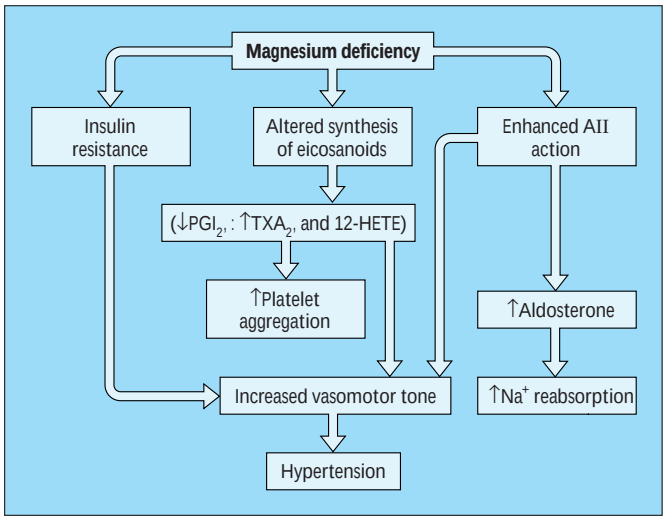

FIGURE 4-16

Mechanism whereby magnesium (Mg) deficiency could lead to hypertension. Mg deficiency does the following: increases angiotensin II (AII) action, decreases levels of vasodilatory prostaglandins (PGs), increases levels of vasoconstrictive PGs and growth factors, increases vascular smooth muscle cytosolic calcium, impairs insulin release, produces insulin resistance, and alters lipid profile. All of these results of Mg deficiency favor the development of hypertension and atherosclerosis [10,11]. Na^+—ionized sodium; 12-HETE—hydroxy-eicosatetraenoic [acid]; TXA_2—thromboxane A2. (*From* Nadler and coworkers [17].)

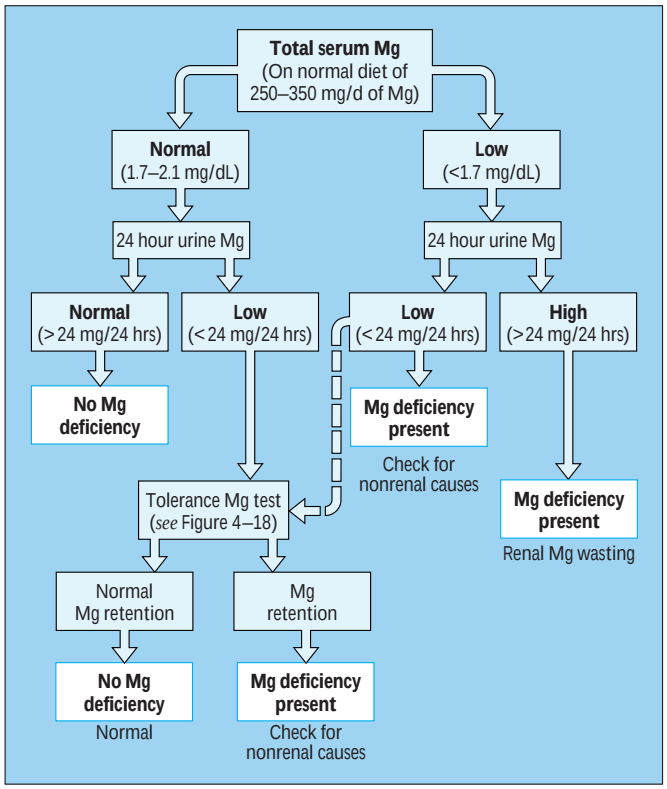

FIGURE 4-17

Evaluation in suspected magnesium (Mg) deficiency. Serum Mg levels may not always indicate total body stores. More refined tools used to assess the status of Mg in erythrocytes, muscle, lymphocytes, bone, isotope studies, and indicators of intracellular Mg, are not routinely available. Screening for Mg deficiency relies on the fact that urinary Mg decreases rapidly in the face of Mg depletion in the presence of normal renal function [2,6,8–15,18]. (*Adapted from* Al-Ghamdi and coworkers [11].)

MAGNESIUM (Mg) TOLERANCE TEST FOR PATIENTS WITH NORMAL SERUM MAGNESIUM

Time	Action
0 (baseline)	Urine (spot or timed) for molar Mg:Cr ratio
0–4 h	IV infusion of 2.4 mg (0.1 mmol) of Mg/kg lean body wt in 50 mL of 50% dextrose
0–24 h	Collect urine (staring with Mg infusion) for Mg and Cr
End	Calculate % Mg retained (%M)

$$\%\,M = 1 - \frac{(\text{24-h urine Mg}) - ([\text{Preinfusion urine Mg:Cr}] \times [\text{24-h urine Cr}])}{\text{Total Mg infused}} \times 100$$

Mg retained, %	Mg deficiency
>50	Definite
20–50	Probable
<20	None

Cr—creatinine; IV—intravenous; Mg—magnesium.

FIGURE 4-18

The magnesium (Mg) tolerance test, in various forms [2,6,8–12,18], has been advocated to diagnose Mg depletion in patients with normal or near-normal serum Mg levels. All such tests are predicated on the fact that patients with normal Mg status rapidly excrete over 50% of an acute Mg load; whereas patients with depleted Mg retain Mg in an effort to replenish Mg stores. (*From* Ryzen and coworkers [18].)

MAGNESIUM SALTS USED IN MAGNESIUM REPLACEMENT THERAPY

Magnesium salt	Chemical formula	Mg content, mg/g	Examples*	Mg content	Diarrhea
Gluconate	$Cl_2H_{22}MgO_{14}$	58	Magonate®	27-mg tablet 54 mg/5 mL	±
Chloride	$MgCl_2 . (H_2O)_6$	120	Mag-L-100	100-mg capsule	+
Lactate	$C_6H_{10}MgO_6$	120	MagTab SR*	84-mg caplet	+
Citrate	$C_{12}H_{10}Mg_3O_{14}$	53	Multiple	47–56 mg/5 mL	++
Hydroxide	$Mg(OH)_2$	410	Maalox®, Mylanta®, Gelusil® Riopan®	83 mg/ 5 mL and 63-mg tablet 96 mg/5 mL	++
Oxide	MgO	600	Mag-Ox 400® Uro-Mag® Beelith®	241-mg tablet 84.5-mg tablet 362-mg tablet	++
Sulfate	$MgSO_4 . (H_2O)_7$	100	IV IV Oral epsom salt	10%—9.9 mg/mL 50%—49.3 mg/mL 97 mg/g	++ ++
Milk of Magnesia			Phillips' Milk of Magnesia®	168 mg/ 5 mL	++

Data from McLean [9], Al-Ghamdi and coworkers [11], Oster and Epstein [19], and Physicians' Desk Reference [20].

*Magonate®, Fleming & Co, Fenton, MD; MagTab Sr®, Niche Pharmaceuticals, Roanoke, TX; Maalox®, Rhone-Poulenc Rorer Pharmaceutical, Collegeville, PA; Mylanta®, J & J-Merck Consumer Pharm, Ft Washinton, PA; Riopan®, Whitehall Robbins Laboratories, Madison, NJ; Mag-Ox 400® and Uro-Mag®, Blaine, Erlanger, KY; Beelith®, Beach Pharmaceuticals, Conestee, SC; Phillips' Milk of Magnesia, Bayer Corp, Parsippany, NJ.

FIGURE 4-19

Magnesium (Mg) salts that may be used in Mg replacement therapy.

GUIDELINES FOR MAGNESIUM (Mg) REPLACEMENT

Life-threatening event, eg, seizures and cardiac arrhythmia

I. 2–4 g $MgSO_4$ IV or IM stat
(2–4 vials [2 mL each] of 50% $MgSO_4$)
Provides 200–400 mg of Mg (8.3–16.7 mmol Mg)
Closely monitor:
- Deep tendon reflexes
- Heart rate
- Blood pressure
- Respiratory rate
- Serum Mg (<2.5 mmol/L [6.0 mg/dL])
- Serum K

II. IV drip over first 24 h to provide no more than 1200 mg (50 mmol) Mg/24 h

Subacute and chronic Mg replacement

I. 400–600 mg (16.7–25 mmol Mg daily for 2–5 d)
IV: continuous infusion
IM: painful
Oral: use divided doses to minimize diarrhea

FIGURE 4-20

Acute Mg replacement for life-threatening events such as seizures or potentially lethal cardiac arrhythmias has been described [8–12,19]. Acute increases in the level of serum Mg can cause nausea, vomiting, cutaneous flushing, muscular weakness, and hyporeflexia. As Mg levels increase above 6 mg/dL (2.5 mmol/L), electrocardiographic changes are followed, in sequence, by hyporeflexia, respiratory paralysis, and cardiac arrest. Mg should be administered with caution in patients with renal failure. In the event of an emergency the acute Mg load should be followed by an intravenous (IV) infusion, providing no more than 1200 mg (50 mmol) of Mg on the first day. This treatment can be followed by another 2 to 5 days of Mg repletion in the same dosage, which is used in less urgent situations. Continuous IV infusion of Mg is preferred to both intramuscular (which is painful) and oral (which causes diarrhea) administration. A continuous infusion avoids the higher urinary fractional excretion of Mg seen with intermittent administration of Mg. Patients with mild Mg deficiency may be treated with oral Mg salts rather than parenteral Mg and may be equally efficacious [8]. Administration of Mg sulfate may cause kaliuresis owing to excretion of the nonreabsorbable sulfate anion; Mg oxide administration has been reported to cause significant acidosis and hyperkalemia [19]. Parenteral Mg also is administered (often in a manner different from that shown here) to patients with preeclampsia, asthma, acute myocardial infarction, and congestive heart failure.

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