

Scientists investigate the role of the 'silent killer' inside deep-diving animals

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Michael Tift with elephant seals at Año Nuevo State Reserve in California.

With its imperceptible features, carbon monoxide is widely known as the "silent killer" due to its risks at lethal concentrations. Far less known is that carbon monoxide is produced naturally in small quantities in humans and animals, and in recent years medical researchers have evaluated the gas as a treatment for diabetes, heart attacks, sepsis, and other illnesses.

Now scientists at Scripps Institution of Oceanography at UC San Diego have furthered science's understanding of [carbon monoxide](#)'s natural characteristics and limitations by studying the gas in one of the world's best divers: the [elephant seal](#).

Colorless and odorless, carbon monoxide (CO) is now monitored in

many homes with inexpensive detectors. In human bodies, CO is produced naturally as a byproduct of the breakdown of hemoglobin—molecules responsible for transporting oxygen—inside red blood cells. Roughly one percent of the hemoglobin inside healthy human adults is linked with carbon monoxide, with elevated percentages for chronic cigarette smokers due to the absorption of CO through tobacco inhalation. Carbon monoxide binds to hemoglobin to form a compound called carboxyhemoglobin, a molecule which can no longer bind and transport oxygen in the blood.

As described in the May 14 issue of the *Journal of Experimental Biology*, Scripps graduate student Michael Tift, Scripps research physiologist Paul Ponganis, and Daniel Crocker of Sonoma State University sought to learn more about carbon monoxide levels in elephant seals, which have the highest blood volume of any mammal and are renowned for their extreme diving proficiency. Elephant seals and other highly efficient divers conserve oxygen by shutting off blood flow to peripheral areas of their body and conserving oxygen for vital organs such as the heart, brain, and lungs.

To their surprise, the researchers discovered that carbon monoxide is bound to 10 percent of the hemoglobin in adult elephant seals, or 10 times the amount found in healthy humans, and roughly comparable to someone who smokes 40 cigarettes per day.

"We found that the elephant seal is able to reach incredible depths, apparently with lots of carbon monoxide, so these results are helping us find answers for the rates at which you can expose organs and tissues to this gas," said Tift. "The elephant seal is giving us the big picture of which concentrations of carbon monoxide might be the most beneficial."

Although carbon monoxide testing to treat human illnesses only began in earnest about five years ago, medical researchers have high hopes for its

healing prospects and protective qualities in procedures such as organ transplants.

"Carbon monoxide is toxic and deadly at specific levels, but at low concentrations it may actually be therapeutic and beneficial by playing a crucial role in protecting us," said Tift. "At low levels it may prevent the inflammatory response seen in some diseases and even inhibit cell death."

The study's results are also forcing scientists to reconsider how oxygen is stored and regulated in elephant seals, since carbon monoxide was found to be so prominent.

Tift and his colleagues are now expanding the scope of their findings by tracking CO levels in other species of seals—including much less efficient divers such as harbor and fur seals—and other animals including penguins. Future testing will be conducted through a blood-gas analyzing instrument in a collaboration with the UC San Diego School of Medicine, as well as with a breathalyzer that can detect levels of CO.

"It is our hope that the elephant seal will be a useful model to explore the biological functions of carbon monoxide as well as to evaluate its potential as a therapeutic agent," said Ponganis, who is also an anesthesiologist. "Examination of carboxyhemoglobin levels in elephant seals and other divers should also aid in understanding the mechanisms by which carbon monoxide accumulates in their blood and tissues as well as determine the role of carbon monoxide in diving physiology and metabolism."

More information: Tift, M. S., Ponganis, P. J. and Crocker, D. E. (2014). Elevated carboxyhemoglobin in a marine mammal, the northern elephant seal. *J. Exp. Biol.* 217, 1752-1757.

jeb.biologists.org/content/217/10/1752.abstract

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