# CALIFORNIA STATE SCIENCE FAIR
# 2015 PROJECT SUMMARY

**Name(s)**

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**Project Number**

35019

**Project Title**

## Safe Free Diving: Tachypnea without Hypocapnia

**Abstract**

**Objectives/Goals**

Hyperventilation before free diving allows the diver to hold their breath longer, but also increases the risk of shallow water blackout and drowning. The urge to come to the surface for a breath does NOT come from a lack of oxygen, but instead from the build up of CO2 in the blood. Hyperventilation before diving causes a dramatic drop in blood CO2 levels, and this suppresses the bodies natural trigger to take a breath. Hyperventilation is dangerous when free diving because if your CO2 level is very low when you start the dive you may dive long enough to have your blood O2 level drop down to the blackout range before your CO2 has built up high enough to give you a strong desire to go to the surface to take a breath. My project was to determine if there is a safe number of deep breathes that can be taken before free diving that allows the diver to hold their breath longer but does not put the diver at risk of shallow water black out. My hypothesis is that there is a number of deep breaths that can be taken before breath holding, that is both safe and effective.

**Methods/Materials**

Methods: The experiment is done under the direct supervision of a physician. Attach a pulse oximeter to the test subject's finger. Tell the test subject to start the stopwatch when they start to hold their breath, and to stop the stopwatch when they experience the first sensation to take a breath and not the maximum breath holding time. Tell the test subject to hold their breath without any preceding deep breaths. Record the blood oxygen level in SpO2% at the beginning and the end of the breath holding. Record the breath holding time in seconds. Allow the test subject to rest for 5 minutes. Repeat the procedure with the test subject now taking 1, 2, 3, 4, and 5 deep breaths before breath holding. Record results. Measure Blood CO2 levels after taking up to 5 deep breaths.

**Results**

There was a very large increase in the breath holding time going from no deep breaths to 1 deep breath taken before breath holding. Each additional breath taken resulted in a progressively smaller benefit. The data showed that with up to 4 deep breaths the CO2 never dropped below the normal range.

**Conclusions/Discussion**

With two deep breaths taken before breath holding, the breath holding time increased by nearly 400%, and the blood CO2 remained in the normal range. Taking two deep breaths is both safe and effective. The data supports my hypothesis.

**Summary Statement**

My experiment is to see if there is a safe number of deep breaths that can be taken before free diving that allows the diver to hold their breath longer without an increased risk of shallow water blackout.

**Help Received**

Dr. Gerdes, Dr. Yandell, and Dr. Sageman approved my experiment and answered questions; Dr. Sageman also hooked me up to the capnography; Leslie Sweeny RN gave me the SpO2 meter for my experiment; Michael Harmon, MD supervised during the experiment and was one of my test subjects.