Tourette Syndrome and Tic Disorders

CHAPTER 12

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Introduction

Tourette Syndrome (TS) is a chronic neurodevelopmental disorder characterised by the presence of multiple motor tics and one or more vocal (phonic) tics for one year or longer, with onset in childhood[1]. The first medical description of TS was authored by Jean-Marc Gaspard Itard in 1825, and the condition later came to be known as TS following a case series by George Gilles de la Tourette in 1885[2]. The current Diagnostic and Statistical Manual of Mental Disorders (DSM-5-TR)[1] diagnostic criteria for TS are outlined in Table 1.

Table 1: Diagnostic and Statistical Manual of Mental Disorders (DSM-5) criteria for Tourette Syndrome

Tourette Syndrome
Criterion A – Multiple motor and one or more vocal tics, not necessarily concurrently.
Criterion B – Waxing and waning frequency, with persistence for more than 1 year.
Criterion C – Onset before 18 years of age.
Criterion D- The condition is not attributable to the physiological effects of a substance (e.g. cocaine) or a medical condition (e.g. Huntington's disease, postviral encephalitis).

In cases involving tics present for less than one year, the term 'Provisional Tic Disorder' is used, and in cases where motor or vocal tics (but not both) are present for over one year, the term 'Persistent (Chronic) Tic Disorder' is used[1].

Tics are sudden, repetitive, nonrhythmic movements or vocalisations, that are typically experienced as involuntary, but that can be suppressed for varying lengths of time[3]. Characteristic features include a premonitory urge relieved by the tic, a waxing and waning course, rostral to caudal (head to toe) progression of new onset tics, voluntary suppression with effort, and suggestibility[2]. The characteristic features of tics, useful for distinguishing them from the repetitive motor movements associated with stereotypies, are presented in Figure 1[4].

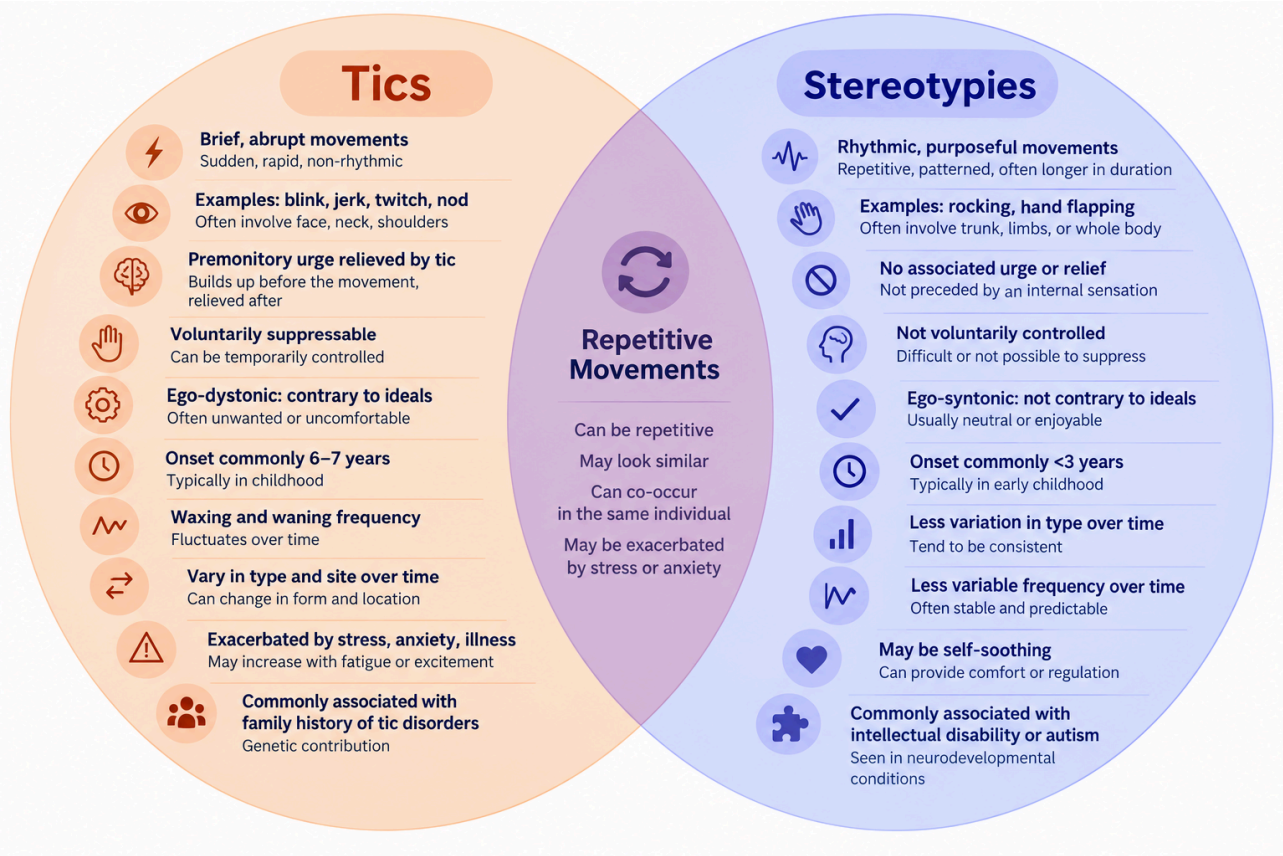


Figure 1: Differentiating Tics from Stereotypies

Tics are exceptionally common in childhood, with most studies estimating at least 20% of children will experience transient tics during their development[5]. However, in many cases transient tics persist for only weeks to months, or are not prominent enough to prompt assessment with a healthcare provider[4]. Commonly reported motor tics include blinking, head jerking and shoulder shrugging, and common examples of vocal tics include sniffing, throat clearing, and grunting. The premonitory urge to tic is often accompanied by increased tension, and in some cases by a sensation of pressure, itch, tingling, or a need to stretch[6]. Tics can be voluntarily suppressed for variable lengths of time, although periods of suppression can be followed by a rebound in tic frequency and intensity. Tic frequency typically decreases whilst a child is relaxed, and typically increases with stress, anxiety, or tiredness[2].

Tics can influence functioning and quality of life directly, but these impacts are compounded by co-occurring neuropsychiatric conditions in 90% of individuals with TS[7]. Cortico-striato-thalamo-cortical (CSTC) dysfunction is implicated in the underlying aetiology of TS, with aberrations in sub-circuits and specific neurotransmitter systems linked to specific patterns of co-occurring traits, most commonly including inattention, hyperactivity/impulsivity, and obsessive-compulsive behaviours[2]. Other co-occurring challenges include anxiety, depression, learning difficulties, sleep disorders, autism, emotional dysregulation and rage attacks[4]. The assessment of individuals presenting with tics requires consideration of the differentials for repetitive movements, (such as stereotypy, chorea, and functional tics), in addition to thorough exploration of these co-occurring conditions.

Prevalence

At least 20% of individuals experience transient tics during childhood[5]. The prevalence of Tourette Syndrome in paediatric population-based studies sits around 0.5% (with a range of 0.3 - 0.8%)[8]. In adults, the prevalence of TS is approximately 5-fold lower[9]. Although it is recognised that some groups are under-represented in epidemiological studies of TS[10], available evidence does not suggest that TS prevalence varies significantly across geographical, ethnic and racial groups[8].

Male Preponderance

In childhood, the male-to-female ratio in TS is 4:1[11], although this ratio falls to 2.3:1 in adulthood[9]. Females have 0.5 lower odds of receiving a formal TS diagnosis, a later mean age of diagnosis (13 years versus 11 years), and longer time-to-diagnosis (3 years versus 2 years)[12]. Biological and gender-related influences leading to the sex differences observed in TS remain unclear, but ascertainment bias may also play a role[13].

Risk factors

Familial studies indicate that approximately 77% of TS susceptibility is attributed to genetics[14]. Environmental factors relevant to TS risk most prominently include perinatal insults, which may modulate the expression of TS in genetically predisposed individuals via immunological and inflammatory pathways[15]. Other maternal factors associated with TS liability in children include lower socioeconomic status, depression, and autoimmunity[16].

Natural History

In TS, tics most commonly emerge between the ages of 5 and 7 years, although tics can emerge in toddlers as young as 2-3 years[5]. In the majority of cases, tics of the eye or facial tics are the first to emerge[17]. Subsequent emergence of limb and trunk tics tend to follow a rostral to caudal pattern, with vocal tic emergence typically observed several years after motor tic onset[5]. Tic complexity commonly increases as children approach or enter adolescence[17]. Tic severity is often maximal around puberty, following a waxing and waning course characterised by gradual improvement towards adulthood[18,19]. Symptom progression varies significantly between individuals with TS, although only around 15% continue to live with moderate to severe and impairing tics as adults[5]. The most common experience (for 80% or more of individuals) is of some ongoing tics into adulthood, typically associated with mild severity and often with minimal to no impairment[5]. Longitudinal studies have suggested that less improvement may be observed in females and in those with greater tic severity in childhood and adolescence[20]. Tic persistence into adulthood is also associated with psychiatric and neurodevelopmental comorbidities, and psychiatric family history[21].

Pathophysiology

The aetiology of TS is attributable to disruption of sensorimotor–limbic–cognitive integration[22]. At the genetic level, genome-wide association studies link common variants with TS liability across a range of loci, e.g. *FLT3, NR2F1, PCDH9, UGP2, HCN1, CELSR3, BCL11B, NDFIP2, RBM26*[23-26]. Rare variants arising as a result of de novo or inherited exomic changes contribute to risk in subsets of individuals, e.g. *CELSR3, WWC1, FN1, NIPBL, OPA1, FBN2, PPP5C, EXOC1, GXYLT1*[27,28]. Environmental factors may also influence the expression of genetic differences via epigenetic pathways involving DNA methylation, histone modification, and non-coding RNA[29]. Downstream, genetic differences alter cellular functioning, immune-inflammatory pathways, and neurotransmission (most prominently, via dopaminergic and GABAergic pathways) that influence the development, maturation and functioning of the cortical-striatal-thalamocortical circuit and allied networks (e.g. cerebellar and insular systems) relevant to inhibitory control, habit formation, and interoceptive processing[30-35]. Key components of the cortical-striatal-thalamocortical circuit are depicted in Figure 2.

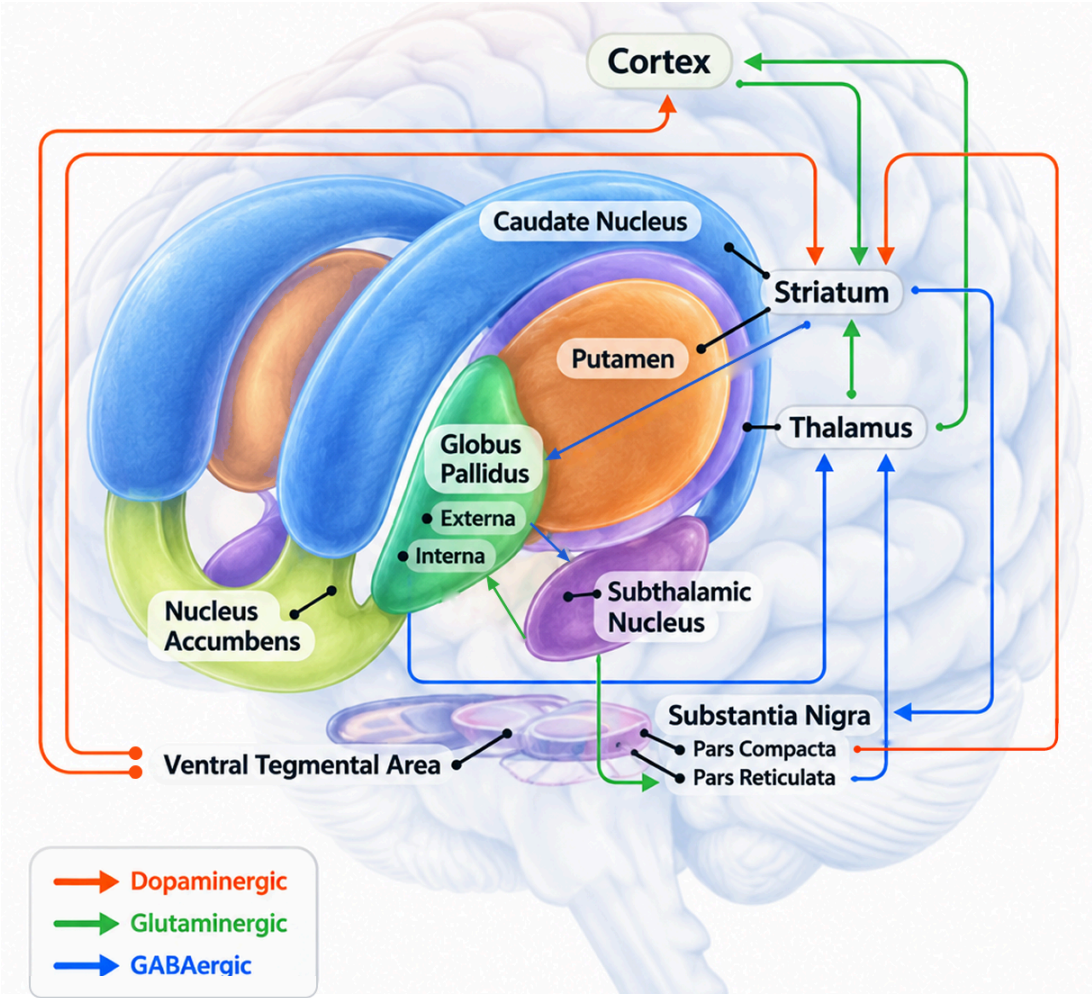


Figure 2: The cortical-striatal-thalamocortical circuit

Figure 2: Adapted from Robertson MM, Eapen V, Singer HS, Martino D, Scharf JM, Paschou P, Roessner V, Woods DW, Hariz M, Mathews CA, Črnčec R, Leckman JF. Gilles de la Tourette syndrome. Nat Rev Dis Primers. 2017 Feb 2;3:16097[2]

In TS, disrupted functioning within the basal ganglia impedes prevention of unwanted movement, leading to increased thalamocortical drive and inappropriate activation of the supplementary motor area, anterior cingulate cortex, sensorimotor cortex, and insula[30,31,36-38]. These changes are associated with loss and dysfunction of striatal GABAergic and cholinergic interneurons, with widespread reductions in GABA receptor binding[39,40]. Neuroimaging studies indicate altered neuroarchitecture in the putamen, caudate, thalamus, orbitofrontal cortex, insula, and cingulate cortex in comparison to control populations, with variation across age, medication status, and comorbidity subgroups[41-43]. Clinically, these changes manifest as tics associated with premonitory urges and suppressibility, and shared liability across a range of neurodevelopmental and psychiatric conditions[35]. The non-static pathophysiological differences observed in TS populations tend to partially normalise into adulthood, in keeping with the common experience of symptom abatement over time[42]. Figure 3 provides an overview of the multi-level pathophysiology of TS.

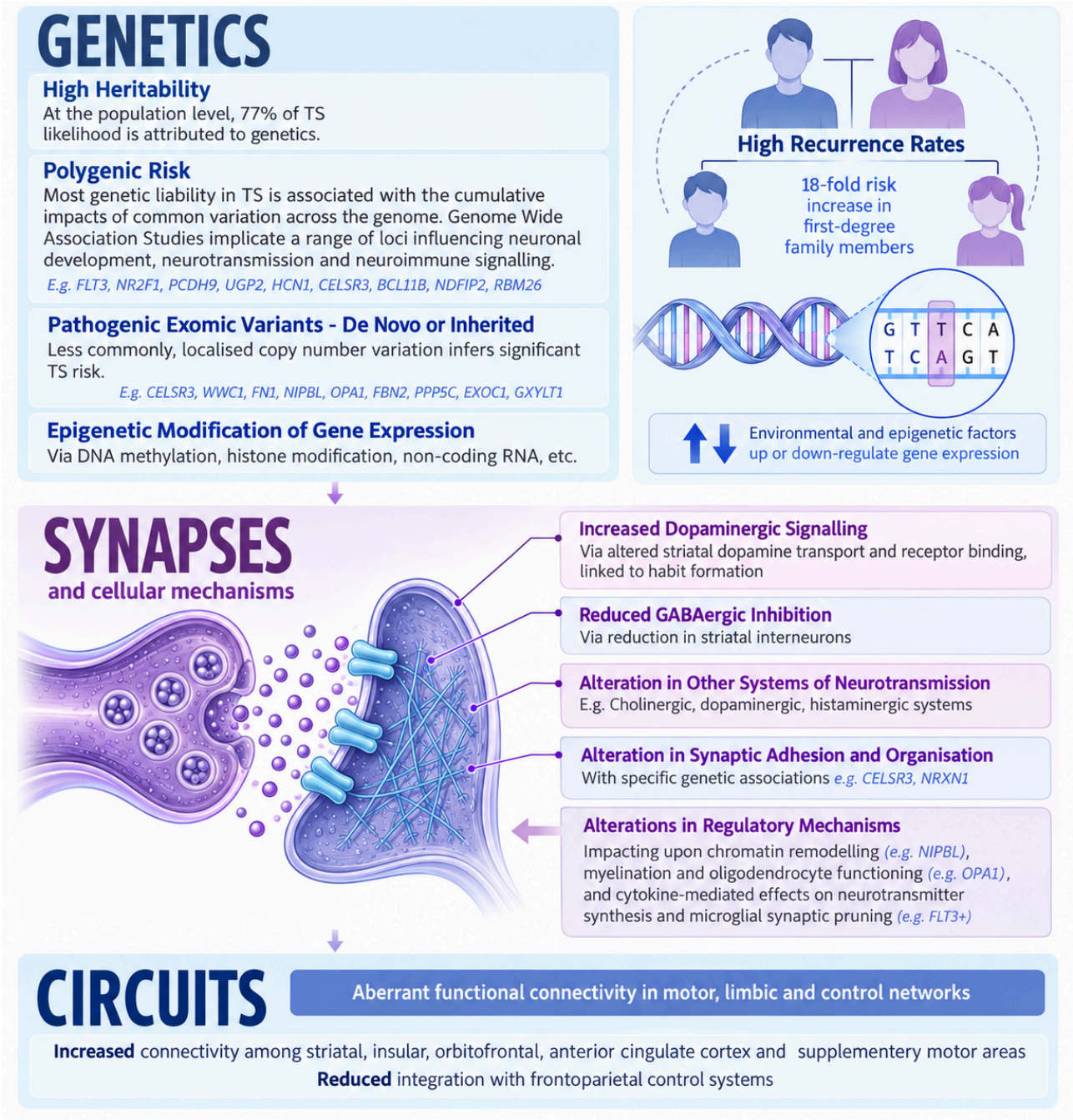


Figure 3: Pathophysiology in Tourette Syndrome – From Genes to Circuits

Tic Assessment

Tics can be classified as simple or complex[4]. Simple motor tics involve a single muscle group or body part, whilst complex tics involve multiple muscle groups, and may occur in coordinated sequences. Simple vocal (or phonic) tics involve sounds, whilst complex tics involve words or phrases. The duration of individual tics last seconds, but coordinated sequences of tics can persist for minutes to hours. Coprolalia is the term for tics involving swearing or socially inappropriate utterances, which occur in a minority of individuals with TS (approximately 10%-30%)[44]. Other common tics seen in around 30% of individuals with TS include immediate repetition of oneself (palilalia) or others (echolalia), and isotonic/dystonic tics (sustained clenching or twisting)[45,46]. Less commonly,

tics can involve copropraxia (obscene gesturing), or self-injury in approximately 2 to 20% of individuals with TS[2,47]. The use of formal rating scales can be helpful for assessing and monitoring tic severity, and tic-related impairment or interference with daily functioning[48]. The Yale Global Tic Severity Scale (YGTSS) is most widely used, and provides a tic severity subscale that considers the number, frequency, intensity, complexity, interference and impairment associated with motor and vocal tics across a range of domains[49].

Differential Diagnoses

Distinguishing Tics from Other Repetitive Behaviours

Tics are generally easy to distinguish from other types of repetitive behaviours, on the basis of their associated premonitory urge relieved by doing the movement, variability over time (changes in type, site and severity of symptoms with one type of movement being replaced by another), rostral to caudal progression (movements starting in the head and neck region and then spreading to lower parts of the body), a waxing and waning course, suppressibility (albeit with effort and with varying success for brief periods of time), and suggestibility[4]. Figure 1 highlights the features that distinguish tics from motor stereotypies, which are most commonly observed in individuals with autism or intellectual disability. Other differentials to consider in the assessment of repetitive movements include chorea and athetosis, myoclonus, tremor, akathisia, and compulsions. Choreiform movements are involuntary, non-rhythmic movements that tend to move unpredictably from one muscle group to another, and may worsen with movement. With chorea, isolated brief and jerky movements are recognisable, whereas athetosis involves involuntary, non-rhythmic movements that are difficult to isolate and appear to flow continuously[3]. Myoclonus involves sudden uni-directional movement due to muscle contraction (‘positive myoclonus’) or relaxation (‘negative myoclonus’), whilst tremor involves involuntary rhythmic oscillation about a joint axis[3]. Akathisia is characterised by excessive restlessness and a need to move, often involves the lower limbs, and associated subjective discomfort that ranges from mild to intolerable[50]. It is most commonly seen as a side effect of first-generation antipsychotic medications or illicit drug use, or in parkinsonian conditions[50].

Tic-Related Obsessive-Compulsive Behaviours versus Obsessive-Compulsive Disorder

In TS, complex tics and tic-related obsessive-compulsive behaviours (OCBs) with similarities to behaviours observed in obsessive-compulsive disorder (OCD) may be concomitantly present[51]. Specifically, the relief of urge following a tic or series of tics may be associated with a need to achieve the experience of feeling ‘just right.’ Unlike in OCD, tic-related OCBs are not goal-directed, i.e. they are not performed to neutralise a thought or appease an obsessional idea, prevent a harmful consequence or to obey an internal rule. Table 2 highlights features that can assist in distinguishing tic-related OCBs and OCD in the context of TS[52].

Table 2: Distinguishing Tourettic Obsessive-Compulsive Behaviours from Obsessive-Compulsive Disorder

	Tic-Related OCBs	OCD
Goal	Not goal-directed but performed to achieve a 'just right' feeling	Goal-directed – to neutralise an obsession, prevent harm or obey an internal rule
Precedent	Premonitory sensation or urge	Cognitive thought or obsession
Type	Brief and involuntary	Purposeful and voluntary
Course	Variable site, intensity, and frequency - waxing and waning and gradual improvement with age	Less variability in site, intensity, and frequency over time
Onset	Most commonly between 6-7 years	Peaks at 8-12 years and again in late adolescence to early twenties
Distress	Inability to perform the action does not typically cause distress	Inability to perform the action may result in extreme distress

Distinguishing Tourette Syndrome from Paediatric Acute-Onset Neuropsychiatric Syndrome

In TS, tic severity and frequency will typically intensify during periods of illness, stress, and fatigue, and dysfunction of neuro-immune pathways are implicated in TS pathophysiology[34]. Paediatric Acute-Onset Neuropsychiatric Syndrome (PANS) is characterised by the abrupt onset of tics and OCD following an infection, with increasing recognition of broader causal pathways than previously associated with Paediatric Autoimmune Neuropsychiatric Disorders Associated with Streptococcal Infections (PANDAS). Whilst evidence surrounding the identification and management of PANS is mixed, meta-analyses and systematic reviews support the notion that immune dysregulation may be relevant in at least a subset of patients[53], particularly in those genetically predisposed - with shared genetic risks leading to pleiotropy and involvement of overlapping neuronal circuitry resulting in psychiatric comorbidities[52].

Distinguishing Tourette Syndrome from Functional Tic Disorder

Cases of functional tic disorder have increased significantly from 2021 onwards, following the coronavirus pandemic and the increasing influence of social media[54]. In contrast to the childhood onset and male predominance of TS, functional tic disorder is most commonly observed in post-pubertal young women[55]. It can be challenging to distinguish tics from functional tics (Table 3), and approximately 20% of individuals with TS also exhibit functional tics alongside non-functional tics[56]. Features that can help to distinguish functional tics from tics[55,57] include sudden onset of complex tics such as thrashing or violent movements, screaming or loud vocal (phonic) tics and vocalisation including coprolalia alongside or immediately after the onset of motor tics in post-pubertal females that often require medical attention (e.g. Emergency Department presentation)[55,57]. In contrast, the typical presentation of TS involves male preponderance, with slow insidious onset of motor tics around 6 to 7 years, with rostro-caudal progression and emergence of vocal tics several years later. Other factors that prompt consideration of functional tics include the presence of a stressor at

the time of tic onset, atypical urge (for example, an electric shock felt throughout the body), absent premonitory urge, high comorbidity with anxiety, depression, arousal and dysregulation (less commonly ADHD and OCD), and asynchronous or disproportionate functional impairment associated with tics[52].

Table 3: Distinguishing Tourette Syndrome from Functional Tic Disorder

	Tourette Syndrome	Functional Tic Disorder
Sex Ratio	Male predominance 3:1	Female predominance 3:1
Onset Age	Typically 6-7 years	Late adolescence or early 20s
Typical Onset	Insidious onset of simple tics with rostral to caudal progression	Abrupt emergence of complex tics, often aggressive or inappropriate
Course	Waxing and waning, with increased complexity building over years	Explosive onset with peak severity within weeks or months
Premonitory Urge	Precedes and relieved by tic	Absent or atypical e.g. experienced over entire body or as 'electric'
Significant Interference	Not common	Dramatic and/or persistent interruption of intended actions
Coprolalia or Copropraxia	Very rarely present at onset (~2%)	Commonly present at onset (60-70%)
Suppressible	Most commonly yes (~60%)	Less common (~20%)
Frequency and Intensity	Rarely more prominent in the presence of others (<5%)	Often more prominent in the presence of others (~50%)
Extreme Tic Attacks	Very rare (2%)	Common (65%)
Self-Injury	Very rare	Common
Contextual Triggers	Unclear	Common
Common Comorbidities	ADHD, OCD	Agitation, anxiety, depression – with ADHD and OCD less common
Impairment	Subjective distress concordant with impact of movements	Subjective distress discordant with expected impact of movements

Source: Eapen *et al.*[52]

Comorbid conditions

TS occurs in the presence of at least one comorbid condition in approximately 80%-90% of cases[58,59]. For many individuals living with TS, these co-occurring conditions are the primary source of functional impairment on a day-to-day basis[60]. These conditions also tend to persist into adulthood, even among those who experience remission of tics over time[61].

The most common comorbid conditions observed in TS include obsessive compulsive disorder (30-60%) and attention deficit hyperactivity disorder (50-60%), with around 30% of individuals with TS presenting with both of these co-occurring conditions[58,59,62]. Anxiety is observed in around 60%, whilst mood disorders, learning disorders and disruptive behaviour disorders (oppositional defiant disorder and/or conduct disorder) are each observed in approximately 30% of individuals with TS, respectively[7]. Autism spectrum disorder and developmental delay are each observed in 20-25%, respectively[7,63].

Medical comorbidities such as epilepsy, migraine and sleep disorders are observed in around 10-30% of cases, and population-based studies support a positive association between the presence of tic disorders and allergic conditions[7]. In adulthood, individuals with TS are at higher risk of substance misuse, even after controlling for psychiatric comorbidity and familial factors[64]. A higher risk of musculoskeletal disorders impacting on the cervical spine, adverse perinatal outcomes and increased mortality have also been reported[65-67].

Management

To achieve optimal quality of life outcomes in the context of TS, a holistic and multidisciplinary approach to management is required[68]. Interventions aiming to reduce tic frequency or intensity must be coupled with interventions addressing co-occurring psychiatric and medical conditions[60]. Furthermore, identification and amelioration of unmet psychosocial needs is paramount, alongside psychoeducation and strategies for reducing stress and enhancing overall wellbeing[69]. Accommodations at school or work, (such as extra time or small group supervision for exams), support to improve self-esteem, confidence and self-advocacy, life-style measures, and acceptance of the condition are all critical in achieving good quality of life regardless of the nature and course of tic symptoms[4].

In many individuals with TS, management strategies focus primarily on psychoeducation, optimisation of health and wellness, and treatment of co-occurring conditions[2]. The decision to specifically target tic frequency and severity with behavioural and/or pharmacological interventions is typically determined by the presence of tic-related impacts on self-esteem, social functioning, interference with daily activities, and in some cases, musculoskeletal pain. Pharmacological options are typically explored in cases where tics are too severe for behavioural treatments to be implemented, or where significant functional impact persists following the provision of psychoeducation and behavioural therapies[2], as both approaches have been associated with similar rates of reduction in tic severity after three months[70].

Pharmacological Management of Co-Occurring Conditions

Evidence supports a modified approach to the management of OCD in the context of TS, with enhanced response to neuroleptic augmentation whilst primary OCD tends to respond primarily to selective serotonin reuptake inhibitors[71]. In contrast, the initial management of co-occurring ADHD in TS tends to follow typical pathways, with meta-analytic evidence not supporting an association between new onset or worsening of tics and stimulant use[72]. However, slower dose titration and more frequent monitoring is recommended[73], and alpha-2 agonists (such as clonidine or guanfacine) are associated with dual benefits in relation to treating both tics and ADHD symptoms simultaneously, such that these non-stimulant medication options are often appealing first line options in the management of co-occurring ADHD and TS, especially in children and adolescents[4].

Behavioural Therapies Targeting Tic Severity

There are three main evidence-based behavioural approaches for the suppression of motor and vocal tics[74]. These include Habit Reversal Training (HRT), Comprehensive Behavioural Intervention for Tics (CBIT), and Exposure with Response Prevention (ERP), with international guidelines supporting CBIT as first-line[75]. The core components of HRT include awareness training (to increase self-awareness of tics and their associated premonitory urge), competing response training (to identify and practice actions that can be taken as the tic or urge emerges, impeding tic completion), and social supports[76]. CBIT encompasses the core components of HRT in addition to relaxation training (such as diaphragmatic breathing and progressive muscle relaxation), and functional interventions to decrease common triggers for tics (e.g. stress management and optimisation of environmental factors for reducing tic frequency and intensity)[77]. ERP involves exposure to triggers for the urge to tic whilst practising active tic suppression, aiming to gradually decrease the effort involved and duration of suppression achieved over time[78]. These approaches to reducing tic severity are supported by randomized, controlled studies in both adult and paediatric populations[79,80], and potential concerns regarding symptom substitution and significant worsening of tics following suppression were not substantiated[74,75].

Pharmacological Interventions Targeting Tic Severity

Options for the pharmacological management of TS[81-85] are outlined in Table 4. In each case, the approach to management involves gradual up-titration to identify the lowest effective dose for each individual, regular monitoring, and after response is maintained for six months, consideration of tapering to determine the need for ongoing medication use. In general, the second-line medication options for TS (antipsychotics and vesicular monoamine transporter-2 inhibitors) are more effective than the first-line agents, but are not typically trialed in the first instance, due to their problematic side-effect profiles[81]. Among second-line options, aripiprazole may be preferred, in view of the lower associated risk of extrapyramidal side effects[82].

Table 4: Medication Options in TS

Medication	Mechanism of Action	Notable Side Effects
First Line		
Clonidine, Guanfacine	Alpha-2 Agonism: Reduction in presynaptic norepinephrine	Sedation, postural hypotension, bradycardia.
Second Line – Atypical Antipsychotics		
Aripiprazole	Partial dopamine agonism	Less weight gain, QTc prolongation and extrapyramidal effects than other antipsychotics.
Risperidone, olanzapine, quetiapine	Dopamine D2 and serotonin 5-hydroxytryptamine 2 antagonism	Sedation, extrapyramidal effects, QTc prolongation, gynaecomastia, weight gain, hyperprolactinemia, depression and anxiety.
Third Line		
Topiramate	GABA-A Agonism: Increased inhibitory neurotransmission	Sedation, weight loss, renal calculi, cognitive difficulties.
Baclofen	GABA-B Agonism: Increased inhibitory neurotransmission	Sedation, dizziness, confusion, headaches, hypotonia, ataxia.
Clonazepam	GABA-A Agonism: Increased inhibitory neurotransmission	Sedation, cognitive difficulties, paradoxical activation, ataxia.
Typical Antipsychotics: Haloperidol, pimozide, fluphenazine	Dopamine antagonism via D1 or D2 receptors	Sedation, extrapyramidal effects, QTc prolongation, gynaecomastia, weight gain, hyperprolactinemia, depression and anxiety.
Vesicular monoamine transporter-2 inhibitors: Tetrabenazine, deutetrabenazine – note efficacy not supported by controlled trials	Presynaptic dopamine depletion	Insomnia, parkinsonism, depression and suicidality
Ecopipam – emerging, trials in progress	Selective D1 and D5 receptor antagonism	Headaches, insomnia. Reduced D2-associated side effects.
Other		
Cannabinoids – emerging, with small trials showing early positive results[83,84]	CB1 and CB2 modulation	Sedation, euphoria, increased appetite, psychosis, depression.

Medication	Mechanism of Action	Notable Side Effects
Botulinum toxin	Presynaptic blockage of acetylcholine release	Muscle weakness, hypophonia.
Neuromodulation - Deep brain stimulation	Neurosurgical stimulation of the thalamus or pallidum	Invasive neurosurgical risks.
Non-invasive neuro stimulation	Transcranial magnetic or direct current stimulation of motor cortex	Headache, dizziness, seizures.
Median nerve stimulation e.g. Neupulse, evidence emerging[85]	Rhythmic median nerve stimulation via wrist-worn device	Tingling, tapping, or pulsing sensation in underside of the wrist

Conclusion

Optimal quality of life outcomes require holistic and multidisciplinary approaches to supporting individuals with TS. Ongoing research is needed to further delineate our understanding of the underlying pathophysiology implicated in TS, to guide personalised recommendation of available treatment options, and to broaden the range of effective and evidence-based treatment options into the future.

Chapter Summary

Definition: Tourette Syndrome (TS) is a chronic neurodevelopmental disorder characterised by the presence of multiple motor tics and one or more vocal (phonic) tics for one year or longer, with onset in childhood.

Epidemiology: Although around 20% of individuals experience transient tics during childhood, the prevalence of Tourette Syndrome sits around 0.3-0.8%.

Clinical Presentation: Tics are sudden, repetitive, nonrhythmic movements or vocalisations. Characteristic features include a premonitory urge, a waxing and waning course, rostral to caudal (head to toe) progression of new onset tics, voluntary suppression with effort, and suggestibility. Co-occurring conditions occur in 80-90% of cases and have a profound impact on quality of life.

Pathophysiology: The aetiology of TS is attributable to disruption of sensorimotor–limbic–cognitive integration, with altered functioning of the cortical-striatal-thalamocortical circuit (CSTC) and allied networks.

Natural History: Following a typical onset around 6 to 7 years, tic severity is often maximal around puberty, following a waxing and waning course characterised by gradual improvement towards adulthood.

Diagnosis: Clinical assessment involves a holistic, biopsychosocial approach with consideration of co-occurring conditions. The Diagnostic and Statistical Manual of Mental Disorders (DSM-5-TR) outlines key diagnostic features.

Assessment: The use of formal rating scales can be helpful for assessing and monitoring tic severity, and tic-related impairment or interference with daily functioning.

Management: Behavioural and pharmacological interventions aiming to reduce tic frequency or intensity must be coupled with interventions addressing co-occurring psychiatric and medical conditions, and unmet psychosocial needs. Optimal quality of life outcomes require holistic and multidisciplinary approaches to supporting individuals with TS.

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