

Certain Face Masks Contain Toxic Chemicals, Inhalation of Which has the Potential to Affect the Upper Respiratory System

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ABSTRACT

Masks have been proven to be a key measure to suppress COVID-19 transmissions and save lives. However, certain types of face masks have been shown to contain toxic chemicals such as formaldehyde, aniline, and Perfluorocarbons (PFCs). Various health organizations and publications have detailed the harmful effects of these toxic chemicals on human body. Various studies have also shown that inhalation of formaldehyde and aniline can have an adverse impact on the human upper respiratory tract. While various agencies have detailed the permissible limits of such chemicals in many products, there has been no guidance provided on the permissible concentration levels of such chemicals in face masks. Since face masks are so close to the mouth, further research should be undertaken on priority to understand whether breathing through such face masks containing these toxic chemicals can have an adverse impact on human organs. Further, since SARS-CoV-2 has been shown to first affect the upper respiratory system and later progress to lower respiratory system, additional research should also be undertaken to understand whether use of face masks containing formaldehyde and aniline is contributing to adverse outcomes in the respiratory system of COVID-19 patients.

Keywords: SARS-CoV-2; COVID-19; Face masks; Aniline; Formaldehyde; Fluorocarbons; Respiratory system; N95 masks; Surgical masks; Coronavirus; PPE; Pandemic

INTRODUCTION

Masks have been proven to be a key measure to suppress COVID-19 transmissions and save lives. Various health agencies continue to recommend that health workers providing care to suspected or confirmed COVID-19 patients wear the medical masks or respirators, N95 or FFP2 or FFP3 standards or equivalent. Universal masking for all persons (staff, patients, visitors, service providers and others) within the health facility has also been recommended. General public have been advised to wear a non-medical masks in indoor and outdoor settings. However, individuals/people with higher risk of severe complications from COVID-19 (individuals >60 years old and those with underlying conditions such as cardiovascular disease or diabetes mellitus, chronic lung disease, cancer, cerebrovascular disease or immunosuppression) have been advised to wear medical masks when physical distancing of at least 1 metre cannot be maintained [1].

With the onset of COVID-19 pandemic, many companies have got into the mask-making business. While there are testing standards established for medical masks, the non-medical masks are pretty much unregulated. The existing testing standards of medical masks focus on filtration efficiency, breathability, differential pressure, splash resistance, and microbial cleanliness. There is no

mandatory requirement to test whether these masks contain any toxic chemicals.

Various scientific studies over the years have reported use of formaldehyde in certain N-95 masks and Surgical masks, and such formaldehyde has been reported to cause various allergic contact dermatitis [2-5]. Recently, a German scientist have also found that various face masks (including surgical masks) contain toxic and banned chemicals, including formaldehyde and aniline [6,7]. Another industry textile chemist, Dr. Dieter Sedlak, Managing Director and Co-founder of Modern Testing Services Augsburg, Germany, in partnership with Modern Testing Services Global, Hong Kong also found elevated concentrations of hazardous chemicals such as formaldehyde, aniline, hazardous Fluorocarbons (PFCs) and other potentially carcinogenic substances on surgical face masks [6,7]. Last year, in December 20, a European manufacturer recalled their 7 month protective mask since aniline was detected in these masks [8]. The material description of these masks did not mention the use of formaldehyde, aniline and any such harmful substances.

There has been very limited research done to study the potential exposure and inhalation of such hazardous chemicals and carcinogens through face masks.

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FORMALDEHYDE

Formaldehyde is a colorless and flammable chemical with strong smell and is often used in building materials and in clothing. It is also commonly used as a fungicide, germicide, and disinfectant, and as a preservative in mortuaries and medical laboratories. Formaldehyde can be mentioned as formalin, formic aldehyde, methanediol, methanal, methyl aldehyde, methylene glycol or methylene oxide on product labels.

The National Toxicology Program (NTP), formed from parts of several different US government agencies, including the National Institutes of Health (NIH), the Centers for Disease Control and Prevention (CDC), and the Food and Drug Administration (FDA), lists formaldehyde as "known to be a human carcinogen" [9]. A study on various workers exposed to high levels of formaldehyde, such as industrial workers and embalmers, have found that formaldehyde causes myeloid leukemia and rare cancers, including cancers of the paranasal sinuses, nasal cavity, and nasopharynx [10]. Even the International Agency for Research on Cancer (IARC), which is part of the WHO, has also concluded that formaldehyde is "carcinogenic to humans" based on higher risks of nasopharyngeal cancer and leukemia [11].

HARMFUL EFFECTS AND SYMPTOMS OF FORMALDEHYDE

WHO's Concise International Chemical Assessment Document on Formaldehyde mentions that since formaldehyde is water soluble, adverse effects resulting from exposure are observed primarily in those tissues or organs with which formaldehyde first comes into contact [12]. This could be the respiratory and aero digestive tract, including oral and gastrointestinal mucosa, following inhalation or ingestion, respectively. Sensory irritation of the eyes and respiratory tract by formaldehyde has been observed consistently in clinical studies and epidemiological surveys in occupational and residential environments. At higher concentrations, formaldehyde may also lead to the induction of generally small, irreversible effects on lung function. Epidemiological studies although do not provide strong evidence for a causal association between formaldehyde exposure and human cancer, the possibility of increased risk of respiratory cancers, particularly those of the upper respiratory tract, cannot be excluded.

As per Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens, sixth edition (a globally recognized reference source), inhalation of formaldehyde can lead to coughing and wheezing, tightness of the chest, and shortness of breath [13]. Difficulty in breathing, cough, pneumonia, pulmonary edema and asthmatic reactions may occur. A short term exposure may prove to be corrosive to the eyes, skin, and respiratory tract and acute exposure may result in burns to the skin, eyes, and mucous membranes, lacrimation, nausea, vomiting (may be bloody), abdominal pain, and diarrhea. Reactions may become more severe if exposure persists. At higher concentration levels, breathing may be impaired and serious lung damage may occur. Ingestion of even 1 liquid ounce of formaldehyde has resulted in death to humans. If the person is pregnant, the possibility of the fetus being aborted exists.

A separate study from Pathological Laboratory of Rush Medical College, Chicago also showed that the inhalation of formaldehyde gas in even small quantities is followed by bronchitis and pneumonia. Such pneumonia was due to the inhalation of gas, and not due to secondary infection [14].

Formaldehyde was declared as the Contact Allergen of the Year for 2015 by the American Contact Dermatitis Society (ACDS) [15]. Infact multiple studies across the globe have reported urticaria and contact dermatitis in healthcare workers on account of use of N95 and surgical masks that contained formaldehyde [2].

Thus, formaldehyde is absorbed in the body in whatever way it is introduced, and can produce lesions in various organs.

ANILINE

Aniline is a clear to slightly yellow liquid with a characteristic odor and is used to make a wide variety of products such as polyurethane foam, agricultural chemicals, synthetic dyes, antioxidants, stabilizers for the rubber industry, herbicides, varnishes and explosives. It is also commonly known as phenylamine, aminobenzene, and aminophen.

As per U.S. Department of Health and Human Services Agency for Toxic Substances and Disease Registry, Aniline can be toxic if ingested, inhaled, or comes in skin contact [16]. It is a powerful blood toxin that can damage hemoglobin, and affect the oxygen as damaged hemoglobin cannot carry oxygen. The severity depends on how much you are exposed to and for how long.

According to the Federal Institute for Risk Assessment (BfR), Regulation (EC) No. 1272/2008 (CLP), aniline is classified as a mutagen (class 2, "can presumably cause genetic defects") and a carcinogen (class 2, "can presumably cause cancer") classified [17].

HARMFUL EFFECTS AND SYMPTOMS OF ANILINE

As per Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens, sixth edition [13], Aniline is classified as very toxic. Inhalation of Aniline can cause irritation of the respiratory tract with wheezing and coughing. Higher concentration levels can affect the blood's ability to carry oxygen, difficult breathing, collapse, and death. Common symptoms of exposure to Aniline include headache, nausea, sometimes vomiting, dryness of throat, confusion, vertigo, lack of muscle coordination, ringing in the ears, weakness, disorientation, lethargy, drowsiness, and coma. Aniline has been linked to bladder cancer according to a NIOSH (National Institute of Occupational Safety and Health) study [18].

Aniline can cross the placental barrier. Because fetal hemoglobin is more easily oxidized to methemoglobin than is adult hemoglobin and is less easily reduced back to normal hemoglobin, methemoglobin theoretically may be at higher levels in fetuses than in exposed mothers [19].

FLUOROCARBONS

Perfluorocarbons (PFCs) are used in water-repellent finishes. These are chemical compounds that contain carbon-fluorine bonds. The issue with fluorocarbons lies in its two side products, called PFOS and PFOA. Both are PBT (Persistent, Bio-accumulative and Toxic). Fluorocarbons tend to be slowly broken down in the environment and therefore many are considered persistent organic pollutants. As per US CDC and EPA, PFOA can remain in the human body for long periods of time and can lead to adverse health outcomes [20,21]. In laboratory animals, large amounts of PFOA has shown to affect growth and development, reproduction, and injure the liver. A study of workers living near a DuPont Teflon plant found an association between PFOA exposure and two kinds of cancer as well as four other diseases [22]. Studies have found

correlation between high PFOA exposure and six health outcomes: kidney cancer, testicular cancer, ulcerative colitis, thyroid disease, hypercholesterolemia (high cholesterol), and pregnancy-induced hypertension [23]. The European Union has banned PFOS and is considering similar action with PFOA [24].

POTENTIAL LINK BETWEEN SYMPTOMS OF COVID-19 AND HARMFUL EFFECTS OF FORMALDEHYDE AND ANILINE

While knowledge about transmission of the SARS-CoV-2 virus is evolving continuously, COVID-19 is primarily considered to be a respiratory disease. COVID-19 has been proven to first affect the upper respiratory system and later progress to lower respiratory system [25]. The major symptoms of COVID-19 include fever, coughing, shortness of breath, trouble breathing, fatigue, chills, sometimes with shaking, body aches, headache, sore throat, congestion/runny nose, loss of smell or taste, nausea and/or diarrhea [26]. There have been reports of acute respiratory failure in 45%-65% of cases in COVID-19 in which the patients lost spontaneous breathing, necessitating the use of ventilators, and eventually died [27,28].

As stated above, inhalation of formaldehyde could lead to difficulty in breathing, cough, pneumonia, pulmonary edema and tightness of the chest among other symptoms. Inhalation of aniline can also cause irritation of the respiratory tract, difficulty in breathing, wheezing and coughing, headache, nausea, confusion among other symptoms. Formaldehyde and aniline have also been found in various medical and non-medical masks. Whether such masks are further contributing to the deteriorating respiratory conditions in COVID-19 patients has not been investigated.

CONCLUSION

Various studies have shown that inhalation of formaldehyde and aniline can affect the upper respiratory system. A detailed study should be undertaken to understand whether the masks containing these toxic chemicals can have an adverse impact on human's body, particularly on the respiratory system. Further, since COVID-19 is primarily considered as respiratory illness, investigation should be conducted to ascertain whether use of masks containing formaldehyde and aniline can contribute to adverse outcomes in COVID-19 patients. Moreover, the impact of inhalation of perfluorocarbons used in masks on human health should also be investigated. In the meantime, the health authorities should provide with the guidance on the permissible concentration levels of such chemicals in face masks, particularly when these are worn so close to the mouth. Use of such chemicals should be strictly regulated in case of child masks.

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CONFLICT OF INTEREST STATEMENT

The authors declare that there is no conflict of interest to disclose.

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