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Letter to the Editor regarding Davis B, McDermott S, McCarter M, Ortaglia A. 2018. Population-based mortality data suggests remediation is modestly effective in two Montana Superfund counties. Environ. Geochem. Health, published online Aug. 23, 2018.

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As a group of citizens, scientists and public health officials, members of the Butte Superfund Health Study & Biomonitoring Working Group are committed to furthering the health and well-being of Butte citizens. We welcome the Davis et al. (2018) examination of mortality rates in Butte and Anaconda. Nevertheless, we are concerned the conclusion that elevated mortality rates reported were associated with the presence of Superfund sites in these two communities is not adequately supported. In this letter we focus on Butte and begin by summarizing findings of two Montana Department of Public Health and Human Services (MDPHHS) studies of cancer mortality and incidence in Butte Silver Bow County that do not find elevated cancer incidence over a 35-year period. We then describe the massive remediation program conducted throughout Butte Silver Bow County over the past thirty years, as well as ongoing programs to reduce and track potential exposures to metals in Butte. Notably, by 2010 average blood lead levels in Butte children were not elevated above those expected in a similar community without a mining history. We conclude by describing the collaborative effort of the Health Study and Biomonitoring Working Group to update the prior exposure studies and to engage in outreach to the community inviting input regarding health concerns and study design.

Morbidity vs. Mortality Considerations

Davis et al. state "Our study's aim was to identify any excess mortality from an a priori selection of causes of death associated with heavy metal exposure in Deer Lodge and Silver Bow"; however, they neglect to acknowledge the multitude of other factors that have been associated with the causes of death selected for their study. Prior to asserting that elevated mortality rates are associated with metal exposures from Superfund sites, it is necessary to examine other possible causes.

While Davis et al. acknowledge that reliance on death certificates is a limitation of their study, they do not explore this limitation further. Epidemiological evaluations of cancer may look at cancer mortality (the number of deaths from cancer) or cancer incidence (the number of newly diagnosed cancer cases). Both provide different measures of health burden. Cancer mortality is influenced by stage at diagnosis, age at diagnosis, access to care, and type and completeness of treatment. These factors are known to differ by race, ethnicity, and income. Studies that look at cancer incidence offer better opportunities to explore causation, including from exposure.

In 2012 and 2018, the Montana Department of Public Health and Human Services (MDPHHS) examined cancer mortality and incidence in Silver Bow County from 1981 through 2016 using data from Montana death records and the Montana Central Tumor Registry (MDPHHS 2012 and MDPHHS 2018-Laura is this posted? Is there a link we can cite?). MDPHHS found that the age-adjusted mortality rates for all cancers

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combined were slightly elevated in Silver Bow County compared to Montana for two of four time periods examined, 1991-2000 and 2012-2016, and found incidence rates for all cancers combined were statistically the same or lower than for Montana during all time periods examined from 1981 through 2016. MDPHHS also examined incidence and mortality of specific cancer sites determined by the International Agency for Research on Cancer (IARC) known to be caused by or associated with the Superfund-related metals. IARC is the global authority on which environmental factors cause cancer in humans. MDPHHS specifically examined the following Superfund-related cancers: lung and bronchus, bladder, kidney, and liver. MDPHHS found that the incidence rates for each of these cancers were statistically lower in Silver Bow County than for Montana for all time periods examined from 1981--2016. MDPHHS found that mortality for lung and bronchus and bladder cancers were statistically the same in Silver Bow County as the rest of Montana for all time periods examined from 1981-2016. However, liver cancer mortality was statistically elevated in Silver Bow county compared to Montana from 2007-2016. There were too few kidney cancer deaths for MDPHHS to calculate stable mortality rates.

MDPHHS's results differ from Davis et al, in part, because MDPHHS defined cancer-related mortality using underlying cause of death (i.e., the immediate cause of death) recorded on the death certificate rather than using multiple cause of death (i.e., intermediate causes), as the Davis et al article did. MDPHHS's approach to defining cancer-related mortality is a standard cancer surveillance method used by state and federal public health agencies, including the Centers for Disease Control and Prevention and the National Cancer Institute. Studies have shown that the two methods of defining cause-specific mortality can yield greatly different results, with the multiple cause definition counting more deaths than underlying cause (Redelings et al. 2006).

Montana does not collect population-level data on the incidence of cardiovascular disease or organ failure, which would allow us to better understand the elevated mortality rates Davis et al. report for these conditions. The finding of Davis et al. that mortality from select neurological conditions was not elevated in Butte is a welcome finding considering the level of concern among residents regarding these conditions. One of our main concerns is that inappropriate attribution of the reported elevated mortality rates to Superfund-related exposures could divert attention from the pressing health concerns identified in the community needs assessments conducted by the Butte Silver Bow Health Department (BSB) (PRC 2014, 2017).

Contaminant Exposure Considerations

The basic hypotheses of the Davis et al. study, that "significantly higher standardized mortality ratios....are related to ***heavy metal exposure,***" fails to recognize the extent to which the Superfund remedy has reduced human exposure to heavy metals. In many cases they cited past exposure data without explaining that those exposures have been largely remedied. For example, their report references Berkeley Pit water being "routinely tested above acceptable levels of COC[1] since remediation began." However, institutional controls ensure that no one uses Berkeley Pit groundwater for drinking – it simply is not an exposure pathway. Additionally, they cited the 2006 Butte Priority Soil Operable Unit (BPSOU) Remedial Investigation Report as stating 2700 soil samples had elevated concentrations of arsenic, cadmium, copper, lead, and zinc as another example of an exposure pathway. These data were

[1] COC = contaminants of concern.

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collected from 1987 to1999 and involved mostly waste dumps. Capping of waste dumps began in 1988, and while the program continues, most of the larger waste dumps having greater exposure potential were capped before 2000. Altogether millions of cubic yards of mine waste and contaminated soil have been remediated in Butte Silver Bow County over the past 35 years. [Josh and Nikia, Is this last sentence accurate? Should we be more specific? I think it is okay without a detailed timeline, but feel free to add a few more sentences if you think it is needed.]

Commented [GN1]: I think the general language is ok. If you wanted to be more specific the initial volume of removal at Colorado Tailings, BRW, and LAO floodplain was reported at 1.2 million. The current repository is holding somewhere around 200K CYs from other removals, RMAP, etc. (based off Survey data). So this is just removal. The capping is extensive and would be measured in acres. Additionally, it might be beneficial to note that there is more remediation scheduled both for BPSOU and WSSOU both contained within BSBC in the next five years.

Identifying surface water, groundwater and (stream) sediment as routes of exposure to aluminum, copper, iron, silver and zinc also fails to recognize the difference between human health and aquatic life risks. Those metals are listed in U.S. Environmental Protection Agency (USEPA) documents because they are or have the potential to be above aquatic life standards, not because they exceed human health standards. Importantly, both Silver Bow and Deer Lodge counties have safe and clean public drinking water supplies. Additionally, both counties have domestic well management programs that ensure residents are not drinking contaminated groundwater.

The Lee and Fraumeni 1969 reference addressing respiratory cancer in exposed smelter workers has little applicability to the stated hypotheses concerning exposure in the 2000 to 2015 time period because the magnitude of exposure was much different than today. We recognize that the latency and disease progression time frames are such that elderly people exposed occupationally during historic mining operations may well experience adverse health effects today. However, the ongoing contaminated soils and mine waste reclamation programs for both Butte and Anaconda have substantially reduced the current human exposure as presented in the 2015 Anaconda 5-Year Review and the 2016 Silver Bow Creek/Butte Area 5-Year Review. These reclamation programs will continue to reduce exposure into the foreseeable future. The Anaconda Regional Water Waste and Soils Operable Unit is a complex site with widely varying potential exposure concerns that has been subdivided into 16 Remedial Design Units. Remediation began in late 1980's and the majority of the remedy is now complete. Most impressive is capping the six square miles of tailings impoundment which now prevents direct dermal exposure and exposure to blowing dust. The urban areas of both Butte and Anaconda have ongoing residential property cleanup programs. In Butte, the Residential Metals Abatement Program, which began in 1994, is now more than half complete, having sampled 3,332 residential parcels and abated 1,152 properties and attics as of 2018 (BSB 2018 – email from Branden Warner, RMAP to Josh Bryson, 11/19/2018. Is there a more formal document we can cite now?).

Overall, we find that the claim that heavy metal exposure is widespread and evenly distributed throughout Deer Lodge and Silver Bow counties for the period 2000-2015 is not supported by the available data. Elevated disease rates cannot be linked to metal exposure without a more accurate characterization of current and historical exposures to specific metals in various areas of each county, as well as consideration of subpopulations with historical occupational exposures.

Epidemiology vs. Risk Assessment in Remediation Decisions

While epidemiology is generally useful for understanding the cause of disease, it has certain inherent limitations that have led USEPA to use risk assessment as the primary methodology to assess exposure and support remediation decisions (USEPA 1989). The latency period from exposure to the onset of disease ranges from many years to decades for cancer and other disease endpoints associated with metals contamination. Moreover, epidemiological studies have limited power to detect effects of chemicals at the relatively low levels found at many Superfund sites. A series of human health risk

assessments for the residential areas in Butte have documented that lead is the primary metal of concern in Butte soils. The risk assessments are summarized in the Butte Priority Soils Record of Decision (USEPA 2006) and in 2011 the USEPA reviewed the earlier health risk assessments and confirmed their findings and the protectiveness of the soil clean up levels (USEPA 2011).

In Butte, a novel home abatement program has been underway for 23 years to reduce residential lead exposures from all sources, not just Superfund-related sources (USEPA 2016). This program also addresses arsenic and mercury, but abatement has seldom been required for these two metals, confirming that lead is the primary metal of concern.

A recent study of blood lead levels (BLLs) in almost 2,800 Butte children documented that BLLs declined substantially from 2003 to 2010, and that 2010 geometric mean BLLs were comparable to BLLs in a reference population matched to the Butte population for house age and various socioeconomic factors known to correlate with BLLs (Schoof et al. 2016). Average BLLs for 2010 of 1.6 micrograms per deciliter (µg/dL) were less than half of the levels for 2003, of 3.5 µg/dL. The percent of BLLs above 10 µg/dL declined by about the same amount. The percent of BLLs above 5 µg/dL dropped by an even greater amount, decreasing from 34 percent in 2003 to 10 percent in 2010.

Even an earlier investigation conducted prior to much of the remediation completed during the last 28 years found little evidence of elevated lead exposures among Butte children. A 1990 exposure study conducted by the University of Cincinnati (BSBDH/UC 1992) included blood lead assessment of 294 children up to age six and found the geometric mean blood lead level was similar to U.S. levels and lower than values from other mining communities tested at that time. The low exposure potential associated with lead in Butte soil is likely related to the very low soil lead bioavailability in Butte as compared with other mining sites (Casteel et al. 2006). While remediation continues, much has been completed, and these results suggest that remediation is having some effect on reducing exposure to lead and likely other metals, and that wide-spread, significant exposure is not ongoing.

Moving Forward

Many of us are participating in a collaborative effort to update the prior studies on blood lead levels and cancer incidence and mortality in Butte, as well as a broader outreach to the community inviting input regarding health concerns and study design. Our Health Study and Biomonitoring Working Group will include the Davis study as another welcomed addition to the studies that seek to inform the status of health in the Butte area and how best to achieve public health improvements. The potential for exposure to Superfund related metals contamination is but one of many factors that could contribute to risk of getting disease (incidence) and succumbing to disease (mortality) in the greater Butte area. In response to an EPA Order of Consent to conduct health studies in the Butte area every five years, the cross section of experts, agency managers, and actively engaged citizens who constitute the Health Study and Biomonitoring Working Group will continue to seek to understand the effectiveness of the Superfund remedy in making the greater Butte area a clean and healthful place to live. We encourage and welcome any and all contributions to this effort.

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