

#	Author and Title	Salient information	Regulatory implications for the industry	Source/link
Health publications				
1	Bellinger, 2016 Lead Contamination in Flint – An Abject Failure to Protect Public Health	The author believes that recent episode in Flint, Michigan, brought the issue of lead in water as a potential, substantial exposure source into the public eye. It also underscored the author’s belief that the burden of childhood lead poisoning has always weighed most heavily on populations that are politically and economically disenfranchised, a community in which 4 in 10 families live below the poverty line, unemployment is high, and the majority of the population is African-American. The author further posed that the Flint contamination might never have been brought to light had citizens not persisted in efforts to force local, state, and federal officials to take action, and that, as a consequence, it reflected failures at every level of government.	The events in Flint have prompted state government to re-examine and attempt to reduce lead exposures in Michigan’s population. This is reflected in current efforts by Michigan-OSHA (MI-OSHA) to reduce lead exposure to the state’s workers via substantial reductions in workplace permissible exposure limits and blood lead levels.	New England J Medicine, 374: 12
3	Lanphear, 2016 Prevention of Childhood Lead Toxicity	In the policy statement by the American Academy of Pediatrics, it was posed that, although blood lead concentrations have decreased dramatically in US children abstract over the past 4 decades, too many children still live in housing with deteriorated lead-based paint and are at risk	Policy statements such as this are highly influential in guiding regulations for lead. A recent example is the influence the US Centers for Disease Control and Prevention’s (CDC’s) 2012 reference level of 5 µg/dL has had on safe workplace exposures as well as	Pediatrics, 138 (1): 1-15

#	Author and Title	Salient information	Regulatory implications for the industry	Source/link
		<p>for lead exposure, with resulting lead-associated cognitive impairment and behavioral problems. In addition, the policy statement noted that commonly encountered blood lead concentrations, even those below 5 µg/dL, impair cognition, and that there is no identified threshold or safe level of lead in blood. It was also noted that from 2007 to 2010, approximately 2.6% of preschool children in the US had a blood lead concentration ≥5 µg/dL, which represents about 535,000 US children 1 to 5 years of age. It was further noted that evidence-based guidance exists for managing increased lead exposure in children, and reducing sources of lead in the environment, including lead in housing, soil, water, and consumer products, has been shown to be cost-beneficial, and that primary prevention should be the focus of policy on childhood lead toxicity.</p>	<p>benchmark levels used in biokinetic models used to guide soil cleanup at contaminated sites. By noting that blood lead levels below 5 µg/dL may impair cognition, and that there is no identified threshold or safe level of lead in blood, the present policy statement may be laying the groundwork for regulatory decisions to lower lead exposures for workers and in communities.</p>	
4	<p>Lioa et al., 2016 Occupational Lead Exposure and Associations with Selected Cancers: The Shanghai Men’s and Women’s Health Study Cohorts</p>	<p>Epidemiologic studies of occupational lead exposure have suggested increased risks of cancers of the stomach, lung, kidney, brain, and meninges; however, the totality of the evidence is inconsistent. This study investigated the relationship between occupational lead exposure and cancer incidence at sites in two prospective cohorts in Shanghai, China. Annual job/industry-</p>	<p>The International Agency for Research on Cancer (IARC) has classified inorganic lead compounds as probably carcinogenic (Group 2A) on the basis of “limited” evidence in humans for cancers of the stomach, lung, kidney, brain, and meninges. The results of the present study – i.e., that lead exposure was positively associated</p>	<p>Environmental Health Perspectives 124 (1): 97-103</p>

#	Author and Title	Salient information	Regulatory implications for the industry	Source/link
		<p>specific estimates of lead fume and lead dust exposure, derived from a statistical model combining expert lead intensity ratings with inspection measurements, were applied to the lifetime work histories of participants from the Shanghai Women’s Health Study (SWHS; n = 73,363) and the Shanghai Men’s Health Study (SMHS; n = 61,379) to estimate cumulative exposure to lead fume and lead dust. These metrics were then combined into an overall occupational lead exposure variable. Cohort-specific relative hazard rate ratios (RRs) and 95% confidence intervals (CIs) comparing exposed and unexposed participants were estimated using Cox proportional hazards regression and combined by meta-analysis. The authors reported that the proportions of SWHS and SMHS participants with estimated occupational lead exposure were 8.9% and 6.9%, respectively. Lead exposure was positively associated with meningioma risk in women only (n = 38 unexposed and 9 exposed cases; RR = 2.4; 95% CI: 1.1, 5.0), particularly with above-median cumulative exposure (RR = 3.1; 95% CI: 1.3, 7.4). However, it was noted that all 12 meningioma cases among men were classified as unexposed to lead. It was also reported that non-significant associations</p>	<p>with meningioma risk in women only, that only non-significant associations were observed for cancers of the kidney, and that elevated risks of lung and stomach cancer were observed with high lead exposure only in males – do not appear to provide strong support for any imminent re-classification of inorganic lead to a known human (Group 1) carcinogen.</p>	

#	Author and Title	Salient information	Regulatory implications for the industry	Source/link
		<p>with lead exposure for cancers of the kidney (n = 157 unexposed and 17 ever exposed cases; RR = 1.4; 95% CI: 0.9, 2.3) and brain (n = 67 unexposed and 10 ever exposed cases; RR = 1.8; 95% CI: 0.7, 4.8) overall. In addition, elevated risks of lung and stomach cancer were observed with high lead exposure in the male cohort, but no such associations were observed in the female cohort. The authors concluded that, although limited by small numbers of cases, lead is associated with the risk of several cancers in women and men.</p>		
5	<p>Seo et al., 2016 Altered executive function in the lead-exposed brain: A functional magnetic resonance imaging study</p>	<p>This study aimed to investigate possible alterations in the neural correlates of “executive function” in the previously lead-exposed brain. Executive function is one of the main functions of the brain’s prefrontal cortex that guides appropriate behavior and is typically measured by the Wisconsin Card Sorting Task (WCST). Forty-three lead-exposed and 41 healthy participants were enrolled. The 43 lead-exposed participants were retired former lead workers who had worked in plants producing lead batteries. During fMRI (functional magnetic resonance imaging) brain scans, participants performed two modified versions of the WCST differing in cognitive demand, and a task that established a high-level baseline condition (HLB). The neural activation of left</p>	<p>This study adds to evidence from other studies that lead may affect subtle neurocognitive endpoints in adults. Such effects are increasingly cited as evidence for the need to re-examine what constitutes a safe level of exposure to lead in adult populations; e.g., workers. However, the results of the present study (and other similar studies) must be interpreted in the context of certain limitations. For example, in the present study the authors lacked information about the participants’ past exposure to lead. Second, it is not possible to establish a causal relationship with the cross-sectional design of the study; a prospective</p>	<p>Neurotoxicology 50: 1-9</p>

#	Author and Title	Salient information	Regulatory implications for the industry	Source/link
		<p>dorsolateral prefrontal cortex was greater in healthy controls than in participants with lead exposure when contrasting the difficult version of the WCST with the HLB. Moreover, cortical activation was found to be inversely associated with blood lead concentration after controlling for covariates. The authors concluded that lead exposure can induce functional abnormalities in distributed cortical networks related to executive function, and that lead-induced neurotoxicity may be persistent rather than transient.</p>	<p>study would be needed to examine any causal relation. Third, the number of study participants recruited was too small to support firm conclusions from the study. Fourth, enrollment was limited to women and thus, any lead-related outcomes that may differ between men and women would not be reportable. Fifth, information on potentially confounding environmental lead exposure, such as lead in water, air, old houses/ buildings, leaded gasoline, and dietary sources, was not available for the study participants.</p>	
6	<p>Tsoi et al., 2016 Continual decrease in blood lead level in Americans: United States National Health Nutrition and Examination Survey (NHANES) 1999-2014</p>	<p>Blood lead levels in 63,890 participants of the National Health Nutrition and Examination Survey (NHANES) for the years 1999-2014 were analyzed using SPSS Complex Samples v22.0. Mean blood lead levels and 95% confidence intervals were 1.65 [1.62-1.68], 1.44 [1.42-1.47], 1.43 [1.40-1.45], 1.29 [1.27-1.32], 1.27 [1.25-1.29], 1.12 [1.10-1.14], 0.97 [0.95-0.99] and 0.84 [0.82-0.86] µg/dL in 1999-2000, 2001-2002, 2003-2004, 2005-2006, 2007-2008, 2009-2010, 2011-2012, and 2013-2014, respectively. Blood lead levels decreased significantly (p <0.001) and the trend remained significant when stratified by age, gender, ethnicity and pregnancy status (p<0.05). Estimated</p>	<p>Even though the raw blood lead data are available from the most recent NHANES study, the CDC has not yet updated their on-line tables with the percentile blood lead data, nor made any reference to what the 97.5th percentile now is. [Note: none of the authors of the Tsoi et al. study are affiliated with the CDC.] The CDC is now several months beyond the end of the 4-year time period at which point the blood lead reference level would be revised; however, from the Tsoi et al. study, this would appear to be imminent.</p>	<p>The American J of Medicine (in press)</p>

#	Author and Title	Salient information	Regulatory implications for the industry	Source/link
		<p>percentages of children with blood lead levels ≥ 5 $\mu\text{g}/\text{dL}$ were 9.9 [7.5-12.9]%, 7.4 [5.9-9.4]%, 5.3 [4.1-6.9]%, 2.9 [2.1-3.9]%, 3.1 [2.0-4.8]%, 2.1 [1.5-3.1]%, 2.0 [1.0-3.6]% and 0.5 [0.3-1.0]% in 1999-2000, 2001-2002, 2003-2004, 2005-2006, 2007-2008, 2009-2010, 2011-2012, and 2013-2014, respectively. The decreasing trend was significant ($p < 0.05$). In children aged 1-5 in NHANES 2011-2014, the estimated 97.5 percentile of blood lead level was 3.48 $\mu\text{g}/\text{dL}$. The authors concluded that blood lead levels have been decreasing in the US population, and as such, CDC's reference level should also decrease (from the reference level of 5 $\mu\text{g}/\text{dL}$, established in 2012).</p>		
7	<p>UBA, 2016 2nd International Conference on Human Biomonitoring, Berlin 2016 (conference proceedings)</p> <p>Shepherd et al., 2016 Tracing fetal and childhood exposure to lead using isotope analysis of deciduous teeth</p>	<p>The 2nd International Conference on Human Biomonitoring (UBA, 2016) was devoted in part to research involving biomonitoring of lead. The research described in the conference proceedings included establishment of first-ever biomonitoring programs for Pb in Tunisia and Spain; a report of an apparent increasing trend in blood lead concentrations in Koreans; a report of a Slovenian biomonitoring program to be used to assess progress toward the goal of achieving a reduction in blood lead levels in children to <100 $\mu\text{g}/\text{L}$ by 2022; a report of blood Pb level trends in the</p>	<p>The use of lead biomonitoring as the basis for regulatory decision-making and assessing morbidity appears to be increasing in parts of the world where previously, no such practices existed. The International Conference on Human Biomonitoring and Wang et al. highlighted the fact that care must be exercised in the conduct of biomonitoring for lead, given that variability arising from analytical measurements of blood lead may contribute significantly to the observed variability in the studied</p>	<p>Journal link (UBA)</p> <p>Journal link (Shepherd et al.)</p> <p>Journal link (Wang et al.)</p>

#	Author and Title	Salient information	Regulatory implications for the industry	Source/link
	<p>Wang et al. 2016 Variability of Metal Levels in Spot, First Morning, and 24-Hour Urine Samples over a 3-Month Period in Healthy Adult Chinese Men</p>	<p>German population; a report of a case study using lead biomonitoring, showing that variability arising from analytical measurements contributed significantly to the overall variability in the studied populations, especially at lower levels of exposure; a report of blood lead levels in Zambia in which, compared to “threshold levels and international recommendation”, children’s blood levels need to be treated and exposure considerably reduced; a report from the Slovenian population that showed that blood lead was highest among older women (aged 50-60) compared to children or other adults; and a description of a new program in Germany in which blood lead levels will be used to determine disability-adjusted life years (DALYs)</p> <p>Shepard et al., 2016 reported results of a pilot study in which it was shown that laser ablation Pb isotope analysis of deciduous teeth, when carried out in conjunction with histological analysis, permitted reconstruction of the timing, duration, and source of exposure to Pb during early childhood.</p> <p>Wang et al., 2016, showed that the high variability observed in the urinary levels of Pb indicated that a single measurement</p>	<p>populations. In addition, Shepherd reported that new biomonitoring techniques may extend the utility of biomonitoring to permit reconstruction of the timing, duration, and source of exposure to lead.</p>	

#	Author and Title	Salient information	Regulatory implications for the industry	Source/link
		provides only a brief snapshot in time of the exposure levels of an individual, which can result in a moderate degree of exposure misclassification.		