The Impact of Mining on Human Health in the Sierra Nevada

Background Information
Results of the Environmental Health History Pilot Project
Recommendations

A Report to the Sierra Fund

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Project Background

• The Sierra Fund launched a project to examine the potential health effects of mining toxics on the people of the Sierra Nevada region of California in 2006
Project Timeline

Phase 1
- Literature Review
- Summer, 2006

Phase 2
- Key Informant Interviews
- December 2006

Phase 3
- Environmental Health History Data Collection
- Summer 2010

Phase 4
- Data Analysis
- February 2011
Initial Project Goals

• Literature review to describe the potential health effects of exposure to three substances: Arsenic, Asbestos and Mercury
• Key Informant Interviews to determine what information was being collected by health clinics and providers related to exposure to mining toxics.
Key Findings

• This effort resulted in a report that summarized the findings
Phase One-Literature Review of Project

Researchers reviewed more than 100 articles pertaining to gold-mining, exposure routes for arsenic, asbestos and mercury from the environment to human populations and the potential health risks from these exposures.

A Miner’s Kit which included a flask of Mercury. On display in the Coleman Centerville Museum where mining documents were reviewed.
Gold was only one of the elements that occurred naturally in this region. A perfect storm was created when gold extraction processes brought Mercury from California’s coastal ranges and mining processes conducted over dozens of years disturbed the naturally occurring asbestos and arsenic.
Environmental Damage from the Gold Mining Process

It has been estimated that in California more than 10,000,000 pounds of mercury was lost to the environment through placer mining operations.
Lakes, Rivers and Streams were affected by the mining waste.

According to the Environmental Protection Agency (EPA) mine waste has contaminated more than 40% of western watersheds.
The Damage Continues to Affect Populations

Abandoned mines combined with the remnants of the Gold Rush can still be found in many parts of California.

Damage around the coastal mercury mine sites can be seen as acid waste.

Damage to the Sierra Nevada is hidden behind dams, in our rivers and lakes and our ground water.
Map Depicting Fish Consumption Advisories
Evidence-Based Decisions

The initial study provided numerous references that documented both the presence of Mercury, Asbestos and Arsenic throughout the Sierra Nevada and the negative effects of exposure to these elements on human health. Particularly vulnerable are women and children.
Literature Review Results

• Numerous reports on the dangers of heavy metals
• No studies examining trends in disease prevalence related to exposure and the effect on human health
• Data collection is complicated by the desire to uphold the historical heritage of the region and the rural population’s resistance to “outside” interventions in areas where, for decades, individuals have relied on mining and the regions natural resources for their livelihood.
Arsenic, Asbestos and Mercury

- Each of the elements studied had a recognized presence in the Sierra Nevada
- Each of the elements studied had known exposure pathways.
- Each of the elements studied had well documented health effects
Asbestos

Naturally occurring asbestos (NOA) includes fibrous minerals found in certain types of rock formations. NOA can take the form of long, thin, separable fibers. Natural weathering or human disturbance can break NOA down to microscopic fibers, easily suspended in air.

There is no health threat if NOA remains undisturbed and does not become airborne. When airborne NOA is inhaled, these thin fibers irritate tissues and resist the body's natural defenses.

Serpentine is the California State Rock—Here you can see the asbestos fibers in Serpentine.
Asbestos
Impact of Asbestos

Health Effects

• Lung Cancer
• Mesothelioma of pleura or peritoneum
• Asbestosis
• Cor Pulmonal associated with severe Asbestosis
• Pulmonary Fibrosis
• Suspected link to laryngeal cancer
• Noted increased mortality from cardiovascular

Contractor in protective gear simulates baseball activity in El Dorado County, CA. (EPA, 2005)
Ultramafic rocks (black) contain naturally occurring asbestos.

Locations of Asbestos Mines
Arsenic

- *Along with mercury, arsenic is part of the toxic residue of gold mining in California and around the world. Unlike mercury, though, arsenic was not used in the extraction of gold from ore. Rather, it occurs naturally in a number of minerals common in gold mining regions and as a result tends to become concentrated in mine tailings, the crushed residue of the ore.*
Exposure Pathway

Arsenic from mine tailings can become dangerous in a variety of ways. It can become airborne as a result of:

- Wind
- Dust being spun up by ATVs and other vehicles driving on the tailings themselves or on dirt roadbeds where mine tailings have been used for gravel
- Children's play in developments where tailings have been used for fill
Impact of Arsenic

Observable symptoms or effects of arsenic poisoning include:

• Thickening and discoloration of the skin
• Stomach pain, nausea, vomiting
• Diarrhea
• Numbness in hands and feet
• Partial paralysis
• Blindness
Arsenic Level in Ground Water and Location of Gold Mines
Mercury

- In many gold-mining areas it is still relatively easy to find quantities of liquid elemental mercury in sediments and stream channels.

- Of even greater concern is the presence of methylmercury, an organic form of mercury that is a potent neurotoxin and is especially detrimental to developing fetuses and children.
Mercury Mining History in California
Mercury

- Most of the mercury used in gold recovery in California was obtained from mercury deposits in the Coast Range on the west side of California's Central Valley (fig. 4).
- Total mercury production in California between 1850 and 1981 was more than 220,000,000 lb (pounds) (Churchill, 2000)
Health Impact of Mercury

- Malaise, weakness, cognition impairment
- Paresthesias
- Decreased visual fields
- Decreased hearing acuity
- Ataxia
- Renal damage
- At high levels possible renal cancer.
- Possible increased risk of lipid deposition with increased risk of coronary artery and carotid artery disease.

Phase 2—Key Informant Interviews
Key Informant Interview

• The original plan was to find a way to examine environmental history records to look for trends in disease patterns that may be related to mining toxics.

• Interviews with professionals who provide care in the region highlighted the absence of an environmental history that might efficiently document exposure and provide disease surveillance information.
Key Informant Interviews

Does the clinic have an environmental History Form?

- Yes
- No
- Other
How Often Was an Environmental History Completed?

- Never
- No Answer
This early information highlighted the need for a better understanding of the ways the environment may be affecting the health of people living in the Sierra Nevada.
Phase 3 - Development of an Environmental History Form

- Project Flow Chart
  - Define Goals and Objectives
  - Determine Methodology
  - Determine Feasibility

- Develop Instruments
  - Establish Survey Design
  - Pilot Test Survey Questionnaire
  - Revise Instrument

- Conduct Survey
  - Identify Clinics
  - Train Interviewers
  - Summarize Data
  - Report Information
Project Goals

- Develop an environmental health history form that answers the project question.
- Identify Clinics in at least 3 communities that are in or near the Sierra Nevada that represented communities of the region to participate in survey.
- Interview 150 patients/participants to complete environmental health history.
- Summarize data and report information.
Development of an Environmental History Form

- Review Existing Forms
- Determine Sample Size
- Branching Questionnaire
- Pilot Test
Sample Size

- 248 surveys were attempted and 223 individuals consented to participation
Survey Results-Demographic Information

![Bar Chart]

Frequency

1 Clinic

Olivehurst
Harmony
DN Oroville
DN Chico
Placer Mkt
RR Mkt
GV Mkt
PennV Mkt
Participation Rate

![Bar chart showing participation rate with 'Yes' significantly higher than 'No'.]
Gender

- Female: 63%
- Male: 37%
Race-Ethnicity

- 55% White
- 21% Hispanic/Latino
- 9% Asian/Pacific Islander
- 6% Black
- 4% Native American
- 3% Other
- 2% Refused
Age of Responders

Age of Participants

- <18*: 1%
- 18-34: 4%
- 35-45: 13%
- >45: 37%
- refused: 45%
Zip Code Where You Live
Age of Home

- <1977: 25.4%
- 1977-1985: 24.4%
- 1986-2002: 19.8%
- >2002: 10.2%
- refused: 20.3%
Drinking Water Source

- Well: 20%
- Town supply: 56%
- Natural spring: 21%
- Purchased-bottled: 2%
- Other: 1%
If you have a well, when was the water tested?
How do you heat your home?
Do you eat fish?
Why it's important to ask about fish consumption

The Bioaccumulation of Methylmercury

Biomagnification of Methylmercury in the Ecosystem

Methylmercury Bioaccumulation in Organisms
Even though warnings are posted, many individuals are unaware of the risk of eating fish from contaminated rivers, lakes and streams.
Do hobbies include dust activities

Do Hobbies include Dust Activities?

- Yes: 0%
- No: 27%
- Unsure: 73%
Dust exposure creates an environmental risk
Do you live near a mine?

Live Near a Mine

- Yes: 80%
- No: 12%
- Unsure: 8%
Does anyone in your home smoke?
Do you have a smoke or carbon monoxide detector in your home?

Smoke-Carbon Monoxide Detectors in the Home

- Yes: 89%
- No: 8%
- Unsure: 3%
Occupations
Do you work around pesticides or chemicals

- Yes: 86%
- No: 10%
- Unsure: 4%
Are you concerned about the safety of your home?
If you are sick, might your symptoms relate to your home or work environment?

**Are Symptoms Related To Where You Live or Work?**

- No: 80%
- Yes: 12%
- Unsure: 8%
Branching questions provided more detail about exposure risk.

- Seventy-Six percent of participants completed one or more branching surveys.
- The branching forms were designed to provide more information about specific exposure risk.
Home Exposure History
Have you ever changed your residence because of environmental problems?
Condition of your home?
Location of home

Home Near Industrial Site or Abandoned Mine

Home Near a Dirt or Gravel Road?
Do you live near a highway?
Are there environmental concerns in your neighborhood?
Occupational Exposure History
If you work around chemicals or pesticides do you shower/change before returning home?
Do you wear protective equipment?

- Does your job require/suggest protective equipment?
  - Yes: High frequency
  - No: Medium frequency
  - Unsure: Low frequency

- Do you wear protective clothing?
  - Yes: High frequency
  - No: Medium frequency
  - Unsure: Low frequency
Does anyone mine for gold?
Are you concerned about your workplace environment?
Food and Water Exposure History
If you get your water from a well, when was it tested?
Do you wash the fruits and vegetables you eat?
Have you become sick from the food you ate or water you drank?
Do you catch fish in local streams to feed yourself or your family?
Are you aware of health warnings about fish?
What type of fish do you catch and eat?
In the past year, who from your household has eaten local fish caught by you or someone else?
Recreation and Hobby History
Does anyone in the family participate in off-road riding activities
Exposure risk based on rider position

Excess Lifetime Cancer Risk vs. Motorcycle Rider Position and Exposure Scenario (Sept. data)

Risk in one million

Motorcycle Rider Position

No. of rider days per year

Unacceptable Risk under CERCLA

1 day
5 days
12 days
Does anyone in the family mine for gold?
Health Related Questions
Does anyone in the family suffer from fatigue or unexplained pain?
Doesn’t the government regulate heavy metals?
Does anyone suffer from unexplained pain?

- No: 79%
- Yes: 20%
- Unsure: 1%
Has a family member been diagnosed with autism?

- Yes: 23%
- No: 71%
- Unsure: 6%
Are there environmental concerns in your neighborhood?
This survey is a snapshot of health exposure risk

- While environmental history taking is not an established practice for the clinical physician and while the logistics of how to efficiently include an environmental history in an already time-limited exam are not clear
- Ignorance of the environmental influences, pollutants, politics and prejudices should not be an excuse for omitting this important information tool.
Recommendations for the next steps

- Modify and shorten the history form
- Incorporate the environmental history into existing history forms that can be completed by patients/clients.
- Make providers aware of the environmental concerns in the Sierra Nevada
- The form should be standardized and part of an electronic health record to provide necessary surveillance information.
- Results of this survey should be considered at face value. A pilot test of an environmental history form applied to a small convenience sample.
- The results of the survey suggest possible connections between heavy metals and certain health conditions. This report should be followed with case controlled studies and a larger sample size.
Do you want to learn more about environmental exposures?

- The Agency for Toxic Substances Disease Registry has a 1.5 unit course that is offered free to interested providers.
- To access this free course go to: http://www.atsdr.cdc.gov/emes/health_professionals/pediatrics.html
Pediatric Environmental Toolkit

- There is also more information and direct access to educational tools to use with patients at:
  - http://www.psr.org/resources/pediatric-toolkit.html
Thank You