

## Nitrate: Risk Assessment and Health Effects

Sarah Johnson, PhD Toxicologist Risk Assessor





### A little bit about who I am

PROTECTING, MAINTAINING AND IMPROVING THE HEALTH OF ALL MINNESOTANS

2

#### **INFORMATION COVERED**

- Introduction to Risk Assessment
- 'Blue Baby' syndrome (methemoglobinemia)
- Epidemiology studies of long term effects
- Co-occurring contaminants
- Final thoughts and questions

PROTECTING, MAINTAINING AND IMPROVING THE HEALTH OF ALL MINNESOTANS

9/16/2019

#### **TOXICOLOGY AND RISK ASSESSMENT**

- Dose makes the poison
- How much for how long
- One chemical paradigm
  - Additive or synergistic
  - Cumulative assessment
- Ultimately: What concentration of a chemical has little or no risk, even for those highly exposed and for sensitive populations?

#### **CONDUCTING A HUMAN HEALTH RISK ASSESSMENT**

• Hazard ID

Ę

- Dose-Response
- Exposure Assessment
- Risk Characterization



Ē

- Can an exposure cause a health effect?
- Does it happen in humans?
- What is already known?





#### DOSE-RESPONSE

- Describes how likely an adverse effect is after a certain amount of exposure
- What is the lowest dose where these health effects are seen?
- What is the highest dose where these effects are not seen
- Uncertainty factors



 The process of measuring or estimating the magnitude, frequency, and duration of human exposure to an agent in the environment.

9/16/2019







#### **RISK CHARACTERIZATION**

## • Summarize/integrate information from steps 1-3

PROTECTING, MAINTAINING AND IMPROVING THE HEALTH OF ALL MINNESOTANS

9



## Nitrate Risk Assessment for Methemoglobinemia







### NITRATE RISK

- Step one Hazard ID: Methemoglobinemia diagnosed in infants drinking well water/formula
  - Hunter (1949)
  - Bosch (1950) and Walton (1951)
  - 20 other documents

#### **STEP TWO: DOSE RESPONSE**

Ē



PROTECTING, MAINTAINING AND IMPROVING THE HEALTH OF ALL MINNESOTANS

12

#### **EXPOSURE ASSESSMENT**

• Who

Ę

- What
- For how long
- How exposed
- Other exposures ???



#### **STEP FOUR-RISK CHARACTERIZATION**

- Infants exposed through well water
- Exposure could be one-time or short term
- When nitrate was removed, the methemoglobinemia often spontaneously resolved
- More cases at higher nitrate concentrations
- No cases at 10 mg/L and below
- Nitrate alone was sufficient to cause methemoglobinemia



# **Nitrate and Chronic Health Risks**

#### **POTENTIALLY LINKED DISEASES/DEFECTS (EPI STUDIES)**



**Colon cancer** 

**Thyroid disease** 

**Neural Tube Defects** 

Nonhodgkins Lymphoma

**Breast Cancer** 





- There are *potential* links to cancer, neural tube defects at or below 10 mg/L
- Potential thyroid disease from drinking water at or above 10 mg/L nitrate.

• The studies need better <u>exposure assessments</u>.



#### CONFOUNDERS IN THE CASE OF NITRATE STUDIES

Other exposures—Very important **Red meat** Pesticides **Disinfection byproducts (city water)** Smoking **Drinking alcohol Sedentary lifestyle** 

PROTECTING, MAINTAINING AND IMPROVING THE HEALTH OF ALL MINNESOTANS

18



#### **OTHER CONTAMINANTS FOUND WITH NITRATES**



- Dakota County
- MN Dept. of Ag Nitrate
  Coliform bacteria
  Pesticides

• EDC (WI)



## Thank you

## Contact info: Sarah.Fossen.Johnson@ state.mn.us

651-201-4080

WWW.HEALTH.MN.GOV

#### AVAILABLE FROM PUBMED CENTRAL FOR FREE

Int J Environ Res Public Health. 2018 Jul 23;15(7). pii: E1557. doi: 10.3390/ijerph15071557.



#### Drinking Water Nitrate and Human Health: An Updated Review.

Ward MH<sup>1</sup>, Jones RR<sup>2</sup>, Brender JD<sup>3</sup>, de Kok TM<sup>4</sup>, Weyer PJ<sup>5</sup>, Nolan BT<sup>6</sup>, Villanueva CM<sup>7,8,9,10</sup>, van Breda SG<sup>11</sup>.

Author information

- Occupational and Environmental Epidemiology Branch, Division of Cancer Epidemiology and Genetics, National Cancer Institute, 9609 Medical Center Dr. Room 6E138, Rockville, MD 20850, USA. wardm@mail.nih.gov.
- 2 Occupational and Environmental Epidemiology Branch, Division of Cancer Epidemiology and Genetics, National Cancer Institute, 9609 Medical Center Dr. Room 6E138, Rockville, MD 20850, USA. rena.jones@nih.gov.
- 3 Department of Epidemiology and Biostatistics, Texas A&M University, School of Public Health, College Station, TX 77843, USA. jdbrender@sph.tamhsc.edu.
- 4 Department of Toxicogenomics, GROW-school for Oncology and Developmental Biology, Maastricht University Medical Center, P.O Box 616, 6200 MD Maastricht, The Netherlands. t.dekok@maastrichtuniversity.nl.
- 5 The Center for Health Effects of Environmental Contamination, The University of Iowa, 455 Van Allen Hall, Iowa City, IA 52242, USA. peter-weyer@uiowa.edu.
- 6 U.S. Geological Survey, Water Mission Area, National Water Quality Program, 12201 Sunrise Valley Drive, Reston, VA 20192, USA. btnolan@usgs.gov.
- 7 ISGlobal, 08003 Barcelona, Spain. cvillanueva@isiglobal.org.
- 8 IMIM (Hospital del Mar Medical Research Institute), 08003 Barcelona, Spain. cvillanueva@isiglobal.org.