Commentary

ARE MEDICAL LABORATORY AND HOSPITAL STAFF EXPOSED TO GASEOUS INHALATION NOT AT HEALTH RISKS? A COMMENTARY.

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Abstract

Toxic exposures are most likely to occur via inhalation, direct contact with the skin or eyes and ingestion, though inhalation with associated fatalities is the most commonly reported. Gases and vapours are the most frequently inhaled substances; nevertheless, liquids and solids can also be inhaled in the form of finely divided mists, aerosols, or dusts. Inhaled substances may cause injury in pulmonary epithelium, reproductive system and other body organs leading to severe disease from simple symptoms. Both hospital and laboratory personnel are affected directly or indirectly. The sources of these toxic inhalants range from environmental contamination to poor professional procedures. International Agency for Research on Cancer in their classification listed that some of these hospital-based inhalants are implicated in cancer pathogenicity, thus need for conscious awareness. The aim of this commentary is to highlight gaseous inhalation hazards associated with medical laboratory and hospital staff, with a view to ensuring preventive procedure that will improve staff safety and health status.

Key words: Medical workers, Inhalation of gases, Health risks.

Cite this article: Udeme KE, Enwere T, Oti ME, Obuna AJ, Uro-Chukwu HC. Are medical laboratory and hospital staff exposed to gaseous inhalation not at health risks? A commentary. Yen Med J. 2020;2(2):1 – 4.

INTRODUCTION

Hospital personnel, both those involved directly and indirectly with promoting the well-being of patients, and in maintaining the proper functioning of the hospital, may be exposed to chemicals with potential reproductive, respiratory and carcinogenic hazards. Exposure to anaesthetic gases is linked to genotoxic effects among operating theatre staff.1 Sterilants, such as ethylene oxide, methyl methacrylate, xylene gas, microbial vapor from the incubator and various organic reagents and solvents may induce genetic damage, cancer, congenital malformation, still-birth, and spontaneous abortion.[2,3,4]

Inhaled substances may directly injure the pulmonary epithelium at various levels of the respiratory tract, leading to a wide range of disorders from tracheitis and bronchiolitis to pulmonary oedema.[5] They may also be absorbed, resulting in systemic toxicity. Strikingly, under many exposure situations, the inhalation and absorption routes may be common.[6] Thus, determining the mechanism of respiratory insufficiency, whether it is a result of direct injury of respiratory tract or systemic toxicity, is difficult. Accordingly, it is best to classify inhaled agents as airway irritants and systemic toxins.[5] For instance, formaldehyde exposure has been found to be associated with nasopharyngeal tumours and increased risk of cancer of certain sites, particularly the brain and lymphohematopoietic system.[7]

In the acute and chronic pulmonary responses, the lungs are primarily affected by toxicity.[8] Thus, this commentary discusses the gaseous inhalation hazards associated with laboratory and hospital staff.

Pathogenesis

Inhaled toxic vapour, mist, gases or dust particles (less than 10 micron thick in diameter) may rapidly pass through capillaries of the lungs and enter the circulatory system, which can result in inflammation of the respiratory tract, occupational asthma due to allergic reactions to these substances and pneumoconiosis.[9] However, concentration of inhaled gases, duration of inhalation and particle size may determine the degree of toxicity in the system.[10]

Inhalants and Exposure Risks

Formaldehyde

Formaldehyde is a colourless, flammable gas with strong irritating smell. When dissolve in water it is called formalin. As a chemical it is widely used in hospitals as disinfectant, tissue preservative.[11] Acute airborne formaldehyde exposure leads to eye irritation, upper respiratory tract irritation, lower airway irritation (cough, chest tightness, and wheezing), pulmonary oedema, inflammation, pneumonia and eventually death.[11] Evidence has it that formaldehyde can provoke skin reactions in sensitized subjects, not only by contact but also by inhalation.[12,13] Studies have linked chronic inhalation of high concentration of formaldehyde to cancers such as leukaemia.[14] Also, a positive association has been observed between exposure to formaldehyde and sino-nasal cancer.[12,15] An investigation of reproductive function in female workers exposed to formaldehyde in the garment industry revealed increased incidence of menstrual disorders, inflammatory disease of the reproductive tract, sterility, anaemia, and low birth weights among offspring. Interestingly, some studies suggest that inhalation of formaldehyde leads to increased micronuclei frequencies in nasal and/or buccal mucosa cells.[12,13,16]

Waste anaesthetic gases

Waste anaesthetic gases are small amounts of volatile anaesthetics gases that leak from the patient's anaesthetic breathing circuit into the air of operating rooms during delivery of anaesthesia. These gases may also be exhaled by patients recovering from anaesthesia. Waste anaesthetics gases include both nitrous oxide and halogenated anaesthetics' such as halothane, enflurane, isoflurane, desflurane, sevoflurane, and methoxyflurane.[17] These gases pose a lot of health hazard to hospital workers.[18] It is understood that exposure to high concentrations of waste anaesthetic gases even for a short time may cause health hazards such as headache, irritability, fatigue, nausea, drowsiness, difficulties with judgment, birth defects, infertility, Liver and kidney disease.[1,19]

Some studies have reported that long-term exposure to low concentrations of waste anaesthetic gases causes miscarriages, genetic damage, and cancer among operating-room workers.[20] Strikingly is the report that waste anaesthetic gases induced miscarriages in the spouses of exposed workers and caused birth defects in their offspring.[20]

Xylene

Xylene is a colourless aromatic hydrocarbon with an irritating smell. It is widely used in the hospital laboratory for tissue processing and in the industries for production of paint, dye and polish. Xylene is mixable with a lot of organic solvents. It is not soluble in water because it is less dense than water hence it floats on the surface of water.[21] Nervous Toxicity of xylene is through inhalation, ingestion, eye or skin contact. The main effect of inhaling xylene is depression of central system, with symptoms like headache, dizziness, mental confusion, nausea and vomiting.[22,23] Exposure to xylene at a level of 200 ppm causes irritation of the lungs, chest pains and dyspnoea. Extreme exposure will cause pulmonary oedema.[22,24]

Inhalation of xylene at the concentration of 100-200 ppm can lead to nausea and headache. Further increase to 200-500 ppm may result in dizziness, weakness, irritability and vomiting. Exposure to 800-10,000 ppm will also result to more complicated health issues such as confusion, loss of balance, and ringing sensation in the ear, while loss of consciousness and death may occur when exposed to concentration of >100,000 ppm.[21]

Conclusion

Studies have established the deleterious effect of gaseous inhalation which health workers are exposed to through inhalation, ingestion and body contact. Precautionary measures such as proper handling, disposal and decontamination of infectious material should be applied. The use of protective equipment such as disposable gloves, chemical goggles, lab

coats, nose mask and chlorine water to decontaminate all the culture samples before disposal is recommended. All the microbial culture and sensitivities should be done in a fume cupboard. Monitoring of the exposure limits of formaldehyde gas using formalin meter and proper labelling of all the chemical bottles and warning labels are equally advised.

AUTHORS' CONTRIBUTIONS

UKE conceptualized the work, ET and OME searched for supportive literatures while HUC and OJA wrote and revised the manuscript.

REFERENCES

1. Borayek GE, Abou El-Magd SA, El-Gohary SS, El-Naggar AM, Hammouda MA. Occupational Genotoxic Effects Among A Group of Nurses Exposed to Anesthetic Gases in Operating Rooms At Zagazig University Hospitals. Egypt. J. Occup. Med. 2018;42(1):105-122.
2. Kawanishi M, Matsuda T, Yagi T. Genotoxicity of formaldehyde: molecular basis of DNA damage and mutation. Frontiers in Environmental Sci. 2014;2:36 – 39. https://www.frontiersin.org/articles/10.3389/fenvs.2014.00036/full. Accessed February 25, 2020.
3. Nielsen GD, Larsen, ST, Wolkoff P. Re-evaluation of the WHO formaldehyde indoor air quality guideline for cancer risk assessment. Arch Toxicol. 2010;91(1):35-61.
4. Vulimiri SV, Pratt MM, Kulkarni S, Beedanagari S, Mahadevan B. Reproductive and Developmental toxicity of solvents and gases, In: Gupta RC, ed. Reproductive and Developmental Toxicology. 2nd ed. Amsterdam, NH: Academic Press; 2017: 379-396.
5. Metin G, Metin A. Acute Inhalation Injury. Eurasian J Med. 2010;42(1):28–35.
6. Robins M, Nava F, Anasco H. Voc mixtures: toxicity and adverse health effects associated with coexposure to xylene and formaldehyde. In: Department of Environmental and Occupational Health, California State University, Northridge (database online). Northridge, CA: CSUN. https://www.csun.edu/sites/default/files/VOC%20MIXTURES-%20TOXICITY%20AND%20ADVERSE%20HEALTH%20EFFECTS%20ASSOCIATED%20WITH%20COEXPOSURE%20TO%20XYLENE%20AND%20FORMALDEHYDE.pdf. Accessed February 25, 2020.
7. Kwon SC, Kim I, Song J, Park J. Does formaldehyde have a causal association with nasopharyngeal cancer and leukaemia? Ann Occup Environ Med. 2018;30:5-9. doi:10.1186/s40557-018-0218-z.
8. Rajan TS, Malathi N. Health hazards of xylene: a literature review. J Clin Diagn Res. 2014;8(2):271–274.
9. Occupational hygiene training association (OHTA). STUDENT MANUAL Basic Principles in Occupational Hygiene. OH learning.com http://www.ohlearning.com/Files/Student/KA02%20v3-0%2022Aug17%20Student%20Manual.pdf. Accessed February 25, 2020.
10. Borm PJ, Schins RP, Albrecht C. Inhaled particles and lung cancer, part B: paradigms and risk assessment. Int J Cancer. 2004;110(1):3–14. doi:10.1002/ijc.20064
11. Public Health England. Formaldehyde: health effects, incident management and toxicology. GOV.UK. https://www.gov.uk/government/publications/formaldehyde-properties-incident-management-and-toxicology. Published July 1, 2014. Updated November 16, 2017. Accessed February 25, 2020.
12. Cogliano VJ, Baan R, Straif K, Grosse Y, Lauby-Secretan B, El Ghissassi F, et al. Preventable exposures associated with human cancers. J Natl Cancer Inst. 2011;103:1827 – 1839.
13. International Agency for Research on Cancer. Evidence for Carcinogenicity 2012. http://monographs.iarc.fr/ENG/Classification/index.php. Accessed October 10, 2019.
14. Swenberg JA, Moeller BC, Lu K, Rager JE, Fry RC, Starr TB. Formaldehyde carcinogenicity research: 30 years and counting for mode of action, epidemiology, and cancer risk assessment. Toxicol Pathol. 2013;41(2):181–189.
15. Sandvik A, Klingen TA. Langård S. Sinonasal adenoid cystic carcinoma following formaldehyde exposure in the operating theatre. J Occup Med Toxicol. 2014;9**:**43 – 51. doi:10.1186/s12995-014-0043-4.2019
16. Sivasankari NP, Sundarapandian S, Sakthivel E Micronucleus assay in formalin exposed individuals. Indian J Clin Anat Physiol. 2018;5(1);81-84.
17. Williams GW, Gumbert S, Pivalizza EG, Syed TA, Burnett, T, Mancillas OL, et al. Evaluation and control of waste anesthetic gas in the postanesthesia care unit within patient and caregiver breathing zones. Proc (Bayl Univ Med Cent). 2018;32(1):43-49.

18. Kampan S. Air quality and employee hygiene-related behavior in a post anesthesia care unit in Thailand. Asian Pac Island Nurs J. 2019;4:11-19.
19. Siha MS, Farahat SA, Rashed LA, Helmy NM. Study of some health hazards among operating theater personnel due to exposure to anesthetic gases (II). Egypt. J. Occup. Med. 2019;43:313-329.
20. Nagella AB, Ravishankar M, Hemanth Kumar VR. Anaesthesia practice and reproductive outcomes: Facts unveiled. Indian J Anaesth. 2015;59(11):706–714. doi:10.4103/0019-5049.170028
21. Kandyala R, Raghavenda SP, Rajasekharam ST. Xylene an over view of it's hazard and preventive measure. J. Oral Maxillofac. Pathol. 2010;14(1):1-5.
22. Agency for Toxic Substances & Disease Registry. Medical management guidelines for xylene. ASTDR https://www.atsdr.cdc.gov/MMG/MMG.asp?id=291&tid=53. Accessed October 11, 2019.
23. Wen-His C, Hui-Min W. Assessing organic chemical emission and works risk of exposure in a medical examination Centre using solid phase microextraction device. Aerosol Air Qual Res. 2019;19:865-870.
24. Kuranchie FA, Angnunavuri PN, Attiogbe F, Nerquaye-Tetteh, EN. Occupational exposure of benzene, toluene, ethylbenzene and xylene (BTEX) to pump attendants in Ghana: Implications for policy guidance. Cogent Environ. Sci. 2019;5:1-9. https://www.tandfonline.com/doi/full/10.1080/23311843.2019.1603418. Accessed February 25, 2020.