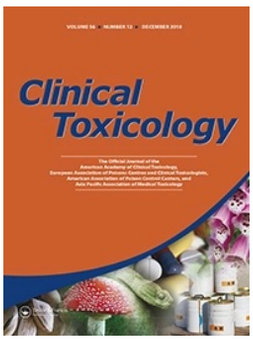

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Allison Lardieri , Carmen Cheng , S. Christopher Jones & Lynda McCulley

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LETTER TO THE EDITOR

Harmful effects of chlorine dioxide exposure

Dear editor,

Chlorine dioxide (CD) products are often marketed under various names (e.g., Miracle Mineral Solution, 28% sodium chlorite) and touted as a cure-all for autism, malaria, cancer, and most recently, coronavirus disease 2019 (COVID-19). However, there is no published evidence to support these claims. CD products are a mixture of sodium chlorite and an acidic solution. Concentrated CD is not intended for human consumption, and in this letter, we describe acute toxicity associated with it.

The U.S. Food and Drug Administration (FDA) recently issued a consumer warning for CD products with misleading health claims and reports of adverse effects (gastrointestinal symptoms, dehydration, hypotension) [1,2]. Published case reports also describe CD toxicities including methemoglobinemia, hemolytic anemia, toxic irritant dermatitis and Kikuchi-Fujimoto disease [3–7].

We report an analysis of the American Association of Poison Control Centers (AAPCC) National Poison Data System (NPDS) cases of CD-associated exposure (involving Miracle Mineral Solution) from 55 U.S. Poison Centers between January 1, 2000-March 31, 2020. Narratives for 53 CD exposures were obtained; all cases were followed to a known outcome. An average of five exposures were reported annually (range 3–9) since 2011. Thirty-three (62.3%) cases were female and the median age was 46 years (range 1.6–88). Seven (13.2%) cases occurred in children ages 19 months–11 years. Twenty-nine (54.7%) exposures cited the reporters' reasons for use in the narrative, including "cure all/supplement" (5/53, 9.4%), accidental exposure (5/53, 9.4%), and detoxification (4/53, 7.5%). The reason for the remaining exposures (24/53, 45.3%) could not be determined from the provided narrative. (See Table 1). Ingestion was the most common route (44/53, 83%); others included inhalation, dermal, rectal, and ocular. The most frequently reported related clinical effects were vomiting (26/53, 49.1%), nausea (15/53, 28.3%), abdominal pain (12/53, 22.6%), and diarrhea (11/53, 20.8%); some exposures reported multiple effects.

We note the majority of exposures represent acute toxicity (45/53, 84.9%), as most effects occurred immediately or $\leq$24 h of exposure (40/53, 75.5%). Thirteen patients (24.5%) were hospitalized. Two critical care unit admissions included significant electrolyte abnormalities, electrocardiogram changes, and altered mental status. Both patients recovered after electrolyte and fluid repletion. We suspect these clinical effects were driven by significant electrolyte loss linked to the gastrointestinal effects of CD. Although the NPDS data do not reflect the same toxicities as reported in the literature, this evaluation augments those by providing further evidence of harm from CD exposure.

This report is subject to limitations common to voluntary reporting systems. NPDS provides an incomplete capture of outcomes, which limits our ability to fully characterize cases and quantitatively measure harm attributed to CD use. Additionally, because poison control centers primarily offer advice following acute exposure, the data rarely include late

Table 1. Reasons for use, related clinical effects, chronicity, and time to onset reported with chlorine dioxide exposure cases, reported to U.S. poison centers, from January 1, 2000 to March 31, 2020 ($N = 53$).

	n (%)
Reason for use as reported in case narratives*	
Cure all/supplement	5 (9.4)
Accidental exposure	5 (9.4)
Detoxification	4 (7.5)
Constipation	2 (3.8)
Toothache	2 (3.8)
Autism	1 (1.9)
Candida	1 (1.9)
Cold	1 (1.9)
Facial abscess	1 (1.9)
Herpes	1 (1.9)
Lyme disease	1 (1.9)
Lymphoma	1 (1.9)
Shingles	1 (1.9)
Self-harm	1 (1.9)
Scabies	1 (1.9)
Sinus pain	1 (1.9)
Not documented	24 (45.3)
Related clinical effects, reported in $\geq$2 cases**	
Vomiting	26 (49.1)
Nausea	15 (28.3)
Abdominal Pain	12 (22.6)
Diarrhea	11 (20.8)
Oral/Throat irritation, Cough/choke	9 (17.0)
Burns 2 − 3 degree, Burns (superficial), Oral Burns (include lips)	4 (7.5)
Ocular - Irritation/pain/red eye/conjunctivitis	3 (5.7)
Diaphoresis	2 (3.8)
Chest pain (include noncardiac)	2 (3.8)
Electrolyte abnormality	2 (3.8)
Chronicity as categorized by poison center staff	
Acute	45 (84.9)
Acute-on-chronic	1 (1.9)
Chronic	6 (11.3)
Unknown	1 (1.9)
Time to onset as reported in case narratives	
Immediate to $\leq$1 hour	16 (30.2)
$>$1 hour to $\leq$24 hours	24 (45.2)
$>$1 day to $\leq$1 week	5 (9.4)
2 months	1 (1.9)
Unknown	7 (13.2)

*We relied on the reason for use as stated in the report because it provided more specificity in determining purported indication than the structured National Poison Data System code.
**Some cases reported more than one related clinical effect. There were 44 cases with a clinical effect assessed as related to chlorine dioxide.

onset clinical effects or long-term complications. We posit there are likely many more exposures than are described in this report, as we limited our search to CD marketed under Miracle Mineral Solution (MMS) and excluded other sodium chlorite products.

FDA has initiated actions against those who fraudulently market CD to treat or prevent COVID-19 [2]. We urge consumers to avoid CD use and we hope to make health care providers aware of potential clinical sequelae associated with CD administration.

Disclosure statement

No potential conflict of interest was reported by the author(s).

ORCID

Carmen Cheng http://orcid.org/0000-0002-1151-7393
S. Christopher Jones http://orcid.org/0000-0002-0478-0978
Lynda McCulley http://orcid.org/0000-0003-0935-3876

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Allison Lardieri, Carmen Cheng, S. Christopher Jones and Lynda McCulley
FDA, Silver Spring, MD, USA
allison.lardieri@fda.hhs.gov

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