

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

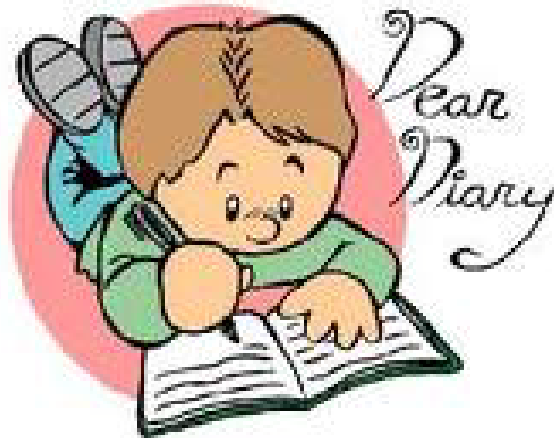
Identifying Triggers -- Diary x 2 weeks, documenting:

- 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 ☹️ ☹️

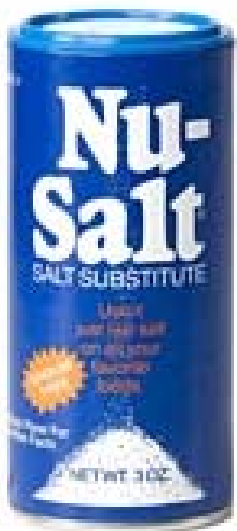


Supplements

- 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

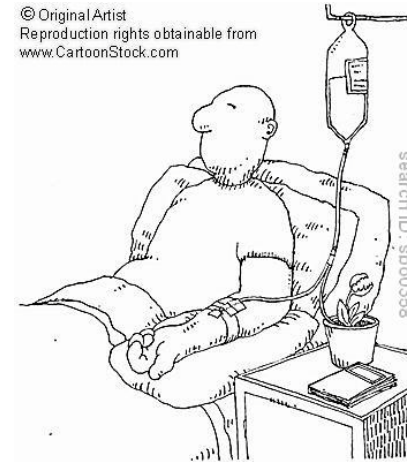


- **Dose:** 0.5 – 1.0 mEq/kg
 - Oral route preferred
 - Large bolus, then smaller increments every 30-60 minutes
 - Blood monitoring after 100mEq
 - Maximum of 200mEq
 - Aqueous form

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

Potassium Dose	Increase in Serum Potassium Concentration
40 – 60 mEq	1.0 – 1.5 mEq/L
135 – 160 mEq	2.5 – 3.5 mEq/L

Each 20 mEq KCl orally → 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 DYZIDE, 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 → dichlorphenamide
 - 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 → acidosis
- **Drug Interactions:**
 - High dose aspirin → acidosis
 - Steroids → 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 (creatinine > 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**
 - **Dichlorphenamide**
 - **Furosemide**
 - Wastes magnesium and calcium too

Dietary Considerations

- USDA website lists high-potassium foods
 - <http://www.nal.usda.gov/fnic/foodcomp/Data/SR16/wtrank/sr16w306.pdf>
 - 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., Klonopin
- 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!

