September Article of the Month

Reproductive outcomes after non-occupational exposure to hexavalent chromium, Willits California, 1983-2014

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ABSTRACT

Background:

Hexavalent chromium (Cr(VI)) is a toxic form, usually industrially produced, of the chemical element chromium (Cr). Some of the industrial uses of Cr(VI) include stainless steel production, pigments in dyes, paints, inks, and as an anti-corrosive agents for paints and primers[1]. Human exposure to Cr(VI) can occur from breathing in contaminated air, drinking contaminated water, or through direct skin contact. Many studies have shown increased lung cancer rates in workers who were exposed to high levels of airborne Cr(VI) in the workplace setting[2].

In contrast, research on the human health effects among non-occupational exposed groups to Cr(VI) is very limited and primarily based on adults. Only 5 studies have examined the reproductive effects of Cr(VI) in occupationally exposed women of child bearing age and not many have performed the same analysis for those domestically exposed via breathing and drinking contaminated air and water[3]. Existing studies have shown an increased risk of spontaneous abortion and low birth weight associated with occupational exposure to Cr(VI)[4],[5].

Additionally, because children can be more susceptible to the effects of toxicant exposure than adults, and because women can be particularly vulnerable during pregnancy, more studies evaluating the impacts of Cr(VI) on child and maternal health are necessary[6].

Objective:

Using hospital discharge abstracts and admission information, researchers investigated the health outcomes for women of reproductive age and their infants domestically exposed to Cr(VI) from a steel manufacturing Plant in Willits, California.

Methods:

Patient discharge data (PDD) of women and infants from the period 1983-2014 was utilized to examine the impact of non-occupational exposure to Cr(VI) on general and reproductive health.

For study analysis, infants were categorized as being born before Plant closure (1983-1966) or after (1997-2014). Pregnant women were grouped in two generations (born 1950-1969 or born 1970-1989). Life course files to assess general and reproductive health were created for non-pregnant women and men (for comparison).

Health outcomes (both pre and post Plant closure) for infants, pregnant women, and non-pregnant women were assessed across generations and compared to the overall health of Mendocino County.

Results:

The entire population of Willits was exposed to Cr(VI) prior to Plant closure, meaning most of the women of the eldest generation (born 1950-1969) were exposed during reproductive age and made up 78% of pregnancy admissions. Among pregnant women of this generation, hospital discharges decreased after Plant closure in 1997 from 5,383 to just 199. Compared to the rest of Mendocino County, both generations of women (born 1950-1969 and 1970-1989) living in Willits had a higher risk of miscarriage or giving birth to infants with low or abnormal birth weights. Willits birth rates were also lower than the state and county rates.

Overall (comparison between generations or pre/post Plant closure), adverse pregnancy conditions for Willits women and infants were more common than they were for women in the rest of the county. Both women and men in Willits also had poorer general and reproductive health, and the risk of developing adverse health conditions was comparable between the two generations.

Conclusion:

Both animal and human occupational studies show that exposure to Cr(VI) before and during pregnancy can have detrimental effects. The following study supports that domestically exposed women living near a Plant that manufactured Cr(VI) experienced adverse reproductive impacts for themselves and their infants.

POLICY IMPLICATIONS

The Centers for Disease Control and Prevention states that eliminating exposure to Cr(V) should be the highest priority in the workplace[7]. Indeed, the Occupational Safety and Health Administration (OSHA) has established Cr(VI) standards and controls to protect employees against exposure risks[8]. The standard was last updated in 2006 [9]. At that time, an estimated 558,000 workers, primarily those working in electroplating, sheet metal, or boiler shops, were potentially exposed to Cr(VI). It is unclear how many of these workers were women of child-bearing age or pregnant but some research indicates that occupationally exposed men can develop abnormalities in sperm which could then negatively impact pregnancy, and potentially birth outcomes[10]. Violations of the OSHA standard are often lack of exposure monitoring in the workplace. OSHA maintains a safety and health topics webpage for Cr(VI) at www.osha.gov/SLTC/hexavalentchromium/index.html. It remains critical for OSHA to monitor compliance with the standard and to review the standard regularly in accordance with the latest scientific findings on prenatal exposures and health effects.

Industrial use and disposal of chromium has led to its presence in waterways and soil, contaminating drinking water supplies. This has caused concern around the potential health consequences of exposure to Cr(VI) among the general public[11]. The U.S. Environmental Protection Agency (EPA) has a total chromium (trivalent chromium plus hexavalent chromium) national drinking water standard of 100 parts per billion (ppb) that was established in 1991; however, many states have taken the initiative to establish total chromium limits of 50 ppb or less. Trivalent chromium is not as toxic as hexavalent

chromium, and so California focused specifically on the latter, becoming the first and only state in 2014 to establish a standard of 10 ppb of Cr(VI) in drinking water [2].[12]. More recently, a 2016 report by the Environmental Working Group found hexavalent chromium to contaminate water supplies for more than 200 million people in all 50 states and for many people, it exceeds the cancer risk level established by California state scientists[13]. There needs to be a health-based federal standard for hexavalent chromium in water as well as required testing by water companies to appropriately adhere to the standard.

EPA also regulates all chromium compounds as hazardous air pollutants (HAP). Industries must control chromium compounds to the level of the maximum achievable control technology (MACT). However, in 2005 EPA released the report, America's Children and the Environment (ACE), which revealed that nearly all children at the time lived in places where HAP's exceeded cancer risk benchmarks. The hexavalent chromium compound was a major contributor to this result[14]. EPA should continue to review and update emissions (MACT) standards for chromium compounds, drawing on the latest health research, and enforce compliance.

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