Deep dive: Research combats oxygen toxicity in navy divers

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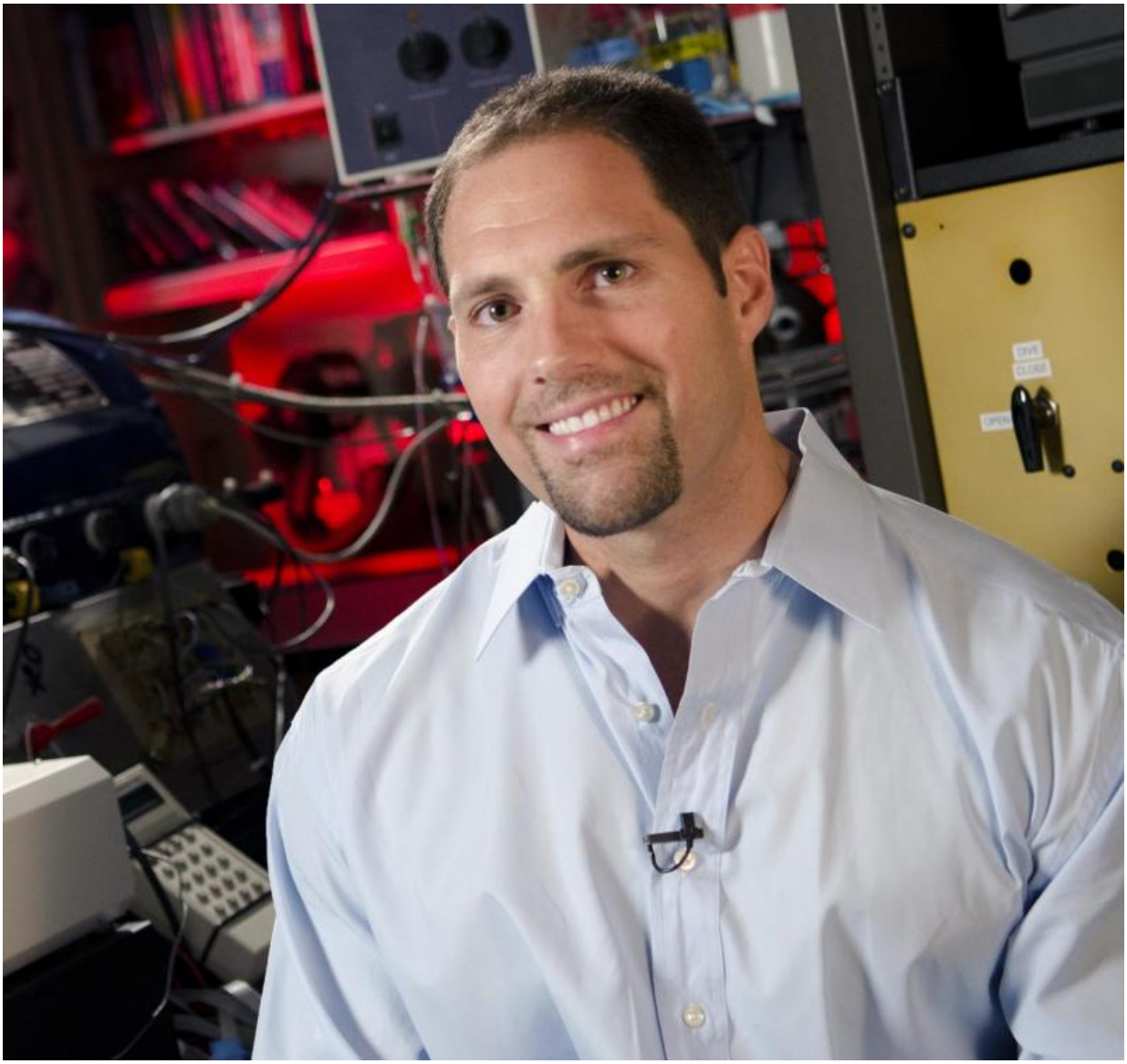

Dr. Dominic D'Agostino in his lab at the University of South Florida. With

support from the Office of Naval Research, D'Agostino is studying ketone esters-oral supplements useful in epilepsy treatment-to fight seizures caused by hyperbaric oxygen toxicity, a life-threatening byproduct of breathing too much oxygen that impacts deep-water divers. Credit: Dr. Dominic D'Agostino

For the first time, ketone esters-oral supplements useful in epilepsy treatment-are being studied to fight seizures caused by hyperbaric oxygen toxicity, a life-threatening byproduct of breathing too much oxygen that impacts deep-water divers.

The Office of Naval Research (ONR) is sponsoring this research.

"This work represents a renaissance in how therapies are repurposed for other applications," said Dr. William D'Angelo, a program manager in ONR's Undersea Medicine Program. "Traditionally, certain therapies were only used to treat specific conditions. There's now a movement to explore how drugs and other therapies already approved by the Food and Drug Administration for one type of treatment could treat more than one ailment."

Dr. Dominic D'Agostino, a professor at the University of South Florida in Tampa, is conducting the ONR-supported research.

In a cruel twist of irony, oxygen toxicity stems from a Navy diver's most precious commodity-oxygen itself. While divers need oxygen to breathe underwater, that ratio can become hazardous the deeper they plunge. Basically, the deeper the dive, the greater the danger.

Special Operations divers such as Navy SEALs are especially at risk. Divers can encounter dangerous levels of nitrogen and carbon dioxide gasses when breathing underwater, requiring a rebreather to mitigate the

toxicity. But Special Operations divers use a closed-circuit rebreather that filters out the gasses in such a way that bubbles don't appear on the water's surface-useful when trying to avoid detection by enemy combatants.

However, this additional stealth increases how much oxygen the divers breathe and, combined with mission stress and physical exertion, can lead to seizures, convulsions, nausea, dizziness and even coma or death-all symptoms of oxygen toxicity.

Currently, anti-seizure sedatives are the only treatment for oxygen toxicity, said D'Agostino. But these drugs must be administered in high doses that could impair warfighters' mental and physical performance. D'Agostino sees a possible solution in ketone esters, which are supplements engineered to raise blood ketones-powerful energy sources the body produces naturally that act as a super fuel.

"Our brains can be fueled by both glucose and ketones," said D'Agostino, "but modern, high-carbohydrate diets and frequent meals prevent the natural metabolic state of ketosis. However, a clinically used ketogenic diet can shift the brain away from glucose and towards ketones as fuel, which has been shown to control seizures in epileptics, even when drug therapy fails. We believe this also can be applied to oxygen toxicity."

D'Agostino's research, the first of its kind, involved feeding ketone esters to laboratory rats and then placing them in special hyperbaric chambers simulating underwater conditions. The animals receiving the dose saw improved performance and greater resistance to oxygen toxicity seizures. D'Agostino is seeking to move his research to human clinical trials in 2016.

In addition to preventing oxygen toxicity, D'Agostino sees another

possible benefit from his ketone ester research: improved warfighter performance.

"Athletes experimenting with ketogenic diets or other less potent forms of ketone supplements consistently report greater strength and endurance, cognitive ability and better recovery and maintenance of lean muscle mass," he said. "A Navy diver could take a ketone ester before a mission and see rapid and sustained performance enhancement for hours-performance fueled by the elevation of ketones that are bio-identical to what our body makes naturally."

D'Agostino's research aligns with the Naval S&T Strategy, which emphasizes health and resilience as key components of warfighter performance. Last year, ONR hosted a Focus Area Forum to discuss how science and technology can improve warfighter performance and resilience.

Provided by Office of Naval Research