Lung-retained Fiber in Animal Lungs Confirms Environmental Exposure to Naturally-Occurring Amphibole Asbestos in El Dorado County, California

Co-author and homeowner (TT) with home soil sample containing tremolite

Jerrold L.Abraham MD[1], Bruce W. Case MD[2], Terry Trent and Bryan R Burnett, MS[3]

[1]Department of Pathology, State University of New York, Upstate Medical University, Syracuse, NY 13210,

[2]Department of Pathology, McGill University, Montreal, QC, Canada, and [3]Meixa Tech, Cardiff, CA. E-mail: abrahamj@upstate.edu

ABSTRACT

RATIONALE: Tremolite-actinolite asbestos has been identified in locations in the western portion of El Dorado county in the Sierra Nevada area of California. This area is under considerable pressure for real estate development. There has been concern about exposure to residents and to children attending schools there, with air and soil measurements and limited remediation by state and federal agencies and individual hygiene companies over the last several years. Previous animal testing found this fiber to have high mesothelioma risk. Analysis of animal lungs for retained mineral fiber has proven useful in exposure assessment in other locations worldwide.

METHODS: We obtained both lungs from four animals at the time of death through veterinarians. Of these, one cat had not lived in the area; one had, but remained indoors, and two dogs had lived in the area for different periods. Analysis of lung fiber burden was by analytical electron microscopy with identification of fiber types by EDS, using Scanning EM in the **SUNY LAB** and Transmission EM in the **McGill Lab.**

RESULTS: The following results were obtained:

LUNG FIBER CONCENTRATION IN EL DORADO COUNTY PETS

ANIMAL	EXPOSURE	SUNY LAB >5um length	McGill LAB >5um length	SUNY LAB >10um length	McGill LAB >10um length
Cat 1	none	0	0	0	0
Cat 2	9 years, indoors	86,000	157,000	86,000	157,000
Dog 1	> 2 years	1,250,000	566,500	192,000	412,000
Dog 2	> 8 years	9,162,000	928,000	2,030,600	928,000

All results in fibers of Tremolite/ Actinolite / gram dry lung

CONCLUSIONS. Animals studied show long-fiber tremolite-actinolite asbestos in great excess, proportional to exposure.

Funded By: None

MESOTHELIOMA STUDIES

HUMAN TREMOLITE EXPOSURES AND NON-OCCUPATIONAL MESOTHELIOMA

Introduction

Mesothelioma and Naturally Occurring Asbestos (NOA)

- Rates of mesothelioma related to NOA have varied from approximately 1 to 43/100,000 per year
- Tremolite has been the most commonly reported NOA type in such situations
- High pulmonary concentrations of tremolite (and sometimes also chrysotile) have been reported in human lungs from some of these locations [up to 227 million fibers/g dry lung]
- Median fiber diameter has been from 0.4 –0.5 micrometers, with 40-50% of fibers > 5 um length

Published studies

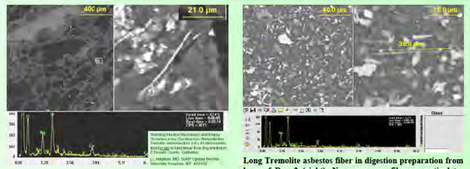
COUNTRY (see references for area(s))	HUMAN CASES	FIBER TYPE	MAJOR USE
Greece	**13**, 1985-94, area of 5000 residents	Tremolite	Whitewash
Turkey (Karain)	Over 50% of deaths	Erionite	Whitewash
Turkey (Southeast)	176	Tremolite	Building materials, whitewash
Quebec	5 Women	"High-Tremolite" serpentine area (mining nearby)	Four lived with chrysotile miners; one played in mine tailings
Corsica	14	"High-Tremolite"	"Environmental"
Cyprus	5	Serpentine areas (mining nearby)	Near high-tremolite chrysotile mines
New Caledonia	15, Two year period	Tremolite outcrops	Whitewash
China	From 6 to 22 per year in area of 68,000 residents	Crocidolite in surface soil	"Environmental"

OBJECTIVES

- We obtained lungs from four deceased pets who had lived in the El Dorado area for varying periods of time.
- The goal of our analysis was to determine to what degree these animals accumulated tremolite asbestos in their lungs, and how this was related to time of residence.

METHODS

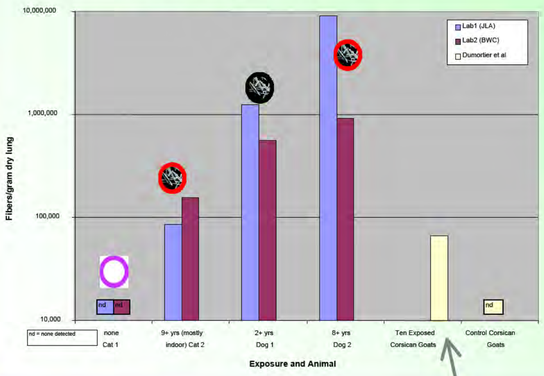
Analysis of lung fiber burden used bleach digestion and analytical electron microscopy, with identification of fibers by Energy Dispersive x-ray Spectroscopy (EDS), using Scanning EM in the SUNY lab (JLA & BRB) and Transmission EM in the McGill lab (BWC).



Long Tremolite asbestos fiber in digestion preparation from lung of Dog 2 (right). Numerous non-fibrous particulates and other fibers can be seen on filter at lower magnification SEM image (left). Tremolite EDS spectrum at bottom.

RESULTS

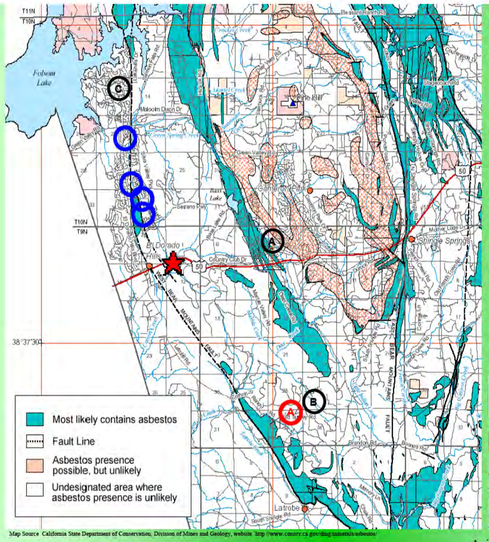
Lung Burdens of Tremolite/Actinolite Asbestos Fibers >5 um Length in El Dorado County Animals and Corsican Goats



CORSICAN GOAT STUDY

ANIMAL SURROGATE FOR HUMAN ENVIRONMENTAL EXPOSURE

- Environmental exposures to chrysotile and tremolite from the soil occur, as do pleural plaques and mesothelioma, in northeast Corsica.
- Goats grazing in the contaminated areas inhale asbestos fibers.
- Investigators used this natural animal model to study whether these exposures actually result in increased lung fiber burdens by using analytical transmission electron microscopy to determine the LUNG FIBER CONTENT of ten goats from areas with asbestos outcrops.
- See: Dumortier et al, 2002



Animal exposure histories estimated by their owners. Dog 2 (illustrated in photo) lived in home directly built on tremolite deposit. Dog 1 lived in areas not known to be directly on tremolite deposits.

LUNG FIBER CONCENTRATION RESULTS FROM TWO LABORATORIES FOR FOUR ANIMALS: EL DORADO COUNTY, CALIFORNIA

Animal	El Dorado Home Asbestos Exposure	TR/ACT fibers >5um length Lab 1	TR/ACT fibers >5um length Lab 2	TR/ACT fibers >10um length Lab 1	TR/ACT fibers >10um length Lab 2
Cat1	none	0	0	0	0
Cat2	9+ yrs (mostly indoors)	86,000	157,000	86,000	157,000
Dog1	2+ yrs	1,250,000	566,500	192,000	412,000
Dog2	8+ yrs	9,162,000	928,000	2,030,600	928,000

TR = tremolite
ACT = actinolite

Fiber concentrations in fibers per gram dry lung

One of the exposed dogs

EPA STUDY

EPA simulating children's play and conducting air sampling at a soccer field in El Dorado Hills, CA.

- The EPA conducted activity-based personal air sampling in October 2004 at sites noted on map
- The tests focused on simulating outdoor activities of the most active children (upper bound of exposure and longer life span)
- The EPA study results released in May 2005 showed that playing sports and riding on bicycle trails generated up to 43 times higher concentrations of tremolite asbestos fibers compared with reference samples.

Summary of Air Sample Results

U.S. EPA Activity-Based Asbestos Exposure Sampling - Community Park, Silva Valley School, Rolling Hills School, & Jackson School, El Dorado Hills, October 2004

Location & Activity Scenario	Long Fibers (PCME) > 5 µ: Ratio: Personal Exposure to Reference [3]	Long Fibers (PCME) > 5 µ: Average of Personal Exposure (Ave) [5]	Long Fibers (PCME) > 5 µ: Reference Concentration (Ref) [6]	Total Structures (AHERA) 10 µ: Ratio: Personal Exposure to Reference [1]	Total Structures (AHERA) 10 µ: Average of Personal Exposure (Ave) [7]	Total Structures (AHERA) 10 µ: Reference Concentration (Ref) [8]	Comments
New York Trail. ► *Child Biking Scenario*	43	0.0336	0.0008	23	0.0564	0.0024	PCME & short fibers ~ all amphiboles.
New York Trail. ► *Adult Jogging Scenario-B*	39	0.0312	0.0008	28	0.0439	0.0016	PCME & short fibers ~ all amphiboles.
North Field Baseball Diamond, Community Park ► *Child Baseball Game*	22	0.0171	0.0008	21	0.0513	0.0024	PCME mostly amphiboles, including actinolite, tremolite & anthophyllite.
South Field Baseball Diamond, Community Park ► *Child Baseball Game A*	22	0.0168	0.0008	217	0.5307	0.0024	PCME mostly amphiboles; short fibers mostly chrysotile.
North/South Soccer Field, Community Park ► *Child Soccer Game*	16	0.0087	0.0005	11	0.0178	0.0016	PCME ~ all amphiboles; short fibers mostly amphiboles.
New York Trail. ► *Adult Jogging Scenario-A*	12	0.0197	0.0017	10	0.0347	0.0035	PCME & short fibers ~ all amphiboles.
Community Park Baseball ► *Adult Observer Exposure*	11	0.0114	0.0010	21	0.0559	0.0026	PCME mostly amphibolos; short fibers mostly chrysotile.
South Field Baseball Diamond, Community Park ► *Pooled Child Baseball Games*	10	0.0118	0.0012	95	0.2823	0.0030	PCME mostly amphibolos; short fibers mostly chrysotile.
Toddler Playground, Community Park, ► *Typical Child Play Scenario*	10	0.0067	0.0007	60	0.0816	0.0014	PCME mostly amphibolos; some chrysotile, tremolite & unnotite.

Excerpt from EPA report on testing results in El Dorado sites. Full report at http://www.epa.gov/region09/toxic/noa/index.html

DISCUSSION

1. We have reported here analyses of lung fiber content for two dogs and two cats residing for different durations in the El Dorado, California area.
2. Results of electron microscopic lung fiber burden analyses by two independent laboratories are presented.
3. **Results from BOTH labs show greatly elevated lung burdens of the tremolite/actinolite type of asbestos fibers > 5 micrometers length in the dogs, with the higher burden in the dog residing for more years in the contaminated area; lower levels in one cat who remained mostly indoors; and no detectable amphibole asbestos in the cat which had not lived in the contaminated area at all.**
4. In a study of dust accumulation in lungs of dogs from another state (Kansas), age-related accumulation of ambient dust was shown. None of those dogs' lungs demonstrated any tremolite or other asbestos {Schoning et al, 1996)

CONCLUSIONS

The concentrations of amphibole asbestos fibers in our dog lungs are substantially higher than those found in goats from Corsica, where ***an exposure to environmental tremolite asbestos is clearly associated with human mesothelioma occurrence.***

- Our results demonstrate that amphibole asbestos fibers from NOA in the El Dorado situation are being inhaled and retained in the lungs of animals residing in that area ***in direct proportion to time spent in the area***.
- It is likely that human exposures from such developments in this area and similar areas **have already occurred**, and because the main disease of concern (mesothelioma) takes decades to develop, excesses will be difficult to detect until considerable time passes.
- Prudent Public Health action to prevent further exposures seems indicated *without waiting for this to happen*.
- In our view, there should be serious consideration given to a moratorium on further development of roads, schools, and housing construction on such sites with exposed amphibole asbestos.
- Additionally, long-term follow up of those already potentially exposed (especially as young children) seems indicated.
- Analyses of a larger group of animal and human lung tissue will provide additional quantitative data.

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Disclaimers

- Neither Dr. Abraham (JLA) nor Dr. Case (BWC) has any direct involvement with any agencies or commercial concerns in the El Dorado area.