



Canadian Forces Submarine Escape Training; Analysis of Injury Patterns



Rideout WE^{1,2}, Grodecki AM^{1,2}, Freiburger JJ², Pestell DL¹

¹Canadian Forces Medical Group, Ottawa, ON ; ²Department of Anesthesiology, Duke University Medical Center, Durham,

Introduction

- Submarine escape training can be accomplished using a variety of depth/time/equipment combinations.
- Documented Submarine Escape Training injuries include death^{1,2}, decompression illness¹, arterial gas embolism (AGE)^{1,2}, pulmonary barotrauma without AGE^{3,4} and otic barotrauma^{5,6}.
- Canadian Forces (CF) Wet Pressurized Escape Training (WPET) entails entering a submersed replica of a Victoria Class submarine escape tower, flooding the tower and being pressurized to 1.8 ATA, opening the escape hatch, ascending to the surface and carrying out a series of surface drills.



- What medical complications are associated with the current submarine escape training system utilized by the Canadian Forces?
- We examined a series of pressurized escapes performed by Canadian Forces members at the current training facility to identify injury patterns and rates.

Materials and Methods

- All CF members who had completed WPET from January 2005 through October 2010 were identified using military and training facility records. Participant's medical records were reviewed for musculoskeletal trauma, pulmonary or otic barotrauma, decompression sickness or arterial gas embolism resulting from submarine escape training.
- Members were considered to have completed escape training only if there was a recorded post-escape examination.
- Otic barotrauma was quantified using the Teed System

Results

- 345 Canadian Forces members presented for WPET
 - 170 escapes (performed by 145 CF members) with complete data
 - 65 escapes with documented change in medical status

Participant Characteristics

	Otic Barotrauma + (n=65)	Otic Barotrauma - (n=105)
Gender		
M	62	101
F	3	4
Age at Escape (yr)	32.9 (s.d 6.5)	34.1 (s.d 7.3)
Body Mass Index	28.1 (s.d. 5.7)	28.2 (s.d 6.9)
Smoking Status		
Current Smoker	27	28
Non-smoker	38	77
Alcohol within 24 hrs	10	18
Active Ear, Nose or Throat Medical Condition	8	21

Participants were 96% male and 68% non-smokers with a age distribution from 20-51 years.

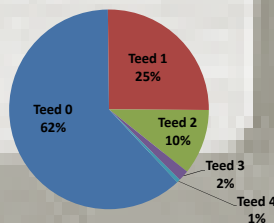
Injury Patterns

There was no musculoskeletal trauma, pulmonary barotrauma, decompression sickness or arterial gas embolism in 170 documented escapes.

Otic barotrauma resulted from 38% of the escapes.

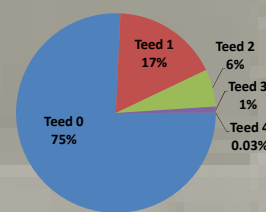
Otic Barotrauma

Distribution of escapee's exhibiting any otic barotrauma



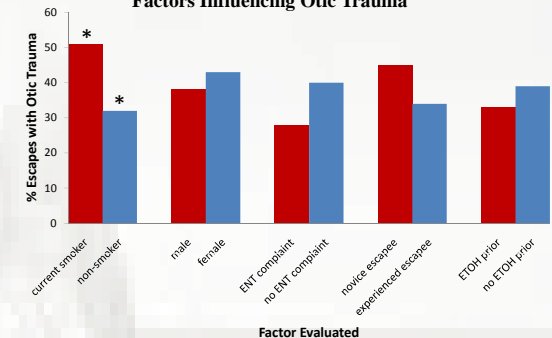
Of 170 completed escapes, 105 resulted in a Teed score 0, 43 Teed score 1, 18 Teed score 2, 3 Teed 3 and 1 Teed score 4 as their most severe Teed score

Distribution of all otic barotrauma



Some participants experienced bilateral otic trauma resulting in 59 Teed 1, 22 Teed 2, 4 Teed 3 and 1 Teed 4 tympanic membrane trauma scores.

Factors Influencing Otic Trauma



Smokers were more likely to experience otic barotrauma than non-smokers ($p = 0.04$), but age, gender, previous escape training, alcohol use within previous 24 hour period and acknowledged ears, nose, or throat symptoms were not significant predictors.

Summary and Conclusions

- The Canadian Forces WPET produced otic barotrauma in 38% of escapes during the study period.
- There was no evidence of pulmonary barotrauma or musculoskeletal system related injuries.
- This study provides evidence that Canadian Forces WPET has a favorable safety profile as compared to other nations' similar training.

References

- Benton PJ, Francis TJR, Pethybridge RJ. Spirometric indices and the risk of pulmonary barotrauma in submarine escape training. *Undersea Hyperbaric M.* Win 1999; 26(4):213-217.
- Brooks GJ, Green RD, Leitch DR. Pulmonary barotrauma in submarine escape trainees and the treatment of cerebral arterial air-embolism. *Aviat Space Envir Md.* Dec 1986;57(12): 1201-1207.
- Broome CR, Jarvis LJ, Clark RJ. Pulmonary barotrauma in submarine escape training. *Thorax.* Feb 1994;49(2):186-187.
- Yildiz S, Ay H, Yaygılı S, Aktas S. Submarine escape from depths of 30 and 60 feet: 41,183 training ascents without serious injury. *Aviat Space Envir Md.* Mar 2004;75(3):269-271.
- Saywell WR. Submarine escape training, lung cysts and tension pneumothorax. *The British Journal of Radiology.* March 1989;62:276-278.
- Toklu AS, Shupak A, Yildiz S, et al. Aural barotrauma in submarine escape: Is mastoid pneumatization of significance? *Laryngoscope.* Jul 2005; 115(7):1305-1309.



Militi Succurrimus

