Diver's Alert Network Internship
Final Report--2010
James Cotton

Five days after returning from Indonesia, where I worked as a Fulbright teaching assistant, I was on a plane from my home in small town Colorado to Durham, NC to begin my Our World-Underwater Scholarship Society internship. For my internship I worked with Divers Alert Network (DAN), an internationally known dive safety/health organization. While I was not entirely certain of what the experience would entail, I knew it would be an ideal way to integrate my interest and passion for diving, medicine, and research.

While at DAN I worked with my mentor Dr. Petar Denoble in the medical research department. Our project focused on the patent foramen ovale (PFO) and decompression sickness (DCS). A PFO is a small opening in the upper chambers (right and left atria) of the heart. A PFO is found in fetuses and allows blood coming from the placenta to flow directly into the left atrium via the right atrium. At birth the infant begins breathing and the lungs expand which increases pressure in the left atrium and a flap valve closes over the hole. In about thirty percent of the general population this process is not complete and a small opening remains between the right and left atria. Past studies have shown an association between persistent PFOs and DCS in divers. It is thought that gas in the venous system from a dive may be able to arterialize through the PFO and lead to DCS; however, no causative relation has been proven.

To reduce the risk of DCI, some divers have had PFO occlusion devices implanted via trans-catheter methods. While some of these divers reported no further neurological decompression episodes, it is difficult to be sure that this represents a true reduction in risk. More information over a greater period of time is needed about this closure groups diving patterns before and after the procedure.

My role was to help conduct a prospective epidemiological study. This study is a cost-benefit analysis looking at trans-catheter PFO closure as a method to reduce the risk of DCS. That is, we were looking at whether divers with a PFO that undergo closure or divers with PFO who continue diving without the closure are better off. The risks related to closure and DCS will are both taken into consideration. DAN will compare the incidence of DCS before the closure with the combined incidence of DCS and subsequent adverse events related to the closure. Ultimately, the study aims to enroll 120 qualified participants and then conduct annual follow-up with each participant over five years. I was responsible for recruiting and enrolling new study participants. This job entailed collecting necessary information and making sure it was accurate. All participants were required to submit an Informed Consent form, complete a relevant health and diving history questionnaire, and provide medical documentation for the diagnosis of PFO and PFO closure if applicable. Often the study participants would submit incomplete information and I was required to email and/or call them in an effort to gather the necessary information. I was also responsible for helping the participants learn how to electronically collect their past dive profile information and how to continue to record it in a way that was beneficial to the study.

While I was working on the prospective study I also initiated a retrospective study that I would be able to focus on and complete within the duration of my internship. The retrospective study took the first thirty participants that enrolled in the prospective study and investigated why some of the participants decided to undergo PFO closure while some did not. As the study developed, we structured the paper based off primary and review literature. From the literature we found factors that were found to be associated between PFO and the odds ratio of DCS. For example, divers who experience neurological DCS are more likely to have a PFO. From these

factors we established five criteria and used them to determine whether the PFO positive participants that received PFO closure were distinct from those that did not. This study required me to gather more accurate and detailed information from the study participants regarding their past DCS history and PFO. While collecting this information I was able to have conversations with multiple divers of various skill levels. I learned more about how diving was important to their lives and why it was so important that they continued diving despite potential increased risk as a result of having a PFO. After collecting sufficient information form participants, I conducted a data analysis and wrote a research paper with the goal of getting it published in a peer reviewed diving medicine journal. The publication of the paper is pending and I look forward to posting it to the Our World-Underwater Scholarship Society website in the near future.

In addition to my primary research endeavors at DAN I also had the opportunity to participate in a variety of exciting dive and medical related activates. Upon my arrival to DAN I met with the Our World-Underwater Scholarship Society Rolex Scholar, Ingrid Rushfeldt Kruger. Ingrid and I spent a week at the DAN Headquarters attending dive trainings and lectures, which ranged from oxygen first aid for divers to dive physiology. We also had the opportunity to tour and learn about the Duke hyperbaric chamber, where I was able to meet many of the employees and learn about the various experiments being carried out within the facilities. We were also exposed to the many departments of DAN, which includes medical services, education, insurance, publications, and research.

During the month of August and September, I volunteered for two flying after diving studies being conducted by Dr. Neal Pollock at the Duke hyperbaric chamber. As a volunteer I was exposed to particular dive profiles while constantly being evaluated using ultrasound and

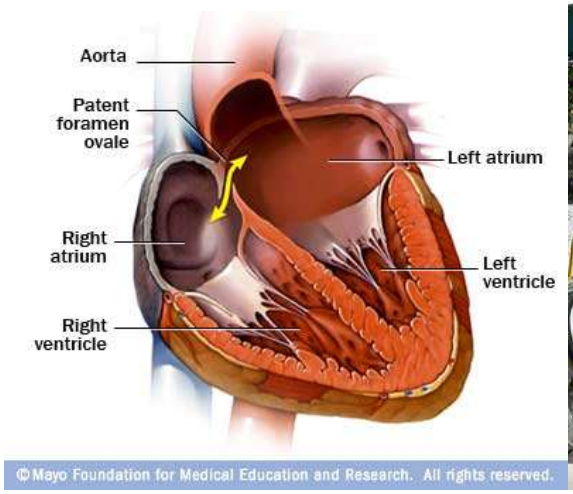
Doppler to detect bubble formation. The purpose of the study is to develop a model for estimating decompression risk.

Thanks to the help of friendly Duke Hyperbaric chamber staff I was also able to observe and learn about the science behind other non-dive related clinical procedures that were being conducted in the hyperbaric chamber, such as diabetic wound treatment. During this time I had the opportunity to communicate and interact with a number of medical personal within the Duke hyperbaric facility. This experience allowed me to gain more insight into the true world of diving and hyperbaric medicine and how I might be able to incorporate it into my career.

In the month of September I was able to participate in the Diver Medical Technician (DMT) course that is held at DAN Headquarters. The course offered lectures presented by internationally known faculty, hands-on practical skills, and fourteen hours of clinical time. During the course I learned about topics ranging from O2 Toxicity to Otoscope Use. The course provided yet another prospective on the world of diving medicine and gave me tangible skills that will enable me to be a safer, more informed diver in both the recreational or professional realm.

Overall, my experience with this Internship was very positive. I was able to carry out my own research project which may be published, take various DAN sponsored dive medicine courses, gain exposure to the work and experiments at the Duke University hyperbaric chamber, and meet various professionals in the field of diving medicine and diving safety. I would like to thank Dr. Petar Denoble for all of his support on my various endeavors during my internship time. I would also like to thank Jeannette Moore, my internship coordinator, and the other DAN and Duke hyperbaric staff for patiently teaching me about the world of diving medicine. Lastly, I would like to thank Our World-Underwater Scholarship Society for providing me and so many

others with the unique opportunity to advance our careers, knowledge, and perspective within the world of diving.



Top Left: Adult heart with patent foramen ovale (PFO)
Top Right: Duke University hyperbaric chamber control center
Bottom Left: Divert Medical Training (DMT) course participants
Bottom Right: Hyperbaric chamber at Blue Stone Rock Quarry that we used for DMT training