Thoughts about Uncertainty in Inhalation of Radionuclides at Cold Water Creek: A review of ATSDR report 2019, Inhalation cancer risk at Cold Water Creek

Roger D. Lewis, PhD, CIH, FAIHA

AIHA/ASSE 3/4/2024

Who are we, what will we be talking about and why

- I am Roger Lewis, a retired professor at Saint Louis University College of Public Health, but still active in my field of environmental and occupational health.
- Lee Sobotka is a professor of chemistry and physics at Washington University.
- We are not paid by anyone to give this talk and we are not consultants for the government or anyone else pertaining to the problems we will be talking about today.
- We will be talking about the history of the Mallinckrodt work in WWII and exposures/risks to radioactive materials at specific sites around St. Louis.
- Our objective is to educate the technical community about the uncertainties, assumptions, and conclusions that have been made about the nature and the remediation of the legacy waste in St. Louis.
- For more information about the Jana Elementary School and the scientific debate that went into that controversy please see the You Tube of the Technical Forum on this matter given at SLU in April, 2023. https://www.youtube.com/watch?v=ZbDhPB2pqRo

What the Headlines Say

- Radioactive waste found at Missouri elementary school *Not proven*
- The school sits in the flood plain of Coldwater Creek, which was contaminated by nuclear waste from weapons production during World War II. *Not proven*
- "Our whole region is injured by this — psychologically, emotionally, physically," *True and not true*
- Federal report: Coldwater Creek contamination may raise the risk of cancer in north St. Louis County residents – *Let's talk about this so we can figure out what else is true and not true.*

Some useful terms and background

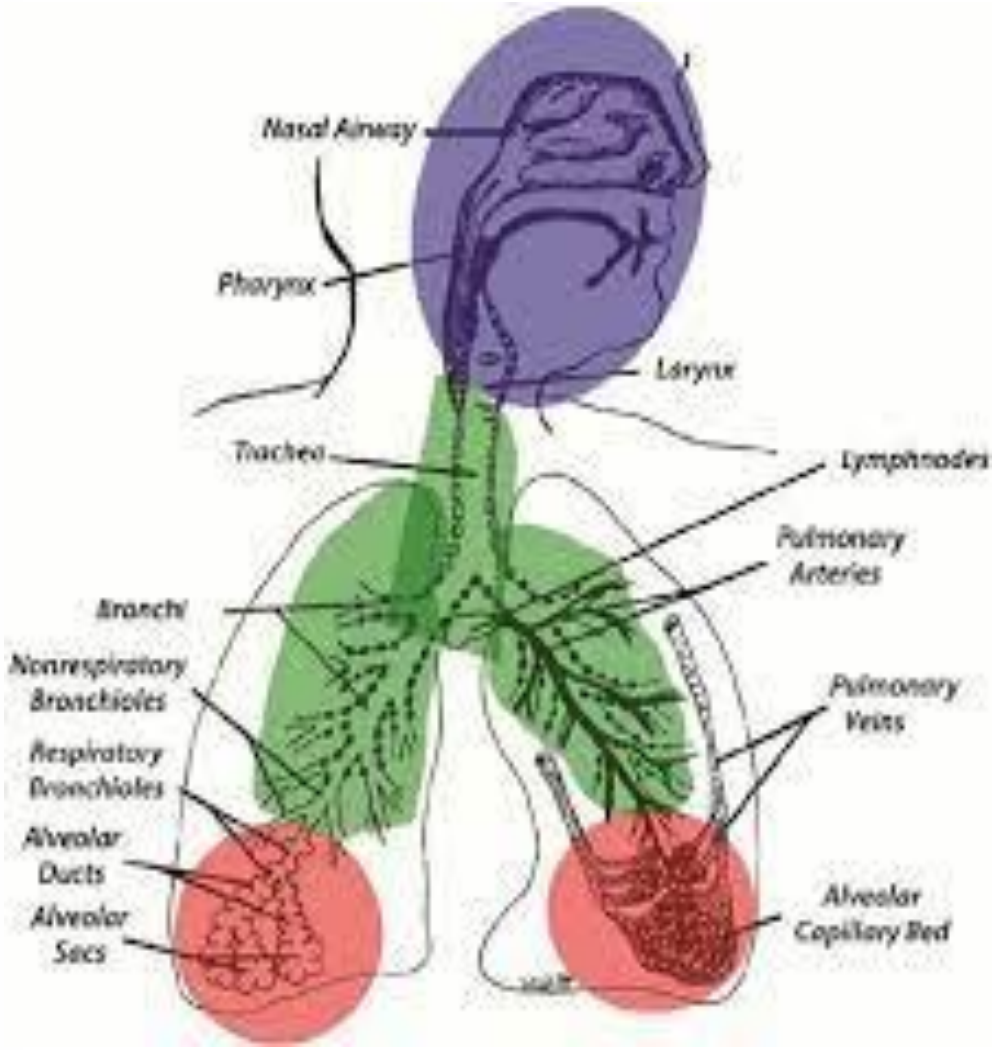
- ATSDR = The Agency of Toxic Substance and Disease Registry, perform health consultations for communities and other government agencies.
- ATSDR did health assessments around the Cold-Water Creek (CWC) area in 1994 and 2019. They found elevated risks of several cancers and lung cancer was the highest.
- ATSDR did studies of former mining and smelting operations, later turned to parks and trails, in Colorado and Michigan. Those studies were key to their 2019 report.
- Resuspension is the process of atmospheric deposition of particles followed by some of these settled particles lifting off a surface after a disturbance over time. 
- The precautionary principle at work here: when the estimate of risk for contaminants are unknown, regulatory limits tend toward greater-protection – that can be a statistical push for levels below a threshold. 

Lung Cancer Risks

Inhalation of alpha particles greatest concern

- Thorium 230 and Radium 226, are two major concerns of ATSDR at Cold Water Creek.
- These radionuclides will decay and release alpha particles, can penetrate lung tissue once inhaled and lead to cancer.
- The primary concern are respirable particles, 1-5 µm aerodynamic diameter (red).
- Inhalable particles are those that enter the nasal airways with only a small fraction ever reaching the deep part of the lung, these are

< 10 µm. (Most settle in blue).



ATSDR Report 2019: Summary finding on lung cancer risk living or playing for 33 years

"LUNG CANCER IS THE SECOND MOST COMMON FORM OF CANCER IN THE U.S. THE LIFETIME RISK OF BEING DIAGNOSED WITH CANCER OF THE LUNG OR BRONCHUS IS ABOUT 6.4%, OR 640 OUT OF 10,000 PEOPLE [47]. **THE PAST RISKS ESTIMATED IN THIS REPORT COULD INCREASE THIS RISK BY A SMALL AMOUNT, LESS THAN 2%" (ATSDR 2019). THIS IS ABOUT 650 OUT OF 10,000 PEOPLE.**

THE PAST RISK IS THE RISK FROM LIVING NEAR COLD WATER CREEK PRIOR TO REMEDIATION OF THE CREEK.

ATSDR's estimate was and is extremely controversial

How did this risk estimate, a 2% increase in cancer risk, come from?

Derived from recreational and residential activity near the creek

What kind of use?

Assuming an exposure of 33 years of frequent exposure (several hours/day) to an all-terrain vehicle in and around the creek

ATSDR estimates this is about 3,375 µg/m3 daily of PM10 dust laden with radionuclides

PM10 is the fraction of dust that is inhalable but NOT respirable

The Controversy

- Today's standard for outdoor air of PM10 is:
- 150 µg/m3, 22 X < ATSDR assumption
- Did kids or people use all terrain vehicles around Cold Water Creek?
- No, they used their bikes!
- Okay but how did ATSDR get this number, 3,375 µg/m3 of PM10 ?

Abandoned smelter data

- ATSDR used a simulation of recreational use by ATVs from the Quincy Smelter Site in Hougton County, Michigan done by the US EPA (ATSDR 2006).
- An ATV was equipped with an air sampling device that trailed behind another ATV on a former mine site converted to recreational use. Sampling was measured for 3 hours! Dust ranged from 18.7 – 23,359 µg/m3. The arithmetic mean was used which ATSDR stated is biased high (typically a geometric mean would be used). Mean total dust was 3,375 µg/m3.

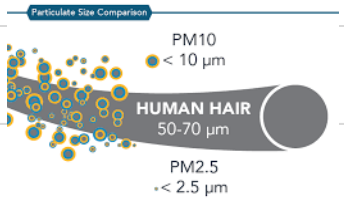
PM10 versus Respirable Risks

- The PM10 fraction was assumed to be 35% (EPA method: SRC 2007, 2009)
- 1,181 µg/m3
- Lung cancer relies on particles that are respirable, 1-5 µm, AED, a much lower number but we don't know what that is

Simulated inhalation exposures for Cold Water Creek: Iron (Fe) sampled at Quincy Smelter, EPA, 11/26/2006

ATSDR Total dust = 3,375 ug/m3

EPA max ATV Fe at Quincy Smelter =



ATSDR PM10 fraction = 1,181 ug/m3

Fe at Quincy, bike, stroll, and other ATV

EPA maximum iron concentration on bike trails in Quincy Smelter Site = 140 ug/m3

Inhalation creek

Review of Activity-Based Sampling on the Hancock/Ripley Trail FORMER QUINCY SMELTER SITE TOWN OF RIPLEY, HOUGHTON COUNTY, MICHIGAN (Included in the Torch Lake Superfund Site, 11/26/2006

ATSDR's response to critics in 2019 (their response to critics is paraphrased here)

The selected PEF is not inconsistent with standard assumptions used on resuspension of radionuclide particles.

A mass loading of soil in air, 5,000 µg/m3, was assumed by the Department of Energy in 1988 in its 1988 hazard assessment of the recreational ball field near SLAPS, St. Louis Airport Site [138]. See next slide.

In 2018, Marshall and coworkers reevaluated existing data to develop a general-purpose resuspension rate constant [140]. Results dependent on time following deposition, ranging from 1,500 µg/m3 within one day of deposition to 67,000 µg/m3 over a period of one year. For periods from 2 to 8 years, resuspension factors were reduced to about 1 µg/m3. .

Resuspension factors from S. Marshal, et.al. **Health Phys. 114(5):500–506; 2018**

Table 2. Integrated resuspension factors comparison for relative dose effect of regression models.

	Integration period (d)				
	0–1	0–10	0–30	0–100	0–365
	Integrated resuspension factors ($d\ m^{-1}$) and model prediction relative to this work (unfixed) for each period				
This work (fixed)	1.50×10^{-6}	1.33×10^{-5}	3.16×10^{-5}	5.45×10^{-5}	6.73×10^{-5}
This work (unfixed)	1.44×10^{-6}	1.29×10^{-5}	3.07×10^{-5}	5.34×10^{-5}	6.04×10^{-5}
NRCP Model[a]	1.00×10^{-6}	3.30×10^{-6}	4.40×10^{-6}	5.61×10^{-6}	7.91×10^{-6}
	+43.8%	+290%	+597%	+849%	+666%
Double-Exponential[b]	1.89×10^{-6}	1.60×10^{-5}	3.42×10^{-5}	4.68×10^{-5}	5.05×10^{-5}
	−24.0%	−19.5%	−10.3%	+9.6%	+20.1%
Double-Exponential[c]	9.67×10^{-6}	7.20×10^{-5}	1.26×10^{-4}	1.43×10^{-4}	1.46×10^{-4}
	−85.1%	−82.1%	−75.7%	−62.8%	−58.5%
Power-Law[b]	4.47×10^{-5}	1.06×10^{-4}	1.19×10^{-4}	1.26×10^{-4}	1.34×10^{-4}
	−96.8%	−87.8%	−74.2%	−57.7%	−54.8%

[a](NCRP 1999).
[b](Maxwell and Anspaugh 2011).

Remaining questions

The SLAPS “ball fields” were covered with fill dirt starting in the 1970s. The ball field was built in 1981 and shut down in 1986 (personal communication, M. Cummings, HGL, 2/18/2024). Aerial photos show the ball fields covered in vegetation in 1986.

AND….Marshall and co-workers didn’t arrive at the figures that ATSDR quoted . ATSDR may be **in error.** The numbers that were quoted in the ATSDR report have different units than those found in the article itself. The units are day/meter, which is an integrated resuspension factor not an emission concentration which ATSDR suggests! No matter what ATSDR concluded, resuspension greatly drops over time.

Final thoughts

- ATSDR, estimated that preschool children, living or playing around the creek, spent about 4 hrs/day playing in the yard and 4 hrs/day riding their bikes or playing around the creek. This exposure is assumed over a 33 year duration (Precautionary principle applied).
- ATSDR, has vastly overestimated average inhalation exposures of alpha particles and likely maximum exposures at CWC.
- So, the risk of living or playing near Cold Water Creek is somewhere between no increase to 2% increased risk and is likely to be on the low side of the estimate.