Urine Arsenic Levels in the Adult Population of Pataz, Peru

Samantha Ward, OMS IV, Ruben Kenny Briceno, MD, Santiago Moises Benites Castillo, MD, Katelyn Phelps, DO, Leah Manimalethu, Lorenzo Lim, DO, Gary Willyerd, DO, FACOEP, FAODME Shane Sergent, DO

Peru Global Outreach Elective 2016

- Est. 2007
  - 200 medial students participating
  - Over 12,000 people treated
  - Over $1,200,000 worth of medications
- 2016
  - 31 Students, 5 Residents, 27 Physicians, 17 volunteers (80 people total)
    - Largest group to date
  - 2,334 patients treated
  - $23,000 raised

2016 Team

Arsenic Background

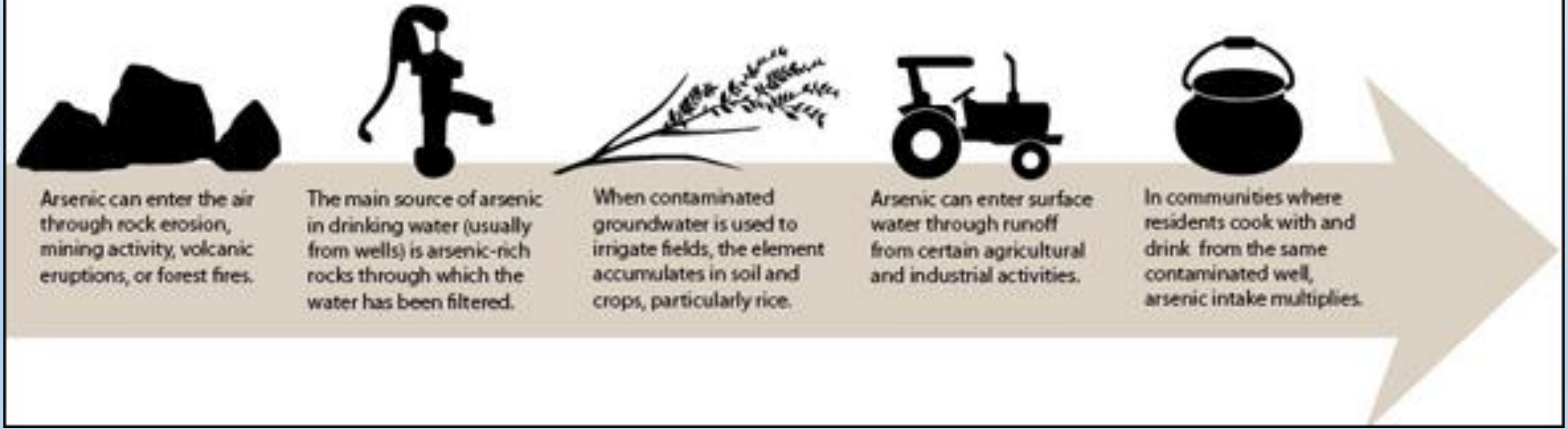
- Odorless and tasteless metal that occurs naturally in rocks and soil
  - Also a byproduct of mining, copper smelting, and coal burning
  - 20th most common element in the earth's crust
- Arsenic seeps into the water naturally or from fertilizers or industrial byproducts
- High levels of arsenic in the drinking water, ingested of time, can lead to renal dysfunction and cancer
- Chronic Arsenic Toxicity S/Sx: Dermatitis, Peripheral Neuropathy, Hepatic and Renal damage

AN ELEMENTAL CONCERN: ARSENIC IN DRINKING WATER

OVERVIEW SYSTEM MAP POPULATION MAP

33
As

Arsenic is a toxic element that is both naturally-occurring in Earth's crust and artificially-produced in agricultural and industrial processes. Most arsenic compounds have no color, smell, or taste—making the chemical dangerously difficult to recognize. In diverse climates and geographies, arsenic contaminates prominent groundwater sources. Exposure to arsenic, especially with the last few decades, has caused illness and death in societies from the United States to Bangladesh, where one in five deaths can be attributed to arsenic poisoning.



Arsenic can enter the air through rock erosion, mining activity, volcanic eruptions, or forest fires.

The main source of arsenic in drinking water (usually from wells) is arsenic-rich rocks through which the water has been filtered.

When contaminated groundwater is used to irrigate fields, the element accumulates in soil and crops, particularly rice.

Arsenic can enter surface water through runoff from certain agricultural and industrial activities.

In communities where residents cook with and drink from the same contaminated well, arsenic intake multiplies.

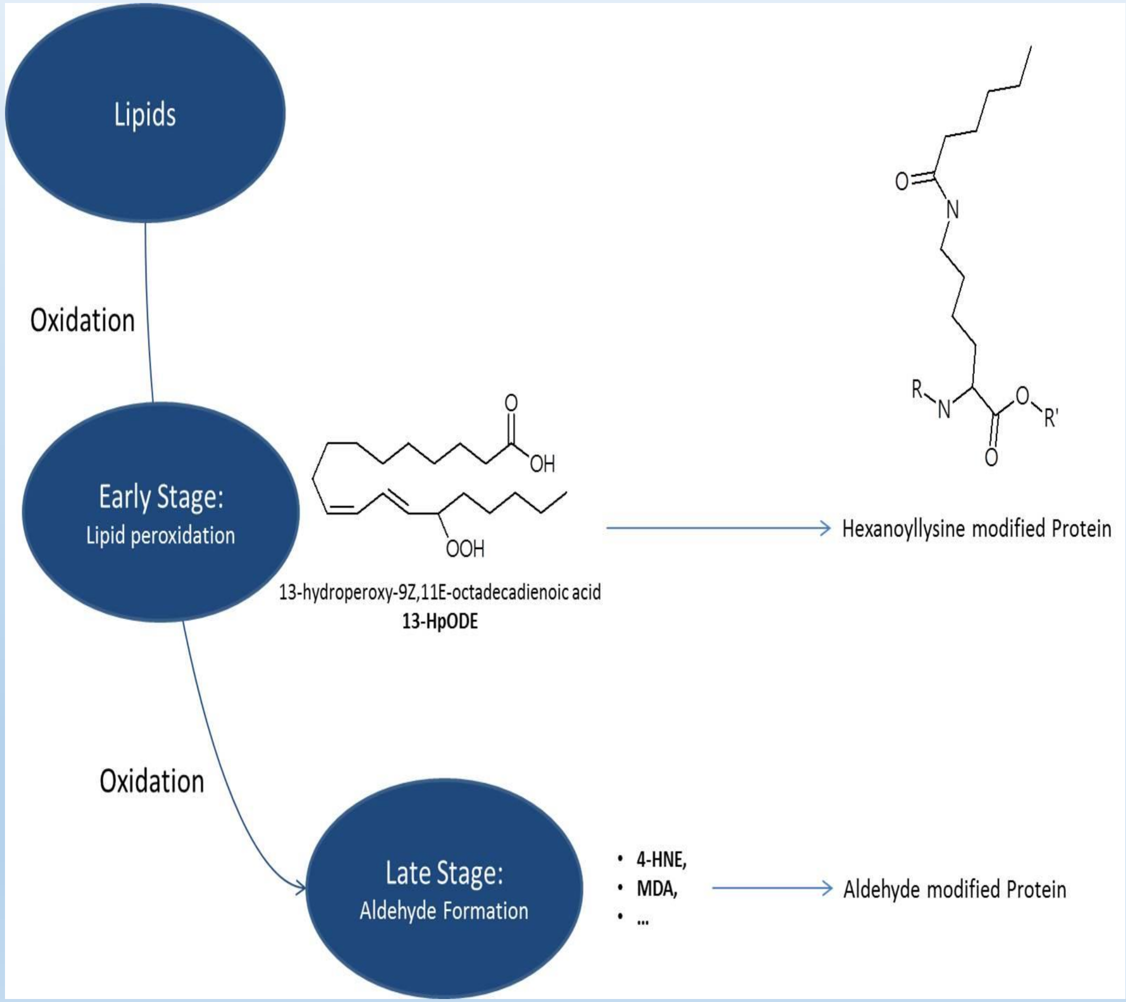
Dermatitis from chronic arsenic toxicity. Hyperkeratosis described as “dew drops on a dusty road”.

Research Background

- To demonstrate a correlation between arsenic in the urine and an increase prevalence of renal disease, MSUCOM students have tested multiple biomarkers such as…
  - urinary malondialdehyde (MDA)
  - 8-hydroxy-2’-deoxyguanosine (8-OHdG)
  - beta(2)-microglobulin (B2M)
  - N-acetyle-beta-D-glucosamindase (NAG)
- Of these biomarkers, MDA is the most promising. In small population samples, it showed direct correlation with high levels of arsenic

MDA Background

- Naturally occurring organic compound that is a marker for oxidative stress
- One of the major mechanisms of heavy metal toxicity is due to oxidative stress
- MDA levels have been shown to increase with arsenic exposure in breast and lung cancer



Objective

- This study further tested the validity of using MDA as a biomarker for kidney damage from arsenic in a previously unstudied region of Peru, Pataz.

Materials and Methods

- Urine and blood samples were collected from 102 patients in Pataz ranging in age from 2 to 81 years old
- An additional 38 urine and blood samples were collected from patients in the same age rage from Trujillo, Peru, to be used as a control sample
- All urine samples were tested for arsenic using the Osumex HMT Arsenic Kit
- Serum MDA was calculated using the malondialchehyche, MDA, ELISA Kit

Materials and Methods

- Values were analyzed and compared to normal standards set by the World Health Organization.
- Standardized normals included urine arsenic <100μ/L and serum creatinine 0.6-1.3mg/dl.
- Physiologic values for serum MDA range from 0.05-10.0μmol/L. In this study, MDA values >5.0μmol/L were considered high based on the control samples from Trujillo, where patients were never exposed to arsenic.

Research Locations

Pataz, Peru – Testing site

Trujillo, Peru – Control Site

Research Locations

Pataz, Peru

- Province of La Libertad Region in Peru
- Population 78,000
- Rural

Trujillo, Peru

- District and Capitol of La Libertad Region in Peru
- Second most populated city in Peru
- Metropolitan
- Population 812,000

Pataz Results

- Of the 102 patients tested in Pataz, 91.2% (n=93) of patients had elevated urine arsenic levels and
- 93.1% (n=95) of the participants had MDA levels >5.0µmol/L
- As the graph shows, 87% had both elevated arsenic and elevated MDA

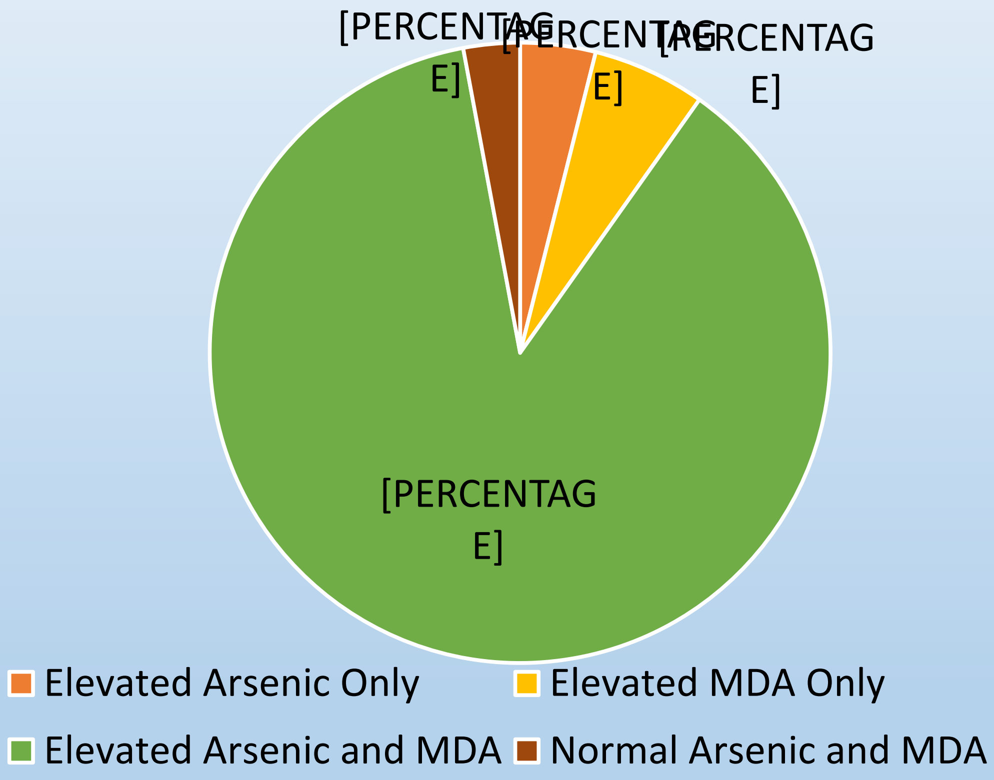


Figure 1: Breakdown of Pataz arsenic and MDA

Trujillo Results

- In comparison, of the control patient samples, none had elevated urine arsenic levels
- Only 5.3% (n=2) had MDA levels >5.0µmol/L
- Of all of the patients tested in both Pataz and Trujillo, Pataz had 98% of the elevated MDA levels and Trujillo had 2%

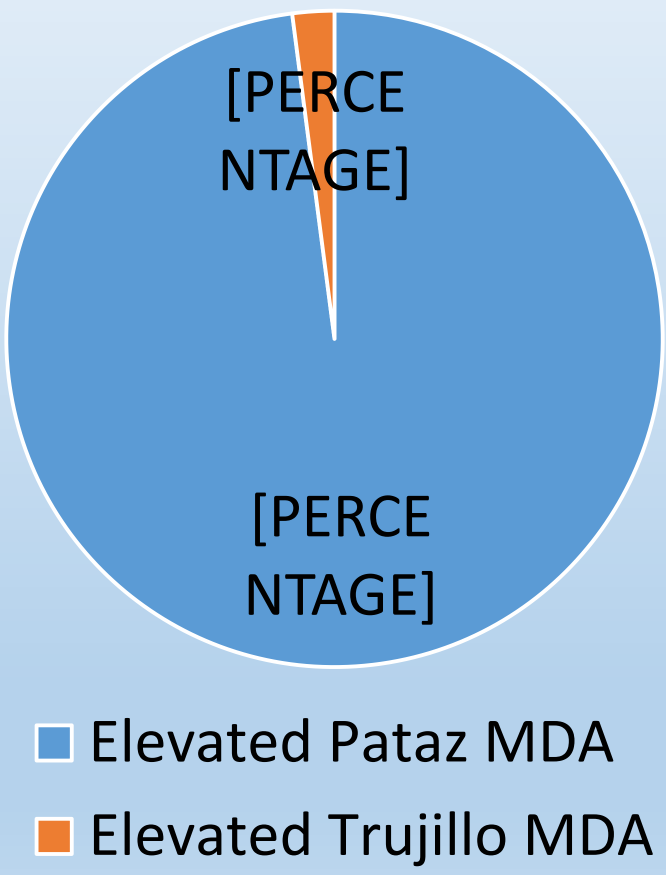


Figure 3: Total elevated MDA

Creatinine Results

- Abnormal creatinine levels were found in 58.4% (n=59) of the Pataz samples
- Whereas only 18.4% (n=7) of the Trujillo samples were abnormal
- Of all of the patients tested for creatinine, 89% of the abnormal results came from Pataz, whereas 11% came from Trujillo

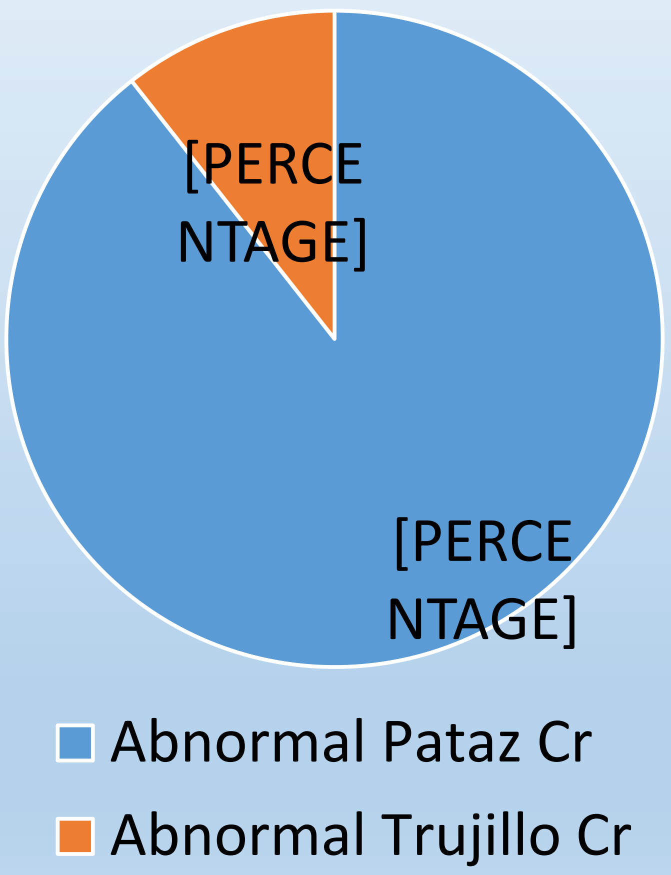


Figure 2: Total abnormal creatinine

Discussion

1) This study suggests that the Pataz population has a significantly high level of urine arsenic, which directly correlates to the elevated levels of arsenic in drinking water
2) The almost equally high levels of serum MDA suggests that the elevated arsenic could be the causative factor
3) The abnormal creatinine results further suggest early signs of renal impairment in this population
4) In conclusion, this study suggests that the population in Pataz has renal impairment due to the high levels of arsenic in the water and would benefit from a water filtration device to prevent further renal damage.

Looking Forward

- The next step is to place filtration devices in Pataz's water supply
- Future research into this topic should include additional MDA and arsenic levels after the implementation of these filtration devices
- MSUCOM students are currently working on developing and testing low cost filtration devices to be placed in various locations around Peru. Pataz would be the perfect location for the next wave of filtration systems.

References

"Arsenic Toxicity", Marcus, Steven MD, March 2014. http://emedicine.medscape.com/article/812953-overview

"Carcinogenic biomarkers in the pediatric population exposed to Arsenic (As3) in drinking water", Pang, Bo et all; August 2015

"Effect of Heavy Metal on Malondialdehyde and Advanced Oxidation Protein Produtcs Concentration: A Focus on Arsenic, Cadmium, and Mercury", Aflanie, I. et al; August 2015

"Risk assessment of low-level cadmium and arsenic on the kidney", Huang, M. et al; 2015

Questions?