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Zinc (Zn)

Scott Leslie and Christopher Martin

Background

CAS: 7440-66-6
ATOMIC MASS: 65.39 g/mol
DENSITY: 7.14 g/cm^3 at room temperature

Zinc (Zn) has many applications, including galvanization (anti-corrosion coating), alloys (brass, bronze, and die-casting), electroplating, batteries, fuses, roofing shingles, gutters, engraver's plates, cable wrapping, pesticides, and pigments.[1–3] Wire buffing of zinc-coated surfaces generates zinc dust.[4]

Zinc oxide (ZnO) fumes are the most frequent zinc-related occupational exposure. Zinc oxide fumes are generated through torch welding or cutting of zinc-containing materials.[4–7]

Zinc fumes may cause asthma, meningitis, pericarditis, pleuritis, and pneumonitis.[8,9] Zinc chloride (ZnCl) inhalation may cause cough, dyspnea, sore throat, chest pain, headache, chemical pharyn-

gitis, asthma, acute tubular necrosis, and acute respiratory distress syndrome (ARDS).[10,11] Zinc chloride ingestion can cause gastrointestinal tract inflammation and gastric stricture.[11]

Skin can become dry and irritated when exposed to excess zinc.[12] Lip burns, angioedema, urticaria, and pruritus have been reported.[11,13]

Metal fume fever (MMF) is a systemic response to zinc fumes or, less readily, zinc dust. After zinc exposure, symptoms begin in 4 to 6 hours and resolve in 24 to 48 hours. Problems include fatigue, malaise, headache, fever, chills, shaking, throat dryness and irritation, cough, rhinnorhea, dyspnea, nausea, vomiting, anterior chest pain, substernal pain and tightness, joint stiffness, muscle cramps, diaphoresis, tachycardia, coarse breath sounds, wheezes, rales, polymorphonuclear leukocytosis, and decreased forced vital capacity (FVC).[4–6,14] Chest x-rays are typically normal or unchanged, although they have revealed increased prominence of bronchovascular markings following zinc oxide exposure.[4–6,8,13–16] Tachyphylaxis is a characteristic of MFF.[17,18]

Because zinc is an essential element, each homeostatic mechanism regulates circulating zinc differently to maintain physiological levels. With increased zinc intake, more zinc is released by muscle, more zinc is excreted in the urine, plasma zinc increases, liver zinc increases, less zinc is absorbed from the gut, less zinc is taken up by red blood cells, and zinc secretion into the gut decreases.[19–21]

Absorption

Zinc is absorbed after inhalation. About 55% of ingested zinc is absorbed via the gastrointestinal tract by a saturable transport mechanism.[21] Gastrointestinal zinc absorption is complete in 4 hours. About 37% of the ingested zinc enters the plasma. First-pass liver metabolism absorbs 67% of the zinc, before it is released into the circulation.[22]

Dermal zinc absorption occurs in burn patients.[12,23,24]

Distribution

Bone and muscle are the major zinc storage sites. Zinc is widely distributed, with 30% stored in bone and 60% stored in muscle.[19,25–29] The plasma zinc pool exchanges with other body compartments (mainly the liver, red blood cells, and the kidneys) roughly 130 times per day.[30]

Small amounts of zinc reside in blood (approximately 2.5% of body zinc). Erythrocyte zinc concentrations are 15 times greater than that of plasma.[19]

Metabolism

Zinc is not metabolized.

Elimination

Zinc is eliminated in the gastrointestinal tract (86%) and urine (14%).[19]

Biological Monitoring

No reliable dose–response relationship exists for zinc. Both blood and urine zinc levels have diurnal variation, with zinc concentrations increasing in the mornings and decreasing in the afternoons and evenings.[31–35]

Urine

Urine zinc levels do not correlate with zinc exposure.[18] Urine zinc correlates with exposure better than plasma or serum, because urine zinc excretion increases because of a zinc regulatory mechanism. In a group of nonexposed, healthy persons, urine zinc levels were reported to be between 266–846 µg/L.[36]

Blood

Following zinc exposure, zinc blood levels may increase, remain normal, or decrease.[11,18,37–39] Biological monitoring in whole blood, plasma, or serum is not recommended to assess exposure or health

effects. Blood zinc levels have been reported to vary between approximately 1,000–11,000 µg/L.[40]

Recommendations for Biological Monitoring of Zinc

Biological monitoring is not recommended. Zinc levels do not correlate with exposure or health effects.

Conversion of zinc (Zn) units of measure:
_____ µmol/L × 65.4 = _____ µg/L
_____ nmol/L × 65.4 ÷ 1,000 = _____ µg/L

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