PHILIPS

Sleep and Respiratory Care update

Clinical information

July 8, 2021

Supplemental clinical information for physicians and providers for specific CPAP, Bi-Level PAP, and mechanical ventilator devices

On June 14, 2021, Philips issued a recall notification for the US only/field safety notice for the rest of the world for specific sleep and respiratory care devices due to two issues related to the polyester-based polyurethane (PE-PUR) sound abatement foam used in certain Philips continuous and non-continuous ventilators: 1) the PE-PUR foam may degrade into particulates which may enter the device's air pathway and be ingested or inhaled by the user, and 2) the PE-PUR foam may emit certain chemicals.

1. Foam degradation

Despite a low complaint rate of 0.03% (i.e. 3 in 10,000) in 2020 [1], Philips has determined from user reports and lab testing that the PE-PUR foam may slowly degrade - through a process called hydrolysis - and produce particulates which may enter the device's air pathway where they could be ingested or inhaled by the user of impacted Continuous Positive Airway Pressure (CPAP), Bi-Level Positive Airway Pressure (Bi-Level PAP) and mechanical ventilator devices.

The foam degradation may be accelerated by environmental conditions of high temperatures and humidity. Unauthorized cleaning methods such as ozone cleaning may exacerbate potential degradation [2].

The sound abatement foam is an open-cell PE-PUR foam that is widely used for sound dampening purposes in many industries. According to a research study reported in the literature, the degradative by-products of a PE-PUR foam after a humid ageing experiment were found to include diethylene glycol (DEG), toluene diamine isomers (TDA) and toluene diisocyanate isomers (TDI) [3].

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Lab analysis of the degraded foam positively confirmed the presence of DEG as well as other compounds. Lab analysis of degraded foam was not able to positively confirm the presence of TDA nor TDI. Laboratory accelerated aged foam and subsequent extractions were used to obtain a sufficient quantity of representative field samples for biocompatibility lab testing; cytotoxicity was noted for the extraction concentrations, while two genotoxicity assays showed a positive mutagenic response. Daily chemical dosages and concentrations are unknown at this time. Considering a reasonable **worst-case scenario**, the following potential risks associated with exposure to the degraded foam particulates have been considered:

- Irritation (skin, eye, and respiratory tract), inflammatory response, headache, asthma, adverse effects to other organs (e.g. kidneys and liver), and possible toxic and carcinogenic effects.
- Foam particulates may cause irritation and airway inflammation, and this may be particularly important for patients with underlying lung diseases or reduced cardiopulmonary reserve.

Philips has received complaints regarding the presence of black debris/particulates within the airpath circuit (extending from the device outlet, including the humidifier, tubing, and mask). Additionally, Philips has received several reports of headache, upper airway irritation, cough, chest pressure and sinus infection. There has been no patient death reported to date. Philips acknowledges that the low complaint rate may not fully reflect the probability frequency or severity of the occurrence, because users may not detect the particulates and/or report the event to Philips.

Based on the test data and information available to date, Philips believes that most degraded foam particulates are too big to be deeply inhaled. According to analysis performed by Philips, the majority of particulates are of a size (>8 µm) that are unlikely to penetrate into the deep lung tissue. Smaller particulates (<1-3 µm) are capable of diffusing into deep lung tissue and deposit into the alveoli. During testing performed by an outside laboratory on lab degraded foam, the smallest particulate size identified was 2.69 µm.

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For affected mechanical ventilator devices, exposure to the particulate hazard (not chemical emissions) may be mitigated through the use of a bacteria filter. Labeling recommends that a main line outlet bacteria filter be used on Trilogy devices whenever the device is used for invasive therapy or if the ventilator may be used on multiple patients. Filter testing [4] indicated 99.97% effectiveness of an inert test with particulate sizes of 0.3 µm or greater. Based on the available information to date on estimated particulate size range, the bacteria filter is expected to effectively filter out some foam particulate that could make its way up the patient circuit.

2. Chemical emissions from the PE-PUR foam

Emission of certain chemicals from the foam has been identified, resulting from trace amounts of organic compounds associated with the production process of the foam. Based on standard ISO 18562-3 testing which ran a device at 35°C ± 2°C for 168 hours, two compounds of concern were emitted from the device: dimethyl diazine and phenol 2,6-bis (1,1-dimethylethyl)-4-(1-methylpropyl).

Possible gas emission of the degraded foam has not been fully characterized yet. Testing results to date suggest that the emission of dimethyl diazene dissipates to below detectable levels after the initial 24 hours of use of a new device, and that also the emission of phenol 2,6-bis(1,1-dimethylethyl)-4-(1-methylpropyl) tapers off during the initial days of use of a new device.

Dimethyl diazene (CAS Number 503-28-6) is also known as azomethane with no specific pre-clinical toxicological data available in scientific literature, nor a known daily permissible daily exposure limit. The oxide derivative of this compound is azoxymethane (CAS Number 25843-45-2), which is a carcinogen [5]. However, azoxymethane was not detected in the tests. Quantitative Structure Activity Relationship (QSAR) computer modeling, which is utilized in toxicology to indicate the potential toxicological effects of unknown chemicals, did not yield any mutagenicity alerts for dimethyl diazene.

Phenol 2,6-bis(1,1-dimethylethyl)-4-(1-methylpropyl) (CAS Number 17540-75-9) is used as an antioxidant and stabilizer in a wide range of organic materials, including polyurethanes. Toxicological data cited in a Health Canada study from 2010 indicates that the compound is not mutagenic [6]. QSAR computer modeling yielded a structural alert for chromosome damage (in vitro chromosome aberration test) due to it being an alkylphenol. No sensitization or additional bacterial mutagenicity alerts were noted.

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The potential hazards that stem from the emitted compounds have not been fully toxicologically characterized yet. Out of an abundance of caution, Philips has considered the following possible risks for a reasonable **worst-case scenario**:

- Headache/dizziness, irritation (eyes, nose, respiratory tract, skin), hypersensitivity, nausea/vomiting, and possible toxic and carcinogenic effects.
- These compounds may cause irritation and airway inflammation, and this may be particularly important for patients with underlying lung diseases or reduced cardiopulmonary reserve.

To date, Philips has received no reports regarding patient impact related to chemical emissions. Philips acknowledges that this may not fully reflect the severity or probability of occurrence, because users may not detect the chemicals and/or report the event to Philips.

The information in this document is based on the test data and information available to date and considers a reasonable worst-case scenario. Further testing, that is ongoing, will help Philips better estimate the reasonable worst-case probability of the health risks related to the two identified PE-PUR sound abatement foam issues.

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Notes and references

[1] *486 foam-related complaints in 2020 for 1.56 million devices shipped in that year, representing a complaint rate of 0.03%.*

[2] *Philips is recommending that customers and patients do not use ozone-related cleaning products.*

[3] *Lattuati-Derieux, A., Thao-Heu, S. & Lavédrine, B.; Assessment of the degradation of polyurethane foams after artificial and natural ageing by using pyrolysis-gas chromatography/mass spectrometry and headspace-solid phase microextraction-gas chromatography/mass spectrometry; J. Chromatogr. A 1218, 4498–4508 (2011).*

[4] *Testing was done on part number 342077.*

[5] *Waly, M.I., Al-Rawahi, A.S., Al Riyami, M., Al-Kindi, M.A., Al-Issaei, H.K., Farooq, S.A., Al-Alawi, A., Rahman, M.S.; Amelioration of azoxymethane induced-carcinogenesis by reducing oxidative stress in rat colon by natural extracts; BMC Complement Altern Med 14, 60 (2014).*

[6] *Screening Assessment for the Challenge Phenol, 2,6-bis(1,1-dimethylethyl)-4-(1-methylpropyl)-, Chemical Abstracts Service Registry Number 17540-75-9, Environment Canada, Health Canada (July 2010): https://www.ec.gc.ca/ese-ees/default.asp?lang=En&n=AE29F426-1 (accessed July 2021).*

Additional information

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