Managing Periodic Paralysis 101

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Hypokalemic Periodic Paralysis

• Identifying Triggers
  – Exercise habits
  – Diet

• The acute attack
  – In hospital
  – At home

• Preventing Attacks
  – Diuretics
  – Prophylactic Potassium
Identifying Triggers --
Diary x 2 weeks, documenting:

• Attacks
  – What body part?
  – Severity on scale of 1-5?
  – Time to regain movement?
  – How did you medicate?

• Some attacks span days rather than being consecutive, separate attacks
Triggers Diary

• **Activity** (esp change in routine)
• **Foods** (carbs, salt, alcohol, MSG)
• **Medications** (with and without physiological explanation)
Triggers Diary

• Infection (aka, the flu)
• Diarrhea
• Lack of sleep
• Weather / Barometric pressure / Cold
• Menstrual cycle
• Other possible triggers
Diet

• Identify triggers
• Not all triggers trigger every time!!!
  – High Carbohydrates
  – High Sodium
  – Fasting
  – Miscellaneous
High Carbohydrates.... BAD!!!

• Pizza, pasta, mac & cheese, too much bread, potatoes

• Are there better complex carbohydrates?
  – Soba, for example?
  – Quantity plays a role
Diet

• What can you eat?
  – Best to find alternatives you can eat rather than those you cannot
  – Unlikely that “foods high in potassium” will obviate treatment

• Bananas?
Bananas?

• 1 medium-sized banana: 118 g, 7 ½”
  – contains 467 mg of potassium
  – 12 mEq of potassium (not all bioavailable)
  – 28 g carbohydrate 😞

• 6 bananas ➔ 72 mEq of potassium
  – 168 g carbohydrate 😞
  – 1.5 lbs. worth of bananas!
  – Diarrhea 😞 😞
Supplements

• Calcium
• Magnesium
• Potassium chloride (KCl)
Supplements: Potassium Chloride

- **NoSalt** or **NuSalt®**
- In the “spices” section of supermarkets
- 3 oz jar has 19 doses of 60mEq
- 5/6 teaspoon = 70mEq
  - 3 oz jar = 85g KCl = 45g K⁺ = 1,156mEq K⁺ = 19 doses of 60 mEq K⁺ = 2.3g K⁺ = 4.4g KCl
  - Serving = 1/6 tsp = 1 g, contains 530mg potassium = 13.6mEq
Potassium: Dosage Forms

• Powder in water (*not in Gatorade!*)
  – Rapid onset

• Solution (pre-made)

• Fizzy tablet

• Sustained release tablet
  – Gastric irritation

• Intravenous
  – Use mannitol, not D5W or Normal Saline
Potassium: Type and Route

• **Counter ion:** potassium....
  – Chloride
  – Bicarbonate
  – Gluconate
  – Citrate

• **Route**
  – Oral (preferred)
  – Prescription should be for maximum anticipated daily dose
    • i.e., assume prophylaxis for exercise or a severe attack each day
  – Intravenous (in mannitol)
Potassium: Acute Attack
oral management

• **Dose:** 0.5 – 1.0 mEq/kg
  – Oral route preferred
  – Large bolus, then smaller increments every 30-60 minutes
  – Blood monitoring after 100mEq
  – Maximum of 200mEq
  – Aqueous form
Potassium: Acute Attack
intravenous management

• IV if airway compromise or impending arrhythmia
  – 10mEq every 20-60 min
    • Don’t overshoot
    • Get patient out of danger, not complete correction via IV
  – Use mannitol (not D5W or ½ NS)
  – Never more than 40-80mEq/L, and use central vein if > 10mEq/L
Potassium: Prophylaxis

- **Dose**: 0.5 – 1.0 mEq/kg
  - Aqueous form, **15 – 30 minutes prior to exercise**
    - < 1 hour prior; dose and timing = trial and error
  - **Before bed**, esp. after exercise or carb intake that evening, sustained release or aqueous
  - Morning and afternoon exercise:
    - if say 3 hours apart, take 60mEq then 40mEq
    - If say 6 hours apart, consider 60mEq each time
### Potassium: Effect on Blood Levels

<table>
<thead>
<tr>
<th>Potassium Dose</th>
<th>Increase in Serum Potassium Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 – 60 mEq</td>
<td>1.0 – 1.5 mEq/L</td>
</tr>
<tr>
<td>135 – 160 mEq</td>
<td>2.5 – 3.5 mEq/L</td>
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Each 20 mEq KCl orally $\rightarrow$ 0.5 mEq K\(^+\) in blood
Overdosing on Potassium

- A real concern with I.V. potassium
- Less likely with oral potassium
  - Diarrhea and paresthesias usually supervene
  - Depends on potassium deficit of body
  - 100mEq or less is probably safe outside an attack
  - Fear is hyperkalemia → arrhythmia → sudden death
Potassium Brands

- Effer-K®
- Klor-Con®
- others
Chronic Therapy

• **Carbonic Anhydrase Inhibitors**
  – **Diamox** (acetazolamide)
  – **Daranide** (dichlorphenamide)
  – **Glauctabs** (methazolamide)

• **Potassium-sparing diuretics**
  – **Inspra** (eplerenone)
  – **Aldactone** (spironolactone)
  – **Dyrenium** (triamterene)
    • **CAREFUL**: NOT **DYAZIDE**, which has potassium-wasting hydrochlorothiazide
  – **Midamor** (amiloride)

• **Experimental**:
  – 3,4 – Diaminopyridine
  – **Pinacidil**
Chronic Therapy: General Points

• Not good for acute attacks
• Optimal dose will require trial and error
• Some may worsen symptoms
  – Usually know this by week one
• If one fails, try another
  – E.g., acetazolamide → dichlorphenamidine
  – E.g., spironolactone → eplerenone
Carbonic Anhydrase Inhibitors

• Diamox (Acetazolamide)
  – Dose: 62.5 – 1000mg/d

• Daranide (Dichlorphenamide)
  – Dose: 12.5 – 200mg/d

• Glauctabs (Methazolamide)
  – Dose: 50 - 300mg/d

• Side Effects:
  – Paresthesia (tingling)
  – Confusion
  – Kidney stones (calcium phosphate)
  – Worsening of paralysis attacks
  – COPD \(\rightarrow\) acidosis

• Drug Interactions:
  – High dose aspirin \(\rightarrow\) acidosis
  – Steroids \(\rightarrow\) hypokalemia
Aldactone (spironolactone)

• Potassium-sparing diuretic
• **Dose:** 25 – 200mg/d
• **Side Effects:**
  – Breast enlargement/tenderness (gynecomastia)
    • Blocks testosterone
  – High potassium
    • With high doses, potassium supplements, or other potassium-retaining drugs
  – Decreased libido
• **Drug Interactions:**
  – Triamterene → 2 deaths
  – Potassium salts
  – Potassium-retaining drugs
    • Cyclosporin, angiotensin converting enzyme inhibitors, NSAIDs
  – **OK to give with potassium and ACEI in hypoPP**
Inspra (eplerenone)

• Works like Aldactone without the hormonal
• **Dose:** 25 – 50mg/d

• **Side Effects:** overall, well-tolerated
  – Hyperkalemia (less likely in hypoPP)

• **Avoid in:**
  – Type 2 Diabetes with microalbuminuria
  – Renal dysfunction (creatitine > 2.0)

• **Drug Interactions**
  – CYP3A4 inhibitors – check with your doctor
    • Erythromycin, verapamil, ketoconazole
Dyrenium (triamterene)

- Potassium-sparing diuretic
- **Dose:** 50 – 300mg/day
- **Side Effects**
  - Hyperkalemia
  - Hyperglycemia
  - Hyperuricemia (gout flare)
- **Drug Interactions**
  - NSAIDS, lithium, ACEI
  - Spironolactone → 2 deaths
Midamor (amiloride)

• Potassium-sparing diuretic
• **Dose:** 5-20mg/d

• **Side Effects**
  – Avoid in renal insufficiency and diabetes

• **Drug Interactions**
  – Cyclosporin, ACEI
Combination Therapy

• Spironolactone and Acetazolamide
• Inspra and Acetazolamide
• Above with potassium

• Monitor:
  – Potassium
  – Blood pressure
  – Other electrolytes (Mg$^{2+}$, Ca$^{2+}$, Na$^+$, Cl$^-$, HCO$_3^-$)
Safe Physical Environment

• **At Bedside** (regardless of weakness):
  – Potassium
  – Water in plastic bottle (NO GLASS)
  – Telephone
  – Avoid direct exposure to air conditioning vent or open windows overnight (shivering = exercise)

• **Never be caught without potassium**
  – on person, in jacket, in work bag, in office, etc.

• Avoid slippery rugs or other obstacles
• Hand rails in bathtub

• **Buddy system** – someone to check in on you
Pregnancy and HypoPP

**Pregnancy Category B:**
- **Inspra** (eplerenone)
- **Midamor** (amiloride)

**Pregnancy Category C:**
- **Carbonic anhydrase inhibitors**
  - **Diamox** (acetazolamide)
  - **Daranide** (dichlorphenamide)
  - **Glauctabs** (methazolamide)
- **Aldactone** (spironolactone)
  - can cause birth defects
- **Dyrenium** (triamterene)
Muscle Pain and HypoPP

• Not well-studied
• What is incidence?
• What has worked for people?
Peri-Operative Management

• Peri-operative Triggers:
  – epinephrine
  – cold
  – muscle contraction (exercise)
  – NPO = fasting
  – D5W = glucose

• Check patient frequently
  – esp. when coming off and when off respirator

• Beware inadequate anesthesia
  – if patient cannot speak or move due to paralysis
Eye Doctor and Dentist

• Epinephrine is a trigger
  – Use plain lidocaine

• Beta-agonist eye drops for dilating the eyes is a trigger
  – Use lacrimal duct plugs to avoid absorption
Thyrotoxic Periodic Paralysis

• Caused by hyperthyroidism
• Common in Asian males
• Therapy:
  – Propranolol helps
  – Potassium helps
    • more danger of overshoot
  – Thyroid ablation with radioiodine (I-131)
  – Acetazolamide may worsen
Hyperkalemic Periodic Paralysis

• Sodium channel mutations
• With or without paramyotonia congenita
Myotonia vs. Paramyotonia

- **Myotonia**: muscle stiffness, better with exercise
  - Seen in Myotonia Congenita

- **Paradoxical Myotonia**: muscle stiffness, worse with exercise
  - Seen in Paramyotonia Congenita (PMC)
  - Seen in HyperPP with PMC
  - PMC stiffness and HyperPP weakness are triggered by potassium
HyperPP Triggers

- Potassium
- Hyperkalemia
- Rest after exercise
- Cold
- Fasting or low blood sugar
HyperPP Therapies: Acute Attacks

- Sugary drink or food
- Insulin with glucose
- Albuterol inhalers
- Calcium gluconate i.v. in severe episode
HyperPP Therapies: Chronic

• **Potassium-wasting diuretics:**
  – Hydrochlorothiazide
    • can get more potassium-wasting at doses above diuretic dose
    • Most doctors only go up to 25mg
  – Acetazolamide
  – Dichlorphenamidine
  – Furosemide
    • Wastes magnesium and calcium too
Dietary Considerations

• USDA website lists high-potassium foods
  – Similar considerations for dialysis patients

• Triggers can be from foods

• Tend to be more sensitive than Hypos
  – That is, potassium in food will not reverse a hypo attack, but it might trigger a hyper attack
Andersen-Tawil Syndrome

• Familial (Genetic): potassium channel

• **Definition:**
  – **Periodic Paralysis** (hyper or hypo)
  – Long QT syndrome (or other **arrhythmias**)
  – **Skeletal abnormalities** (wide spaced eyes, low-set ears, webbed fingers or toes, small head, clinodactyly)
Andersen-Tawil Syndrome

- **Main Symptoms:**
  - Weakness
  - Palpitations
  - Atypical attacks with muscle twitching (myoclonus)
    - May respond to benzodiazepine, e.g., Klonapin
  - May mimic seizure
  - Low or high serum potassium (depends on associated periodic paralysis)

- **Main Triggers:**
  - same as that for the associated type of periodic paralysis

- **Things that Alleviate Attacks:**
  - same as that for the associated type of periodic paralysis

- **Things that Prevent Attacks Chronically:**
  - same as that for the associated type of periodic paralysis
Andersen-Tawil Syndrome: Cardiac Issues

• Cardiac monitoring and therapy
  – EKG
  – Automated Implantable Cardioverter-Defibrillator

• Long QT – drugs to avoid:
  – Many (check each new drug prescribed with a reliable website)

• Drugs for Arrhythmia
  – Tricky with Long QT
Paramyotonia Congenita

Familial (Genetic): sodium channel

**Definition**: muscle stiffness that worsens with exercise (paradoxical myotonia) and with cold

**Main Symptoms**:  
– Muscle stiffness followed by weakness, especially with exercise in cold weather  
– Can be associated with hyperkalemic periodic paralysis  
– Normal serum potassium  
– No warm-up phenomenon
Paramyotonia Congenita

• Main Triggers:
  – Same as those for hyperkalemic periodic paralysis
  – Cooling and heavy muscular work

• Things that Alleviate Attacks Acutely:
  – Warm environment relieves stiffness
  – No therapy to relieve weakness acutely (mexilitene?)
  – Same as for hyperkalemic periodic paralysis (if hyperkalemic periodic paralysis is a feature)

• Things that Prevent Attacks Chronically:
  – Acetazolamide
  – Mexilitene, Flecainide, Propafenone
  – Same as for hyperkalemic periodic paralysis if that is a feature
Potassium-Sensitive Myotonia

• Familial (Genetic): Sodium channel

• Main Symptoms:
  – Intermittent, generalized muscle stiffness
  – No weakness
  – Not worsened by cold

• Main Triggers:
  – Potassium ingestion
  – Rest after exercise
  – Succinylcholine anesthesia
Potassium-Sensitive Myotonia

• Things that Alleviate Attacks Acutely:
  – same as for hyperkalemic periodic paralysis

• Things that Prevent Attacks Chronically:
  – Mexilitene
  – Acetazolamide
Myotonia Congenita

Familial (Genetic): Chloride channel

• **Main Symptoms**: muscle stiffness
• **Main Triggers**: sudden exercise, sudden noise
• **Things that Alleviate Attacks Acutely**:  
  – repeated movement of stiff muscle (warm-up phenomenon)
• **Things that Prevent Attacks Chronically**:  
  – mexilitene, acetazolamide, phenytoin, quinine, carbamazepine
Thank you for your attention!
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