Magnesium, Stress, and Neuromuscular Hyperexcitability (Latent Tetany Syndrome)

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• **U.S.**
  – Burton and Bella Altura

• **FRANCE**
  – Jean Durlach, Amid Reba
  – Jean-Georges Henrotte

• **GERMANY**
  – Roland Fehlinger
  – Hartmut Iseng
Human Mg Deficiency

- asthenia
- tremor
- convulsions
- irritability
- tetanic spasms
- muscle cramps
- confusion

These symptoms are produced by heightened neural and neuromuscular excitability.
A. Tetany treated with mineral salts as early as the 17th century

B. Tetany syndrome described in 19th century:
   - emotional lability
   - paresthesia
   - carpal-pedal spasm
   - convulsions

C. Physical signs (Trousseau’s, Chvostek’s and von Bonsdorff’s) described in 19th century
Mechanism of Tetany

Kugelberg (1951) : a failure of neuronal accommodation

Accommodation =

Nerves adapt to a gradual decline in transmembrane electrical potential by increasing the voltage requirements for generating an action potential.
Tetany Syndrome in the Early Twentieth Century

Electromyographic and electroencephalographic changes were described.

Kugelberg analyzed the mechanism: a failure of neuronal accommodation.

1959, Roselle and de Doncker: Tetany Syndrome associated with chronic Mg deficiency.
Symptom Classification
Jean Durlach, 1960’s

1. **Central manifestations**: emotional lability, breathlessness, hyperventilation, tremor, headache, dizziness, insomnia, asthenia

2. **Peripheral manifestations**: paresthesia, formication, fasciculation, cramps, radicular pain, poor exercise tolerance
Durlach’s Symptom Classification

3. **Organ-specific functional disorders** producing palpitation, chest pain, pallor, diaphoresis, Raynaud’s phenomenon, biliary dyskinesia, spastic colon

4. ‘**Trophic’ phenomena** with fragility of nails, hair, and teeth

5. **Acute crises** of hyperventilation, carpal-pedal spasm, convulsion.
A. Tetany and hyperventilation syndrome were indistinguishable by history, physical examination, psychological testing or electrodiagnostic testing.

B. Tetanic patients with attacks of hyper-ventilation had significantly lower Mg levels than those without; Mg deficiency is a probable cause of hyperventilation.
C. Impaired mitochondrial function increases anaerobic glycolysis in the brain, creating a local metabolic acidosis and hypocapnia, which causes cerebral vasospasm.

D. RDBPC trial of Mg: improvement in overall symptoms, hyperventilation attacks, muscle strength, concentration, hypocapnia-induced cerebral vasoconstriction.
Iseng: Experiments on Noise Stress and Magnesium

Noise Stress/Mg Interactions:

Guinea pigs and rats:

Two hours of noise stress reduces erythrocyte Mg and increases serum and urinary Mg, suggesting a shift of Mg from the intracellular to the extracellular space, with net loss due to increased urinary excretion.
Iseng: Noise Stress and Magnesium

Noise stress/Mg in humans:

- 57 human volunteers worked under 7 h of traffic noise.
  - a. serum Mg increased by 2.4%
  - b. urine Mg increased by 15%
  - c. erythrocyte Mg decreased by 1.5%
Iseng: Magnesium and Noise Stress in Humans

Increase in serum Mg correlated with decrease in work performance.

Erythrocyte Mg was negatively correlated with self-reported noise sensitivity, with noise-induced emotional lability, and with noise-induced feelings of tenseness.
Magnesium, Catecholamine Interactions with Noise

Urinary catecholamine excretion increases progressively with increasing dietary Mg deprivation in rats without noise stress.

The addition of noise further increases norepinephrine excretion.
A signal detection task under noise stress among type A and 19 type B French university students.

Plasma Mg increased by 1.5% and erythrocyte Mg decreased by 0.5% in type A subjects; there was no change in these levels for type B subjects.
Mg, Stress and Latent Tetany: Multifactorial Etiology of Symptoms

- Low or marginal Mg status
- Personality characteristics
- Stress-induced catecholamine secretion
- Catecholamine-induced Mg excretion
- Serum Mg usually normal
- Production of tetanic symptoms
Case Study:
19 year old female college student with severe fatigue

• Background:
  – Migraine headache and chronic daily headache, onset at menarche
  – Asthma, aggravated by stress
  – Perfectionistic, straight A student

• Precipitating events (June 2011)
  – Acute diarrhea for one week
  – Increased dose of estrogen in OCP
Case Report: Present Illness

• Episodic sinus tachycardia
• Severe progressive exhaustion
• Feeling of muscle weakness; at rest feels as if she’s already exercised to exhaustion
• Unable to get off couch
• Consulted 5 physicians with no diagnosis
  – Magnesium levels never measured
Case Report: Evaluation

• Physical examination: unremarkable except for a strongly positive Chvostek sign

• Laboratory studies all normal
  – Serum Mg 2.1 mg/dl
  – RBC Mg 4.6 mg/dl
  – Serum K 3.7 mEq/L
  – Serum Ca 9.6 mg/dl
Case Report: Assessment

- Migraines and asthma are each associated with Mg deficits and Mg responsiveness
- Diarrhea can deplete Mg
- Estrogen is tetanogenic
- Potassium retention is influenced by Mg
- Mg-responsive tetany syndrome likely
Oral supplementation with 200 mg/day of magnesium (glycinate) was associated with a rapid improvement in all symptoms, especially muscle exhaustion.