ORANGE COUNTY FIRE AUTHORITY HYDRATION STUDY

PRELIMINARY SUMMARY

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We extend our sincere thanks to all the volunteers who participated in the study and all the peer fitness trainers who volunteered countless hours to help make this study a success.

We would also like to express our gratitude to OCFA management and Local 3631 for their continuing support of WEFIT's activities.

Special thanks to:
Chief Nevarez and the Training Section
and
The Service Center

Preliminary Summary
(Full Report to Follow)

Background: Orange County Fire Authority's Wellness and Fitness Program (WEFIT) strives to continue to improve the health and well-being of firefighters. Over the last year, WEFIT has been monitoring and recording the heart rates of recruits and firefighters during a variety of firefighting activities. Analysis of the heart rate data has resulted in a better understanding of firefighter exertion levels and how to properly prepare to work at those exertion levels.

The Hydration Study was the next progression in WEFIT's continuing efforts to gain insight into the job demands placed on firefighters and determine which cooling measures are most effective during post-incident rehab.

The WEFIT program, with the approval of the WEFIT Oversight Committee (comprised of OCFA management and Local 3631), conducted a study to evaluate the incidence of dehydration among firefighters and the physical stresses placed on firefighters during simulated firefighting activities.

Study Description: The OCFA Hydration study was conducted at the RFOTC during the week of August 6 through August 10. Two drills were conducted each day: one at 0900 and one at 1300. Participation was voluntary. All data collection was anonymous, and no names were used in recording the data or reporting the findings.

Study participants were asked to ingest a core temperature capsule to monitor core body temperature throughout the activities. Prior to the study, extensive research on the core temperature capsule was conducted. A variety of research studies conducted on the core temp pill, and a variety of literature that supports the use of the core temp pill, were made available to all participants. In addition, a representative from the company which produces the core temperature pill was available on-site to answer questions. Any volunteer participant who was not comfortable proceeding with the study after having had an opportunity to review the material was permitted to proceed with the drills without ingesting the core temperature pill.

After receiving all instructions, participants were weighed and asked to urinate in a plastic container. The urine was analyzed using a refractometer to determine participants' hydration level.

Vitals, including blood pressure, tympanic temperature, heart rate and respiration rate, were taken. These readings were taken before, during and after the activities. Heart rate and respiration rate were continuously monitored using the Suunto t6 heart rate monitor.

Participants then performed two 15-minute drills. The first drill consisted of a live fire drill in the drill tower, and the second consisted of fifteen minutes of continuous movement while performing firefighting related skills, such as stair climbing or overhaul.

After the completion of both drills, a variety of cooling measures, including peripheral cooling, cooling chairs and misting fans, were administered to participants. During the 20-minute recovery, core body temperature and vitals were measured and recorded at regular intervals. After 20 minutes, participants were weighed again.

Preliminary Results: While the goal was to evaluate at least 100 firefighters, 126 OCFA firefighters volunteered for the study. Participants reflected a range of different ages, body types, physical fitness levels and firefighting experience levels.

While a thorough report of the findings has not yet been completed, the preliminary results for each category analyzed have been summarized in this report. The complete report will contain a detailed explanation of the data collection, as well as all conclusions drawn from the findings, recommendations regarding hydration and fitness and recommendations for post-incident rehab.

- Over 90% of participants were categorized as dehydrated prior to commencing the drills.
- The average maximum heart rate during the drills was 180 beats per minute.
- 44% of participants reached a core body temperature of 102.1° or higher.
- Even after several minutes of rest and recovery, core body temperature continued to rise.
- On average, tympanic (i.e., measured in the ear) temperature readings were 2.4° lower than core body temperature readings, as recorded by the core temperature pill.
- During recovery, wet towels proved to be the most effective and practical cooling measure.
- The average weight loss during the drill was over three pounds of body weight.

Participants

Total participants	126
Number of participants who did not complete all physical aspects of the study	4
Number of participants who did not provide all necessary personal data (age, fitness level, etc.)	4
Number of participants for whom heart rate data was not collected (e.g., participant did not start heart rate monitor)	7
Number of participants for whom hydration status was not measured (e.g., chose not to participate in hydration portion of the study)	10
TOTAL NUMBER OF PARTICIPANTS FOR WHOM DATA WAS ANALYZED	**101**

Participant Characteristics

Gender Male Female	 98 3
Average Age	39.5
Average Years of Fire Service Experience	13.5
Average Fitness Level (Based on a scale of 1-7, with 1 being a low fitness level and 7 being the highest fitness level. Fitness level was determined from participants' response to questions before and after their participation and individual resting heart rate and recovery heart rate data.)	3.3

Hydration Status

Category	Number	Percentage
Well Hydrated: Urine Specific Gravity over 1.020	9	9%
Minimally Dehydrated: Urine Specific Gravity between 1.010 – 1.020	66	65%
Significantly Dehydrated: Urine Specific Gravity between 1.020 – 1.030	22	22%
Seriously Dehydrated: Urine Specific Gravity over 1.030	4	4%

Sources: National Athletic Trainers Association, National Collegiate Athletic Association

Heart Rate Data

Time or Reading	Average Heart Rate
Resting Heart Rate	77
During Live Fire Drill	164
During Fire Skills Drill	179
After 5 Minutes of Rest	148
After 10 Minutes of Rest	121
After 15 Minutes of Rest	102
Average Maximum Heart Rate	180

Participants' heart rates were monitored continuously throughout the study to analyze the exertion level of firefighting skills and to monitor recovery heart rate. Recovery heart rate is particularly important because research suggests that the rate of decrease in the heart rate after exercise is a good indicator of fitness level and a powerful predictor of overall mortality.

In general, a drop in recovery heart rate of at least 12 beats per minute within the first minute is considered favorable. Eighty percent of participants had a decrease of at least 12 beats per minute within the first minute of recovery. Not surprisingly, these individuals also had a higher fitness level.

Sources: The Journal of the American Medical Association, New England Journal of Medicine

Core Body Temperature Data

Time or Reading	Average Core Body Temperature
Prior to Start of Drill	99.5°
Post Live Fire Drill	100.8°
Post Fire Skills Drill	101.8°
After 5 Minutes of Rest	102.0°
After 10 Minutes of Rest	101.6°
After 15 Minutes of Rest	101.1°

Category	Number of Individuals	Percentage
Peak Core Body Temperature between 100° - 102°	57	56%
Peak Core Body Temperature between 102.1° - 103°	33	33%
Peak Core Body Temperature between 103.1° - 104°	8	8%
Peak Core Body Temperature between 104.1° - 105°	1	1%
Peak Core Body Temperature above 105°	2	2%

Comparison of Core Body Temperature and Tympanic Temperature

Time or Reading	Average Core Body Temperature	Average Tympanic Temperature	Difference
Prior to Start of Drill	99.5°	98.0°	1.5°
Post Live Fire Drill	100.8°	99.6°	1.2°
Post Fire Skills Drill	101.8°	100.3°	1.5°
After 5 Minutes of Rest	102.0°	99.2°	3.8°
After 10 Minutes of Rest	101.6°	98.2°	3.4°
After 15 Minutes of Rest	101.1°	98.0	3.1°

On average, tympanic temperature readings were lower than core body temperature readings by over two degrees. One of the most interesting differences between core body temperature and tympanic temperature was that during recovery, tympanic temperature began to drop instantly while core body temperature continued to rise despite the cessation of physical activity. Most individuals' core body temperature peaked after several minutes of rest before decreasing. It is also important to note that even after twenty minutes of rest, few core body temperatures had returned back to the starting temperature.

Comparison of Cooling Measures

Cooling Measure Used	Number of Participants that Used the Cooling Measure	Average Core Body Temperature Decrease During 20-Minute Rehab
Misting Fan	28	0.009°
Wet Towels	28	0.013°
Cooling Chair	17	0.013°
Ambient Air	28	0.008°

While the wet towels and cooling chairs had the same rate of core body temperature decrease, the wet towels proved to be more practical; they required less space, less set-up and were less expensive than the cooling chairs.

An interesting point is that when asked which cooling measure looked most appealing, most participants responded that the wet towels looked refreshing and most effective. An in-depth analysis may reveal some added benefit from the psychological effects that these beliefs have.

Weight Loss Data

Category	Average Weight Loss
Well Hydrated: Urine Specific Gravity over 1.020	2.75 lbs.
Minimally Dehydrated: Urine Specific Gravity between 1.010 – 1.020	2.93 lbs.
Significantly Dehydrated: Urine Specific Gravity between 1.020 – 1.030	3.25 lbs.
Seriously Dehydrated: Urine Specific Gravity over 1.030	3.68 lbs.

The average weight loss among participants was 3.1 pounds, and the highest was a loss of seven pounds. Overall, 62% of all participants lost over three pounds. The rapid amount of weight loss is alarming and is being analyzed closely to give specific recommendations for rehydrating after an incident.

An interesting finding was also the fact that the more a person was dehydrated, the more weight he or she lost. This finding will also be thoroughly studied and researched to determine the cause and give recommendations.