

## POPCORN LUNG: THE E-DISEASE

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### ABSTRACT

Popcorn lung is a rare disease which is growing with use of e-cigarettes. It is mainly caused by diacetyl, found in artificial flavors used in popcorn and e-cigarettes. Bronchiolitis obliterans commonly known as popcorn lungs is a serious and irreversible condition in which the tiny air sacs in the lungs become scarred and constricted, which results in no air movement or O<sub>2</sub> - CO<sub>2</sub> exchange in the lungs. The other symptoms of popcorn lungs are fever, cough, weight loss and night sweats. However, because the symptoms are so similar to tobacco-related chronic obstructive pulmonary disease (COPD) as well as asthma, the diagnosis may be difficult to make without a high level of suspicion. The primary treatment of popcorn lung is removal of any exposure to the diacetyl agent which is used in e-cigarettes for flavors causing more exposure to this chemical.

**Keywords:** Bronchiolitis obliterans, diacetyl, chronic obstructive pulmonary disease, e-cigarettes.

### INTRODUCTION

Popcorn lung is a rare disease. It is the nickname for bronchiolitis obliterans, a serious and irreversible lung disease that can damage the smallest airways in your lungs, resulting in coughing and shortness of breath. Popcorn lung results in scarring and inflammation to the bronchioles. These are the lung's smallest airways. When they're inflamed, symptoms like coughing, shortness of breath, and difficulty breathing can occur. The condition got its nickname because of the chemical diacetyl, a buttery flavored chemical that was commonly found in microwave popcorn. After workers at the factories that produced microwave popcorn began to experience symptoms associated with bronchiolitis obliterans after inhaling diacetyl, manufacturers removed it from their products. One of those chemicals is diacetyl. It's an artificial butter-flavored ingredient found in:

- Popcorn
- Fruit drinks
- Caramel
- Some dairy products

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Medical Sciences, Wayanad, Kerala, India reported a case of popcorn lung in the coffee growing district of Kerala, India<sup>2</sup>. While the U.S Food and Drug Administration (FDA) considers diacetyl generally safe to eat, it's dangerous when inhaled. There are reports of some other chemicals or lung illnesses causing popcorn lung<sup>1</sup>. Lungs are the organs where blood picks up oxygen before carrying it to cells in the rest of body. When we breathe in, air flows into our lungs through windpipe, or trachea. Our windpipe divides into two tubes called the bronchi, which lead to left and right lungs. Inside lungs, those tubes split again and again, like the branches of a tree. The smallest of those branches are called bronchioles, and they end in tiny air sacs called alveoli. The alveoli are where the oxygen is picked up by blood. When someone is suffering from "popcorn lung," those tiny air passages get irritated and inflamed. That leads to scarring that makes them narrower. That makes it harder for the person to get enough air<sup>3</sup>.

### Causes

The chemical that gave this condition its nickname is diacetyl. After workers at a factory that packaged microwave popcorn were found to have bronchiolitis obliterans more often than other

people, some companies stopped using diacetyl as a flavoring. But it's still used in some electronic cigarette flavors<sup>3</sup>

Other causes of popcorn lung may be due to some of the following chemicals when inhaled.

- Acetaldehyde
- Formaldehyde
- Sulfur dioxide
- Nitrogen oxides
- Chlorine
- Hydrochloric acid
- Ammonia
- Metal oxides (formed during welding)
- Mustard gas (chemical weapon)<sup>4</sup>

Sometimes, bronchiolitis obliterans happens after a serious illness that affects lungs, for example some forms of pneumonia or bronchitis. And some people who have rheumatoid arthritis can get popcorn lung as a side effect of that condition.

If a person had a lung transplant or a stem cell transplant, he/she may get this condition if the body tries to reject the new organ. It's the primary cause of death in people who get lung transplants<sup>1</sup>

### Symptoms

The main symptoms of popcorn lung are a dry cough and shortness of breath. These show up between two weeks and two months after person have been around a toxic gas or had an illness. Suffering person likely to have them after exercising or heavy labor.

Other symptoms may include:

- Flu-like illness with fever
- Unexplained fatigue
- Weight loss
- Wheezing
- Eye, skin, mouth, or nose irritation, if caused by chemical exposure<sup>5</sup>

### Diagnosis

In general, however, because the symptoms are so similar to tobacco-related chronic obstructive pulmonary disease (COPD) as well as asthma, the diagnosis may be difficult to make without a high level of suspicion. Popcorn lung is often misdiagnosed as asthma, bronchitis, or emphysema. To diagnose popcorn lung, your doctor will order an X-ray, CT scan or a surgical lung biopsy. Your doctor may also want to measure your lung's function by conducting a pulmonary function test

The diagnosis of bronchiolitis obliterans lung begins by taking a thorough history, and additional testing is required to confirm the diagnosis. Lung function testing (spirometry), chest X-rays, and CT scans usually are done to help determine a preliminary diagnosis. Lung tissue biopsy, which often requires an open lung surgical procedure, is necessary to confirm the

diagnosis of bronchiolitis obliterans. The disease can be randomly located in lung tissue, making it difficult at times for the pathologist to make an accurate diagnosis<sup>4</sup>.

### Treatment

There's currently no cure for popcorn lung, but there are treatments to help alleviate symptoms. Treatment may also help slow the progression of the disease. One option for treatment is prescription corticosteroids. Your doctor may also recommend immunosuppressant therapy to decrease your body's immune response.

Depending on your symptoms, your doctor may also prescribe:

- Cough suppressants
- Bronchodilators (medication that helps open the airways)

or oxygen supplementation, if needed

Some people living with severe cases of popcorn lung are candidates for a lung transplant. However, popcorn lung may redevelop as a complication of the transplant. If left untreated, popcorn lung can be fatal in some cases<sup>6</sup>.

A single US study published in 2016 looked at whether e-cigarette liquids available at the time contained diacetyl. It found that 39 of the 51 e-liquid flavours tested contained some level of diacetyl. The idea that e-cigarettes could cause popcorn lung came from this study.

However, this study didn't look at whether there was a link between e-cigarette use and popcorn lung in people. So far, there's no good evidence that e-cigarettes could cause popcorn lung.

In the UK, diacetyl was banned in e-cigarette liquids under the EU Tobacco Products Directive (TPD) in 2016. So, e-liquids sold in the UK shouldn't contain diacetyl<sup>7</sup>.

### Popcorn lungs and e cigarettes

Electronic nicotine delivery systems (ENDS) go by many names. The most common name is "e-cigarette," but others such as e-cigs, vapes, vape pens, mods and tanks are common terms. Recently, the e-cigarette brand JUUL has become so ubiquitous among youth that "JUULing" is also used as a common verb for all e-cigarette use. For the purposes of this resource we refer to the entire category as "e-cigarettes."

### WHAT IS AN E-CIGARETTE?

- E-cigarettes are devices that operate by heating a liquid solution to a high enough temperature so that it produces an aerosol that is inhaled.
- Solutions, sometimes called e-liquids, almost always include nicotine, flavoring and a humectant, such as propylene glycol, to retain moisture and create the aerosol when heated.

- While many of the flavorings and humectants used in e-liquids have been approved by the Food and Drug Administration for oral consumption, they have not been approved for inhalation. Thus, their health consequences are not well known when consumed in this manner.
- There is an ongoing outbreak of significant lung illness and death (2,051 reported cases and 39 deaths as of November 5, 2019) due to vaping. Most of these cases (over 80%), but not all, were from users who reported use of THC vaporizer products. On November 8, 2019, the CDC identified vitamin E acetate as a significant concern in the outbreak finding the chemical in all 29 samples it had analyzed from victims. The CDC states, "it is possible that more than one compound or ingredient could be a cause of lung injury, and evidence is not yet sufficient to rule out contribution of other toxicants." It continues to advise non-smokers to avoid vaping of any variety and especially products purchased "off the street."
- Older generations of e-cigarettes used a form of nicotine called free-base nicotine. The most recent generation of e-cigarettes on the market, which include pre-filled pod systems like JUUL and refillable systems like Suorin Drop and Kandypens, use nicotine salts in the e-liquids.
- The nicotine salt formulas allow for much higher levels and efficient delivery of nicotine with less irritation compared to earlier generations of e-cigarettes — prompting questions about the use, purpose and safety of this novel form of nicotine.
- Higher nicotine e-cigarettes have driven the surge in e-cigarette sales in recent years, with those containing at least 4% nicotine comprising nearly three-quarters of the e-cigarette market in 2018. Unlike in Europe, where e-cigarette nicotine concentrations

cannot exceed 2%, there are no nicotine concentration restrictions in the United States.

- While using an e-cigarette is often called "vaping," the devices produce an aerosol, not a vapor.
- Unlike vapor, which is simply a substance in gas form, the aerosol from an e-cigarette contains tiny chemical particles from both the liquid solution and the device (e.g., metals from the heating coil). There is evidence to suggest that these particles lead to cardiovascular injury, with links to negative effects on resting heart rate, blood pressure and the cells that line the blood vessels.

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