Prioritization of reproductive toxicants in unconventional oil and gas operations using a multi-country regulatory data-driven hazard assessment

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Highlights
- 157 oil & gas-related reprotoxicants analyzed using 11 regulatory databases
- Variations in stringency of reprotoxicant classifications observed across nations
- Known/presumed reprotoxicants further evaluated for cancer and mutation hazards
- Scoring and visualization system applied to identify high priority chemicals
- This novel approach can inform exposure assessments and use of safer alternatives.

Abstract

Background
Recent trends have witnessed the global growth of unconventional oil and gas (UOG) production. Epidemiologic studies have suggested associations between proximity to UOG operations with increased adverse birth outcomes and cancer, though specific potential etiologic agents have not yet been identified. To perform effective risk assessment of chemicals used in UOG production, the first step of hazard identification followed by prioritization specifically for reproductive toxicity, carcinogenicity and mutagenicity is crucial in an evidence-based risk assessment approach. To date, there is no single hazard classification list based on the United Nations Globally Harmonized System (GHS), with countries applying the GHS standards to generate their own chemical hazard classification lists. A current challenge for chemical prioritization, particularly for a multi-national industry, is inconsistent hazard classification which may result in misjudgment of the potential public health risks. We present a novel approach for hazard identification followed by prioritization of reproductive toxicants found in UOG operations using publicly available regulatory databases.

Methods
GHS classification for reproductive toxicity of 157 UOG-related chemicals identified as potential reproductive or developmental toxicants in a previous publication was assessed using eleven governmental regulatory agency databases. If there was discordance in classifications across agencies, the most stringent classification was assigned. Chemicals in the category of known or presumed human reproductive toxicants were further evaluated for carcinogenicity and germ cell mutagenicity based on...
government classifications. A scoring system was utilized to assign numerical values for reproductive health, cancer and germ cell mutation hazard endpoints. Using a Cytoscape analysis, both qualitative and quantitative results were presented visually to readily identify high priority UOG chemicals with evidence of multiple adverse effects.

Results

We observed substantial inconsistencies in classification among the 11 databases. By adopting the most stringent classification within and across countries, 43 chemicals were classified as known or presumed human reproductive toxicants (GHS Category 1), while 31 chemicals were classified as suspected human reproductive toxicants (GHS Category 2). The 43 reproductive toxicants were further subjected to analysis for carcinogenic and mutagenic properties. Calculated hazard scores and Cytoscape visualization yielded several high priority chemicals including potassium dichromate, cadmium, benzene and ethylene oxide.

Conclusions

Our findings reveal diverging GHS classification outcomes for UOG chemicals across regulatory agencies. Adoption of the most stringent classification with application of hazard scores provides a useful approach to prioritize reproductive toxicants in UOG and other industries for exposure assessments and selection of safer alternatives.

Graphical abstract

Keywords

Chemical prioritization; Globally harmonized system; Regulatory list; Reproductive toxicants; Unconventional oil and gas

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