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Editorial: Challenges and emerging issues on firefighter's toxic chemical exposure: smoke chemicals, contaminated PPE, and off-gassing

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Editorial on the Research Topic

Challenges and emerging issues on firefighter's toxic chemical exposure: smoke chemicals, contaminated PPE, and off-gassing

Introduction to the theme

This Research Topic delves into a pressing issue within the firefighting community: the exposure to toxic chemicals and its long-term health consequences for those at the forefront of firefighting emergencies. Under the theme “Challenges and Emerging Issues in Firefighters' Toxic Chemical Exposure: Smoke Chemicals, Contaminated Personal Protective Equipment (PPE), and Off-gassing,” we aim to demystify the occupational dangers and advance a collaborative discourse among researchers, practitioners, and technologists to find tangible solutions. This initiative addresses the significant health hazards associated with smoke chemicals, contaminated PPE, and the off-gassing of equipment, seeking to bring clarity and actionable insights.

Context and background

Firefighters' bravery is undeniable, yet their battle against the silent enemy of toxic chemical exposure requires a thoughtful and informed response. Historically, firefighter safety has centered on immediate threats like burns and structural hazards. In 2022, the occupational activity as firefighter was classified as carcinogenic to humans by the International Agency for Research on Cancer. Yet, the chronic dangers of toxic chemical exposure, from the combustion at fire sites to contaminants on PPE, are now recognized as leading to serious health issues, such as cancer and cardio-respiratory diseases.

Firefighting personnel are routinely exposed to a complex array of harmful substances released during fires, including training exercises, and brought inside fire stations on contaminated PPE and firefighting tools and vehicles. The increased use of synthetic materials has escalated the risk, producing more dangerous particulates and chemicals like

semi-volatile organic compounds (SVOCs) and volatile organic compounds (VOCs). This focus on smoke chemicals is crucial, as they represent a widespread danger.

The risk persists beyond the flames. PPE, intended for protection, can harbor fine toxic particles that compromise firefighter health during and after the incident. Such contamination highlights the urgency for stringent decontamination protocols.

The array of chemical hazards, including BETXs (benzene, ethylbenzene, toluene, and xylene), formaldehyde, and heavy metals, demonstrate the complexity of exposure and health risks. Furthermore, the scrutiny on per- and polyfluoroalkyl substances (PFAS) used in fire-resistant PPE and foams has unveiled significant health threats, emphasizing a systemic hazard that extends into the environment.

Overview of scholarly contributions

This Research Topic presents a series of nine meticulously researched articles that collectively enhance our understanding of the various health risks associated with firefighters' exposure to toxic chemicals. The contributions are thematically diverse yet interconnected, providing a holistic view of the topic. To facilitate a coherent synthesis, the articles are categorized into related research domains for a consolidated overview.

Cancer risks and biochemical pathways

Sweeney et al. An in-depth review focusing on the aryl hydrocarbon receptor (AhR) pathway reveals the complex role of environmental toxins in breast cancer, highlighting AhR as a pivotal element in cancer biology and offering insights into the environmental injustice of toxin exposure.

Lee et al. A meta-analysis that synthesizes data on cancer incidence and mortality, unearthing a correlation between firefighting and an elevated risk for certain cancers, advocating for improved cancer surveillance and longitudinal studies within the profession.

Mazumder et al. A critical examination of PFAS, their presence in firefighting gear and foams, and the consequential cancer risks, underpinning the urgent need for revisiting exposure risks and protective measures for firefighters.

Mental health and psychosocial dynamics

Cheng et al. Original research utilizing network analysis to dissect the relationship between PTSD and depression in Chinese firefighters, offering groundbreaking insights that could inform more nuanced mental health interventions.

Protective equipment and decontamination

Girase et al. An investigation into various cleaning methods, including liquid CO₂, highlighting their effectiveness in removing

contaminants while preserving the functional integrity of turnout gear.

Hossain et al. Research evaluating the efficacy of surfactants and charcoal-based cleaners in decontaminating PAHs from gear, challenging existing protocols and suggesting improvements for enhanced safety.

McQuerry et al. A study addressing the sizing and fit challenges in PPC for female firefighters, underscoring how inadequate protective gear can increase exposure risks and impact operational performance.

Epidemiological studies and environmental assessments

Koru-Sengul et al. An epidemiological analysis revealing that firefighters have a higher 5-year lung cancer survival rate compared to other groups, possibly due to healthier lifestyles and better medical treatment adherence.

Williams et al. An exploratory study detecting PAHs within fire stations, implying that PPE could inadvertently introduce harmful substances into firefighters' working environments, suggesting a reevaluation of decontamination practices.

Collective insights and future directions

Together, these articles present a compelling body of evidence that underscores the multifaceted nature of toxic chemical exposure risks in firefighting. From individual health vulnerabilities and mental wellbeing to broader epidemiological trends and systemic risks associated with equipment and environments, the research spans a wide spectrum. The collective insights advocate for enhanced protective measures, rigorous cleaning protocols, and tailored approaches to address gender-specific needs in PPE. This work also calls for an overarching strategy that includes proactive health screening, improved decontamination procedures, and continued research into the long-term impacts of toxic exposures in the firefighting community.

Author contributions

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