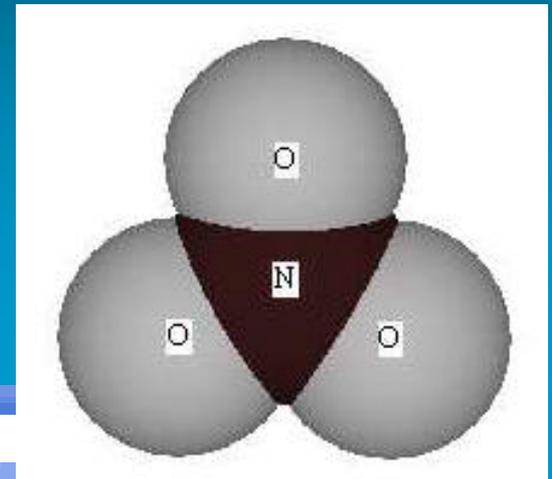


Nitrates & Human Health

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Case history of fatal methemoglobinemia in an infant:

In South Dakota, a baby girl was born in April, 1986 on a Sioux reservation. She was breast-fed initially. Later, supplementary feedings occurred with powdered formula mixed with well water.

A one-month check up revealed nothing unusual, although the mother reported blueness in the infants lips & extremities, as well as vomiting, occasional diarrhea and difficulty breathing.

At home, the infant was given progressively more formula made with well water. One week later, the infant began to vomit and developed severe diarrhea and cyanosis.

Infant was rushed to the hospital and administered O₂. The infants color did not improve. The infant stopped breathing and died in route to another hospital. Water in the well had a concentration of 150 mg/L (ppm) nitrate-N.

History of Nitrates & Health Effects:

Association between blue-baby syndrome and nitrate contaminated well water was described in Iowa City by a physician named Hunter Comly in the early 1940s while treating babies with cyanosis

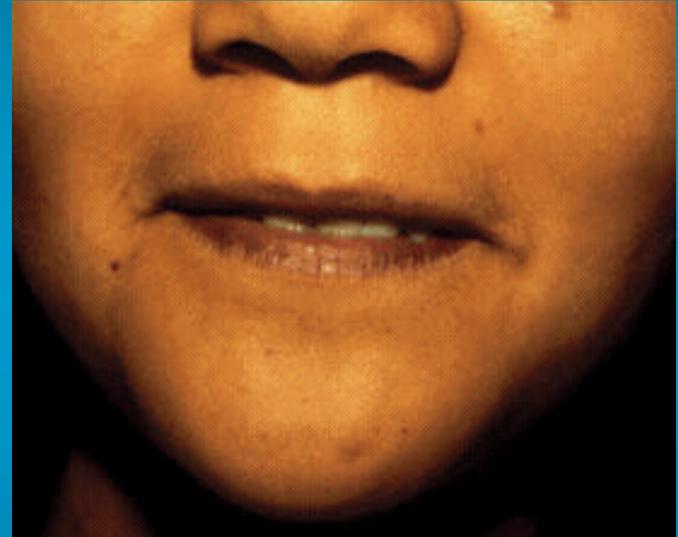
Dr. Comly observed two infants fed formula diluted with well water were becoming ill (wells had 90 & 150 mg/L nitrate-N).

Infants are still affected, but last known fatality in the U.S. occurred in 1986.



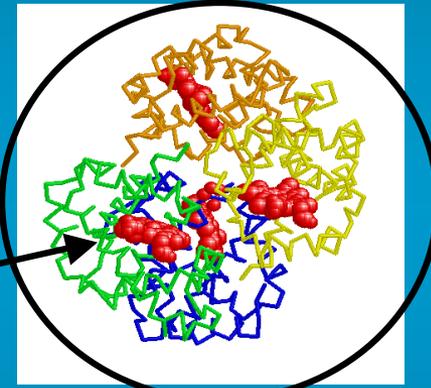
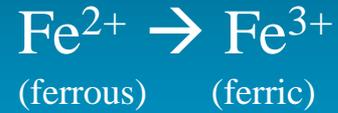
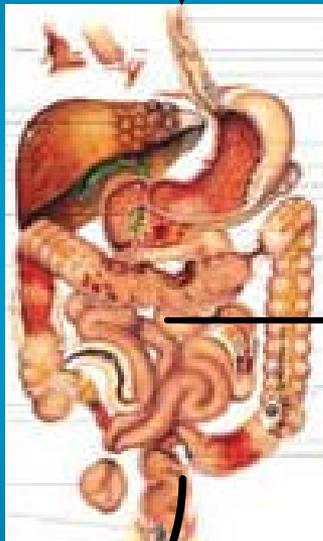
Typical symptoms of methemoglobinemia:

- skin looks pale, gray and mottled**
- chocolate brown lips**
- unusual amount of irritability**
- low body temperature**
- difficulty in breathing**
- failure of infants to gain weight & excessive crying**



Physiological Effects of Nitrate Ingestion:

Nitrates



Nitrites

$\neq \text{O}_2$
(hypoxia)

Bacteria



Why are infants more susceptible?

-In the early weeks of life, the gastric acid barrier is under development

-Bacteria colonize the entire length of the gut, allowing for more conversion of nitrates to nitrite

-Gastric pH in infants is less acidic, thus more bacteria can grow (conversion of nitrates → nitrites)

-Infants have not yet developed a RBC enzyme that destroys nitrates and protects hemoglobin



The Dose Makes the Poison...

Percent total hemoglobin that is methemoglobin	Possible symptoms
5% → 10%	Cyanosis evident in lips and nail beds
~ 20%	Severe cyanosis
> 50%	Possible infant death

Treatment for methemoglobinemia:

Most chemical treatment is IV or oral administration of methylene blue

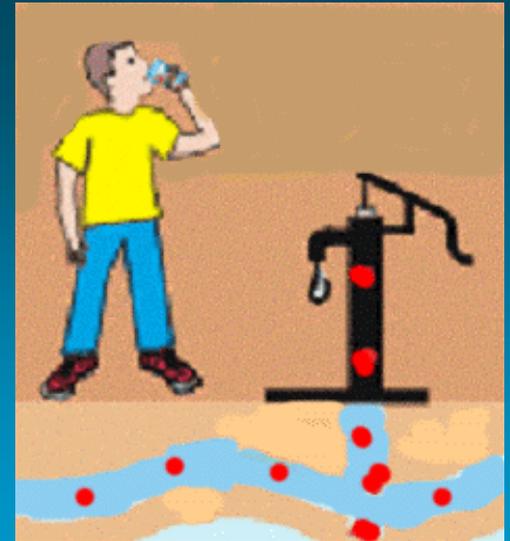
In severe cases, ascorbic acid and/or blood transfusions may be used

Often, the removal of the patient from the source of nitrates is sufficient



Factors affecting susceptibility to nitrates:

- dose and frequency of exposure
- age of child (< 3 months = highest risk)
- diet and nutrition (ex. vitamin C ingestion; nitrate-laden foods)
- inherited enzyme deficiencies
- infectious & inflammatory conditions



Other potential effects of nitrate ingestion:

- **Uncertain association between Type I diabetes and nitrate contaminated wells**
- **Risk of bladder & ovarian cancer in women**
- **Hypotension, related to decreased venous pressure**
- **Formation of N-nitroso compounds & gastric cancer**
- **Decreased motor reflexes in exposed children**
- **Potential congenital malformations & miscarriages**
- **Recurrent acute respiratory infections**

Other methemoglobin inducing substances/conditions:

-naphthalene (mothballs)

-exogenous nitrogen oxide (automobile exhaust, wood smoke, gas burning appliances)

-endogenous nitrate production by tissues as a response to inflammation, infection or ingestion

-sulfonamides (antibiotics)

-nitrates from cured meats, fruits & vegetables

Fugate Family of Troublesome Creek or the Blue People of Kentucky:



Future challenges:

Expanding rural population

Controlling sources of nitrates

Recognition of methemoglobinemia by doctors

Educating the public about nitrates and well water

