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CHEMICAL EFFECTS

Regulation of Persistent Chemicals in Hazardous Waste: A Case Study of Washington State (USA)

2020-11-05

Despite ongoing controversy, several strategic frameworks for defining chemicals of concern (e.g., persistent, bioaccumulative, toxic [PBT]; persistent, mobile, toxic [PMT]; persistent organic pollutant [POP]) share persistence as a key criterion. Persistence should be considered over the entire chemical life cycle from production to disposal, including hazardous waste management. As a case study, we evaluate persistence criteria in hazardous waste regulations in Washington state (USA), illustrate impacts on reported waste, and propose refinements in these criteria. Although Washington state defines persistence based on half-life (>1 year) and specific chemical groups which exceed summed concentration thresholds in waste (i.e., >0.01% halogenated organic compounds [HOCs] and >1.0% polycyclic aromatic hydrocarbons [PAHs]), persistence is typically addressed with HOC and PAH evaluation but seldom with half-life estimation. Notably, persistence is considered (with no specific criteria) in corresponding federal regulations in the United States (Resource Conservation and Recovery Act). Consequently, businesses in Washington state report annual amounts of state hazardous waste (including persistent waste) separately from federal hazardous waste. Total state-only waste, and total state and federal waste combined, nearly doubled (by weight) over 2008-2018. For the period 2016-2018, persistence criteria captured 17% of state-only waste and 2% of total state and federal waste combined. Two recommendations are proposed to improve persistence criteria in hazardous waste regulations. First, Washington state should consider aligning its half-life criterion with federal and European Union PBT definitions (e.g., 60-120 days) for consistency (and provide specific methods for half-life estimation). Second, the state should consider expanding its list of persistent chemical groups (e.g., siloxanes, organometallics) with protective concentration thresholds. Ultimately, to the extent possible, Washington state should strive towards harmonizing persistence in hazardous waste regulations with corresponding criteria

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in global PBT, PMT, and POP frameworks. This article is protected by copyright. All rights reserved.

Authors: Amy L Leang, Justin E Meyer, Craig C Manahan, Damon A Delistraty, Robert J Rieck, Teague P Powell, Marissa N Smith, Myles S Perkins

Full Source: Integrated environmental assessment and management 2020 Nov 5. doi: 10.1002/ieam.4365.

Persistent organic pollutants and couple fecundability: a systematic review

2020-11-04

Background: Despite increasing regulation, exposure to persistent organic pollutants (POPs) remains a serious public health concern due to their accumulation in the environment and ability to biomagnify up the food chain. POPs are associated with endocrine-disrupting effects including adverse reproductive outcomes that could affect fecundability, i.e. the capacity to conceive a pregnancy, quantified as time to pregnancy (TTP). Objective and rationale: Results of epidemiologic studies that examine the impact of various chemical classes of POPs on TTP have not been synthesised. We undertook a systematic review to summarise the strength of evidence for associations of four common groups of POPs with couple fecundability and to identify gaps and limitations in the literature in order to inform policy decisions and future research. Search methods: We performed an electronic search of literature published between 1 January 2007 and 6 August 2019 in MEDLINE, EMBASE.com, Global Health, DART/TOXLINE and POPLINE. We included empirical research papers that examined human exposure to organochlorine (OC) pesticides, brominated flame retardants, polychlorinated organic compounds and/or per- and polyfluoroalkyl substances (PFAS) and considered TTP or fecundability as an outcome. Standardised forms for screening, data extraction and study quality were developed using DistillerSR software, and all reviews were completed in duplicate. We used the Newcastle-Ottawa Scale to assess risk of bias and devised additional quality metrics based on specific methodological features of fecundability studies. Outcomes: The search returned 4573 articles, and 28 papers from 19 different studies met inclusion criteria. Among them, four studies measured TTP prospectively, three had data on participants' prenatal exposure, three examined associations in both male and female partners and one focused exclusively on males. Analyses varied widely in terms of exposure characterisation, precluding a meta-analytic approach. Evidence was strongest for adverse associations of female exposure to polychlorinated biphenyls with TTP,

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with some additional support for associations of female exposure to polybrominated diphenyl ethers and PFAS with longer TTP. Our review provided little or no support for associations between female exposure to OC pesticides or male exposure to any of the POP groups and TTP. Wider implications: Evidence suggests that female exposure to at least some POPs may reduce fecundability. Although many of these chemicals are no longer in production, they are still detectable in human biosamples because of their persistence in the environment. Replacement chemicals that are being introduced as older ones are restricted may have similar reproductive consequences. Future studies should examine these newer POPs, assess interactions between POPs and other chemical and non-chemical exposures, investigate how POPs are distributed in and metabolised by the human body and focus on populations that may be disproportionately exposed.

Authors: Linda G Kahn, Kim G Harley, Eva L Siegel, Yeyi Zhu, Pam Factor-Litvak, Christina A Porucznik, Michele Klein-Fedyshin, Alison E Hipwell
Full Source: Human reproduction update 2020 Nov 4;dmaa037. doi: 10.1093/humupd/dmaa037.

A biosensing soft robot: Autonomous parsing of chemical signals through integrated organic and inorganic interfaces

2019-06-26

The integration of synthetic biology and soft robotics can fundamentally advance sensory, diagnostic, and therapeutic functionality of bioinspired machines. However, such integration is currently impeded by the lack of soft-matter architectures that interface synthetic cells with electronics and actuators for controlled stimulation and response during robotic operation. Here, we synthesized a soft gripper that uses engineered bacteria for detecting chemicals in the environment, a flexible light-emitting diode (LED) circuit for converting biological to electronic signals, and soft pneu-net actuators for converting the electronic signals to movement of the gripper. We show that the hybrid bio-LED-actuator module enabled the gripper to detect chemical signals by applying pressure and releasing the contents of a chemical-infused hydrogel. The biohybrid gripper used chemical sensing and feedback to make actionable decisions during a pick-and-place operation. This work opens previously

The integration of synthetic biology and soft robotics can fundamentally advance sensory, diagnostic, and therapeutic functionality of bioinspired machines.

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unidentified avenues in soft materials, synthetic biology, and integrated interfacial robotic systems.

Authors: Kyle B Justus, Tess Hellebrekers, Daniel D Lewis, Adam Wood, Christian Ingham, Carmel Majidi, Philip R LeDuc, Cheemeng Tan
Full Source: Science robotics 2019 Jun 26;4(31):eaax0765. doi: 10.1126/scirobotics.aax0765.

Molecular and biophysical basis for the disruption of lung surfactant function by chemicals

2020-10-31

With the intention to move away from animal testing for the toxicological evaluation of chemicals comes the need to develop new approach methodologies which are mechanism-anchored and target relevant key events leading to an adverse outcome. To date, no validated alternative methods are available for studying the acute inhalation toxicity potential of airborne chemicals but the constrained drop surfactometer measuring the surface tension of a drop of lung surfactant presents as a promising candidate. Indeed, the correlation of the increase in minimum surface tension of lung surfactant in vitro with changes in the breathing patterns of mice after inhalation of test compounds has been shown in multiple studies. However, the causal factors leading to lung surfactant inactivation remain speculative. This paper combines molecular and biophysical methods (constrained drop and captive bubble surfactometers, Langmuir-Blodgett balance, epifluorescence microscopy, cryogenic transmission electron microscopy, and differential scanning calorimetry) applied to purified porcine lung surfactant and dipalmitoylphosphatidylcholine interfacial films to gain insights into the disruption of lung surfactant function by three chemicals known to show acute inhalation toxicity (trimethoxyoctylsilane, methyl 3-oxo-2-pentylcyclopentaneacetate, and diisopentyl ether). The results of this study suggest that the test chemicals intercalate between the phospholipids at the air-liquid interface, reduce the stability of the films, and decrease the cohesivity of interface-associated multilayered structures thereby perturbing the lung surfactant surface activity. These findings contribute to a better understanding of chemically-induced lung surfactant function disruption.

Authors: Emilie Da Silva, Chiara Autilio, Karin Sørig Hougaard, Anders Baun, Antonio Cruz, Jesus Perez-Gil, Jorid Birkelund Sørli
Full Source: Biochimica et biophysica acta. Biomembranes 2020 Oct 31;1863(1):183499. doi: 10.1016/j.bbamem.2020.183499.

With the intention to move away from animal testing for the toxicological evaluation of chemicals comes the need to develop new approach methodologies which are mechanism-anchored and target relevant key events leading to an adverse outcome.

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ENVIRONMENTAL RESEARCH

Air Pollution as a Risk Factor for Incident COPD and Asthma: 15-Year Population-Based Cohort Study

2020-11-04

Rationale: Current evidence on the relationship between long-term exposure to air pollution and new onset of chronic lung disease is inconclusive.

Objective: To examine associations of incident chronic obstructive pulmonary disease (COPD) and adult-onset asthma with past exposure to fine particulate matter (PM_{2.5}), nitrogen dioxide (NO₂), ozone (O₃), and the redox-weighted average of NO₂ and O₃ (Ox), and characterize the concentration-response relationship.

Methods: We conducted a population-based cohort study of all Ontarians, aged 35 to 85 years, from 2001 to 2015. 3-year moving average of residential exposures to selected pollutants with 1-year lag were estimated during follow-up. We used Cox proportional and Aalen's additive hazards models to quantify the pollution-disease associations, and characterized the shape of these relationships using newly developed non-linear risk models.

Measurements and main results: Among 5.1 million adults, we identified 340,733 and 218,005 incident cases of COPD and asthma, respectively. We found positive associations of COPD with PM_{2.5} per interquartile-range (IQR) increase of 3.4 µg/m³ (hazard ratio, 1.07; 95% confidence interval, 1.06-1.08), NO₂ per 13.9 ppb (1.04; 1.02-1.05), O₃ per 6.3 ppb (1.04; 1.03-1.04), and Ox per 4.4 ppb (1.03; 1.03-1.03). By contrast, we did not find strong evidence linking these pollutants to adult-onset asthma. Additionally, we quantified that each IQR increase in pollution exposure yielded 3.0 (2.4-3.6) excess cases of COPD per 100,000 adults for PM_{2.5}, 3.2 (2.0-4.3) for NO₂, 1.9 (1.3-2.5) for O₃, 2.3 (1.7-2.9) for Ox. Furthermore, most pollutant-COPD relationships exhibited supralinear shapes.

Conclusions: Air pollution was associated with higher incidence of COPD, but not adult-onset asthma.

Authors: Saeha Shin, Li Bai, Richard T Burnett, Jeffrey C Kwong, Perry Hystad, Aaron van Donkelaar, Eric Lavigne, Scott Weichenthal, Ray Copes, Randall V Martin, Alexander Kopp, Hong Chen
Full Source: American journal of respiratory and critical care medicine 2020 Nov 4. doi: 10.1164/rccm.201909-1744OC.

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OCCUPATIONAL

TGFβ/Smad mediated the polyhexamethyleneguanide aerosol-induced irreversible pulmonary fibrosis in subchronic inhalation exposure

2020-11-04

Aim: Polyhexamethylene guanidine (PHMG) is widely used as a disinfectant with broad spectra of bactericidal activity and low oral toxicity. However, inhalation of PHMG can cause pulmonary injury and severe pulmonary fibrosis. The mechanism underlying PHMG aerosol induced pulmonary fibrosis remains unclear. In this study, we aimed to examine the subchronic lung injury and determine potential cytokines involved in PHMG aerosol induced fibrosis.

Methods: C57BL/6N mice were exposed to 1.03 mg/m³ PHMG through aerosol inhalation for 3 weeks, or 3 weeks followed by other 3 weeks recovery.

Results: The results indicated that the expression of transforming growth factor-beta1 (TGF-β1) and extracellular matrix remodeling markers were up-regulated in the PHMG-treated mice and these parameters were aggravated after 3 weeks recovery. Bronchoalveolar lavage fluids (BALFs) analysis showed that the number of total cells was significantly decreased in exposure group. The percentage of macrophages in BALFs decreased significantly whereas the percentage of neutrophils and lymphocytes increased. Extensive collagen deposition was observed in the peribronchiolar and interstitial areas in the PHMG exposed lungs.
Conclusion: In conclusion, even low-dose PHMG aerosol exposure could induce mice pulmonary local inflammation and irreversible fibrosis. In addition, TGF-β/Smad signaling pathway mediated the extracellular matrix remodeling involved in the development of pulmonary fibrosis.

Authors: Xiaoxiao Zhu, Xiao Kong, Sai Ma, Rui Liu, Xin Li, Shaobo Gao, Dunqiang Ren, Yuxin Zheng, Jinglong Tang
Full Source: Inhalation toxicology 2020 Nov 4;1-12. doi: 10.1080/08958378.2020.1836091.

Aim: Polyhexamethylene guanidine (PHMG) is widely used as a disinfectant with broad spectra of bactericidal activity and low oral toxicity.

Study of Occupational Chromium, Iron, and Nickel Exposure and Amyotrophic Lateral Sclerosis in Denmark

2020-11-02

Studies of occupational metal exposures and amyotrophic lateral sclerosis (ALS) have focused primarily on known neurotoxicants, including lead, mercury, selenium, and cadmium. However, these exposures are often co-

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occurring with other lesser studied metals. We conducted a population-based case-control study with the aim of assessing associations between occupational chromium, iron, and nickel exposures and risk of ALS. We identified ALS cases in Denmark from 1982 through 2013 from the Danish National Patient Registry and matched them to 100 controls based on birth year and sex. Cumulative metal exposures were estimated using job exposure matrices applied to occupational history from the Danish Pension Fund. Although mutually adjusted odds of ALS were higher in men with chromium exposures in the third quartile (aOR = 1.24; 95% CI 0.91, 1.69) and fourth quartile (aOR = 1.19; 95% CI: 0.80, 1.76) compared to those with no exposure, differences did not reach statistical significance. We also observed higher odds of ALS in women with nickel exposures in the third quartile (aOR = 2.21; 95% CI: 1.14, 4.28), but not for the fourth quartile (aOR = 0.61; 95% CI: 0.23, 1.64). Our findings do not suggest associations between occupational exposures to these metals and ALS. However, unavoidable non-differential misclassification from the use of JEMs may have masked truly increased risk.

Authors: Aisha S Dickerson, Johnni Hansen, Ole Gredal, Marc G Weisskopf
Full Source: International journal of environmental research and public health 2020 Nov 2;17(21):E8086. doi: 10.3390/ijerph17218086.

Work Exposure to VOC in Storage Areas of Retail Stores

2020-11-04

Poor indoor air quality (IAQ) has been linked to airway disease and early deaths. The ESQUISSE study of IAQ conducted by the French Research and Safety Institute (INRS), characterized the concentrations of various volatile organic compounds (VOCs) in 10 retail stores and storage areas. The IAQ was generally better in sales areas than storage areas, which are more often unventilated and overloaded with new products. For example, in clothing stores, formaldehyde concentrations between 29.0 and 45.0 $\mu\text{g m}^{-3}$ were measured in non-ventilated storage areas located in the basement; in sales areas, concentrations did not exceed 10.2 $\mu\text{g m}^{-3}$. Similarly, total VOC (TVOC) concentrations in the two main storage areas were 1153 and 1223 $\mu\text{g m}^{-3}$ toluene equivalent, whereas they were less than 77.0 $\mu\text{g m}^{-3}$ toluene equivalent in all sales areas. Many employees work in these high-exposure areas either temporarily or for the entire day, unpacking boxes, placing products on shelves, or collecting products. Reporting primarily on formaldehyde, toluene, or TVOC concentrations, this article shows, in addition to the distinction between sales and storage areas, how an unpacking task can affect an employee's exposure, and an example of the impact of ambient temperature on VOC concentrations.

Poor indoor air quality (IAQ) has been linked to airway disease and early deaths.

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The results presented clearly highlight the issue of occupational exposure of workers in storage areas.

Authors: Laurence Robert, Romain Guichard, Jennifer Klingler
Full Source: Annals of work exposures and health 2020 Nov 4;wxaa103.
doi: 10.1093/annweh/wxaa103.

PHARMACUETICAL/TOXICITY

In silico health effect prioritization of environmental chemicals through transcriptomics data exploration from a chemo-centric view

2020-10-17

With the explosive growth of synthetic compounds, the health effects caused by exogenous chemical exposure have attracted more and more public attention. The prediction of health effect is a never-ending story. Collective resource of transcriptomics data offers an opportunity to understand and identify the multiple health effects of small molecule. Inspired by the fact that environmental chemicals of high health risk frequently share both similar gene expression profile and common structural feature of certain drugs, we here propose a novel computational effect prioritization method for environmental chemicals through transcriptomics data exploration from a chemo-centric view. Specifically, non-negative matrix factorization (NMF) method has been adopted to get the association network linking structural features with transcriptomics characteristics of drugs with specific effects. The model yields 13 pivotal types of effects, so-called components, that represent drug categories with common chemo- and geno- type features. Moreover, the established model effectively prioritizes potential toxic effects for the external chemicals from the endocrine disruptor screening program (EDSP) for their potential estrogenicity and other verified risks. Even if only the highest priority is set for the estrogenic effect, the precision and recall can reach 0.76 and 0.77 respectively for these chemicals. Our effort provides a successful endeavor as to profile potential toxic effects simultaneously for environmental chemicals using both chemical and omics data.

Authors: Xian Liu, Huazhou Zhang, Qiao Xue, Wenxiao Pan, Aiqian Zhang
Full Source: The Science of the total environment 2020 Oct 17;143082. doi: 10.1016/j.scitotenv.2020.143082.

With the explosive growth of synthetic compounds, the health effects caused by exogenous chemical exposure have attracted more and more public attention.

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Microplastics and their associated organic pollutants from the coastal waters of the central Adriatic Sea (Italy): Investigation of adipogenic effects *in vitro*

2020-08-22

Even though microplastic (MP) pollution in aquatic environment is nowadays widely studied, a huge gap of knowledge exists on their actual biological effects. In this study we first reported environmental baseline data on the occurrence and characterization of floating MPs in Italian coastal waters of the Central Adriatic Sea by using a standardized monitoring protocol. Further, we analyzed the concentrations of MP-associated chemicals and evaluated their potential adipogenic effects using 3T3-L1 preadipocytes. MPs were found in each sampling stations showing the highest abundance (1.88 ± 1.78 items/m³) in the sites more distant from the coast with fragments as the most common shape category. All targeted organic pollutants (i.e. polychlorinated biphenyls - PCBs, polycyclic aromatic hydrocarbons - PAHs, organophosphorus - OP, and organochlorine - OC pesticides) have been detected on the surface of the collected MPs. The highest concentrations of PAHs were found on MPs from inshore (i.e. <1.5 NM) surface waters with low-ring PAHs as dominant components. Similarly, MPs from inshore waters had higher Σ PCB concentrations (64.72 ng/g plastic) than those found in offshore (i.e. >6 NM) waters (10.37 ng/g plastic). Among pesticides, all measured OPs were detected in each sample analyzed with pirimiphos-methyl as the most representative compound. For OCs, the sum of all concentrations of congeners was higher in coastal with respect to offshore waters. Moreover, *in vitro* 3T3-L1 screening of MP extracts indicated potential metabolic effects resulting in both adipogenesis and lipid uptake/storage.

Authors: Martina Capriotti, Paolo Cocci, Luca Bracchetti, Erika Cottone, Rosaria Scandiffio, Giovanni Caprioli, Gianni Sagratini, Gilberto Mosconi, Patrizia Bovolín, Francesco Alessandro Palermo

Full Source: Chemosphere 2020 Aug 22;263:128090. doi: 10.1016/j.chemosphere.2020.128090.

Even though microplastic (MP) pollution in aquatic environment is nowadays widely studied, a huge gap of knowledge exists on their actual biological effects.