Dive Incident Investigation

Report 2011-02

EXECUTIVE SUMMARY

A NOAA diver conducted two technical[1] scuba dives in the Gulf of Mexico. Following the first dive to 138 feet for 65 minutes total dive time (TDT), the diver exhibited blotchy skin and itching on the upper right arm which were not reported and dispelled by the diver as an allergic reaction. Following the second dive to 111 feet for 51 minutes (TDT), the diver noticed a dull pain in the upper arm that seemed to coincide with heavy lifting of gear and disappeared within 15 to 20 minutes after the activity ceased. There was also noticeable swelling on the lateral side shoulder to elbow. The arm was warm and painful to the touch. NOAA Diving Medical Officers (DMO) were contacted concerning the diver's signs and symptoms and they concurred with the diagnoses of an allergic reaction or infection. Lacking the proper antibiotics to treat the condition on the ship, the decision was made to transfer the diver to shore with orders to report to the nearest medical facility. The diver was given hard copies of the incident report and medical summary to pass along to medical facility staff and transported ashore via a small boat. Upon arrival at the medical facility, a Doppler test was performed which detected clotting or bubble formation. Therefore the diagnosis of allergy/infection was ruled out in favor of a diving-related injury. The diver was transferred to a hospital for further evaluation by a hyperbaric physician. The diver was diagnosed and subsequently treated for Type I decompression sickness.

There were no operational infractions of OSHA or NOAA diving regulations, standards or policies noted during the investigation.

[1]Technical diving is a term used to describe diving methods that utilize multiple gas mixtures, redundant equipment configurations and in-water decompression and is typically used for dives to depths and/or immersion times beyond that of typical scientific scuba diving.

The Diver

The diver was originally certified to scuba dive by the National Association of Underwater Instructors (NAUI) in 1980 and later received additional certifications in Advanced Diver, Recue Diving, and Nitrox. The diver was certified as a NOAA Working Diver in 1993 and was certified as a 'Technical Diver' by the International Association of Nitrox and Technical Diving (IANTD) in 2006.

Since becoming dive certified, the diver has logged 1568 dives, 163 of which involved decompression similar to that which was performed during the incident dive.

The Dive

On the date of the incident, the diver conducted two decompression scuba dives in the Gulf of Mexico. The dives were conducted from a NOAA Ship.

The sea temperature was 82 degrees F, air temperature 86 - 97 degrees F, there was no current, the sea state was calm, and the underwater visibility was 75+ feet.

The profiles for the two dives are as follow:

Dive 1: 23 Aug, 0830 hrs, max depth 138 fsw for 65 min (run time) on air
- stop 1: 90' at 30 min for 2 min
- stop 2: 62' at 34 min for 2 min
- stop 3: 30' at 38 min for 3 min
- stop 4: 20' at 45 min for 19 min on 100% O2

Dive 2: 23 Aug, 1332 hrs, max depth 111 fsw for 51 min (run time) on air
- stop 1: 72' at 30 min for 2 min
- stop 2: 48' at 34 min for 2 min
- stop 3: 30' at 36' for 1 min
- stop 4: 20' at 39 min for 12 min on 100% O2

Following the first dive, the diver exhibited blotchy skin and itching on the upper right arm which were not reported and dispelled by the diver as an allergic reaction. Following second dive, the diver noticed a dull pain in the upper arm that seemed to coincide with heavy lifting of gear and disappeared within 15 to 20 minutes after the activity ceased. There was also noticeable swelling on the lateral side shoulder to elbow. The arm was warm and painful to the touch. NOAA Diving Medical Officers were contacted concerning the diver's signs and symptoms and they concurred with the diagnoses of an allergic reaction or infection. Lacking the proper antibiotics to treat the condition on the ship, the decision was made to transfer the diver to shore with orders to report to the nearest medical facility. The diver was given hard copies of the incident report and medical summary to pass along to medical facility staff and transported ashore via a small boat. Upon arrival at the medical facility, a Doppler test was performed which detected clotting or bubble formation. Thus the diagnosis of

allergy/infection was ruled out in favor of a diving-related injury. The diver was transferred to a hospital for further evaluation by a hyperbaric physician and diagnosed with a decompression sickness (Type I DCS) in soft tissues (likely lymphatic tissue) within the right arm.

Treatment

The diver was treated for Type I DCS in a hyperbaric chamber on a US Navy Treatment Table 9. Following treatment, the swelling in the arm was reduced noticeably. The pain in the right arm was described as a deep bruising and persisted up to a week after treatment. Swelling was completely gone 3-4 days after treatment.

The diver had a follow-up visit with a hyperbaric physician 24 days following the initial treatment in the hyperbaric chamber and was advised to refrain from diving for 6 weeks.

Findings, Lessons Learned and Corrective Actions

1. Finding: All dives were conducted per planned procedures and protocols. No deviations occurred. One factor that may have contributed to this DCS incident was the combination of the water temperature (82 degrees F), and the diver's use of a full 1-piece 3mm wetsuit. The diver stated that they felt hot during the dive and was possibly dehydrated.

   Lesson Learned: It is inconclusive whether or not the diver's hyperthermic condition contributed to the onset of DCS. Research supports the notion that thermal imbalance can lead to a variety of diving-related maladies, including DCS. Therefore, it is incumbent upon all NOAA divers to know and watch for the signs and symptoms of both hypo and hyperthermia and take immediate action to mitigate the conditions.

   Corrective Action: A copy of this report will be sent to all NOAA divers and posted on the NOAA Diving Center webpage. NOAA divers are encouraged to review Section 3.4 in the NOAA Diving Manual (4th revision) titled, "Hypothermia/Hyperthermia."

   Lead: NOAA Diving Program Manager (NDPM)

   Completion date: Prior to any future technical diving operations

2. Finding: This was a ship-based operation and initial diagnoses were made by off-site DMOs. Secondary diagnosis and treatment was performed on shore and results were not immediately relayed to appropriate authorities within the NDP.

   Lesson Learned: The Dive Supervisor was a non-NOAA diver and unfamiliar with the reporting procedures. The diver's UDS happened to be participating in the dive operation and reported the incident to the NDC DMO, but not the LODO, NDSO or NDPM per the NOAA Working Diving Standards and Safety Manual (NWDSSM). As a result, NOAA upper management was alerted to the incident before

appropriate members of the NOAA Diving Control and Safety Board were notified. Such breeches in protocol reflect poorly on the entire image of the NOAA Diving Program. All NOAA divers and supervisors must be familiar with reporting requirements specified in the NWDSSM to avoid a similar occurrence in the future.

Corrective Action: A copy of this report will be sent to all NOAA divers and posted on the NOAA Diving Center webpage. NOAA divers are encouraged to review Section 10.2 in the NOAA Working Diving Standards and Safety Manual titled, "Reporting Diving Incidents."

Lead: NDPM

Completion date: Prior to any future technical diving operations

3. Finding: Once transferred to shore, the diver had no direct support and had to handle all medical activities and communications alone. A patient advocate should have accompanied the diver to the shore-based medical facilities. Had the diver's condition worsened, this "patient advocate" support would have been critical. Communications might have been better if there was someone to handle this responsibility while the diver was dealing with their own health issues.

   Lesson Learned: A patient advocate should be assigned to accompany any divers departing NOAA ships to seek medical attention immediately following dive operations. This was not done in this incident because the diver was initially diagnosed with non-diving related signs or symptoms. As it turns out, the diagnosis was incorrect and the diver was suffering from DCS. Having a companion to assist with logistical arrangements or to render assistance had the symptoms worsened, would have been important.

   Corrective Action: A copy of this report will be sent to all NOAA divers and posted on the NOAA Diving Center webpage. The OMAO Staff Diving Officer will discuss issue with the Director, Marine Operations Centers and report findings to NDCSB.

   Lead: NDPM and OMAO SODO

   Completion date: Prior to any future technical diving operations

4. Finding: A hurricane made landfall at the diver's duty station on the day of treatment. Preparation for that event, and dealing with the storm itself caused distraction to many of the people involved and delayed communications as phone and email services were down.

   Lesson Learned: Divemasters and Unit Diving Supervisors should be prepared for the unexpected and have a backup plan ready, especially those units in hurricane-prone locations during hurricane season.

   Corrective Action: A copy of this report will be sent to all NOAA divers and posted on the NOAA Diving Center webpage. Unit Diving Supervisors are encouraged to have a continuation-of-operation-plan (COOP) in case of adverse weather events.

   Lead: NDPM

   Completion date: Prior to any future technical diving operations

5. Finding: No evaluations or discussions were held with other divers participating on the mission, including the diver's buddy, regarding their condition. While it seemed apparent there were no issues with other divers, the questions still should be asked to ensure this was in fact the case.

   Lesson Learned: Students attending NOAA Divemaster training are instructed to always check and monitor the condition of the injured diver's buddy just in case external factors (e.g., gas contamination, thermal issues, and exertion levels) may be present for both divers.

   Corrective Action: A copy of this report will be sent to all NOAA divers and posted on the NOAA Diving Center webpage. NOAA divers and supervisors are reminded of the importance of evaluating the condition of other members of the dive team other than the injured diver.

   Lead: NDPM

   Completion date: Prior to any future technical diving operations

6. Finding: A non-NOAA diver was supervising the technical dives because of that individual's expertise; but was not familiar with NDP policies for handling and reporting diving-related incidents.

   Lesson Learned: The on-site Divemaster was not a NOAA diver and was unfamiliar with incident reporting requirements. The NDP needs to develop and disseminate a policy requiring a NOAA Divemaster or Lead Diver be present at the dive site whenever non-NOAA Divemasters or Lead Divers are supervising technical dive operations. In case of emergencies, the NOAA diver will be responsible for reporting the incident per NOAA policies.

   Corrective Action: A copy of this report will be sent to all NOAA divers and posted on the NOAA Diving Center webpage. An OMAO policy will be developed and disseminated to all NOAA divers requiring a NOAA Divemaster or Lead Diver be present at the dive site whenever non-NOAA Divemasters and Lead Divers are supervising technical dive operations.

   Lead: DNDP

   Completion date: Prior to any future technical diving operations

7. Finding: Oxygen was not administered immediately, and was not recommended by the consulting DMO when the initial diagnosis was made that diving was not thought to be a factor in the diver's condition.

   Lesson Learned: NOAA health care providers are asked to provide medical advice based strictly on the information provided by the on-site team. In this incident the information provided suggested the signs and symptoms were not diving related, and thus oxygen did not seem to be indicated. Additionally, there was a delay in contacting a DMO. The administration of 100% oxygen is the primary adjunctive treatment for diving related maladies. In retrospect, the administration of oxygen, both prior to and after making contact with the DMO, may have been beneficial.

Action: A copy of this report will be distributed to all NOAA divers and posted on the NOAA Diving Center webpage. NOAA divers and supervisors are encouraged to administer 100% oxygen immediately whenever there is an incident that could possibly be related to diving. They are also reminded that they are authorized to use oxygen for treatment of a suspected diving casualty, even when contact with a DMO proves difficult.

Lead: NDPM

Completion date: Prior to any future technical diving operations

8. Finding: Initial communications between the diver and the ship DMT and MPIC regarding first signs and symptoms were delayed. Diver was reticent to recognize this as a DCS condition. The diver should have informed onboard medical staff of condition before conducting the second dive.

   Lesson Learned: Early recognition and treatment is essential for successful outcomes of diving-related maladies. The diver should have notified the Dive Supervisor of signs/symptoms as soon as the diver recognized them.

   Corrective Action: A copy of this report will be sent to all NOAA divers and posted on the NOAA Diving Center webpage. NOAA divers are encouraged to review Section 2.10.3 of the NOAA Working Diving Standards and Safety Manual which outlines divers' responsibilities for reporting of any changes of a physical or psychological nature that may adversely impact either their own, or their dive buddy's, fitness to dive.

   Lead: NDPM

   Completion date: Prior to any future technical diving operations

9. Finding: There were several shortfalls in communications during and after this incident.

   a. Diver should have notified the CO, XO, and UDS of developments as they occurred, especially once the initial diagnosis was ruled out and recompression therapy was prescribed.

   b. Leadership was not informed until late in the event response (after the diver had returned to their duty station 4 days later).

   c. The diver's UDS, who was on board the ship and participating in the cruise, should have tracked the condition of the diver through treatment and release from medical care. The UDS should have confirmed communications of diagnostic developments (Type I DCS) and prescribed treatments (recompression therapy) as soon as the UDS was informed. This did not occur until 6 days later.

   Lessons Learned:

   a. The diver involved in the incident did not notify anyone at their official duty station or anyone within her NDP chain of command about the medical treatment received until after they returned to work. This significantly delayed

reporting of the incident and completion of the required incident documentation. NOAA divers are reminded to notify their UDSs within 12 hours of any medical treatment received as a result of a work-related injury.

b. UDS responsibilities are not relinquished when assuming other roles (e.g., dive support). In this incident, the UDS should have assumed responsibility as if they were sitting in their office at their official duty station.

Corrective Action: A copy of this report will be sent to all NOAA divers and posted on the NOAA Diving Center webpage. NOAA divers are reminded to keep their Unit Diving Supervisors informed of any medical treatment received in response to any signs or symptoms occurring during or following diving activities. UDSs are reminded that their responsibilities are not relinquished when assuming other roles.

Lead: NDPM

Completion date: Prior to any future technical diving operations

10. Finding: Individuals in leadership positions were unclear about what to do and when various reports were due.

    Lesson Learned: Clearer guidance is needed for reporting dive-related incidents from NOAA ships.

    Corrective Action: A copy of this report will be sent to all NOAA divers and posted on the NOAA Diving Center webpage. The NDPM will work with the OMAO Chief, Safety and Environmental Compliance Division to develop clearer guidance for reporting dive-related incidents from NOAA ships. The results will be disseminate to all NOAA divers and included in the next revision of NOAA Diving Standards and Safety Manuals. The appropriate LODO and Deputy LODO will conduct a full debrief with all those directly involved in the incident, either individually or as a group.

    Lead: NDPM, LODO and Deputy LODO

    Completion date: Prior to any future technical diving operations

11. Finding: The NDCSB needs to reiterate reporting procedures for divers in supervisory roles when members of their chain of command are unavailable.

    Lessons Learned: The UDS responsible for this diver did not attempt to contact the LODO to inform them of this incident because the UDS knew the LODO was at-sea and presumed unreachable. In fact, the LODO could have been reached via email or the ship's satellite phone. The UDS was also not aware that a Deputy LODO had been assigned and should have been contacted in the absence of the LODO.

    Corrective Action: A copy of this report will be sent to all NOAA divers and posted on the NOAA Diving Center webpage. NOAA divers and supervisors are reminded that when immediate supervisors (within the NDP chain of command) are not available, they may contact the next higher level individual.

    Lead: NDPM

Completion date: Prior to any future technical diving operations

The Chair of the NDCSB will monitor completion of the Corrective Actions and report them to the Director, OMAO and Director, SECO on a quarterly basis.

Conclusion

This incident should remind all that diving is a risky activity and that injuries can occur even if divers do everything right. Such was the case in this incident. No operational infractions of OSHA or NOAA diving regulations, standards or policies were noted by the Board.

Although the outcome of this diving incident was successful, a number of miscues and mistakes were committed by the diver and on-site supervisors. Lessons learned from this incident will be shared with all NOAA divers in an effort to prevent similar mistakes in the future.

It is the decision of the NDCSB that once all corrective actions are resolved, technical diving will be reinstated within the NOAA Diving Program.