

E-cigarette aerosols caused embryo defects in the laboratory

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By Tim Newman

New research has found that e-cigarette aerosol exposure can cause facial defects in frog embryos and disrupt mammalian embryonic cell growth.



The risks of smoking e-cigarettes during pregnancy are largely unknown.

Electronic cigarettes (e-cigarettes) are widely considered as a safer alternative to smoking tobacco; they deliver nicotine in a vapor. Their use has skyrocketed: in women, from 2010 to 2013, the number of current e-cigarette users rose from 0.5 percent to 6.6 percent.

Many pregnant women have also switched to e-cigarettes as they are perceived to be safer for their babies. However, because they are a relatively new technology, studies regarding their safety are lagging behind.

In particular, very little is known about the effects of e-cigarette aerosol mixtures (e-cigAMs) on the developing embryo.

Studies have shown that smoking cigarettes during pregnancy increases the risk of craniofacial defects such as cleft palate. To date, whether chemicals in e-cigarettes could cause the same problems has not been established.

These defects are the result of chemicals produced in cigarette smoke, but it is not clear whether e-cigAMs could have similar or related effects. Research that was published recently in the journal PLoS ONE has investigated this question.

What is in e-cigarette fluids?

The main ingredients of e-liquids include nicotine, vegetable glycerin, propylene glycol, water, and flavorings. When heated, some of these compounds produce toxic substances — for instance, propylene glycol produces acrolein, formaldehyde, and benzene.

Studies have found other compounds in heated e-cigAMs that produce adverse effects on health, such as hemiformals, glycidol, dihydroxyacetone, and vinyl alcohol isomers.

This complex concoction becomes even more complicated when flavorings are added. There are thousands of flavors available, all with their own signature cocktail of chemicals. Many contain aromatic aldehydes such as vanillin and benzaldehyde.

The health effects of these are not known, but when heated, they can convert to benzoic acid and benzene, which are known to be carcinogenic.

E-cigarettes and embryos

Little research has explored the effects of e-cigarettes on embryos, but those that have been done indicate a potential hazard. For example, a study on zebrafish larvae found that aerosols produced by e-liquid caused heart defects. Another study on developing mice found a reduction of neurodevelopmental gene expression in the frontal cortex.

For the recent study, the researchers used African clawed frog embryos, which is a species useful for studying craniofacial development. The embryos were exposed to different types of e-cigAM.

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The first type, referred to as "lab grade," only included nicotine, propylene glycol, and vegetable glycerin. Another six flavored e-cigarette fluids were chosen at random.

The former caused only minor changes to the shape of the embryos' mouths, and higher nicotine levels increased this effect. With the latter, effects were more pronounced, but differed between flavors. Two flavors in particular caused the largest changes. According to the authors:

"We determined that embryos exposed to two e-cigAMs [...] had dramatic craniofacial defects including eye abnormalities, midface hypoplasia, and a median cleft."

Upon closer examination, the team found that "[t]hese defects were accompanied by reductions in cranial cartilage and muscle, as well as a deficiency in the amount of blood cells in the facial tissue."

Is nicotine to blame?

To understand the influence that nicotine might have, the team carried out the same experiment using the two e-cigAMs that produced the largest changes — but this time, without the nicotine. They found the same facial abnormalities, but they were slightly less severe.

When they investigated the faces of the embryos treated with these two flavors, they were very different from each other. So, in a nutshell, two flavors caused defects, but the defects were different from each other and not solely down to the nicotine.

As a final test, the team looked at rodent neural crest cells. Neural crest cells are part of the embryo that goes on to become craniofacial cartilage and bone, among other structures. They found that a range of growth factors were significantly reduced in the cells exposed to e-cigAMs.

The authors conclude:

"Our study is the first to show that exposure to [e-cigarettes] can have adverse effects on craniofacial development. This is of particular importance, since [e-cigarettes] are generally perceived by the public as 'safe' for recreational use and only associated with mild effects when used during pregnancy."

This study was not carried out on humans and the mammalian cells were laboratory-cultured, so it is difficult to equate e-cigAMs diluted in liquid surrounding an in vitro embryo to the delivery of e-cigAMs to a human fetus in utero.

But because so little is known regarding the effects of e-cigarettes on the developing fetus, more research is certainly called for. However, the growing number of e-cigarette brands and flavors makes a complicated problem ever more complicated.

It is important to understand not just the effects of the liquid's components, but also what those components produce when they are heated.

There is much debate surrounding the use of e-cigarettes and the comparative risks of smoking cigarettes. When it comes to pregnancy, no risks should be taken. As the Centers for Disease Control and Prevention ([CDC](#)) say, "[I]f you're pregnant, quitting all forms of tobacco products, including e-cigarettes, is best for you and your baby."