PedsCases Podcast Scripts

This is a text version of a podcast from Pedscases.com on "**Approach to Acute Ataxia.**" These podcasts are designed to give medical students an overview of key topics in pediatrics. The audio versions are accessible on iTunes or at www.pedcases.com/podcasts.

Approach to Acute Ataxia

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Introduction:

Hello, and welcome to this PedsCases podcast on Acute Ataxia. My name is Aran Yukseloglu, and I am a 1st year Pediatrics resident at the University of Alberta. This podcast was made in collaboration with Dr. Francois Jacob, a pediatric neurologist at the Stollery Children's Hospital in Edmonton, Alberta. By the end of this podcast, we hope you will have achieved the following objectives:

1) Construct a differential diagnosis for acute ataxia in children
2) Discuss important aspects of the history that differentiate the etiology of ataxia presentations
3) Describe key physical exam findings that inform the differential diagnosis
4) Distinguish potentially life-threatening causes of ataxia from common ones
5) Review initial workup/management of common causes of acute ataxia

To start this topic, let me introduce you to our patient:

The Clinical Case:

Two worried parents present to the Pediatric Emergency Department with their 4-year-old boy, Stephen. Until today, Stephen had been doing very well and was otherwise healthy and meeting developmental milestones. Yesterday, Stephen's parents brought him to a local playground to play with some friends. This morning, after Stephen got out of bed, his parents noticed that he was having trouble walking; he was much slower than normal and seemed to be unsteady on his feet. Otherwise, he has been interacting with them normally and hasn't complained of any pain or discomfort anywhere. However, they're very scared as Stephen has never had anything like this before.

On physical examination, Stephen is afebrile with all vital signs within normal limits, he is alert with a GCS of 15. When you complete a neurological examination, he has normal strength and reflexes, but you think his muscle tone seems a bit low and he has some mild dysmetria on your cerebellar testing. You notice some mild nystagmus, though he does not endorse any visual troubles, and you find that he sways a little bit while trying to sit still for visual testing. After doing the visual testing, he says he has a

headache, so you check and confirm he has no meningitic signs. Examination of his cranial nerves is unremarkable, and he has no other focal neurological deficits. When you get him to walk, he has a very wide based gait and stays close to the wall, reaching at it for support when he wobbles and lurches. If you get him to close his eyes briefly, there is no change to his balance.

Introduction to Ataxia:

When assessing a patient like Stephen who presents with unsteadiness, one must first understand what ataxia is, and how it may affect a patient's movements.

> *Ataxia is a disturbance in the coordination of movement, leading to difficulties with fine control of movements and posture.*

Coordination of movement comes from the cerebellum, which is normally capable of analyzing movements as we do them, in order to fine-tune and coordinate our movement. Cerebellar dysfunction can affect movement coordination, balance, eye movements, feeding and play behaviours, and some aspects of cognition (1,2)**.** The cerebellum is composed of the two cerebellar hemispheres, and of the cerebellar vermis. Cerebellar hemispheres are responsible for the extremities, whereas the vermis is in control of the trunk. A lesion of the hemispheres can lead to dysmetria, dysdiadochokinesis, intention tremor, and speech abnormality. In case of a unilateral cerebellar hemisphere lesion, the symptoms will affect the ipsilateral limb. Lesions of the vermis cause gait ataxia (requiring patients to walk with a wide space gait), titubation of the head and trunk, dysmetria (often more lower than upper extremity), abnormal eye movements, and vertigo. However, one must keep in mind that coordination of movement also requires motor input to the muscles needed for the movement, and proprioceptive sensory input returning from the body. If either of these are altered, coordination of movement will be affected Therefore, before localizing a lesion to the cerebellum as the cause of someone's unsteadiness, one must be sure that there is no motor or sensory dysfunction.

The first step in any case of ataxia is completing a history. Establishing the timeline of development of symptoms is key in narrowing your differential. Ataxia can be either acute or chronic. Acute ataxia arises in a period less than 72 hours in otherwise healthy children, common causes include drug ingestion, and post-infectious cerebellar ataxia. Recurrent discrete episodes may point towards causes such as basilar migraines or benign paroxysmal vertigo, which will be covered later. Chronic ataxia develops gradually, and include genetic causes such as Freidrich's ataxia, ataxia telangiectasia, and spino-cerebellar ataxias to name a few. For the purpose of this podcast, we will be focusing on acute or recurrent presentations of ataxia, not chronic or progressive ataxias.

Next, considering any other associated illness or injury, such as recent infections or any possible trauma, is very important. Concussion can often be the cause in young children, although post-infectious etiologies represent the most common causes.

A complete review of systems, must be done in order to better localize the symptoms. The presence of otalgia or vertigo can be suggestive of an inner ear issue, while night time or early morning vomiting can be seen in increased ICP.

Finally, family history is also critical, for conditions such as migraine which may link to the child's ataxia or genetic causes of ataxia. Furthermore, if family members are taking

medications, there is always a risk that your patient may have had an accidental ingestion causing their ataxia.

The second step is the Physical and Neurological examination, which will help you confirm your localization and narrow your differential diagnosis. During your examination, you must also test motor and sensory abilities, to ensure that deficits in these realms are not responsible for making the patient seem ataxic.
Red flags on physical examination include:

- Abnormal vital signs. The combination of bradycardia, hypertension and an abnormal breathing pattern is called Cushing's Triad and is seen with high intracranial pressure.
- Any altered level of consciousness or encephalopathy
- Any new focal neurological deficits, such as weakness, sensory changes, brisk reflexes or absent reflexes
- Visual loss
- Papilledema
- Head tilt can be associated with posterior fossa tumors or CN deficits (VI)
- Abnormal eye movements such as nystagmus or opsoclonus
- Rash
- Meningismus; neck stiffness, headache, photophobia

Features which may be seen in a child with a cerebellar lesion include:

1. Abnormal gait. Patients *typically* have a wide-based gait, and will often be lurching or staggering, sometimes seeming at risk of falling. The wide-base is due to the patient's attempt to adapt and maintain their balance. Young patients might simply be refusing to walk. In a patient who refuses to walk one must rule out pain.
2. You may also see disturbances of the patient's core, in which they may be unable to keep their torso still while sitting or have tremulous nodding movements of their head, known as titubation.
3. You may also find dysmetria, in which patients may overshoot attempts to touch an object (as with the finger-nose test), and also
4. Dysarthria in which a fluctuating scanning speech pattern is heard (3).
5. Nystagmus

Before we continue with the case of Stephen, we'll go through some of the possible causes of acute ataxia. These can range from common, such as intoxications or post-infectious occurrences like acute cerebellar ataxia, to rarer events such as strokes and brain tumours.

Differential Diagnosis for Acute Ataxia:

Life-Threatening Causes:

In some cases, acute ataxia may in fact be an early presentation of a life-threatening illness. It is critical to rule-out these serious causes before considering other less dangerous possibilities.

One of a family's initial fears is "Does my child have a brain tumor?" since in children, 45-60% of brain tumor occur in the posterior fossa and they may present with ataxia. One would expect, depending on the grade of the tumor, that the ataxia would have been progressively getting worse. However, there may be a more abrupt onset of ataxia such as; obstructive hydrocephalus, hemorrhage within the tumor, or edema that begins to impact nearby structures. In many cases the early course of ataxia may go unnoticed by caregivers until it becomes severe enough to catch their attention, at which point it may present as "acute ataxia". On examination, one may find red flag signs of increased intracranial pressure, such as papilledema and cranial neuropathies. Other red flag symptoms to consider include early-morning headaches and nausea or vomiting. If there is any concern about possible brain tumours in an ataxic child, imaging (such as CT or MRI) should be rapidly obtained.

Intracranial hemorrhages and ischemic strokes are rare cause of acute ataxia in children, outside of a history of trauma. A spontaneous cerebellar hemorrhage can occur as the result of an aneurysm, venous thrombosis, or other vascular malformation. Clinically there can be rapid decompensation as the hemorrhages grows, and this may be a surgical emergency. The presence of unexplained intracranial hemorrhages in a child of any age should raise the suspicion of possible non-accidental injury (child abuse).

In an ataxic patient, one must also rule out **meningitis**. Any meningitic signs, headaches, and or a generally sick appearing child especially in the context of a fever should increase suspicion and warrant a lumbar puncture. In rare instances a cerebellar abscess can be preceded by a otitis media or mastoiditis.

In any patient who has an altered level of consciousness, features concerning for CNS masses, a history of trauma, or findings such as marked asymmetry of ataxia, cranial neuropathies, or focal neurological deficits, brain imaging is necessary. An MRI is ideal, but in emergent situations a CT is more accessible and is the typical first step.

Immune Post-Infectious

A major cause of ataxia includes immune and/or post-infectious etiologies, which may range from life threatening to self-limited.

One of the more severe (and rare) condition is **acute demyelinating encephalomyelitis (ADEM)**. ADEM typically occurs 1-4 weeks after a febrile illness and is characterized by encephalopathy associated with wide range of possible neurological deficits from ataxia to optic neuritis to hemiplegia. In severe cases ADEM can even result in coma. On MRI, ADEM shows multiple areas of demyelination, and an LP reveals both high white cells and protein.

Two other conditions with symptoms that can overlap with ADEM include **Miller-Fisher Syndrome,** and **Brainstem encephalitis. Miller Fisher syndrome** is classically characterized by ataxia, areflexia, and ophthalmoplegia. Affected children will often have had a recent viral illness, with neurological effects occurring 5-10 days after a viral prodrome in 50% of cases (4)**.** Miller Fisher syndrome is closely related to Guillain Barré Syndrome, which primarily affects motor neurons, and results in areflexia. In both Miller-Fisher Syndrome and GBS, the CSF will have what is known as albuminocytologic dissociation, with elevated protein without elevated white cells. **Brainstem Encephalitis** is characterized by predominantly cranial nerve palsies and altered level of consciousness. Causes of brainstem encephalitis can be post-infectious, infectious

(echoviruses, coxsackieviruses, adenoviruses, and *Coxiella burnetii* (4), as well as autoimmune conditions such as Behcet's and Sarcoid.
Opsoclonus-Myoclonus syndrome is one of the few paraneoplastic syndrome in children. It is characterized by opsoclonus, which consist of rapid jerking eye movements, and rhythmic myoclonic jerks, and ataxia. All children should be investigated thoroughly for an occult neuroblastoma – up to 50% of children with that presentation are found to have neuroblastoma (2,3,5), while others are typically post infectious. These children, typically younger than 5 years old, may present with falls due to the ataxia, as neuroblastoma can cause a paraneoplastic encephalopathy (6).

Acute Cerebellar Ataxia:

The most common cause of acute ataxia is **acute cerebellar ataxia** (ACA), which accounts for about half of cases of acute ataxia. ACA is a post-infectious autoimmune phenomenon that typically affects young children, aged 2-5 years old. It is on a spectrum with acute cerebellitis (a term that was previously used interchangeably), an infectious process that is typically more severe and can be differentiated clinically from ACA as it can have altered mental status and neuroimaging changes (7,8). ACA usually occurs about 5-10 days after a prior infection, most commonly with varicella, but has been associated with other pathogens such as mycoplasma, EBV, parvovirus B19, coxsackie, and HHV6 – it has also been known to occur following receival of live-inactivated varicella vaccines. ACA has a very abrupt onset, and the ataxia reaches its worst within the first hours after onset of the condition. It varies from mild gait abnormalities and unsteadiness, to so severe that a patient cannot stand. The gait is usually affected more than the limb movements, and dysmetria will be mild; there may also be nystagmus, but also quite mild if present (5). Overall, the child should not have any changes to mental status and should be otherwise well.
However, ACA is a diagnosis of exclusion, and the myriad of other (potentially more serious) causes of acute ataxia must be ruled out. Symptoms of ACA are generally self-limited, and may begin to approve within a matter of days; on average, full recovery of gait occurs in two weeks (9), but it can take many weeks to months to fully resolve and for the child to regain normal gait and coordination of fine movements. Around 90% of children will have full resolution of symptoms (10), though some may have transient intellectual or behavioural problems, and those who had very severe symptoms may be left with residual neurological sequelae. If one is suspecting ACA, close follow-up to ensure symptoms are resolving is required.

Drug or Toxin Ingestion:

Another very common cause of acute ataxia is **drug or toxin ingestion**. A variety of medications, such as phenytoin, phenobarbital, carbamazepine, benzodiazepines, antihistamines, and other psychoactive medications or street drugs. Toxins such as ethanol and ethylene glycol can also cause ataxia. Intoxication is most likely to affect very young children, from ages 1-4, or adolescents who may be experimenting with substances. In the case of ataxia caused by drugs or toxins, there may be changes to the patient's mental status, or other effects depending on the drug ingested. Certain medications, like phenytoin, can lead to nystagmus and ataxia without affecting the mental status.

It is very important to get a thorough history regarding any medications may have been administered to the child, accessible wherever the child was, or if there were any visitors to the house who may have had medications. A child with epilepsy may have received excessive doses of their normal antiepileptics, or a child who has allergies may have received supratherapeutic levels of antihistamines by a concerned family member. If any member of the household uses antiepileptic or psychoactive medications this a big clue as to what might have happened. If one is suspecting ingestion as the cause of ataxia, a toxicology screen can be done, and the blood levels of certain antiepileptic drugs can be measured. For ataxia caused by drug ingestion, the needed management varies based on the suspected substance, as well as how stable the patient is in other regards, as certain medications could lead to end-organ failure. If the child is doing well, supportive management may be all that is needed to provide time for the drug to be metabolized and excreted, though severe cases with an unwell child may necessitate intensive care and dialysis to remove a toxic substance.

Traumatic Brain Injury:

Another key consideration, particularly in active children, is the possibility for traumatic brain injury or concussion. In such events, there can be cerebellar damage – either directly or indirectly – leading to cerebellar atrophy and symptoms such as ataxia, tremor, dysmetria, hypotonia, and various other neuropsychological consequences (11). In young children, post-concussive ataxic symptoms including dizziness and balance difficulties are some of the most common complaints (12).

Although recurrent episodes of ataxia are uncommon, migraine and migraine variants are the most common causes. Rarer etiologies can include metabolic disorder such as disorders of pyruvate metabolism, and genetic conditions such as episodic ataxia type 1 and 2.

Benign Paroxysmal Vertigo

What appears to be acute ataxia can also be a presentation for a variety of migraine syndromes. In younger patients, this may be **benign paroxysmal vertigo** (BPV), and older patients may have basilar migraines or familial hemiplegic migraines. BPV is characterized by episodes of severe vertigo, recurring over time, that typically affects preschoolers. Patients with BPV will not show true cerebellar signs of ataxia, but they may have nystagmus, pallor, and be unable to stand – the vertigo they experience should be worst at onset, and there should not be an associated headache. The episodes self-resolve within minutes, and there should not be any change to level of consciousness – typically, no treatment is needed, though migraine prophylaxis can be considered. As the child ages, attacks should become less frequent, or may evolve into classic migraines in about 21% of patients – there is a positive family history of migraine in about 40% of cases of BPV (4).

Basilar Migraines:

Basilar migraines (or migraine with brainstem aura) are migraines with aura, where the aura can include visual disturbance (hemianopsia), vertigo, ataxia, dysarthria, bilateral tingling, or numbness (Bickerstaff ER, Lancet 1961 or Uptodate). When experiencing a basilar migraine, about half of patients will become ataxic, followed by a severe throbbing occipital headache. Diagnosis is based on clinical features. The treatment provided for basilar migraine is the same as that for classic migraines, and in

most cases the children will end having symptom evolution towards those of classic migraines as they age. If a presentation of ataxia has a history of similar prior episodes, this should raise your suspicion for causes such as migraines or seizures. A family history is also key, since relatives with migraine may help to guide your evaluation.

Conversion Reaction:

Conversion reaction is another condition that may present with a child who seems to be ataxic. Conversion reaction is a psychiatric condition, typically occurring in females aged 10-15, in reaction to a significant stressor. However, there are some key features on physical examination and history that may help you distinguish it from an organic cause of ataxia. Those with conversion reaction – while struggling greatly with their gait – often will not exhibit features of an organic cause of ataxia, such as an adapted wide-based gait in an attempt to maintain balance; in conversion reaction, a narrow base may be present as the child lurches and staggers. Furthermore, they will not have signs of truncal ataxia or titubation, and will be able to sit quite comfortably, generally having their movement disturbance only when trying to stand or walk. Neurological examination should also be unremarkable, with normal strength, tone, reflexes, and sensation, and serial examinations may reveal inconsistencies. If one is suspecting conversion reaction, it is critical to delve into a social and psychiatric history in attempts to determine the causative stressor. Conversion disorder is a diagnosis of exclusion, so organic causes must be ruled out first.

Continuing the Clinical Case

Coming back to Stephen, we must get more history to know what is going on. His parents state that Stephen tripped and fell once at the playground, but he got up quickly and seemed to be okay. They also explain that Stephen was sick about a week ago, with a runny nose and red spots on his palms and around his mouth. He's an otherwise healthy boy, is fully immunized, and doesn't take any medications regularly. While he was sick, his parents gave him some Tylenol, but nothing else. Regarding medications, Stephen's mother states that she does have some benzodiazepines she uses for anxiety attacks, but she keeps them locked away safely and out-of-reach; there have been no recent guests, or any other medications brought into the home.

As mentioned before, his physical examination was remarkable for mild dysmetria and nystagmus, slightly low muscle tone, and a wide-based, lurching gait, and titubation. Bloodwork ordered shortly after he arrived at the ER, including CBC, electrolytes, and glucose all come back normal. Given that Stephen did fall at the playground, you want to rule out any life-threatening causes of ataxia, such as an intracranial bleed, so Stephen was sent for an CT, and it came back normal. Having considered meningitis, the team thought about an LP, but decided one was not needed as Stephen looked well, was afebrile and only had a mild headache, with no altered LOC or meningitic signs.

Having not found any features on exam, history, or investigations that point to a life-threatening cause of ataxia, you begin to reassure Stephen's parents. Given that his ataxia was worst soon after it started and that he had recently had a viral infection of some kind, along with lack of other focal neurological symptoms and with Stephen seeming systemically well, his case seems to be acute cerebellar ataxia. Close follow

up is indicated to ensure his symptoms begin to resolve within a few weeks, and that he has no new or progressing symptoms.

Conclusion/Key Learning Points:

- Time-course/progression of symptoms helps narrow a differential
- Acute ataxia in a toxic ingestion until proven otherwise. Always ask about drugs that are at home
- Concussion and mild head trauma, as well as migraine variants are often overlooked as a cause of ataxia in children.
- The presence of encephalopathy or new focal neurological deficits is always concerning and should prompt further investigations
- Brain tumors can present acutely – *progressive symptoms always warrant investigations*

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