



Cyanide Exposure in Firefighting: An Epidemiological Perspective

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Introduction and Background

Hydrogen cyanide (HCN), a toxic byproduct of burning nitrogen-containing materials, poses a significant risk to firefighters, especially during overhaul when self-contained breathing apparatus (SCBA) use declines³⁷.

Despite its dangers, cyanide exposure is under-monitored, and standardized detection and treatment protocols are lacking³⁴.

This literature review examines epidemiological trends, diagnostic challenges, and the role of biomarkers in assessing cyanide exposure in firefighters. The review was developed in partnership with a local fire department to better understand and manage these risks.



Research Questions

- What is currently known about the risk and prevalence of cyanide exposure in firefighting?
- How effective are existing cyanide detection tools and biomarkers (i.e. lactate, carboxyhemoglobin (%COHb), thiocyanate) for assessing cyanide exposure in firefighters?
- Does proper use of personal protective equipment (PPE) protect against significant cyanide exposure during fire suppression?

Methods

We conducted a literature review to assess the epidemiological evidence on cyanide exposure in firefighters.

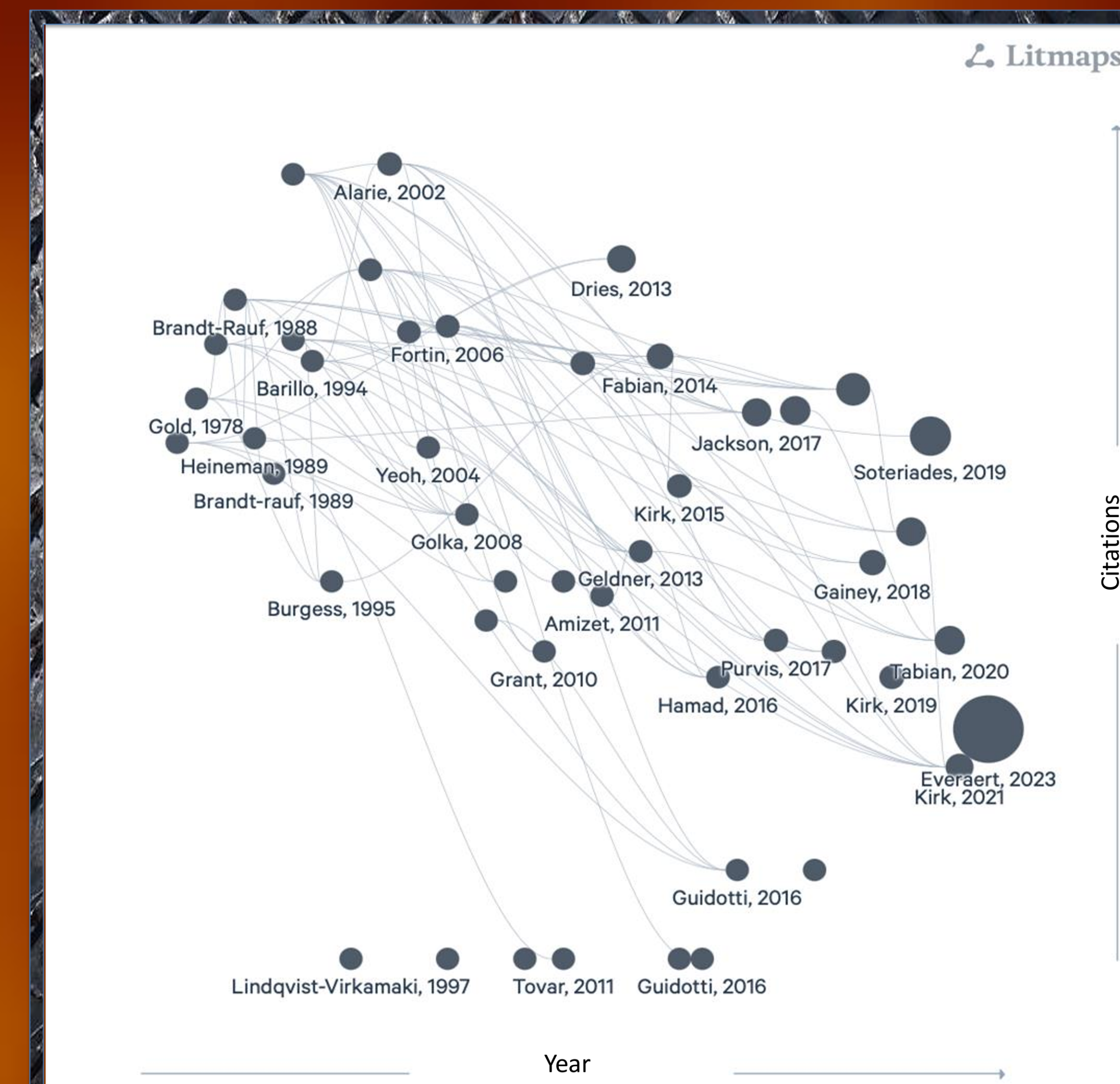
Articles were identified using academic databases and organized using LitMaps, a visual tool that helped refine search terms, explore citation networks, and prioritize relevant studies.

- Included studies with epidemiological components (n = 48; years: 1978-2023).
- Used a shared codebook for consistent data collection.
- Included peer-reviewed studies, case reports, and occupational surveillance data.
- Evaluated articles for:
 - Study design and population
 - Exposure context (e.g., suppression, overhaul)
 - Biomarkers (e.g., thiocyanate, COHb, lactate)
 - Clinical outcomes and relevance to cyanide exposure

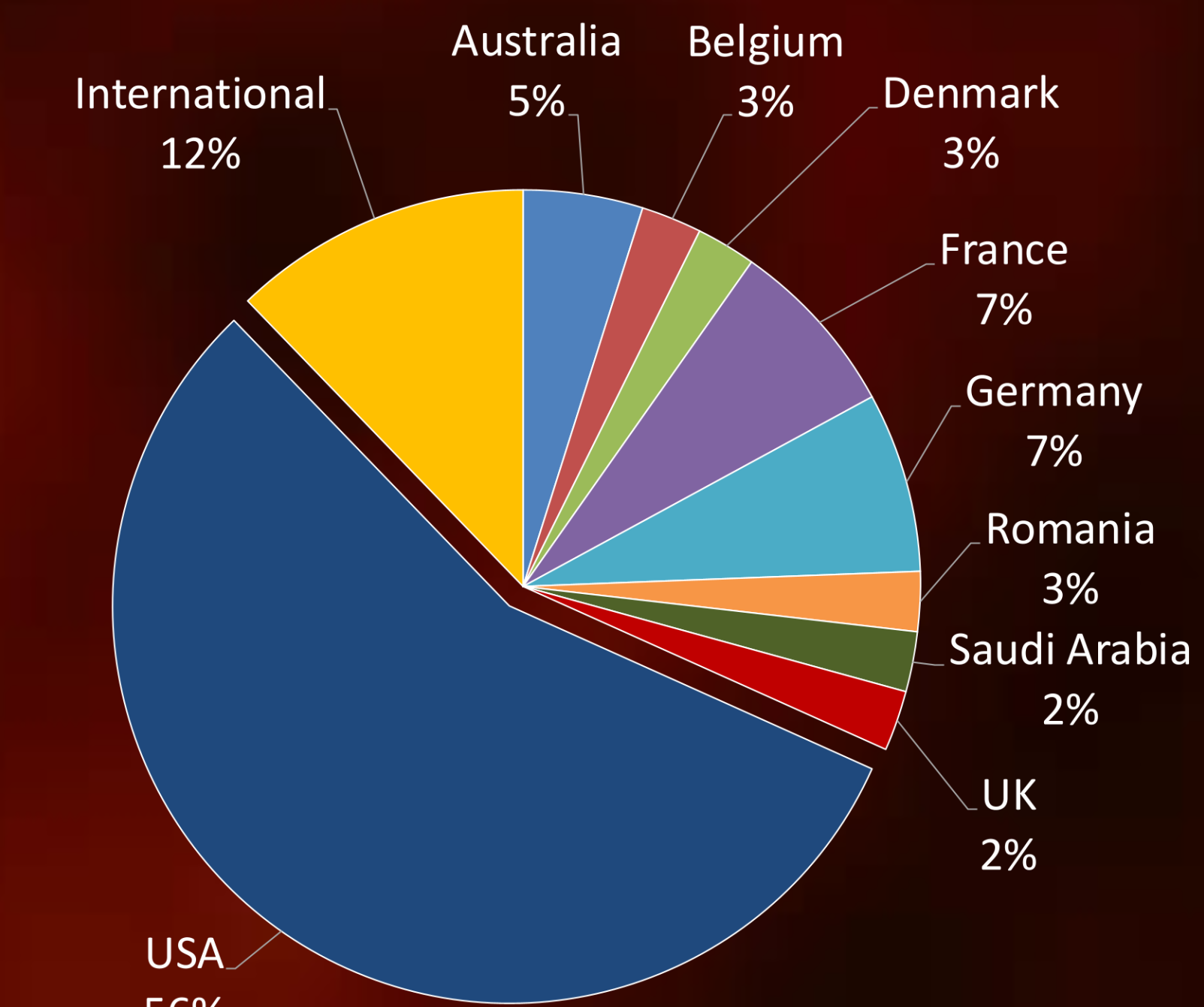
Observed a live fire training drill to better understand fireground roles, exposure scenarios, and SCBA use; no data from this event were included in the analysis.

Key Findings

- Hydrogen cyanide (HCN) was consistently detected in both fireground and fire training environments^{14,23}.
- Multiple studies reported co-exposure to carbon monoxide (CO) and cyanide and supported the use of carboxyhemoglobin and serum lactate levels as indirect indicators of significant cyanide exposure.
- Use of appropriate PPE is associated with reduced exposure risk but is dependent on proper use and compliance.
- Biomarkers such as thiocyanate have been used to confirm systemic cyanide exposure but are not routinely implemented in occupational health monitoring.
- Cyanide exposure is under-recognized due to non-specific symptoms and a lack of field-ready diagnostic tools.



Discussion & Limitations



Our review concludes that there is limited information currently available as to whether firefighters are at significant risk of cyanide exposure during fire suppression activities.

While there is some research discussing use of serum lactate and %COHb as indicators of cyanide toxicity in fire victims, less research is available regarding the accuracy of these biomarkers in determining the incidence or extent of toxic exposure in the firefighter population.

Other limitations identified in this review include short half-life of cyanide in the blood, and lack of access to rapid field testing for use at structure fire scenes.

Future Research

Future studies could examine the use of a combination of vital signs, CO oximeter readings, and blood measurements of lactate, %COHb, and cyanide to assess the degree of toxic exposure during fire suppression.

Stratification of these measurements by specific fireground assignment may provide valuable insight into which crew members are at highest risk of substantial exposure. Such studies could inform changes to firefighter safety protocols, as well as recommendations for cyanide antidote administration or other supportive on-scene medical care.

References

