

Regulating Hexavalent Chromium in Drinking Water

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The Bottom Line:

Drinking the water from a public supply should be about the safest thing you do

The Safe Drinking Water Act Directs EPA's DW Regulations

- **Maximum Contaminant Level Goal**
 - ◆ Not enforceable, but directs MCL selection
 - ◆ "Each MCLG...shall be set at the level at which no known or anticipated adverse effects on the health of persons occur and which allow an adequate margin of safety"
- **National Primary Drinking Water Regulations**
 - ◆ Enforceable
 - ◆ Set as close as feasible to MCLGs
 - ◆ Feasible analytical methods and treatment technologies
 - ◆ Administrator can adjust MCL for cost reasons
- **Other regulatory applications generally not considered**

Regulatory Construction

- A drinking water regulation needs several things:
- Health risk information
 - ◆ Is it a problem at the levels found?
- Suitable quantitative analytical methods
- Occurrence information
 - ◆ What levels is it found at?
 - ◆ Where, when?
- Feasible treatment technologies
- Holistic cost information (i.e., for everything)
- Benefit-cost analysis (is it worth it?)

Current Chromium Regulatory Status for Drinking Water

- MCL for total chromium [$\text{Cr}3 + \text{Cr}6$] is based on $\text{Cr}6$ toxicity
 - ◆ USEPA MCL = 100 ug/L
 - ◆ California MCL = 50 ug/L
- No federal or state MCL specific for $\text{Cr}6$ alone
- CA proposed MCL of 10 ppb in August 2013
- USEPA reconsidered chromium MCL in recent 6-Year Review, but passed on revision at that time
 - ◆ Lacked health, occurrence data that said “change”

Chromium

- Chromium can occur as a metal, or in two ionic forms
 - ◆ Trivalent chromium (Cr3), an essential nutrient
 - ◆ Hexavalent chromium (Cr6), toxic at high doses
- Chromium in water is mostly naturally occurring
 - ◆ Cr3 found mostly in surface water
 - ◆ Cr6 found mostly in ground water
- USEPA is gathering national occurrence data under the third Unregulated Contaminants Monitoring Rule
 - ◆ First cut: total Cr 69% detections at MRL 0.2 ppb
 - ◆ Cr6 89% detections at MRL 0.03 ppb

Erin Brockovich, “Erin Brockovich” and Public Perceptions of Cr6

- Pacific Gas and Electric used Cr6 for corrosion control in its cooling towers in Hinkley, CA, and elsewhere
 - ◆ Contaminated water got into aquifer
 - ◆ PG&E got crosswise with public
- EB championed the issue, helped win a \$333M settlement in 1996, got a movie made
- EB led a similar lawsuit in Kettleman City, got them \$335M in 2006 settlement (but no sequel)
- Neither case ever argued on merits of toxicity
 - ◆ CA DPH epidemiology study showed no health impacts

Glendale, Burbank, LADPW, et al

- Superfund sites in San Fernando Valley for solvents, Cr6 in groundwater
 - ◆ Leftovers from aircraft fabrication
- EPA got involved, 1989
 - ◆ Three wells with Cr6 >50 ug/L found in 1997
- Glendale, Burbank, LA, CA DTSC, Water Master and LA Regional WQ Control Board formed management group in 1997
- EPA began investigation of Cr6 sources in 1999

Erin Speeds Up Cr6 Activities

- EB got involved at Glendale/Burbank in 2000
- 2000 election year maneuvers
 - ◆ Hearings and media events
 - ◆ EB showed her stuff
- CA legislature enacted law in 2001 to require Cr6 MCL
- Glendale city council decided on 5 ug/L Cr6 for city DW
 - ◆ Superfund “responsible parties” to pay the costs

Consequences...

How Do You Get Cr6 <5 ug/L?

- Glendale, Burbank, LADWP, et al, pooled money and funded WRF treatment project
- Newly-elected Rep Schiff provided series of EPA grants for further treatment research
- Open, flexible R&D process allowed best approaches to emerge
- R&D started small and wide
- Moved to bench and pilot scale as data indicated
- Allowed new questions to get answered

Current Chromium R&D

- Drinking water community fostered needed research
 - ◆ Pilot studies on treatment approaches
 - ◆ Cost evaluations
 - ◆ Treatment residuals management
- Some promising treatment approaches
 - ◆ Weak base anion exchange
 - ◆ Strong base anion exchange
 - ◆ Reduction, coagulation and filtration
- Other CA utilities now doing treatment work
 - ◆ Livermore, Davis, Coachella Valley, Soquel Creek, etc

The Evolution of Cr6 Health Risk Assessments

- Trivalent chromium (Cr3) is an essential nutrient
 - ◆ Blood sugar control
- Hexavalent chromium (Cr6) is toxic
 - ◆ Airborne Cr6 tissue damage, skin sensitization, rashes
 - ◆ Cr6 is an oxidant, “burns” tissue
 - ◆ Long-term oxidation may yield secondary effects
- 1991 MCL based on RfD with no adverse endpoint
- IRIS RfD (1998) at 3 ug/kg/d (~100 ug/L)
 - ◆ Similarly based on no adverse endpoint

Cr6 as a Carcinogen, 1998

- EPA reconsidered carcinogenicity (1998 IRIS)
 - ◆ Lung damage from Cr6 plating mists, aerosols
 - ◆ Lung cancer in humans from inhalation
 - ◆ Probably from oxidation resulting from metabolic reduction of Cr6 to Cr3
- “The oral carcinogenicity of Cr(VI) cannot be determined. No data were located in the available literature that suggested that Cr(VI) is carcinogenic by the oral route of exposure.”
- CA OEHHA assumed Cr6 was an oral carcinogen, because of its inhalation carcinogenicity

Evolution of Cancer Risks

- National Toxicology Program studies, 2005-07
 - ◆ Tested oral exposure of Cr6 in rats, mice
 - ◆ Found elevated mouth and intestinal epithelial neoplasms, starting around 20 mg/L in mice
 - ◆ Doses to 180 mg/L did not kill animals
- Rapid reduction from Cr6 to Cr3 occurs in stomach
 - ◆ DeFlora, et al (2008) suggested effects threshold as reduction (detoxification) capacity is exceeded

Cr6 Cancer Mode of Action

- Mode of Action (MOA) describes how something could be toxic
- For carcinogens, some can damage DNA, chromosomes directly (genotoxicity)
- Some carcinogens kill cells; healing process can trigger cancer (cytotoxicity)
- CA OEHHA considers Cr6 primarily genotoxic, with no threshold for effects
- Other data indicate that Cr6 cytotoxicity dominates at lower exposures
 - ◆ Cytotoxicity has a threshold

Current Cr6 Health Risk Thoughts

- CA OEHHA finalized PHG at 0.02 ug/L on July 27, 2011
 - ◆ PHG set at 1 cancer per million risk level
 - ◆ Did not consider detoxification as risk reduction
 - ◆ Used linear, no threshold extrapolation
- EPA is reconsidering its risk assessment
 - ◆ EPA withdrew 2010 draft after peer review
 - ◆ EPA considering the new data on Mode of Action of carcinogenicity
 - ◆ Unclear when new draft will appear

Rendezvous with Destiny

- CDPH proposed their MCL at 10 ug/L
- Implementation issues will be important
- Treatment will be costly
 - ◆ Most of the systems with elevated Cr6 are small GW systems
 - ◆ Few, if any, will have Glendale's Superfunding
 - ◆ Water rates would rise markedly for many communities

And USEPA?

- Unlike CDPH, EPA has an option: Revise the current chromium MCL
 - ◆ Groundwater is mostly Cr6
 - ◆ Surface water is mostly Cr3
- Because of possible oxidation during treatment or in distribution systems (Cr3 -> Cr6), revising total Cr MCL downwards might be best
- EPA will await full data from UCMR3
- Also needs completion of health risk review
- Any decision is a long ways off