Let's start with a case

- **Chief complaint:** 8 year old boy with progressive balance disturbances and frequent falls
- **HPI:** slowly progressive difficulty with balance, “trip” over nothing
  - No preceding head injury, insult or trauma or injury
  - PMH: term, uncomplicated twin pregnancy, mild gross motor delay
  - FH: twin brother does the same thing
- **Exam:**
  - General exam: unremarkable
  - Neurological examination:
    - Very broad based gait, severely unsteady
    - Fast, abrupt jerks of the extremities and trunk causing him to become off balance
Outline

- Why is this important?
- Define terms used to describe movements
- Pattern recognition
- What work-up can/should be started before a referral to a specialist?
- Interventions
Background

- Movement disorders are common
- Tourette syndrome, essential tremor: 1%
- Functional neurological Disorders: 2nd most common reason to see a neurologist
- Sometimes lifelong impact, life-limiting
- Some are uncomfortable, embarrassing, cause occupational dysfunction
- Cost of treatment

Definitions

Hypokinetic
- Ataxia
- Athetosis
- Bradykinesia
- Chorea
- Dyskinesia
- Dystonia
- Hyperkinesia
- Mirror movements
- Myoclonus
- Myokymia
- Myorhythmia
- Restless leg
- Spasms
- Stereotypy
- Tic
- Tremor

Hyperkinetic
- Akathisia
- Ataxia
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Definitions

- Hypokinetiс
  - Akathisia
  - Atonia
  - Athetosis
  - Bradykinesia
  - Chorea
  - Dystonia
  - Dyskinesia
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- Hyperkinetiс
  - Hyperkinesia
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  - Hypokinesia
  - Hyperkinesia
  - Tics
  - Stereotypy
  - Spasms

Catatonia

https://youtu.be/3AEQ-Aj1msg
Zerati 2010
Definitions

- Hypokinetic
  - Catatonia
  - Parkinsonism/extrapyramidal symptoms
  - Some tics
- Hyperkinetic
  - Akathisia
  - Akinesia
  - Athetosis
  - Ballism
  - Choreia
  - Dystonia
  - Eyelid twitching
  - Hyperkinesia
  - Mirror movements
  - Myoclonus
  - Myokymia
  - Myorhythmia
  - Restless leg
  - Spasms
  - Stereotypy
  - Tic
  - Tremor

Tic
Definitions

- Hypokinetic
  - Akathisia
  - Ataxia
  - Athetosis
  - Ballism
  - Chorea
  - Dystonia

- Hyperkinetic
  - Hyperexplexia
  - Mirror movements
  - Myoclonus
  - Myokymia
  - Myorhythmia
  - Restless leg
  - Spasms
  - Stereotypy
  - Tic
  - Tremor

Dystonia

Brandma et al 2020

- Hyperkinetic
  - Akathisia
  - Ataxia
  - Athetosis
  - Ballism
  - Chorea
  - Dystonia

- Hyperkinetic
  - Hyperexplexia
  - Mirror movements
  - Myoclonus
  - Myokymia
  - Myorhythmia
  - Restless leg
  - Spasms
  - Stereotypy
  - Tic
  - Tremor

- Dystonia
  - Hyperexplexia
  - Mirror movements
  - Myoclonus
  - Myokymia
  - Myorhythmia
  - Restless leg
  - Spasms
  - Stereotypy
  - Tic
  - Tremor
**Stereotypy**

Brandoma et al. 2020

**Definitions**

- Hypokinetic
  - Catatonia
  - Parkinsonian/extrapyramidal symptoms
  - Some tics
  - Akathisia
  - Akinesia
  - Athetosis
  - Ballism
  - Chorea
  - Dysthria
  - Dyssoria
  - Hyperexplexia
  - Mirror movements
  - Myoclonus
  - Myokymia
  - Myorhythmia
  - Restless leg
  - Spasms
  - Stereotypy
  - Tic
  - Torsion

- Hyperkinetic
  - Ballism
  - Twisting, swinging, jerking movement
  - Chorea
  - Sudden, jerky, irregular, dance-like, often contiguous
  - Dystonia
  - Econic writhing movements with or without dystonic component

- Akathisia
  - Inability to stay still, restlessness, muscle quivering
  - Common side effect of antipsychotic or antidepressant medications
  - Athetosis
  - Slow, writhing movements, worm-like
  - Ballism
  - Seizing, swinging, jerking movement
  - Chorea
  - Sudden, jerky, irregular, dance-like, often contiguous
  - Dystonia
  - Econic writhing movements with or without dystonic component
Definitions

- Hyperekplexia
  - Exaggerated startle resulting in hypertonia

- Mirror movements
  - Simultaneous contralateral identical movement accompanying voluntary movement

- Myokymia
  - Localized quivering of nerves or muscles within a small area

- Hypertonicity
  - Repetitive, rhythmic, slow, coarse tremor

- Example: oculomotor (pathognomonic for Whipple's disease of the CNS)

- Restless leg
  - Uncontrollable urge to move the legs accompanied by unpleasant sensation

Spasms
- Sustained involuntary muscular contraction

Tremor
- Rhythmic low amplitude to and fro movement around a joint of variable frequency
  - Various subtypes: kinetic, postural, intention

Neurodiagnostic evaluation

- Is it a movement disorder (MD)?
- Classify the MD phenotype and which MD is most prominent?
- Could the MD be functional?
- Determine the clinical syndrome
- Can the movement disorder be caused by an acquired cause?
- Does the clinical syndrome fit a treatable etiologic syndrome of metabolism?
- Consider genetic testing
- Post next-generation sequencing phenotyping

Brundin et al 2020
Laboratory testing

- Serology:
  - Infectious
  - Autoimmune
- Spinal fluid:
  - Infectious
  - Autoimmune
  - Neurotransmitter disorder

<table>
<thead>
<tr>
<th>Treatable inborn errors of metabolism</th>
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<tr>
<td>Brandma et al. 2020</td>
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MRI

- Trauma
- Vascular
- Autoimmune
- Genetic/metabolic
- Infectious

Back to our case

Genetic testing

- Specific gene panels for ataxias, dystonias, channelopathies
- Whole exome sequencing
  - Limitations:
    - Does not detect large deletions/duplications
    - Does not detect triplet repeat expansions
    - Does not detect intronic variations
  - Diagnostic yield ~30%
Back to our case

Whole exome sequencing revealed a heterozygous known pathogenic mutation in the KCNC3 gene compatible with autosomal dominant spinocerebellar ataxia type 13.

- Phenotypic spectrum
- Includes progressive and nonprogressive types
- May feature learning disabilities and/or psychiatric manifestations
- Treatment: therapies
  - Perhaps medication, based on gain or loss of function
  - Avoid: alcohol (may exacerbate ataxia)
- Not generally thought to be life-limiting (unless dysphagia is present)
- Parent/patient support groups

Summary

- Pediatric movement disorders are common, debilitating, costly
- Phenomenology is paramount for classification, guiding work-up
- Encourage parents to get a video (and share with you in a HIPAA-compliant fashion)
- Metabolic, genetic testing, and neuroimaging can be revealing
- Treatments are available

Functional Neurological Disorders

- Motor, sensory, other symptoms that are
  - Genuinely experienced
  - Related to a functional (rather than structural) problem with the nervous system
  - Huge historical burden (hysteria, conversion disorder)
  - Not necessarily a diagnosis of exclusion
  - Functional neuroimaging and neurophysiology can help in the diagnosis
  - Represents 5-10% of new neurology consultations
  - Incidence ~12/100,000/year
  - Disproportionately affects females ~3:1 but this decreases with age
  - Rare before age 10

Bennett et al. 2021
Functional Neurological Disorders

- Associated with high levels of disability
- Higher frequency of psychological comorbidities than other neurological disorders
- Can co-occur with other functional disorders (abdominal or chronic pain)
- Can co-occur with other neurological disorders (~20% of cases)
- Symptoms typically persist for many years
- Estimated total annual healthcare cost is ~$900 million

Bennett et al 2021
Stephen et al 2019

Functional Neurological Disorders

- Make a thorough list of symptoms
- Investigate for mechanism of onset
- Diagnostic pitfalls
  - Failure to consider comorbidity of another medical condition
  - Reliance on unusual clinical features
  - Fail to consider psychiatric features/recent stress
  - Dependence on normal investigations
  - Misinterpretation of abnormal investigations

Bennett et al 2021

Functional Neurological Disorders

- Physical exam pearls
  - Hoover’s sign
  - Splitting the forehead
  - Entrainable movements
  - Distractibility
  - Suggestibility
  - Retained consciousness with whole-body convulsions
  - Spontaneous resolution of prolonged whole-body convulsions without confusion
  - Astasia abasia

Bennett et al 2021
Functional Neurological Disorders

- Pathophysiology hypotheses
  - Changes in brain networks
  - Altered predictive processing
- Treatment
  - Validation
  - Confident delivery of diagnosis
  - Education/Support
    - www.fndhope.org
    - www.fndaction.org.uk
    - www.neurosymptoms.org
- Therapies
  - Medication
  - Alternative treatments

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Thank you!
Questions?

References


https://www.youtube.com/watch?v=Jvndm