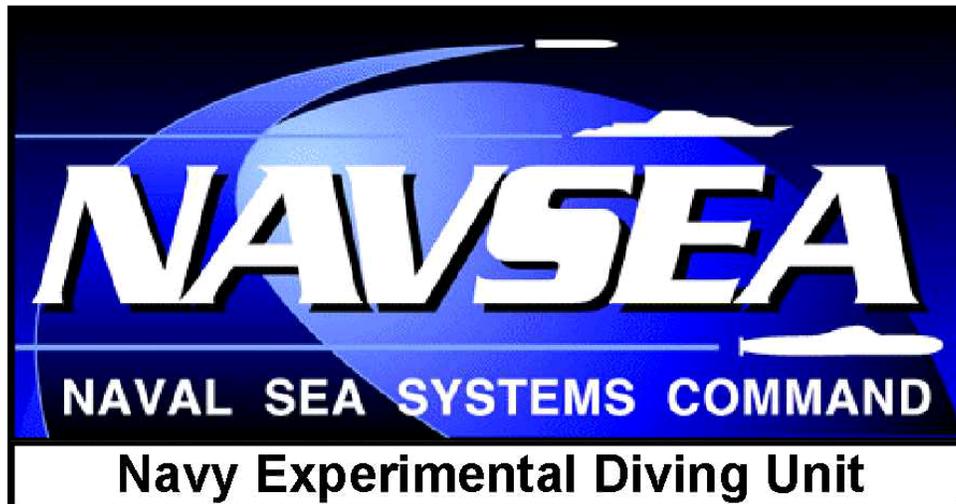


Navy Experimental Diving Unit
321 Bullfinch Rd
Panama City, FL 32407-7015

LT 13-06
NEDU TR 13-07
October 2013



A Modified Prophylactic Regimen for the Prevention of Otitis Externa in Saturation Divers

Authors:
Paul C. Algra, LT, MC, USN, D.O.

DISTRIBUTION STATEMENT A.
Approved for Public Release
Distribution is Unlimited.

STANDARD FORM 298

REPORT DOCUMENTATION PAGE			<i>Form Approved</i> <i>OMB No. 0704-0188</i>		
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.					
1. REPORT DATE (DD-MM-YYYY) 15 Sept 2013		2. REPORT TYPE Technical Report		3. DATES COVERED (From - To) May 2012 - May 2013	
4. TITLE AND SUBTITLE A Modified Prophylactic Regimen for the Prevention of Otitis Externa in Saturation Divers			5a. CONTRACT NUMBER		
			5b. GRANT NUMBER		
			5c. PROGRAM ELEMENT NUMBER		
6. AUTHOR(S) Paul C. Algra, LT, MC, USN, D.O.			5d. PROJECT NUMBER		
			5e. TASK NUMBER LT 13-06		
			5f. WORK UNIT NUMBER		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Navy Experimental Diving Unit 321 Bullfinch Rd Panama City, FL 32407			8. PERFORMING ORGANIZATION REPORT NUMBER 13-07		
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) Navy Experimental Diving Unit 231 Bullfinch Road Panama City, FL 32407			10. SPONSOR/MONITOR'S ACRONYM(S)		
			11. SPONSOR/MONITOR'S REPORT NUMBER(S)		
12. DISTRIBUTION / AVAILABILITY STATEMENT Distribution Statement A: Approved for Public Release Distribution is Unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT To prevent acute otitis externa (AOE) in the saturation setting and to decrease the side effects of the 2% acetic acid solution, a modification to the ear prophylactic regimen was implemented by the Diving Medical Officers (DMOs) of Navy Experimental Diving Unit (NEDU) in May of 2012. The modification consisted of the use of the Domboro solution once daily, following immersion or after daily hygiene requirements. A retrospective log review was performed over a one year period to determine if the use of Domboro solution one time daily in a saturation dive setting would be as effective with limited or no side effects as the use of Domboro two to three times daily as initially implemented by Dr. E. Thalmann ¹ and the U.S. Navy Dive Manual regimen ² . In this research, a total number of four dives were completed with 48 ears being exposed to the modified regimen. The incidence was noted to be the same as Dr. Thalmann's results from a study in 1974, 0% of the divers developed AOE, but with fewer complaints of unwanted side effects. The results from the modified regimen yielded no complaints as compared to the 0.012% - 0.024% from the previous year's saturation dives. The success of the once daily use of Domboro is likely secondary to the strength of the solution, the success of the divers continuing to use the solution because it has reduced side effects, and the ability to better control the overall saturation chamber environment.					
15. SUBJECT TERMS Modified Ear Prophylaxis; Prevention of Otitis Externa in Saturation Divers					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES 9	19a. NAME OF RESPONSIBLE PERSON NEDU Librarian
a. REPORT UNCLAS	b. ABSTRACT UNCLAS	c. THIS PAGE UNCLAS			19b. TELEPHONE NUMBER (include area code) 850.230.3170

TABLE OF CONTENTS

SF 298.....	i
Table of Contents.....	ii
Introduction	1
Procedures.....	1
Results	2
Discussion.....	2
Conclusion	4
References.....	5
Appendix A: Acronyms	A-1

INTRODUCTION

Over the course of the last 39 years, the Navy Experimental Diving Unit (NEDU) has conducted saturation dives ranging in depth and time. On dives lasting longer than three days, it had been determined that without a topical 2% acetic acid in aluminum solution, 25-75% of divers would develop acute otitis externa (AOE)¹. The development of AOE was likely secondary to long periods of water immersion or the warm water temperature ranging from 89-91 °F and humid hyperbaric chamber conditions between 50-100%. The ear prophylactic regimen proposed and tested by Dr. E. Thalmann¹ at NEDU in 1974, is similar to the one included in the United States (U.S.) Navy Diving Manual². Divers routinely irrigate their ears in the morning, evening, and after every immersion. This method was shown to reduce the rate of AOE from 25-75% to 0%¹. Anecdotally, it has been observed that saturation divers experience severe side effects from the 2% acetic acid in aluminum solution (Domboro) use at the extent proposed by Dr. E. Thalmann¹ and the U.S. Navy Dive Manual². These side effects include erythema and cracking of the outer ear canal to crystallization throughout the external canal and on the tympanic membrane. Given these effects, divers have taken it upon themselves at times to stop or “fake” the use of Domboro on dives, increasing their risk of AOE. At NEDU, it has been proposed by the Diving Medical Officers (DMOs) that a decrease in the frequency of the Domboro prophylaxis would potentially prevent these unwanted side effects while maintaining the efficacy of the treatment.

From May 2012 to May 2013 a modified ear prophylactic regimen was implemented across all saturation dives per the direction of the DMOs of NEDU. The modified regimen consisted of the use of Domboro once daily after in-water immersions or following daily hygiene requirements. This retrospective saturation medical and dive log record-review examined the outcome of the modified ear prophylactic regimen and the efficacy in which it prevented the occurrence of AOE as well as any decrease in incidence of any undesirable side effects of the Domboro.

PROCEDURES

This study retrospectively evaluated the modified prophylactic regimen used by NEDU DMOs against the standard practice stemming from Thalmann’s research from 1974¹ and the U.S. Navy Dive Manual². Medical and diving records were examined for saturation dives performed at NEDU from April 2011 until May 2012, where two to three times daily ear prophylactic was applied during saturation dives. This was followed by a record review from May 2012 to May 2013, where once-daily ear prophylactic following water immersions or hygiene requirements was instituted. Specifically, the reports made by the DMOs performing sick call, twice daily, during these dives were evaluated. The modified prophylactic regimen was tested during four saturation dives. A total number of 24 subjects and 48 ears were exposed to the modified ear prophylactic regimen. The dives were performed in the Ocean Simulation Facility (OSF). The divers had no more than 1 hour of total immersion time in the wetpot during these dives. The chamber temperature necessary to achieve comfort was set anywhere from 85-93 °F and the humidity between 30% - 80% (with 50 - 70% being the most desirable).²

The ear prophylactic was made part of the daily dive protocol and followed by each diver throughout the dive. The routine consisted of irrigating the ear canals with a 2% acetic acid in aluminum acetate solution with the head turned to one side, while the ear canal is filled with solution and allowed to remain in the canal for five minutes. The solution is then allowed to run out of the canal and the external auditory meatus is dried with a towel. This procedure is repeated for the other canal.

RESULTS

During the dive and medical log review from April of 2011 to May of 2012 it was noted that no divers were ever treated for acute otitis externa (AOE) while performing an ear prophylactic regimen of two to three times daily while in a saturation environment. However, on two occasions during a 1000 feet of sea water (fsw) dry saturation dive and during a 150 fsw dive in the U.S. Navy Saturation Flyaway Diving System (SATFADS), two different divers noted bilateral ear itching and irritation. During the 1000 fsw dive, one diver reported bilateral ear itching and irritation of the left ear that was greater than the right ear on day six of an eleven-day dive. Physical exam records reports erythema with patient's subjective findings. At the time of complaint, the diver was instructed to cut down use of Domboro to once daily following hygiene requirements. Throughout the remainder of the decompression the diver continued to report symptoms of itching and irritation, however, signs and symptoms improved and at no time was the diver placed on oral or otic medications. On a subsequent dry saturation dive that took place in September of 2011, also within SATFADS, a second diver reported "itching and irritation" of the bilateral ears. This complaint was reported on the first night of a five-day dive and was no longer reported on any subsequent days of the dive. At no time was the individual's ear prophylactic regimen modified. The diver was also never treated with oral or otic medications for their complaints.

Over the course of the four saturation dives that took place between May 2012 and May 2013 no clinical evidence of AOE was noted while using the modified ear prophylactic regimen. These dives ranged from 100 to 300 fsw and seven to nine days in length with water temperatures between 50 - 80 °F in the wetpot of the OSF. Record reviews during this time period showed that at no time did divers complain of any itching, burning, or irritation while performing the modified prophylactic regimen of once daily following in water immersions or daily hygiene requirements. In all incidents, divers were monitored via video capabilities by a dive watch supervisor and dive watch officer for rigid compliance with the prophylactic regimen.

DISCUSSION

NEDU has practiced prophylactic ear regimens for saturation dives for the last 39 years. Initially it was determined that high acetic acid solutions and a regimented manner of irrigation is considered the best route in order to prevent acute otitis externa. While prevention of AOE is the primary purpose of irrigation with Domboro solution,

consideration should also be given to the prevention of known undesirable side effects. These negative side effects could prevent diving from occurring because of cracking and irritation of the thin skin of the external auditory canal which could potentially lead to AOE. Tables 1 and 2 below reflect two of these issues over the course of a year span.

Table 1.

Thalmann's/ U.S. Navy Dive Manual Prophylactic Regimen								
Date	Depth (fsw)	Duration (days)	Number of divers	Number of ears immersed	Total number of ears with otitis externa	Incidence of otitis externa (by percentage)	Side effects of Domboro	Days affected
Apr-11	1000	11	6	12	0	0%	1 diver bilateral ears	6
Sep-11	150	5	6	12	0	0%	1 diver bilateral ears	2
Feb-12	150	5	6	12	0	0%		
Mar-12	20	5	6	12	0	0%		
May-12	1000	15	6	12	0	0%		
Aug-12	5	5	6	12	0	0%		
Sep-12	5	4	5	10	0	0%		

Table 2.

Modified DMO Ear Prophylactic Regimen							
Date	Depth (fsw)	Duration (days)	Number of divers	Number of ears immersed	Total number of ears with otitis externa	Incidence of otitis externa (by percentage)	Side effects of Domboro
Sep-12	100	9	6	12	0	0%	0
Dec-12	300	7	6	12	0	0%	0
Jan-13	300	9	6	12	0	0%	0
Apr-13	100	8	6	12	0	0%	0

With Domboro solution being applied two to three times daily over the course of a day during dives lasting five days or more in duration, the incidence of unwanted side effects increased from 0% to 16% as documented for two out of seven dives. The four dives that took place over the course of May 2012 – May 2013, in which the prophylactic regimen was modified to once daily, after diving or hygiene requirements, was noted to be just as effective in preventing AOE (0% incidence), as well as any unwanted side effects (0% incidence) from the 2% acetic acid solution. On physical exam following these dives it was determined that all diver's ears were less erythematous and/or irritated with reduced crystal formation upon the tympanic membrane. Diver's also reported an increased compliance in the use of the Domboro solution.

Thalmann's 1974 study strictly focused on preventing the incidence of acute otitis externa, which he proved to be successful with the regimen of the three times daily use of Domboro solution over the course of a saturation dive. However, Thalmann did not look at the possibility of a once or twice daily application in a continued regimented manner nor was mitigation of possible side effects evaluated relative to a modified regimen. Thalmann compared his study to what was occurring in commercial saturation dives at the time, in which a decreased strength of acetic acid applied in a regimented manner was not well documented or monitored within the commercial saturation

community. Due to these findings from the 1970s, it is clear that the over use of the Domboro solution can have potentially negative side effects on the saturation diver.

Further examination illuminates the changes that have occurred over the last 39 years in saturation diving. It is clear that in 1974 variations in chamber temperature were not as great and temperatures were maintained higher. Thalmann reported that chamber temperatures varied between 87-89 °F and the humidity was maintained between 50-90%. Given such a narrow range in temperature and a large range in humidity it is difficult to know the exact set points for those 1974 dives. Per the U.S. Navy Diving Manual ², temperatures tend to be set to the level that is most comfortable for the group of individuals (approximately 85 °F) as well as the most comfortable humidity (between 50-70%). This allows for a much narrower control of the saturation environment and a potential decrease in the environmental effects on the divers in preventing AOE.

Another contributing factor is changes in hygiene practices. Hygiene during saturation diving has changed since Thalmann's initial report in 1974. The equipment used from diver to diver is routinely sanitized or cleaned with appropriate solutions or fresh water and allowed to dry either between dives or over the course of a day prior to the use of these items again. During all saturation dives clothing and linen are washed and changed out every 24 hours to prevent any unwanted bacteria growth from occurring in the chamber over any period of time. All chambers that are used for any type of hygiene requirements or for any type of diving preparation are also cleaned on a daily basis. This cleanliness helps to eliminate standing water within the chamber and once again any type of growth, bacterial or fungal, that could develop over a 5 to 16 day period while individuals are living in the chambers. These specific chamber and personal hygiene standards were not implemented in saturation diving until the 1980s³. The changes in hygiene practices have significantly helped to reduce the likelihood of the spread of bacteria from individual to individual. It has also reduced the need for increased use of an ear prophylactic that can lead to negative side effects.

CONCLUSION

The modification to a once daily use of the 2% acetic acid in aluminum acetate irrigation solution (Domboro) has shown to be as effective in preventing AOE in saturation divers as compared to Thalmann's study from 1974¹. The modified regimen not only proves to be as effective in preventing AOE but has also significantly decreased diver's ear irritation and other negative side effects from the solution. In addition, increased compliance with Domboro has been demonstrated, which independently could account for the effectiveness of the modified regimen in preventing AOE in U.S. Navy saturation divers.

REFERENCES

1. Thalmann, E.D, A Prophylactic Program for the Prevention of Otitis Externa in Saturation Divers, U.S. Navy Experimental Diving Unit, 1974, AD779075.
2. U.S. Navy Diving Manual, Revision 6A; NAVSEA 0910-LP-106-0957; 15 October 2012.
3. U.S. Navy Diving Manual, Revision 2; NAVSEA 0994-LP-001-9010; 15 December 1988.

APPENDIX A: ACRONYMS

AOE – acute otitis externa
DMOs – Diving Medical Officers
NEDU – Navy Experimental Diving Unit
OSF – Ocean Simulation Facility
SATFADS – Saturation Flyaway Diving System
U.S. – United States