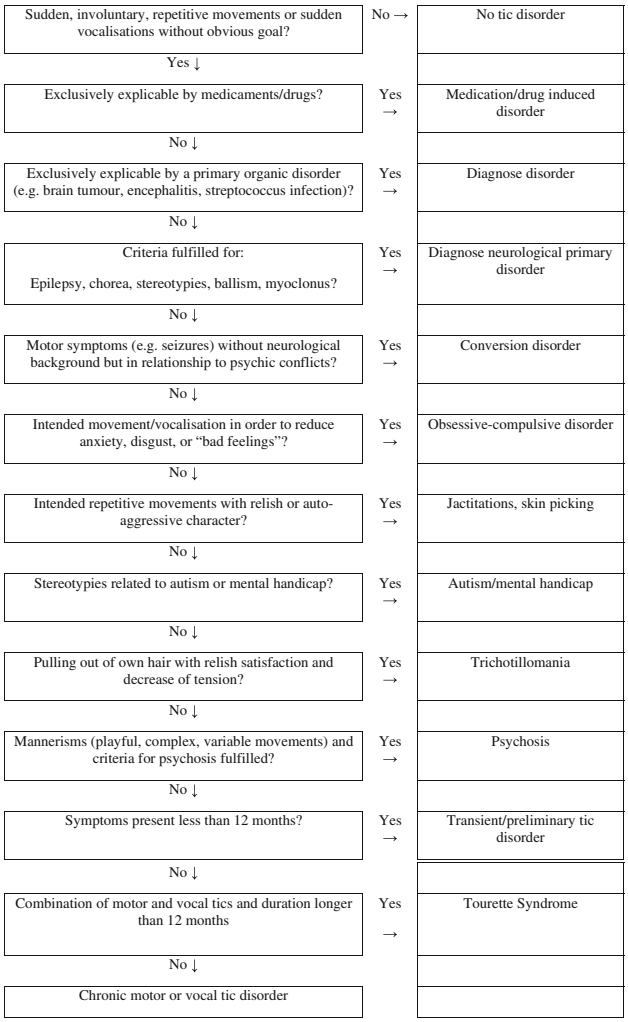

Fig. 1 Differential diagnostic decision tree for tic disorders

Work up

General evaluation

A *general evaluation* of both children and adults includes assessment of the most debilitating complaints and symptoms, assesses how the symptoms developed and inquires about potential stressors and triggers. Especially in children, a developmental history is obtained. In children and adolescents, family functioning is assessed including parental coping styles and parental conflict, social network

and financial & housing situation. In adults, partner status, current work and financial/housing situation is assessed as well. Moreover, if available hetero-anamnesis on tic and disease status is obtained from a partner, spouse or confidential person in the vicinity of the adult patient.

Parent- and patient rating scales to support the general evaluation

In children, adolescents as well as adults, it is highly advisable to supplement clinical interviewing with screens that rate general psychopathology. In children and adolescents, these are parent and/or teacher-derived, in adolescents complemented with self-reports, and in adults self-reports are taken, when necessary complemented with hetero-anamnestic assessments of a partner, parent or other person in the neighbourhood of the patient.

Self-report scales are recommended to provide general information on psychopathology. In children and adolescents, the parent-derived Child Behaviour checklist (CBCL) or—in adolescents and adults—the Young Adolescent Self-report or Youth Self-report which is fully in line, is highly recommended [79–81]. The same holds true for the SDQ (Strengths and Difficulties Questionnaire [82]; see also internet at www.sdqinfo.com). These scales are well validated across the different age groups, providing the clinician with the opportunity to follow children across the lifespan essentially using the same scale.

A detailed medical history is conducted (including medication and drug consumption in pregnancy by the mother, birth history, early development and past medication use by the patient etc.), and a complete psychosocial and family history to detect psychiatric and/or neurological conditions in relatives.

Interviews to assess disorders of infancy, childhood and adolescence including tics are abundant in child psychiatric settings. Various interviews are (1) compatible with international diagnostic systems (DSM-IV and/or ICD-10), and (2) explore the whole range of childhood derived disorders [83]. These are: the Diagnostic Interview Schedule for Children (DISC) [84, 85], the Children's Interview for Psychiatric Syndromes (ChIPS) [86], the Schedule for Affective Disorders and Schizophrenia for School-Age Children (Kiddie-SADS-PL; http://www.wpic.pitt.edu/ksads/default.htm; [83, 87], the Diagnostic Interview for Children and Adolescents (DICA[88]; psychometrically weak), the Child and Adolescent Psychiatric Assessment (CAPA) [89], of which young adult and young children versions are available; and the Interview Schedule for Children and Adolescents (ISCA [90]). All interviews are administered by clinicians and include a child/adolescent version and a parent version. In general, children seem to be better informants in describing internalising disorders, and adults (parents, teachers) more reliably describe externalising disorders [83]. The ISCA and the CAPA also explore on DSM-IV axis II diagnoses. Inter-rater reliability appears to be good for the 6 instruments, with kappa's ranging from 0.5 to 1. Overall, the K-SADS-PL has the best test–retest reliability [91] and is mostly used across countries, but takes somewhat lengthy interviewing (between 1 and 3 h).

Notably, in adults, no structured interviews are available that include the full range of disorders of infancy, childhood and adolescence including tic disorders. The most used instruments to assess other comorbid disorders are the Structured Clinical Interview on DSM-IV axis I disorders including the TR form (SCID-I [47, 92]; between 1 and 2.5 h), and the Mini International Neuropsychiatric Interview (MINI), which is an abbreviated version of the SCID-I and takes between 30 min and 1 h to complete [93]. Both the SCID-I and the MINI require training.

Specific evaluation

Clinical interview

Age of onset of first tics should be recorded, as well as tic history and course and age at worst tic severity. Further, inquiries are made about which tics (or comorbid conditions) are considered to be most debilitating, and about their physical consequences (including pain/injury of muscles and joints), about somatosensory phenomena accompanying the tics, tic suppressibility and about exacerbating or relieving factors accompanying the tics (e.g. stress sensitivity). Patients and parents are asked about any possible relationship between infections (throat, ear) and tic exacerbation, to determine whether streptococcal autoimmunity could be a factor (e.g. in relation to Pediatric Autoimmune Neuropsychiatric Disorders Associated with Streptococcus (PANDAS) [94]). Patients and family members are questioned about the circadian profile of tic activity (including during sleep), to clarify the psychosocial impact of tics on family functioning, learning and quality of life [74]. Finally, the family history should be pinpointed to specific questions about tics, obsessive compulsive and ADHD behaviours in first degree family members.

The clinical examination is accompanied by standardised assessment of tics, comorbid conditions (including ADHD, OCD, self-injurious and anger control behaviours, mood and anxiety, sleep and learning difficulties) and their severity.

Assessment of tics

A considerable difficulty in assessing and quantifying tics is caused by (1) the spontaneous variations of tics in an

individual over time, (2) The large variability in impact of a given level of physical tic severity on an individual or their family and (3) the tendency of patients to suppress their tics, especially when in the office with the clinician. Therefore, it is advisable when assessing tics, to use multi informant data, and to combine direct observation (both at home and in the school/work environment), historical information and—if available—to collect video data, in the clinical setting, 'home alone' or both [95]. Additional videotape tic monitoring might enhance capturing the whole tic repertoire of the patient. Various video protocols have been developed and extensively described, usually advising between 5 and 15 min of videotape recording [95–97].

In general (see Table 5), the evaluation of tics and comorbid symptoms in children and adults is highly comparable, using similar self-report scales and clinician-derived interviews. The differences predominantly lie in the person of the informant. In children this is mostly a parent, in adults the information is obtained—if available—from partner or spouse. In choosing an instrument it is advisable to make a choice based on (1) compatibility of the instrument to international (DSM-IV-TR) criteria; (2) the quality of its psychometric properties and (3) whether it provides scales that are normed across age groups, preferably ranging between infancy and adulthood.

A helpful assessment tool to systematically assess several aspects of the clinical history is of tics is the Diagnostic Confidence Index [98]. The DCI provides a score between 0 and 100 which allows clinicians to measure the likelihood that a person meets criteria of TS. However, validity and reliability criteria are not very well developed.

The most widely used checklists on tic characteristics and severity that combine an observant component and historical information obtained from the patients, parents and or spouses include the YGTSS [69], the Shapiro Tourette SyndromeSeverity Scale (STSSS) [16] and the Hopkins motor and vocal tic scale [99] (for an overview: see Kompoliti and Goetz [100]). The YGTSS includes a clinician-administered inventory of 30 items including 18 categories of motor and vocal tics, self-injurious behaviour and anger control problems to which a severity rating scale has been added. These 10 YGTSS severity items measure the number, frequency, intensity, complexity and interference of motor and phonic tics, and a separate impairment rating on 0–4 scales for each item [69]. Children and adults can be followed using the severity ratings. The YGTSS has high internal consistency and stability [101], convergent validity with other scales and discriminant validity. Overall, the psychometric properties appear to be better than in other scales. Two disadvantages are that time needed to collect information is up to 20 min and the use of the scale needs some training [100].

The STSSS is developed for clinical trials, encompasses five items including the noticeability to others, and interference of daily life due to tics [102]. The STSS is short, easy to use and reliable with high internal consistency. A limitation is that it does not assess tic characteristics. The Hopkins motor and vocal tic scale focuses both on tics and their impairments, using visual analogue scales on which physicians and parents separately rank motor and vocal tics. Three scores are obtained: a total score, a parent (or partner)-derived score and a rater score. Interrater reliability to evaluate tic severity is equally well as seen in the YGTSS, STSSS and CGI [99].

Assessment of comorbid conditions

Recommendations are given to assess the most prevalent comorbid conditions, i.e ADHD and OCD. For recommendations on other comorbidities, we refer to Table 4.

ADHD

To establish the presence and severity of comorbid ADHD, both in children, adolescents and adults, several rating scales can be used to screen on presence of ADHD. However, these scales can only be used as an aid to help diagnosing using standard interviews. With respect to interviews used, assessments should contain key questions for parents (of both children and adults; [103]) on present as well as past performance (starting before age 7) with respect to inattention, impulsivity and hyperactivity. In children, various well validated instruments are used, a.o. the Kiddie-SADS, and the DICA (see here-above). In adults, the picture is less clear, and various interviews, mainly based on DSM-IV criteria of ADHD, have been developed across countries [104]. The particular challenge in assessment of adults lies in the gathering of reliable information on behaviour that has started before age 7 to establish an ADHD diagnosis. This can be extremely difficult, particularly if no informants (parents, older siblings or other family members) are available to provide information on childhood behaviour, and when current comorbid depressive or other psychiatric symptoms hamper reliable information provided by the patient.

ADHD rating scales that are mostly used in children are: the Swanson, Nolan and Pelham questionnaire, 4th edition (SNAP-IV) [105] and the Children's version of the Connors ADHD Rating Scale (CAARS) [106, 107]. The SNAP-IV encompasses a 30 item validated self-report questionnaire with ratings between 0 and 4 per item. Internal consistency, interrater reliability and validity are good. The CAARS (66 item or 30 item versions) has a children's and an adult version and encompasses several subscales with ratings

Table 4 Features of tic disorders versus stereotypies

Feature	Tics	Stereotypies
Age at onset (years)	6–7	<2
Pattern	Variable	Fixed, identical, foreseeable
Movement	Blinking, grimassing, warping, jerking	Arm-hands, wavelike, fluttering, jiggling
Rhythm	Quick, sudden, aimless, but not rhythmic	Rhythmic
Duration	Intermittent, short, abrupt	Intermittent, repeated, prolonged
Pre-movement sensorimotor phenomena	Yes	No
Trigger	Excitement, stress	Excitement, stress, also in case of demands
Suppressibility	Self-directed, short (associated with increased inner pressure)	By external distraction, seldom conscious effort
Family history	Often positive	Maybe positive
Treatment	Primarily neuroleptics	Rarely responsive to medication

between 0 and 4 per item which measure ADHD symptoms, impulsivity, inattention and hyperactivity domains, and (in the long version) ratings with respect to global psychological functioning and self-esteem. The CAARS has the advantages of being thoroughly validated across different age groups, and is suitable to be filled in by multiple informants. The CAARS displays good internal consistency, interrater reliability and validity [103] but has—in adults—the disadvantage of not inquiring retrospectively, although it inquires on whether symptoms have been present before age 7 and caused distress or impairment. An adult self-report rating scale that meets with the criterion of retrospective inquiry on symptoms is the Wender Utah Rating Scale (WURS) [108].

In conclusion, in children the diagnosis of ADHD is more easy to establish than in adults, where assessments with multiple informants should be combined to establish a diagnosis of ADHD [103].

OCD

Some instruments designed to capture the OCD are suitable as a screener in epidemiological samples, some capture the OCD symptoms in clinical samples and some measure OC severity over time. Reliable screeners are: the OC symptom subscale of the CBCL [109] (as an adult version the OC scale of the YASR [110]), an 8 item screener on OC behaviour, and the SOCS [111], a 7 item screener on presence of OC symptoms, the latter being developed for adolescents between 11 and 18 years. Both screeners have good sensitivity and specificity in general populations of children but specificity is lower in psychiatric populations.

To assess symptoms and severity in clinical samples of children and adults, the Leyton Obsessive Inventory including both adult and children's versions are in use (LOI and LOI-CV; 20 and 11 item versions; yes/no answers and 0–3 answers, respectively) [112–114]. The LOI-CV has a self-report and a parent-derived form, the latter being preferable with respect to sensitivity to pick up OC complaints [115]. Disadvantages are that not all OC symptom domains are captured and that the scores predominantly correspond with compulsion severity and not obsession severity. Further, the Children's Obsessive Compulsive Inventory (CHOCI) has been developed [116], based on Maudsley Obsessive Compulsive Inventory [117] and with severity ratings comparable to the YBOCS severity scale [118]. The CHOCI has 14 symptom items and 6 severity items, and is useful as a severity rater but does not encompass the whole range of OC symptoms.

The most recommendable instruments to use which capture the full range of OC symptoms and assess OC severity in children as well as adults are the Children's Yale-Brown Obsessive–Compulsive Scale; CY-BOCS (in children)/YBOCS (in adults), entailing 58–80 items on symptoms and 10 severity items [118–120]), and the Obsessive–Compulsive Inventory-Child's Version; OCI-CV [121] and the adult version: OCI-R [122, 123]. The YBOCS symptom checklist + severity scale have interviewer-based as well as self-report based versions that are equally well in terms of sensitivity and specificity [124], and in children parent-derived versions are used. The (C)Y-BOCS extensively rates presence or absence of lifetime OC symptoms in four domains, of obsessions and checking, washing and contamination, symmetry/ordering behaviour and hoarding [125, 126]. Further, a 10 item severity rating is added, measuring obsession and compulsion severity separately with respect to: time consumingness, distress, interference, resistance and amount of control over obsessions and compulsions. As an extension,

the Dimensional Y-BOCS (DY-BOCS) has been developed, in which symptom severity is measured separately over each symptom domain and avoidance ratings are added [127]. The YBOCS and DYBOCS scales have good psychometric qualities but are very time consuming; (between 1 and 3 h to assess symptoms). Therefore, as a much shorter alternative, the 18 item Obsessive Compulsive Inventory-revised version (OCI-R) [123] and as a child version, 21 item the OCI-R CV [121] is recommended. The OCI-R/OCI-CV encompass 18–21 items on OC symptoms in six symptom domains including doubting/checking, washing, ordering, hoarding and neutralising, with ratings between 0 and 4. Test–retest reliability, comparability with YBOCS and construct and divergent validity (i.e. higher correlations are found with measures of anxiety than depression) are all well.

Physical examination

A general physical and a specialised neurological examination is mandatory to ensure correct diagnosis and exclude severe or progressive neurological disorders [128]. The necessity for any further investigation is determined at this early diagnostic stage. In practice, the typical features of TS virtually rule out alternative major diagnoses. Atypical features such as apparent adult onset or severe deterioration or progression in symptoms should always lead to detailed consideration and investigation to include EEG and neuro-imaging.

Neurological examination is performed to distinguish tics from other movement disorders, most importantly myoclonic dystonias, some forms of epilepsia and stereotypies. In practice, myoclonus—brief shock-like movements of 'non-functional' muscle groups which are not suppressible and usually do not have an associated urge—are the most difficult movements to distinguish from tics. With the presence of sustained or dynamic abnormal postures, it is useful to enquire about and examine for signs of dystonia. A good technique to identify kinesogenic involuntary movements is to for instance observe the writing of the patients; an individual with a myclonic dystonia will need to steady the pen-holding hand with the other to avoid shock-like movements affecting the manoeuvre. Also, observation of fine motor tasks such as putting the lid on a pen is useful to exacerbate/test for myoclonus. Whilst 'dystonic tics' are well recognised, focal or generalised dystonias should not be mistaken for a tic disorder.

Additional investigation with the aid of MRI scanning or EEG is rarely indicated except in those cases where the presentation is not typical in terms of either the semiology of the movement disorder or the presence of features suggestive of the differential diagnoses mentioned above. Indeed, the more common situation is over-investigation, for instance with EEG in cases where a typical tic disorder is mistaken for epilepsy or myoclonus. It is worthwhile seeking expert opinion if doubt exists about the extent of investigation to pursue. Certain neurological conditions can be associated with tic-like movements (Table 4). It is usually straightforward to differentiate these conditions with a thorough history and examination.

The physical examination includes careful examination for dysmorphic features to identify any indication of genetic syndromes. Unusual features may prompt specific genetic testing by consulting a clinical geneticist. Further, in the presence of additional learning difficulties or autism spectrum diagnosis it might be advisable to consult a clinical geneticist as well, as in some cases this high resolution array might reveal a rare genetic aetiology of these heterogeneous disorders.

Neuropsychological profile and assessment

Recent research has provided new insights into the neuropsychological profile of children with TS, mainly through direct comparisons between patients with comorbid ADHD, or, to a lesser extent, OCD, and patients with 'uncomplicated' TS, which represents a minority of the clinical population of children with TS. Although the majority of studies indicate that only TS patients with comorbid conditions exhibit cognitive dysfunction on standardised tests, the actual impact of having TS upon social and academic achievement, quality of life and the overall disability burden of the different subgroups of TS requires further study. For this reason, the prognostic value, and, as a consequence, clinical usefulness of formal neuropsychological testing in children with TS has not been clearly established to date, and most neuropsychometric tools seem appropriate, at present, only in research settings. However, it is useful to summarise the findings on cognitive performance in different subgroups of children with TS, and to identify tests that hold promise for standardised neuropsychometric assessment. Table 5 provides an overview of the test batteries suggested from published studies and more ecologically applicable screens (Fig. 1)..

Patients with 'uncomplicated' TS show barely any impairment on all the main areas of cognitive functioning [129–132]. It should also be noted that no ecologically valid measure of manual speed or dexterity (e.g. typing) has been evaluated in children with TS that shows practically relevant results. Of note, enhanced cognitive function has been identified on tasks of response inhibition in TS patients, with children with 'uncomplicated' TS showing enhanced cognitive control on an oculomotor switching task [133]. Authors suggest that this heightened ability to

Table 5 Tic and comorbidity assessment in children and adults

Topic	Measurement instrument children	Measurement instrument adults	Time
Demographics	Age, sex, education level child and parents, work status parents, ethnicity child and parents (based on country of origin info), marital status parents	Age, sex, education level, work status, ethnicity patient and parents (based on country of origin info), marital status	Max 20
Age at onset tics, OCD, ADHD	Age at onset, age at worst ever	Age at onset, age at worst ever	Max 10
Family history tics/OCD/ADHD	Family tree including disease in family members	Family tree including disease in family members	Max 20
Tic diagnosis according to DSM	Interview (derived from DCI or parts of DISC)	Interview (derived from DCI)	Max 10
Other DSM diagnoses	Kiddie-SADS-PL	MINI/SCID	Max 60
Tic symptoms (past/present)	Y-GTSS (36 items)	Y-GTSS (36 items)	Max 30
OCD symptoms (past/present)	CY-BOCS	Y-BOCS/D-YBOCS	Max 30
ADHD	SNAP/CAARS (parent/teacher/selfrating)	SNAP/CAARS	Max 20
Autism symptoms	Social Responsiveness Scale (SRS)	Autism Questionnaire	Max 25
Impulsive behaviour	BIS 11	BIS 11	Max 5
Sensory premonitory urges	PUTS (10 items)	PUTS (10 items)	
Course of psychopathology			
Severity-tics	Y-GTSS (2 × 10 items; current & worst ever; age at worst ever)	Y-GTSS (2 × 10 items; current & worst ever; age at worst ever)	Max 15
Severity OC symptoms	CY-BOCS severity (2 × 10 items; current & worst ever)	Y-BOCS severity (2 × 10 items; current & worst ever)	Max 10
Severity depression & anxiety	RCADS (47 items)	BDI/BAI (42 items)	Max 20
Psychosocial functioning	CGI	CGI	Max 2
	GTS-QOL (28 items)	GTS-QOL (28 items)	Max 15
Life events	Brugha (29 items)	Brugha (29 items)	Max 15
Estimation of patients' time for the specific baseline measurements	Max 130		Max 125
	Max 175		Max 165

Brugha list of threatening experiences [153]; *DCI* Diagnostic Confidence Index [98], *DISC* Diagnostic Interview Schedule for Children [84, 85], *Kiddie-SADS-PL* Schedule for Affective Disorders and Schizophrenia for School-Age Children (http://www.wpic.pitt.edu/ksads/default.htm) [83, 87], *SCID* Structured Clinical Interview on DSM-IV axis I disorders [47, 92], *MINI* Mini International Neuropsychiatric Interview [93], *CY-BOCS* Children's Yale-Brown Obsessive Compulsive Scale [119], *Y-BOCS* Yale-Brown Obsessive Compulsive Scale [118, 120], *DY-BOCS* Dimensional Yale-Brown Obsessive–Compulsive Scale [127]; SNAP-IV = Swanson, Nolan and Pelham questionnaire, 4th edition [105]; CAARS = Children's version of the Connors ADHD Rating Scale [106]; SRS = Social Responsiveness Scale [154]; BIS = Barratt Impulsivity Scale [155]; PUTS = Premonitory Urge Tics Scale [156]; Y-GTSS = Yale Global Tic Severity Scale [69]; RCADS = [157]; BDI = Beck Depression Inventory-II [158]; BAI = Beck Anxiety Inventory [159]; CGI = Clinical Global Impression [71]; GTS-QOL = Gilles de la Tourette Syndrome–Quality of Life Scale [76]

control inhibition may be a result of tic suppression over time. This finding needs confirmation in subsequent studies. In sum, based on current evidence, no specific clinical neuropsychological assessment is advised in children with 'uncomplicated' TS.

A body of evidence suggests that the main comorbid conditions, ADHD and OCD, have a detrimental influence on the cognitive performance of children with TS [134].

Children with TS + ADHD exhibit cognitive dysfunction. The main negative impact on cognitive performance seems determined by ADHD, independent of the coexisting tic disorder [131]. This might explain why comorbid ADHD is the main predictor of poorer psychosocial health [135, 136] and the main determinant of the burden of disability [137] in TS patients. However, it is unclear how much of the negative effects of ADHD on disability and social/academic functioning in TS patients is caused by ADHD-related intellectual dysfunction. ADHD comorbidity seems to impact on the general intellectual function of children with TS, as the majority of reports suggest that a lower Full-Scale IQ is accounted for by the presence of the comorbidity [138–140]. Moreover, learning disabilities and other problems concerning academic achievement are estimated to occur in approximately 23% of children with a diagnosis of TS and appear to be highly influenced by coexisting ADHD [140, 141]. Specifically, numerical skills [140] and written language [134] have been highlighted as prevalent in TS.

The performance on manual dexterity (Purdue Pegboard test) or visual-motor integration (Beery Visual-Motor

Integration test) tasks does not differ significantly between patients with TS + ADHD and 'uncomplicated' GTS [132, 142, 143]. In line with children with ADHD only, children with TS + ADHD have been demonstrated to show marked impairment on visual attention (e.g. the Trail Making Test [144]) and sustained attention (Continuous Performance Tests; [132, 145]). Other cognitive domains in which children with TS + ADHD show impairments, compared to patients with 'uncomplicated' TS, are: planning skills [142, 146], response inhibition [131, 147, 148] and cognitive flexibility/set shifting [35, 148, 149]. The meaning of these cognitive impairments to predict outcome in children with TS remains inconclusive. However, the neuropsychological tests described here-above may provide clinically useful additional information on the cognitive profile of children with TS + ADHD.

There is very limited evidence on the neuropsychological profile of children with TS + OCD. It is unclear whether this comorbidity is associated with selective cognitive impairment in children with TS. The cognitive profile of OCD appears to be one of the primary executive dysfunctions, mainly affecting response inhibition and cognitive flexibility [150]. Although memory may be affected as well, these deficits are thought to be secondary to a failure of organisational strategies during encoding [150]. In line with this, patients with TS + OCD demonstrate executive function deficits primarily in response inhibition [151] and set shifting paradigms [152]. As underscored for the other two TS subgroups, information is lacking on the prognostic indicators of this dysfunction on social, academic and psychological wellbeing in children with TS + OCD. For TS + OCD patients, a neuropsychological assessment focused on executive function, primarily response inhibition and cognitive flexibility, may be clinically indicated.

To conclude, in children who are diagnosed with TS in combination with comorbid ADHD or OCD should undergo neuropsychological evaluation encompassing intellectual function, academic attainments, motor skills, attention, executive function and memory. Neuropsychological tests of certain test-batteries with good psychometric properties for the country in question are suggested from published studies and more ecologically applicable screens.

Conclusion

Tic disorders represent a wide range of tics and co-existing symptoms with a varied and heterogeneous presentation. In this guideline, we have recommended a broad range of assessments and investigations to capture the tic/TS phenotype, taking developmental issues into account. In our opinion, it is highly advisable to choose instruments that cover the whole age range between infancy and adulthood, so that the time course of symptoms across ages and life stages can adequately be captured. In most situations, a standard interview with a few additional questionnaires and rating scales are sufficient to guide diagnosis and treatment. However, psychiatric comorbidity occurs in more than three quarters of cases that are referred for specialised care. Further, in a minority of cases a more extensive neurological and psychiatric screen is necessary to differentiate tics from other hyperkinetic disorders and from psychogenic disorders. Finally, neuropsychological assessment can be useful because of the high concurrence of tics with learning disorders, especially in children who have not yet finished education or professional training.

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Appendix

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