Uncovering Scientific Misconduct: The Impact of Intellectual Dishonesty on Occupational Health Studies of Leukemia and Benzene Exposure at The Workplace

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Abstract

Introductions: There are several unscrupulous companies using benzene in the industry that have taken various actions to manipulate the actual health impacts that can occur due to exposure to benzene, resulting in the dissemination of misleading information to the public. This review aims to compile and analyze scientific misconduct, exploring how this action has impacted public health policies and worker safety regulations over the years and their efforts throughout the years to prevent the right action.
Methods : A literature review was conducted to explore instances of scientific misconduct in occupational health studies related to leukemia due to benzene exposure in October 2024. The sources were taken from Google Scholar and PubMed. From the entire search, 2 relevant studies and 1 report were reviewed.
Results: Globally, companies using benzene which had manipulated data have contributed to significant delays in implementing regulations regarding benzene exposure. Many scientific errors related to benzene exposure have been identified, especially in the United States. This includes manipulating data from the 1950s to 1970s, specifically regarding the health impacts of benzene exposure and its relationship to the incidence of leukemia. Scientific misconduct causes significant delays in the implementation of necessary regulations.
Conclusions: The industry that uses benzene has intentionally manipulated scientific data to shape corporate and public perceptions, causing prolonged production and use of benzene. This has involved the use of research and manipulation of research data to obscure the true results that benzene causes leukemia.
Keywords: benzene, benzene exposure, leukemia, conflict of interest, occupational health research, scientific misconduct.

Abstrak

Pendahuluan : *Terdapat beberapa oknum perusahaan pengguna benzena dalam industrinya yang telah melakukan berbagai tindakan untuk memanipulasi dampak kesehatan sebenarnya yang dapat terjadi akibat paparan benzena, sehingga mengakibatkan penyebaran informasi yang menyesatkan kepada masyarakat. Tinjauan ini bertujuan untuk mengumpulkan dan menganalisis pelanggaran ilmiah, mengeksplorasi bagaimana tindakan ini berdampak pada kebijakan kesehatan masyarakat dan peraturan keselamatan pekerja selama bertahun-tahun serta upaya mereka untuk mencegah tindakan yang tepat.*
Metode : *Tinjauan literatur dilakukan untuk mengeksplorasi contoh kesalahan ilmiah dalam studi kesehatan kerja terkait leukemia akibat paparan benzena pada Oktober 2024. Sumber diambil dari Google Scholar dan PubMed. Dari keseluruhan pencarian, direview 2 penelitian dan 1 laporan yang relevan.*
Hasil : *Secara global, perusahaan-perusahaan yang menggunakan benzena yang telah memanipulasi data telah berkontribusi terhadap penundaan yang signifikan dalam penerapan peraturan mengenai paparan benzena. Banyak kesalahan ilmiah terkait paparan benzena telah teridentifikasi, terutama di Amerika Serikat. Hal ini termasuk memanipulasi data dari tahun 1950an hingga 1970an, khususnya mengenai dampak kesehatan dari paparan benzena dan hubungannya dengan kejadian leukemia. Pelanggaran ilmiah menyebabkan penundaan yang signifikan dalam penerapan peraturan yang diperlukan.*
Kesimpulan : *Industri yang menggunakan benzena dengan sengaja memanipulasi data ilmiah untuk membentuk persepsi perusahaan dan publik, sehingga menyebabkan produksi dan penggunaan benzena berkepanjangan. Hal ini melibatkan penggunaan penelitian dan manipulasi data penelitian untuk mengaburkan hasil sebenarnya bahwa benzena menyebabkan leukemia.*
Keyword : *benzena, paparan benzena, leukemia, konflik kepentingan, penelitian kesehatan kerja, pelanggaran ilmiah.*

Introduction

Benzene (C6H6, CAS 71-43-2) is a highly flammable, highly volatile liquid aromatic hydrocarbon. This clear, colorless liquid is characterized by a gasoline like smell.[1] It was first isolated in 1825 by the British scientist, Michael Faraday (1791-1867), who extracted it from a complex mixture obtained as a by product of illuminating gas production.[1] It was used as an ink component in printing, a solvent for organic materials, and substance in the chemical and pharmaceutical industries to produce rubbers, lubricants, dyes, detergents, and pesticides.[1] Nowadays, benzene is used primarily in the manufacture of organic chemicals such as styrene, ethylbenzene, cumene, cyclohexane, and phenol to produce polymers.[1]

Benzene is classified as a Group 1 human carcinogen by The International Agency for Research on Cancer (IARC). Entry point of benzene is through oral ingestion, skin contact, or inhalation.[2] Long term exposure of benzene may lead to negative health effects, impacts to the blood circulation system causing conditions such as anemia, leukopenia, and thrombocytopenia. The National Institute for Occupational Safety and Health (NIOSH) suggests occupational exposure limit (OEL) of 0.1 ppm, which is the recommended exposure limit (REL) is using an 8 hour time weighted average (TWA) that should not cause harm to the worker's health.[2] Meanwhile, the legal airborne permissible exposure limit (PEL) for benzene is 1 ppm for averaged over an 8 hour work shift and may not exceed 5 ppm for a 15 minute exposure.[3]

Exposure to high concentrations of benzene, which significantly exceeds the first detectable odor threshold can cause breathlessness, irritability, euphoria, giddiness, irritation of the eyes, nose, and respiratory tract, headache, dizziness, nausea, or a sensation of intoxication. In severe cases, it can result in convulsions and loss of consciousness.[4] Prolonged or repeated exposure to benzene at relatively low concentrations has been associated with various blood disorders, such as anemia and leukemia. Many blood disorders related to benzene exposure may develop asymptomatically.[4]

Benzene affects the body by disrupting normal cell function. It can impair bone marrow's ability to produce sufficient red blood cells, potentially resulting in anemia.[5] It can also harm the immune system by altering blood antibody levels and leading to a reduction in white blood cells. The severity of benzene poisoning is influenced by the amount, route, length of time of exposure, age and pre existing medical condition of the exposed person.[5]

Despite the recognized risks to the human body, the production and utilization of benzene products persist worldwide not just for certain applications but also because it remains as an impurity.[6] The removal of benzene as an impurity is both technically challenging and costly, making it difficult to eliminate benzene entirely from the products.[6] Therefore, benzene continues to be present in petrochemical products used for industrial purposes. It is crucial that the Material Safety Data Sheet (MSDS) for the products must clearly indicates the use of benzene.[6]

In 1928, Delore and Borgomano reported the first case of leukemia related to benzene exposure in a man who had worked for fifteen years at a pharmaceutical manufacturing plant.[1] In the last five years he experienced excessive benzene exposure at the workplace.[1] In 1932, Emile-Weil reported the case of a woman who died from leukemia and she had exposed to benzene in a rubber factory.[1] In 1934, Thompson, Richter and Esdall reported a new case of leukemia in a man exposed to a large quantity of benzene.[1]

In 1977, Infante et al. conducted the first cohort study that examined the association between benzene exposure and the incidence of leukemia.[10] This research led the U.S. Occupational Safety and Health Administration (OSHA) to reduce the permissible occupational exposure limit (PEL) for benzene from 10 ppm to 1 ppm in 1978.[7] By 1987, OSHA had gathered enough evidence to estimate how many workers would be protected by the original 1 ppm limit which was later reintroduced.[7] This regulatory delay resulted in 30 to 490 deaths from benzene related leukemia and multiple myeloma that could have been avoided.[7] The ongoing debate regarding what qualifies as adequate proof of benzene's harmful health effects makes the actions of petroleum industry representatives between 1980 and 1987 particularly important in the context of the history of benzene regulation.[7]

The U.S. Office of Science and Technology Policy defines misconduct as fabrication, falsification, or plagiarism in proposing, conducting, or reviewing research, or in reporting research findings.[8] Fabrication means creating data or results.[8] Falsification includes manipulating data, equipment, or processes, altering or omitting data or results in a way that misrepresents the

research in the record.[8] Meanwhile plagiarism means the unauthorized use of another person's ideas, processes, results, or words without giving appropriate credit.[8]

Companies that use benzene in their industry have conducted various experiments to obscure the link between benzene exposure and leukemia. Through lobbying, legal tactics, and manipulation of scientific literature, they have significantly halted research and allowed them to continue their actions. By shaping public opinions, they have delayed the creation of regulations regarding benzene. This literature review provides examples of how companies using benzene have disrupted occupational health research, thereby inhibiting early recognition of the risk of leukemia due to benzene exposure in workers.

Method

In October 2024, a literature review was conducted on manuscripts published from 2000 to 2024 that address scientific misconduct in occupational health studies related to Benzene. Only English language reports were included. We searched terms like "benzene studies", "scientific misconduct," and "benzene and leukemia" in Google Scholar and PubMed. This review focuses on misconduct in Benzene research that is related to leukemia incidence. From the entire search, 2 relevant studies and 1 report were reviewed.

Results

Jury Compensation to Worker for Leukemia Caused by Benzene Exposure

A Texas jury awarded $8.2 million to Virgil Hood, a 60 year old man diagnosed with MDS (*myelodysplastic syndrome*) / AML (*acute myeloid leukemia*), related to previous exposure to benzene in paint and thinner from E.I. DuPont during his employment from 1973 to 1996.[9] Evidence presented during the trial showed that DuPont had long known about the dangers of benzene but failed to eliminate it from their products or warn workers about such exposure.[9] Even though they had been aware of the dangerous effects of benzene exposure since the late 1930s, DuPont allegedly misled government safety officials about the risks associated with its paint products.[9] The jury's verdict included compensatory damages of $6.7 million and punitive damages of $1.5 million, and DuPont was liable for 80% of the compensatory amount.[9] This case highlights the broader issue of accountability for manufacturers of hazardous materials and aims to support others affected by similar health issues.

Another case from the first cohort study on benzene exposure, examined workers at Goodyear Tire and Rubber Company involved in the manufacture of "Pliofilm," a rubberized food wrapping material, at facilities in Akron and St. Marys, Ohio.[10] History suggests that between two and five workers diagnosed with *acute myelogenous leukemia* (AML) could be included in the cohort for further analysis.[10] During the late 1950s and early 1960s, Goodyear did not inform these workers or their doctors about the benzene solvent they used in work processes and they refused to provide compensation for AML cases related to benzene exposure until required by the State of Ohio in 1968.[10]

Corporate awareness of health risks has largely gone unnoticed. As a result, companies often identify the problem earlier than others but do not disclose the results, leading companies to deny there is a relation between leukemia and benzene exposure at the workplace.[10]

Research Falsification In Shell's Benzene Historical Exposure Study

Starting Point

In 1983, anticipating upcoming OSHA hearings on benzene regulations, Shell launched the Benzene Historical Exposure Study (BHES) to investigate the reported increase in leukemia cases at two of its refineries.[7] The BHES report submitted to OSHA found no connection between benzene exposure and the elevated leukemia rates.[7] Over the next two decades, Shell published several papers based on or expanding the BHES data.[7] All concluding that the increased risk of leukemia was not linked to benzene exposure.[7] The study aimed to either establish a connection by showing that leukemia cases clustered in high benzene exposure jobs or fail to identify a cause for the excess cases.[7] The BHES report noted that nine of the 23 leukemia cases at Wood River and Deer Park had "nil" benzene exposure when calculating career parts per million (ppm) days, and eleven had "nil" exposure when calculating peak ppm minutes per year.[7] Consequently, lacking evidence of a dose response relationship, Shell's BHES study

concluded that the excess leukemia is unexplained at this time.[7]

Underestimating Exposure in BHES

Since Shell did not monitor benzene exposure levels, it relied on the retrospective detection of benzene odor to estimate exposures.[7] Odor recognition refers to the concentration levels, measured in parts per million (ppm), at which a substance can be smelled.[7] At the beginning of the BHES data collection, Shell established that "the lowest detectable exposure level for benzene has reportedly been identified as 1.5 ppm".[7] Thus, they concluded that if a worker could smell benzene, they were exposed to at least 1.5 ppm.[7] This approach is based on the flawed assumption that an individual's perception of odor can accurately indicate exposure levels.[7] However, olfactory fatigue, or "adaptation," refers to a person's decreasing ability to detect an odor after prolonged exposure.[7]

Shell and its consultants deliberately excluded discussions of these issues in their reports and publications.[7] In the BHES report submitted to OSHA while Shell acknowledged the problem of olfactory fatigue, they misleadingly stated, "A specific literature search during the project development phase had not turned up any applicable information".[7] Furthermore, Shell did not consider the varying benzene concentrations in different product mixtures.[7] Without measuring actual exposures, Shell arbitrarily reduced exposure estimates for workers exposed to mixtures containing benzene.[7]

Shell Dismissing Positive Reports of Exposures

Documents from the BHES study contain repeated references to benzene as a cleaning solvent, with direct contact of benzene with skin being classified as high exposure risk by Shell.[7] Despite reports of benzene use, Shell dismissed this evidence and claimed "benzene was not available in the refinery" during the relevant employment period.[7] In February 1984, Shell submitted a report to OSHA stating that the excess cases of leukemia remained unexplained, but Shell later admitted that the methods they used were unreliable.[7]

In 1985, Shell published a study in the Journal of Occupational Medicine that only reported 14 out of 24 leukemia cases from the BHES, omitting key cases from the Deer Park facility and two live cases from Wood River to limit reporting.[7] They presented a statistically significant excess of leukemia at Wood River but misleadingly stated that affected workers did not hold jobs with high benzene exposure, despite evidence to the contrary.[7] Overall, the study manipulated data and excluded critical evidence related to benzene exposure among workers.[7]

Expanded Study of BHES Data

In late 1984, Dr. Cole and Dr. Harland Austin submitted a comprehensive study on the BHES data to NIOSH, entitled "A Case-Control Study of Leukemia at an Oil Refinery," which was published in 1986.[7] The study aimed to identify jobs or departments at the refinery associated with increased cases of *acute myelogenous leukemia* (AML) by comparing workers exposed to benzene with workers who were not affected.[7] Despite significant criticism and recommendations from NIOSH including combining data from two facilities, Shell published the study without changes and did not respond to NIOSH's criticism.[7]

In 1989, a mortality study conducted by Wongsrichanalai, Delzell, and Cole expanded the cohort to include more workers and extended follow up to 1984.[7] They reported a significant 50% excess in leukemia deaths, and acknowledged that benzene was a potential cause.[7] In 1995, Delzell, Cole, and Honda conducted another mortality study which concluded occupational exposure had decreased to a level insufficient to cause leukemia.[7] However, their methodology was flawed and misclassified exposed workers, such as refinery patrolmen as "unexposed".[7] Additionally, Shell's internal documents revealed bias in the reporting findings and selectively excluded certain leukemia cases from publication.[7] Overall, the studies have been criticized for methodological issues and data manipulation, undermining the reliability of their conclusions about benzene exposure and leukemia risk.[7]

Research Falsification In Pliofilm : Leukemia Deaths Among Akron Goodyear Tire and Rubber Company Employees

Local Hematologist Testimony on Leukemia Deaths

The first cohort study of workers exposed to benzene at Goodyear Tire and Rubber Company found a significant

increase in leukemia risk with a fivefold increase overall and a tenfold increase in *myelomonocytic leukemias*.[10] Following these findings, the US Department of Labor established an Emergency Temporary Standard to limit workplace exposure to benzene to 1.0 ppm.[10] The NIOSH investigation was informed by hematologist Dr. Sakol after diagnosing several cases of *acute erythroleukemia* among Pliofilm workers starting in 1954.[10] He provided evidence during the 1977 OSHA Benzene Rulemaking. By 1963, he had diagnosed nine cases of AML in this population and highlighting an association between benzene exposure and the incidence of blood cancer.[10]

Company Physician Withholding Information on Benzene Exposure

Dr. Sakol discovered a potential link between *acute myeloid leukemia* (AML) and exposure to chemicals in the Akron Goodyear Tire and Rubber Company's Pliofilm Department after treating several patients who had worked there.[10] He noted that blood counts were regularly performed on employees, which raised his suspicion about environmental factors contributing to AML.[10] Despite his inquiries, the company physician insisted that all chemicals were non toxic and refused to disclose details about specific substances, including one called "*urbine*." Further investigation revealed that "*urbine*" was actually a term for benzene, which known to cause AML.[10]

Dr. Sakol assisted widows of affected workers in filing compensation claims, but the company consistently denied any connection between occupational exposure and AML.[10] It wasn't until 1969 after years of appeals, the Industrial Commission of Ohio ordered Goodyear to recognize these claims relate to impacts resulting from industrial exposure.[10]

Misdiagnosis by The Company Physician

Testimony of Dr. Sakol revealed that several Pliofilm workers diagnosed with *acute myeloid leukemia* (AML) were initially misdiagnosed with anemia.[10] Patients were treated by Goodyear company doctors, who administered liver extract, vitamin B-12, and iron.[10] Three of these workers were classified as leukemia deaths in the NIOSH study.[10] The fourth worker who was initially told he had heart trouble, was later hospitalized for anemia and thrombocytopenia before being diagnosed with AML.[10] However, he was not counted as a leukemia death in the study due to an incorrect diagnosis on his death certificate.[10] Notably, none of the workers had been told they had leukemia by the company doctor, raising questions about the potential for misdiagnosis and the physician's ability to interpret blood monitoring results especially given his involvement in legal proceedings related to benzene exposure and other health issues.[10]

Discussion

Consequences of Scientific Misconducts

Shell implemented strategies to downplay concerns about benzene, disseminating communications that contradicted their internal data and relying on the "healthy worker effect" to skew findings.[7] The rushed BHES study was fraught with design flaws, including biased data treatment and underreporting of benzene exposure linked to leukemia cases.[7] Later studies such as an SMR analysis in 1984 and a case-control study in 1986 supported this weakness, although OSHA gathered enough evidence to reestablish benzene regulations in 1987, Shell continued to produce biased research.[7] Overall, Shell's tactics contributed to delays in benzene regulation that potentially resulting in an estimated 30 to 490 additional deaths.[7]

The situation described in Shell's research on benzene and leukemia demonstrate scientific misconduct through various means of bias and manipulation.[7] The rushed BHES study ignored crucial suggestions for improvement and employed biased data treatment.[7] This manipulation can mislead regulatory decisions and public perception about the safety of benzene exposure.[7] Shell's tactics included underreporting benzene exposure in leukemia cases and misclassifying workers' exposure categories.[7] This is a form of data falsification that can skew results and obscure the true risks associated with occupational exposure.[7] By failing to disclose conflicts of interest and misrepresenting their findings, Shell created a misleading narrative that aligned with their corporate interests rather than scientific integrity.[7] The goal of their flawed studies was to delay stricter benzene regulations but it directly impacting public health and safety.[7] This represents a violation of the ethical obligation that scientists have to promote health rather than hinder it.[7]

Meanwhile, the Akron Pliofilm cohort highlights several instances of scientific misconduct related to issues of transparency and ethical responsibility.[10] The company's lack of communication regarding industrial use of benzene and its potential health risks is an example of a significant violation of ethical standards.[10] By not informing workers diagnosed with *acute myeloid leukemia* (AML) about their condition or the environmental hazards, the company prioritized its interests over employee safety, a violation of their ethical obligation to protect public health.[10] The review suggested that previous studies may have underestimated the risk of leukemia associated with benzene exposure suggesting potential manipulation or omissions in early research.[10] This may reflect a systematic disregard for accurate data reporting and analysis, which is characteristic of scientific misconduct.[10]

The company's reluctance to provide compensation to the widows of affected workers until they are forced by the state suggests that the company's reluctance to acknowledge the link between occupational exposure and health outcomes.[10] The findings from this cohort imply that historical research may have been biased or flawed, potentially designed to minimize the perceived risk of benzene exposure.[10] This aligns with the broader theme of scientific misconduct where the integrity of research is compromised to serve corporate interests, ultimately endangering worker's health.

Conclusion

The risks posed by worker exposure to benzene are well documented. It is also linked to serious health problems, such as leukemia. However, the benzene industry has a history of manipulating scientific data to shape public perception and delaying necessary regulations for the use of benzene in the industry. This manipulation has taken the form of biased research practices, suppression of critical information, and a lack of transparency regarding the health risks associated with benzene.

We must remain alert to the potential for misuse of scientific misconduct, especially in Occupational Medicine. This can result in spreading lies and misleading information due to scientific errors. The continued distortion of scientific integrity by corporate interests has resulted in countless health problems and preventable deaths related to occupational exposure to benzene. To improve health and safety in the workplace, a deeper examination of how corporate power influences scientific research, the dissemination of information, and the development of policies that prioritize worker well being is needed.

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