

# COMPARISON OF TIMED SUBMERGED SWIMMING (SCUBA) TRIALS WITH AND WITHOUT LOWER EXTERMITY PROSTHESES

Duffy Felmlee<sup>1,2</sup>, Michael McCauley<sup>1,2</sup>, Kristamarie Pratt, PhD, MEng<sup>2</sup>

<sup>1</sup>Combat Wounded Veterans Challenge, St. Petersburg, FL, USA

<sup>2</sup>Prosthetics and Orthotics Department, University of Hartford, West Hartford, CT, USA  
felmlee@hartford.edu

## INTRODUCTION

It is known that controlled aquatic activities can have a normalizing effect across many physiological differences: cardiopulmonary, musculoskeletal, respiratory, geriatric, and athletic training.<sup>1</sup> It has been hypothesized that impact of lower extremity amputation on swimming activity can be minimized in the buoyant environment of submerged swimming. It is further known that land based activity at differing amputation levels require increasing energy expenditure.<sup>2</sup> The purpose of this study was to examine preliminary data on the level of exertion measured by heart rate (HR) and compare a 50m swimming trial completed with and without swim prosthesis and level of amputation.

## METHODS

The study protocol was approved by the institutional review board at the University of Hartford. Utilizing an outdoor pool six (6) lower extremity amputees of varying amputation side and level (5 male, 1 female; 3 unilateral trans-femoral, 2 unilateral trans-tibial, and 1 bilateral trans-tibial) participated in two (2) trials of three (3) attempts of a 50m length submerged swim at a minimum of 1.2m depth from surface<sup>3</sup>; the first task utilizing of swim specific prosthesis and second task being without. All participants have been cleared for participation in SCUBA activities by various certification agencies. Subjects were instructed to maintain bilateral upper extremities in fully extended position and wrist grasp pattern. This position was an attempt reduce drag, but more so to keep visible real-time HR monitoring as the focus of the participant. Each participant was assigned a target HR based of 60% of maximum HR equations. HR monitoring was achieved with use of chest mounted Polar H7 Heart Rate monitor and wrist mounted Polar M300 display units utilized to water compatibility. Wrist unit displayed subject current HR in one second intervals throughout all swim attempts. After each attempt the subject was given a 20 minute cool down period as to reduce fatigue and reset base HR. After six attempts were completed subject was released from pool.

## RESULTS

Results show that no significant difference in time was required to traverse 50m submerged with or without prosthesis. In this sample population a statistically significant difference in the participants' ability to reach the 60%HR<sub>max</sub> target was observed (Fig.1).

### Heart Rate and Time Compared Across With and Without Prosthesis Swim Trials

Subject	HR Diff w/ PRO	HR Diff w/o	Time Diff w/ PRO	Time Diff w/o
A	6.7	3	76.67	84.33
B	6.3	15.7	72.33	87.67
C	3.7	16.3	107.00	124.00
D	4	8.3	68.67	106.00
E	7	16	116.67	102.67
F	2	16	80.67	85.67
<b>Avg of Abs Difference</b>	<b>4.95</b>	<b>12.55</b>	<b>87.00</b>	<b>98.39</b>
p-value	0.019		0.296	
<b>Avg of Reported Difference</b>	<b>-0.05</b>	<b>-12.55</b>		

Figure 1. Data table for mean HR and Time.

## DISCUSSION AND CONCLUSION

It was noted that average 60% HR<sub>max</sub> in the non-prosthesis trials was lower than in trials with prosthesis. It is hypothesized that this may be due the subjects not being able to maintain focus on the target value of 60% of HR<sub>max</sub> as without their prosthesis the swim pattern is unnatural. Furthermore, these results may be explained by the fact that all of the participants were veterans prior to amputation and received extremely specialized training related to fitness both mentally and physically. Current physical condition and familiarization with swimming prosthesis may also explain the variance in swim trial completion time. Future work will continue to explore these variables and the relationship between aquatic activities and prosthesis.

## REFERENCES

1. Becker, BE. *PM&R* 1.9, 859-872, 2009.
2. Göktepe, AS, et al. *J Prosthet Orthot Int* 34.1, 31-36, 2010.
3. Pendergast, D. R., et al. "Energetics of underwater swimming with SCUBA." *Medicine and science in sports and exercise* 28.5 (1996): 573-580.

## ACKNOWLEDGEMENTS

Combat Wounded Veteran Challenge, St. Petersburg, FL