

• **Editorial**

Humidifier disinfectants, unfinished stories

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Once released into the air, humidifier disinfectants became tiny nano-size particles, and resulted in chemical bronchoalveolitis. Families had lost their most beloved members, and even some of them became broken. Based on an estimate of two million potential victims who had experienced adverse effects from the use of humidifier disinfectants, we can say that what we have observed was only the tip of the iceberg. Problems of entire airways, as well as other systemic effects, should be examined, as we know these nano-size particles can irritate cell membranes and migrate into systemic circulation. The story of humidifier disinfectant is not finished yet.

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Humidifier disinfectant was added to the humidifier water tank to keep the water sterile. As microbial growth was contained by chemicals, however, the aerosolized water droplets became contaminated with chemicals instead. With the evaporation of tiny water droplets, the fine particulates of chemicals entered into the deeper parts of the lung [1]. The result was chemical bronchoalveolitis in place of microbial infections [2].

However, people did not suspect that products marketed under the slogan of hygiene could result in unhygienic conditions, and blamed themselves for the unexpected tragedies. Some people lost their most beloved ones, including mothers, wives, babies, and grandchildren, and some families were broken by the burden of the tragedy. As humans can only explain their lives with stories they have been told, the victims and their families had to make up their stories around allergies, genes, cleaning habits, and all sorts of misfortunes that came to mind. However, none of the stories could explain their misfortunes that lay beyond their individual control.

Two of the most toxic humidifier disinfectants, polyhexamethylene guanide phosphate (PHMG) and poly(oxyalkylene guanidine) hydrochloride (PGH), were macromolecules that had not been tested for their complete toxicities. The toxicity testing of these macromolecules had become exempt in the process of government de-regulation campaigns, and the products were marketed as safe materials [3]. Business should be legally bound

to advertise the toxicity exemptions as a safety certificate, but the failure to do this could not be committed without the failure of the government in deregulating materials that should have been regulated. However, the stories have yet to be told about who is responsible for these misfortunes, as no legal entities appear in the current stories. Deregulation, toxicity testing, and advertising do not happen spontaneously, but nobody or no legal person is yet responsible for these decisions.

In a recent survey of humidifier disinfectant use among the general population, 22% of respondents had used disinfectants and 21% of these users had experienced adverse effects, leading to an estimate of at least two million potential victims [4]. The current estimate is similar to a previous estimate of 18% usage rate found in a small sample survey [5]. The most troubling finding, though, is the rate of 21% who experienced adverse effects. As the peak exposure to the chemicals rather than the chronicity of exposures was found to be most important in reaching the threshold for the occurrence of humidifier disinfectant lung injuries, many of those with adverse effects could have just experienced transient reversible symptoms [6].

However, the magnitude of two million potential victims with adverse effects from humidifier disinfectants suggests that we should examine the entire airways rather than just focus on the terminal parts of the bronchioles to assess the effects of fine particulates of chemicals. This is especially true for the effects on

the upper airways, such as asthma and sinusitis, as these macromolecules were shown to exert their biocidal effects by irritating microbial cell membranes [7]. There are ample evidences of irritation from these chemicals and also from 5-chloro-2-methyl-3(2H)-isothiazolone and 2-methyl-3(2H)-isothiazolone [8], and we should focus on how these manmade chemicals could sustain inflammatory responses in human mucosal linings of the upper airways in the coming rounds of humidifier disinfectant victim surveys.

Other potential, but yet to be verified, effects are the systemic effects of these ultra-fine particulates of chemicals. We know that nano-sized particles can migrate into the brain through the nose and also into systemic circulations through the lungs, but do not understand their systemic effects sufficiently. In this respect, a report on the unexpected cardiovascular effects of PHMG and PGH on fish [9] prompts us to examine the inflammatory potential of these chemicals on cell membranes of the brain in senile dementia, of the pancreas of diabetics, and the hearts of hypertensive patients.

With renewed attention directed to previous episodes of other macromolecule induced lung diseases such as Ardystil syndrome [10], we need to examine in a systematic way other similar sources that might have been overlooked. The story of humidifier disinfectants is not finished yet, even though many people believe humidifier disinfectant to be an episode in the past.

Conflict of Interest

The authors have no conflicts of interest associated with material presented in this paper.

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