The right way to breathe during the coronavirus pandemic

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Inhale through your nose and exhale through your mouth. It's not just something you do in yoga class—breathing this way actually provides a powerful medical benefit that can help the body fight viral infections.

The reason is that your nasal cavities produce the molecule nitric oxide, which chemists abbreviate NO, that increases blood flow through the lungs and boosts oxygen levels in the blood. Breathing in through the nose delivers NO directly into the lungs, where it helps fight coronavirus infection by blocking the replication of the coronavirus in the lungs. But many people who exercise or engage in yoga also receive the benefits of inhaling through the nose instead of the mouth. The higher oxygen saturation of the blood can make one feel more refreshed and provides greater endurance.

I am one of three pharmacologists who won the Nobel Prize in 1998 for discovering how nitric oxide is produced in the body and how it works.

The role of nitric oxide in the body

Nitric oxide is a widespread signaling molecule that triggers many different physiological effects. It is also used clinically as a gas to selectively dilate the pulmonary arteries in newborns with pulmonary hypertension. Unlike most signaling molecules, NO is a gas in its natural state.

NO is produced continuously by the 1 trillion cells that form the inner lining, or endothelium, of the 100,000 miles of arteries and veins in our bodies, especially the lungs. Endothelium-derived NO acts to relax the smooth muscle of the arteries to prevent high blood pressure and to promote blood flow to all organs. Another vital role of NO is to prevent blood clots in normal arteries.

In addition to relaxing vascular smooth muscle, NO also relaxes smooth muscle in the airways – trachea and bronchioles—making it easier to breathe. Another type of NO-mediated smooth muscle relaxation occurs in the erectile tissue (corpus cavernosum), which results in penile erection. In fact, NO is the principal mediator of penile erection and

sexual arousal. This discovery led to the development and marketing of sildenafil, trade name Viagra, which works by enhancing the action of NO.

Other types of cells in the body, including circulating white blood cells and tissue macrophages, produce nitric oxide for antimicrobial purposes. The NO in these cells reacts with other molecules, also produced by the same cells, to form antimicrobial agents to destroy invading microorganisms including bacteria, parasites and viruses. As you can see, NO is quite an amazing molecule.

Nitric oxide gas as an inhaled therapy

Since NO is a gas, it can be administered with the aid of specialized devices as a therapy to patients by inhalation. Inhaled NO is used to treat infants born with persistent pulmonary hypertension, a condition in which constricted pulmonary arteries limit blood flow and oxygen harvesting.

Inhaled NO dilates the constricted pulmonary arteries and increases blood flow in the lungs. As a result, the red blood cell hemoglobin can extract more lifesaving oxygen and move it into the general circulation. Inhaled NO has literally turned blue babies pink and allowed them to be cured and to go home with mom and dad. Before the advent of inhaled NO, most of these babies died.

Inhaled NO is currently in clinical trials for the treatment of patients with COVID-19. Researchers are hoping that three principal actions of NO may help fight COVID: dilating the pulmonary arteries and increasing blood flow through the lungs, dilating the airways and increasing oxygen delivery to the lungs and blood, and directly killing and inhibiting the growth and spread of the coronavirus in the lungs.

How nitric oxide kills viruses

In an in vitro study done in 2004 during the last SARS outbreak, experimental compounds that release NO increased the survival rate of nucleus-containing mammalian cells infected with SARS-CoV. This suggested that NO had a direct antiviral effect. In this study, NO significantly inhibited the replication cycle of SARS-CoV by blocking production of viral proteins and its genetic material, RNA.

In a small clinical study in 2004, inhaled NO was effective against SARS-CoV in severely ill patients with pneumonia.

The SARS CoV, which caused the 2003/2004 outbreak, shares most of its genome with SARS CoV-2, the virus responsible for COVID-19. This suggests that inhaled NO therapy may be effective for treating patients with COVID-19. Indeed, several clinical trials of inhaled NO in patients with moderate to severe COVID-19, who require ventilators, are currently ongoing in several institutions. The hope is that inhaled NO will prove to be an effective therapy and lessen the need for ventilators and beds in the ICU.

The sinuses in the nasal cavity, but not the mouth, continuously produce NO. The NO produced in the nasal cavity is chemically identical to the NO that is used clinically by inhalation. So by inhaling through the nose, you are delivering NO directly into your lungs, where it increases both airflow and blood flow and keeps microorganisms and virus particles in check.

While anxiously awaiting the results of the clinical trials with inhaled NO, and the development of an effective vaccine against COVID-19, we should be on guard and practice breathing properly to maximize the inhalation of nitric oxide into our lungs. Remember to inhale through your nose; exhale through your mouth.

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