

THE CrossFit JOURNAL

Consortium for Health and Military Performance and American College of Sports Medicine *Consensus Paper* on Extreme Conditioning Programs in Military Personnel

An Answer

By J. A. Glassman, PhD, CrossFit Chief Scientist

ABSTRACT

An epidemic in military cases of rhabdomyolysis is a reporting error at the expense of an under-reporting of classic heat stroke, two potentially fatal types of exertional heat illness (EHI) indistinguishable in their initial and milder forms. The opinion of the authors of the subject paper that a companion increase in other exertional injuries might be looming is unsupported and contradicted by military studies. None of those studies includes any significant injuries in trials preliminary to replacing traditional military physical training (PT) with the CrossFit® conditioning program. EHI, which includes rhabdomyolysis, has been rising at 5.5% per year over the last eight years, and is correlated ($R^2 = 83.8\%$ at a 6.5-year lag) with a sudden rise in military deaths attributable to the War on Terror. The authors' opinion that CrossFit is a cause of increased injuries or illness absent any data is beyond science, and without data in a lead-lag relationship, it is a scientific error in causality.

CrossFit workouts are less extreme than those of ACSM-sanctioned military PT. It is safer than military PT because it tends to limit rhabdomyolysis, the rupturing of skeletal muscles, from developing into Acute Kidney Failure. CrossFit workouts typically last no more than about 20 minutes, which with normal hydration initially, minimizes the dehydration essential to rhabdomyolysis first interfering with normal kidney function. CrossFit workouts generally mix anaerobic and aerobic exercises, tending to neutralize metabolic acidosis. Therefore CrossFit minimizes the contribution of acidosis to the breakdown of urinary myoglobin into toxic elements in the pathogenesis of severe rhabdomyolysis. CrossFit workouts include individualizing through scaling or substitution of movements, as required, and always by prescribing an individual's best effort. Individualizing marginally stresses each athlete to his current capabilities, tending to limit muscle damage to those microtears desirable in physical conditioning, a necessary state of mild rhabdomyolysis. Because the individual determines the intensity of each of his workouts, CrossFit is not suited to the regimentation of group drills that lead to overexertion, clustering of cases, and intermediate rhabdomyolysis recognizable by darkened urine.

TABLE OF CONTENTS

PART 1:

**EXERTIONAL HEAT ILLNESSES, INCLUDING RHABDOMYOLYSIS, AND PARTICIPATION IN
CONDITIONING PROGRAMS ARE GRADUALLY RISING IN RESPONSE TO WAR TIME RISKS, AND NOT THE
TROOPS' VAIN DEMAND FOR GETTING RIPPED. PAGE 8**

- 1.1. Severe exertional rhabdomyolysis is unambiguous, but the distinctions between stages of rhabdomyolysis is pragmatic. Page 11
- 1.2. Military heat illness reports confuse rhabdomyolysis and heat stroke, but support a finding that war and not ECPs is the cause of an overstated rise in injuries. Page 15
 - 1.2.1 Exertional rhabdomyolysis cases in the military are dominantly heat amplification of the effects of exertion. Page 21
 - 1.2.2 The War on Terror is a probable cause for observed increases in heat illness. Page 23
 - 1.2.3 How not to mistake correlation for Cause & Effect. Page 25
- 1.3. The Conclusions of the Consensus Paper must be rejected as unsupported and contradicted. Page 28

PART 2:

THE *CONSENSUS PAPER* DISCLAIMS ITS OWN AUTHORITY Page 30

- 2.1. The *Consensus Paper* supports the conclusion that it is a mock interim consensus or final consensus of a mock conference. Page 30
 - 2.1.1 Conference proceedings are missing. Page 32
 - 2.1.2 Critical discussions once initiated went no further. Page 32
 - 2.1.3 The *Consensus Paper* may constitute the workshop's "initial consensus-based recommendations", an impromptu work of the nine authors. Page 33
 - 2.1.4 The "initial consensus-based" document was neither comprehensive, nor definitive, nor evidence-based. Page 33
 - 2.1.5 Promised final guidelines are chimerical, eventualities to reduce injuries. Page 33
 - 2.1.6 Missing from the conference by implication were representatives of the individual services, Warfighters, and subject matter experts other than the authors of the *Consensus Paper*. Page 34
 - 2.1.7 Workshop discussions on producing a mere summary of the conference were inconclusive. Page 34
 - 2.1.8 The sole accomplishment of the conference was to change the name High Intensity Training (HIT) in its title to Extreme Conditioning Programs (ECPs). Page 34

2.2. While the authors have abundant official channels for their work product, they rely instead on unofficial channels. Page 35

2.3. ACSM has a dog in the fight. Page 36

2.3.1 Helen Vanderburg, ACSM spokesperson and counterfeit CrossFit trainer, addressed the ACSM Summit on "How To Make the Most Of Top Global Fitness Trends in your Business". Page 36.

2.3.2 Nora Constantino, PhD, FACSM, with Associate Professor and UNR recreation Director James Fitzsimmons, EdD, both CrossFit Games competitors and operators of CrossFit UNR, addressed the Summit on "CrossFit : Menace To Society Or Future Of The Fitness Industry?" Page 38"

2.4. The *Consensus Paper* relies on inaccessible and unofficial citations. Page 39.

2.5. The *Consensus Paper* characterization of conditioning programs is exclusively subjective. Page 39

2.5.1 Edward Zambraski, PhD, FACSM, misrepresents CrossFit. Page 40

PART 3:

BENEATH THE SURFACE OF THE CONSENSUS PAPER Page 44

3.1. The CHAMP consensus overlooked the military's extensive adaptation of CrossFit , its principles, and the objective studies into its efficacy by the US Army. Page 44

3.1.1 The USMC Has Adapted CrossFit as the Corps standard. Page 45

3.1.2 The *Consensus Paper* confuses aggressively marketed conditioning programs with CrossFit, which does not advertise. Page 50.

3.1.3 The *Consensus Paper* Claims Contrary Evidence To Be Anecdotal, Ignoring Well-designed Army Demonstrations of CrossFit Efficacy. Page 51

3.1.4 The *Consensus Paper* appeals to its fabricated opinions of Warfighters. Page 52.

3.1.5 The *Consensus Paper* demeans Warfighters with subjective, unscientific conclusions. Page 60.

3.2. The *Consensus Paper* claims ECPs are responsible for a potential emerging, disproportionate injury risk and increased rate of rhabdomyolysis cases, based on a coincidence from health reports and a rise in ECP popularity at policy levels. Page 61

3.2.1 Hadeed is an ACSM-sponsored case study of an isolated occurrence of rhabdomyolysis and compartment syndrome for an out-of-condition athlete. Page 62

3.2.2 Mitchell is a journalist's view of the outcome of a civil lawsuit for damages from a single incidence of rhabdomyolysis alleged to have been induced from CrossFit exercises, a suit to which CrossFit was not a party. Page 63

- 3.2.2.1 CrossFit Is the Safest of All Fitness Programs. Page 65
- 3.2.2.2 Mitchell Misrepresents CrossFit and 'Killer Workouts'. Page 66
- 3.2.2.3 Mitchell relies on another news article without confirming the source. Page 67
- 3.2.2.4 Mitchell relies on Dr. Priscilla Clarkson, FACSM, a policy level spokesperson for ACSM, and an activist and courtroom expert for the dangers in eccentric exercises. Page 68.
- 3.2.2.5 Other physicians, referenced by Mitchell, do not say what the *Consensus Paper* claims. Page 74
- 3.2.3 The *Consensus Paper* relies on an AFHSC Medical Surveillance Monthly Report for information not in the Report. Page 74
- 3.2.4 The *Consensus Paper* relies on a news article by Tilghman whose source appears to be the authors of the *Consensus Paper*. Page 75
- 3.2.4.1 CrossFit Is Safer than Traditional PT. Page 77
- 3.3. The *Consensus Paper* confesses that its subject is not ripe for academia. Page 77

PART 4:

APPENDIX. Textbooks on Military Medicine, SELECTED EXCERPTS and Facts Page 79

- 4.1. Vogel, J.A., and J.F. Patton, "Physical Fitness and Physical Training for Military Performance", TMM, *Rehabilitation of the Injured Combatant*, v. 2, (1999) Ch. 13. Page 79.
 - 4.1.1 Fitness is work capacity. Page 79
 - 4.1.2 Intensity is power, or perhaps speed. Page 80
 - 4.1.3 Cells generate power from three metabolic pathways. Page 80
 - 4.1.4 Power capacity is a matter of individualized conditioning. Page 80
 - 4.1.5 Intensity is energy. Page 80
 - 4.1.6 Intensity has meaning in context with duration and frequency. Page 80
 - 4.1.7 Conditioning entails muscle damage and repair. Page 81
 - 4.1.8 Fitness extends over broad time and modal domains. Page 81
 - 4.1.9 Training maintains what conditioning creates. Page 81
 - 4.1.10 Fitness has an economy. Page 81
 - 4.1.11 Training must stress all three domains. Page 81
 - 4.1.12 Exertional rhabdomyolysis results from trainer miscalculation of individual conditioning coupled with environmental stress. Page 81

- 4.2. Gardner, J. W., and J.A. Kark, "Clinical Diagnosis, Management, and Surveillance of Exertional Heat Illness", TMM, Medical Aspects of Harsh Environments, v. 1 (2002). Page 82**
- 4.2.1 Exertional rhabdomyolysis is difficult to impossible to diagnose in individual cases. Page 82
 - 4.2.2 Mild to severe rhabdomyolysis is equivalent to intermediate to severe Exertional Heat Illness. Page 82
 - 4.2.3 Severe rhabdomyolysis includes life-threatening complications. Page 82.
 - 4.2.4 Exertional rhabdomyolysis is a problematic diagnosis in an individual case because of the large number of possible and unknowable cofactors or alternative causes. Page 82
 - 4.2.5 Exertional rhabdomyolysis is a syndrome caused by the release of the contents of skeletal muscles. Page 83
 - 4.2.6 Individuals can maintain good hydration by keeping their urine volume, color, and density at normal levels. Page 83
 - 4.2.7 A cluster of rhabdomyolysis cases can provide a statistical solution to the differential diagnosis dilemma. Page 83
- 4.3. Cowan, D. N., B. H. Jones, and R.A. Shaffer, "Musculoskeletal Injuries in the Military Training Environment", TMM, Medical Aspects of Harsh Environments, v. 1 (2002). Page 83**
- 4.3.1 Running is a predictor of physical injuries. Page 83
 - 4.3.2 Annual heat-related injuries amount to about one eight-hundredth of total exercise related injuries. Page 84
 - 4.3.3 Between 16% and 45% of military trainees will suffer an exercise-related injury each month, more than two orders of magnitude more common than EHI. Page 84
 - 4.3.4 Knee injuries rank third among injuries to male trainees. Page 84
 - 4.3.5 Active duty statistics are available from the US Army. Page 84
 - 4.3.6 Exercise injury rates depend on body type. Page 84
 - 4.3.7 Infrequent exercise and not the work expended leads to injury. Page 85
 - 4.3.8 Fitness reduces injury risk. Page 85
 - 4.3.9 Exercise as infrequent as once a week is a predictor of injury. Page 85
 - 4.3.10 Running injuries are a measure of lack of fitness. Page 85
 - 4.3.11 The rate of change of training predicts injuries. Page 85
 - 4.3.12 Training injuries are the cost for the payoff of reduced active-duty injuries. Page 85

4.4. Walsh, J.J., and S.M. Page, "Rhabdomyolysis and Compartment Syndrome in Military Trainees", TMM, Medical Aspects of Harsh Environments, v. 1 (2002). Page 86

- 4.4.1 All basic training produces muscle injuries. Page 86
- 4.4.2 Urine darkens as serum myoglobin exceeds 100 mg/dL. Page 86
- 4.4.3 Rhabdomyolysis and compartment syndrome are closely related. Page 86
- 4.4.4 Exertional rhabdomyolysis is commonplace, but requires differentiation from other factors. Page 86
- 4.4.5 Compartment syndrome cannot assist in the differential diagnosis of exertional rhabdomyolysis because rhabdomyolysis itself can cause edema and compartment syndrome. Page 87
- 4.4.6 Acute exertional rhabdomyolysis is a spectrum of symptoms usually requiring no more than rest, but requiring differentiation from about 100 known causes and cofactors. Page 87
 - 4.4.6.1 Rhabdomyolysis may occur after traumatic events, including: Page 88
 - 4.4.6.2 Rhabdomyolysis may occur after excessive muscular activity, such as: Page 88
 - 4.4.6.3 Toxin-mediated rhabdomyolysis may result from substance abuse, including abuse of: Page 88
 - 4.4.6.4 Toxic-mediated rhabdomyolysis may result from prescription and nonprescription medications, including: Page 89
 - 4.4.6.5 Rhabdomyolysis may be caused by other toxins, including: Page 89.
 - 4.4.6.6 Environmental causes of rhabdomyolysis include: Page 90
 - 4.4.6.7 Metabolic causes of rhabdomyolysis include: Page 90
 - 4.4.6.8 Viral infectious disease agents may cause rhabdomyolysis, including: Page 90
 - 4.4.6.9 Bacterial infectious agents may cause rhabdomyolysis, including: Page 91
 - 4.4.6.10 Fungal infectious agents may cause rhabdomyolysis, including: Page 91
 - 4.4.6.11 Causative connective tissue diseases that can cause rhabdomyolysis include: Page 92
 - 4.4.6.12 Inherited disorders may cause rhabdomyolysis, including: Page 92
 - 4.4.6.13 Rhabdomyolysis also has been reported in patients with sickle cell anemia and has mistakenly been identified as a pain crisis. Page 92

4.5. Danzl, D.F. and E.L. Lloyd, "Treatment of Accidental Hypothermia", TMM, Medical Aspects of Harsh Environments, v. 1 (2002) Ch. 16. Page 92

- 4.5.1 Immobility induced rhabdomyolysis. Page 92

PART 1

PART 1:

**EXERTIONAL HEAT ILLNESSES, INCLUDING RHABDOMYOLYSIS, AND PARTICIPATION IN
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TROOPS' VAIN DEMAND FOR GETTING RIPPED.**

Published records show exertional rhabdomyolysis (ER) in military training rising in epidemic proportions—at 166% per year, as shown in the next chart¹:

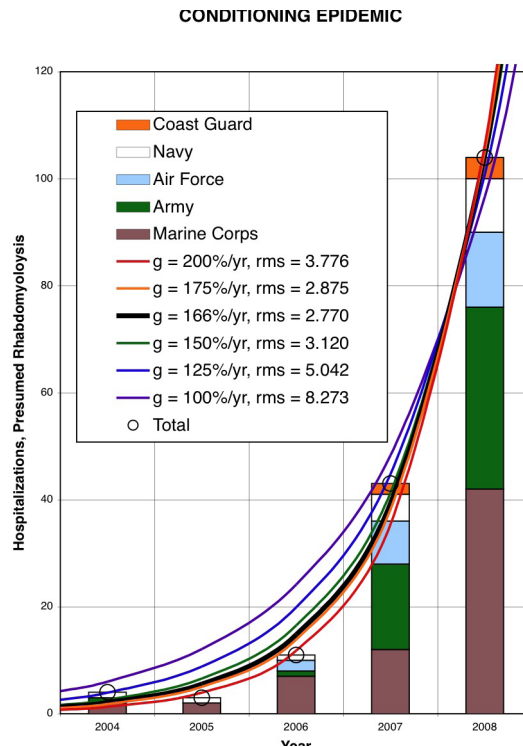


Figure 1

Hospitalizations for presumed exertional rhabdomyolysis in the first five years was growing exponentially at 166% per year, an extreme epidemic.

At the same time, evidence shows that the CrossFit conditioning program is growing at about 50% per year in the number of affiliates², and approaching 90% per year as an open-source Internet activity—extraordinary rates of growth among start-up companies, and unprecedented in both method³ and marketing⁴. The CrossFit growth rate is reflected in a demand for its conditioning among trainees of all services, a demand that has led to military trials with its adaptation by Canadian Forces, U.S. Army commands, and the U.S. Marine Corps to replace traditional physical training programs comprising calisthenics and running.

¹ Original chart in AFHSC, Medical Surveillance Monthly Report (MSMR), No. 16-3, March, 2009, p. 11, Figure 2. www.afhsc.mil/viewMSMR?file=2009/v16_n03.pdf

² Private correspondence from Kathy Glassman, Lynne Pitts.

³ Functional movements, high relative intensity (i.e., individualized conditioning), short sessions with ample rest periods.

⁴ Open source, no paid advertising for products, services, or members. View Internet activity on Google Trends > CrossFit.

From this evidence, the subject *Consensus Paper* determines the following:

A potential emerging problem associated with increasingly popularized extreme conditioning programs (ECPs) has been identified by the military and civilian communities. That is, there is an apparent disproportionate musculoskeletal injury risk from these demanding programs, particularly for novice participants, resulting in lost duty time, medical treatment, and extensive rehabilitation. This is a significant and costly concern for the military with regard to effectively maintaining operational readiness of the Force. While there are certain recognized positive aspects of ECPs that address a perceived and/or actual unfulfilled conditioning need for many individuals and military units, these programs have limitations and should be considered carefully. Moreover, certain distinctive characteristics of ECPs appear to violate recognized accepted standards for safely and appropriately developing muscular fitness and are not uniformly aligned with established and accepted training doctrine. Accordingly, practical solutions to improve ECP prescription and implementation and reduce injury risk are of paramount importance. *Id.*, Abstract.

Muscle strains, torn ligaments, stress fractures, and mild to severe cases of potentially life-threatening exertional rhabdomyolysis are reportedly occurring at increasing rates as the popularity of ECPs grows (4,27). *Id.*, p. 383.

Two unwarranted assumptions in the abstract complicate any response. First, the *Paper* generalizes from problematic rhabdomyolysis data by adding a subjective, independent, anecdotal, chance of musculoskeletal injuries.

The word *rhabdomyolysis* derives from three Greek combining forms, rhabdo- (striated) + myo- (muscle) + -lysis (rupture). According to the International Classification of Diseases (ICD), 2009 (ICD-09), rhabdomyolysis, code 728.88, is one of the “disorders of muscle ligament and fascia”, 728.8, within “Diseases of the Musculoskeletal System and Connective Tissue, 710-739. While no specific agent causes rhabdomyolysis, over one hundred causes and co-factors are known (see list, Part IV, Walsh, ¶4.4.6), listed in 14 categories. In the final diagnosis, rhabdomyolysis includes abnormal levels of muscle proteins, specifically myoglobin (Mb) and creatine kinase (CK, also known as creatine phosphokinase (CPK)), in the blood or urine, but estimates of normal levels vary widely. It is an injury to the musculoskeletal system distinct from strains, torn ligaments, and stress fractures.

The authors’ added risk is a presumption for which the only evidence is contradictory. One such contradiction is the non-trivial absence of injuries during the several military CrossFit trials. An old saw is that the absence of evidence is not evidence of the absence, but the failure of responsible investigators to report injuries would be an error of omission. Reason creates a significant exception to the saw for studies on the effectiveness of a conditioning program: the absence of any injury report implies that no reportable injuries occurred.

Another contradiction is from a recent ACSM-sponsored conference. Nora Constantino, PhD, FACSM, and James Fitzsimmons, PhD, reported that UNR (University of Nevada, Reno) CrossFit had conducted 87,000 supervised workouts with only one injury: a strained ligament that had been recently repaired.

A third contradiction is found in the presentation by E. Zambraski (§2.5.1, below) at the subject Conference. He included this as his Chart 9:

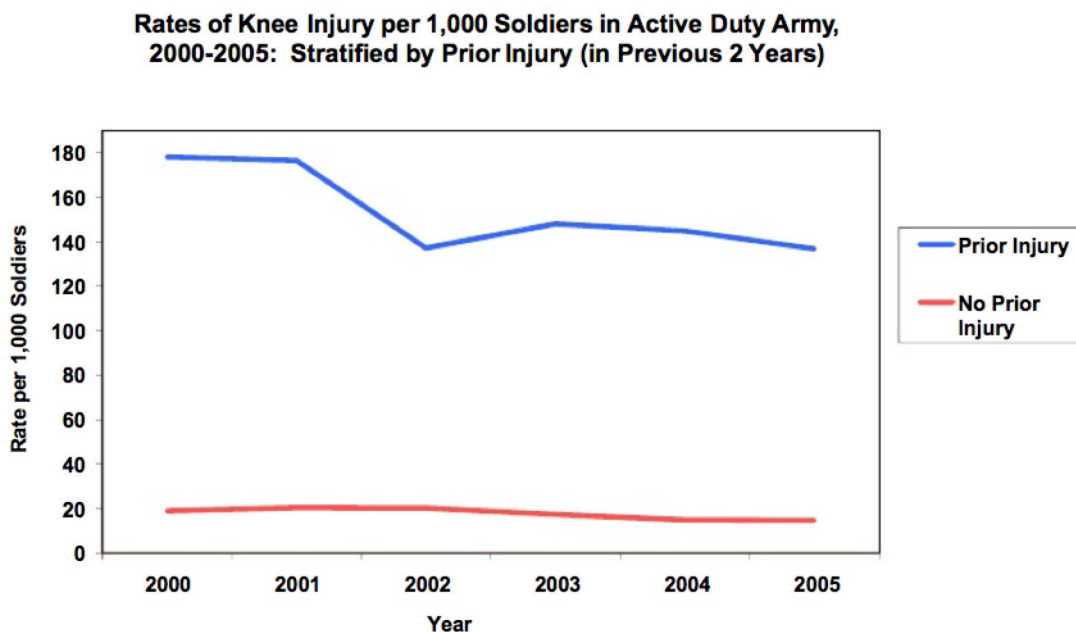


Figure 2
Musculoskeletal injuries declined over the available record, from 2000 to 2005,
if the knee was indicative.

This chart illustrates Zambraski's previous, Chart 8, on "Risk Factors for Muscle Injury", in which the first bullet is "Prior Injury". That title along with Chart 9 suggests the author considered the knee to be a muscle, but more relevantly that it is part of the musculoskeletal system allegedly undergoing "disproportionate ... injury risk".

The Textbooks on Military Medicine, available online from the Army's Borden Institute, U.S. include a treatise called "Musculoskeletal Injuries in the Military Training Environment" (2002) by Cowan, et al. See excerpts below, Part IV, §4.3. This is an excellent reference for understanding musculoskeletal injuries, but it provides no support for claims in the *Consensus Paper* of an increase in injuries. It does say, however, that the majority of training-related injuries in the military are lower-extremity injuries,⁵ and knee injuries rank third after muscle strains and ankle injuries.⁶

None of the data contains a hint of an emerging problem, at least as of 2005. If extreme workouts are causing the claimed disproportionate injuries, how does it happen that the knee, a classically susceptible joint, is immune? The explanation might lie in the fact that the knee injuries are for 2000 to 2005, while the alleged emerging problem is post 2004, dating from the time that rhabdomyolysis was first coded by ICD. This choice of data is not CrossFit's, but the authors and the conference participants, who should explain the discrepancy.

The only data supporting the *Consensus Paper's* opinion of an "emerging problem" are the service reports on exertional rhabdomyolysis.

⁵ §4.3.3, below.

⁶ §4.3.4, below.

1.1. Severe exertional rhabdomyolysis is unambiguous, but the distinctions between stages of rhabdomyolysis is pragmatic.

Rhabdomyolysis was first recognized as a disease among victims of crush injuries in the London blitz in 1940-1941. It was not listed in the 1999 Merck Manual (17th Ed.). It received its first specific code in ICD in 2004, and the Merck Manual first acknowledged rhabdomyolysis in its 18th Ed., in 2006. During this time, the Textbooks on Military Medicine were recognizing exertional rhabdomyolysis as a syndrome within a syndrome:

Exertional heat illness (EHI) encompasses a spectrum of disorders deriving from the combined stresses of exertion and thermoregulation. These include exertional dehydration, heat cramps, heat exhaustion, heat injury, heat stroke, rhabdomyolysis, acute renal failure, and hyponatremia. Early in the course of EHI it may be **difficult or impossible to distinguish** these entities and, in fact, they often overlap and are differentiated as the clinical manifestations evolve. They represent primarily a **continuum of multisystem illnesses** related to elevation of body core temperature and the metabolic and circulatory processes (including changes in fluid and electrolyte balance) that are brought about by exercise and the body's thermoregulatory response.⁷

Gardner classifies rhabdomyolysis as mild or severe,⁸ where severe rhabdomyolysis includes life-threatening complications.⁹ Vogel identifies exertional rhabdomyolysis by "myoglobinuria [myoglobin in urine], muscle pain, weakness, and soreness."¹⁰

Apart from myalgia [muscle pain], the initial clinical sign of rhabdomyolysis is the appearance of discolored urine. The presence of myoglobin gives urine a brown-red color. ... If myoglobin is more than 25 µg/ml, urine gets a dark brown red color. Efstratiadis.¹¹

However,

Myoglobin is rapidly and unpredictably eliminated by hepatic metabolism. Therefore, tests for myoglobin in plasma or urine are not a sensitive diagnostic procedure.¹²

Serum myoglobin has a half-life of 2-3 hours.¹³ Myoglobin in urine is unstable at low pH, with a half-life of 2.1 hours at pH = 4.5, and 45 to 70 hours at pH > 6.5.¹⁴

Besides being difficult to measure, the myoglobin molecule is not toxic until it is cleaved in an acidic medium.¹⁵ Therefore the normal treatment for preventing mild exertional rhabdomyolysis from becoming severe requires alkalinizing the urine to at least 6.5.¹⁶ However, the fact that the darkened urine has disappeared could signal greater danger for the athlete, that the myoglobin has disintegrated into particles toxic to the kidneys.

Mild and severe rhabdomyolysis may be considered two distinct forms, each difficult to diagnose. Muscle destruction is always present during physical conditioning.¹⁷ Under normal conditions, another authority teaches:

7 Bold added, Gardner, Textbooks on Military Medicine, (2002), Part IV, §4.2.1, below.

8 Gardner, *id.*, §4.2.2, below.

9 Gardner, *id.*, §4.2.3, below.

10 Vogel, Textbooks on Military Medicine, (1999), Part IV, §4.1.13, below.

11 Efstratiadis (2007), *id.*, p. 134. The figure of 25 mg/ml is likely a typographical error for 250 mg/ml.

12 Vanholder, R., et al, "Rhabdomyolysis", J.Am.Soc.Nephrol. 11:1553-1561, 8/1/2000, p. 1557.

13 Hamilton, R.W., et al., "Myoglobinuria, Hemoglobinuria, and Acute Renal Failure", Clin.Chem. 35/8, 1713-1720 (1989), p. 1716

14 Calculated from Chen-Levy, Z., et al., "Factors Affecting Urinary Myoglobin Stability In Vitro", Am.J.Clin.Pathol., 2005; 123-432-438, p. 436, Figure 1.

15 Efstratiadis (2007), *id.*, p. 133.

16 Sauret, J.M., et al., "Rhabdomyolysis", American Family Physician, 3/1/02. <http://www.aafp.org/afp/2002/0301/p907.html?printable=afp>

17 Vogel, §4.1.8.

In general, the diagnosis of rhabdomyolysis depends on clinical impressions and on the patient's symptoms, with laboratory results for confirmation. However, in about one-fourth of the cases – e.g., in nontraumatic rhabdomyolysis – the symptoms are vague, and biochemical analysis is necessary for diagnosis.¹⁸

The clinician is thus dependent on his medical interview especially to differentiate between exertional rhabdomyolysis and other forms, or to discover aggravating co-factors. When the NYPD Police Academy experienced a cluster of rhabdomyolysis cases in 2002, it attempted to discover the cause by a 15-page questionnaire. It met with such resistance for reasons of privacy and bias from refusal to respond to certain questions that it had to be abandoned.¹⁹ Those reasons seem particularly strong in any group environment where the individual is bound by codes, regulations, contracts, and the sagacity of deference.

Laboratory tests while essential cannot be definitive. Threshold levels have not been established for muscle products considered essential because upper healthy ranges overlap the lower disease ranges:

An increase in both serum myoglobin and serum CK of up to 40 times the upper reference interval has been detected in healthy military recruits (27) and in Olympics trainees performing strenuous exercises.²⁰

Unfortunately, neither Efstratiadis nor a literature search supplies the elusive upper reference levels. One of the CHAMP authors says,

Although the diagnostic criteria for ER are somewhat controversial, clinical practice guidelines recognize a serum CK level ≥ 5 times normal and a urine analysis positive for myoglobinuria as diagnostic.²¹

Deuster, et al., do not provide those critical normal levels, but their discussion reveals that the patterns of these chemistries along with muscle pain over several days are diagnostic.

The following from a report by Katrina Hedberg, MD, is illuminating.

Among 43 team members participating in the varsity "immersion" football camp held the week 15 Aug 2010, 3 had triceps compartment syndrome, 5 others had rhabdomyolysis with CK $> 23,200$ U/L (100 times the upper limit of normal for WVMC laboratory), and 14 others had rhabdomyolysis with CK between 2,320 U/L (10 times the upper limit of normal) and 23,200 U/L. Of the 22 team members with triceps compartment syndrome and/or rhabdomyolysis, all had muscle-related symptoms referable to the upper arm, 12 were hospitalized, and none had kidney failure. CK testing at McMinnville High School identified 16 of the 22 cases.²²

Although the CK threshold for diagnosing rhabdomyolysis has been proposed as 5-10 times the upper limit of normal, conditioned athletes who have had CK measured post-exertion in a non-clinical setting can have very high CK values. In one study of college football players in preseason practice, the average CK was 5,125 U/L, 30 times the norm for men. *Id.*, p. 11 of 12.

18 Citations deleted, Hamilton, RW, et al., "Myoglobinuria, Hemoglobinuria, and Acute Renal Failure", Clin.Chem. 35/8, 1713-1720 (1989), p. 1715.

19 Bragdon, C., "Investigating Cases of Rhabdomyolysis: Following a March 2002 New York Police Academy Training Course", 9/30/02.

<http://www.slideshare.net/dangthanhluan/36-investigating-cases-of-rhabdomyolysis>

20 Hamilton, R.W., et al., "Myoglobinuria, Hemoglobinuria, and Acute Renal Failure", Clin.Chem. 35/8, 1713-1720 (1989), p. 1716.

21 Muldoon, S., P. Deuster, M. Voelkel, J. Capacchione, and R. Bunker, "Exertional Heat Illness, Exertional Rhabdomyolysis, and Malignant Hyperthermia: Is There a Link?", ACSM, Current Sports Medicine Reports, Abstract, March/April 2008 [Deuster, et al., (2008)], p. 75.

22 Hedberg, K., "Preliminary Report: Cluster of Compartment Syndrome and Rhabdomyolysis Among McMinnville High School Football Team", 9/2/10, pp. 8-10 of 12.
http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&ved=0CCIQFJAA&url=http%3A%2F%2Fpublic.health.oregon.gov%2FDiseases&ons%2FInjuryFatalityData%2FDocuments%2FOPHD_Football_Prelim_Report.pdf&ei=IR0-UM2xJ4aKrgGyo4GYAg&usq=AFOJCNG-x4Q8Aj3fKJm2ds-8rz98Cc4ow

Hedberg's normal level is a local level, established for the Willamette Valley Medical Center. Hospitalizations were for CK levels between 10 and 100 times the local normal, although in another study cited, the average for a number of football players post-exertion was 30 times the norm for men, whatever that might have been. With the release of myoglobin a concern arises for the pH of both blood and urine, and Robergs reports that only two to three minutes of intense exercise to exhaustion has been shown to decrease serum pH from 7.0 to 6.4,²³ just below the common threshold found in the literature for alkalinizing the patient's urine.

Efstratiadis, et al., provide an instructive diagram for the evolution of rhabdomyolysis into acute renal failure.²⁴ It illustrates the essential step of the breakdown of myoglobin by uric acid causing cast formations that restrict blood flow in the tubules of the kidney. The authors attribute the rise in uric acid to the release of nucleotides in the cells, which is a byproduct of ATP breakdown during anaerobic exercise, and their metabolism in the liver. The chart implicitly has two inputs to the disease—breakdown in muscles leading to myoglobin in the urine, and dehydration, which initiates constriction of blood vessels in the kidney and reduces pressures necessary for filtration. This model underscores the importance of maintaining good hydration for exercise, and including urinary pH as soon as any symptoms develop. Gardner suggests that individuals should maintain good hydration by keeping their urine color, volume, and density at normal levels. Gardner says one of the most important indicators of acute renal failure is “evidence of myoglobinuria”, but he does not expound on that evidence, and never mentions darkened or colored urine.

Gardner's classification scheme, above, is unsymmetrical, and it does not satisfy those definitions of rhabdomyolysis linked to an unspecified degree of muscle damage, including his own.²⁵ In his scheme, mild EHI has no rhabdomyolysis, intermediated EHI includes mild rhabdomyolysis, and severe EHI includes severe rhabdomyolysis. His mild rhabdomyolysis can be either “asymptomatic elevation of serum skeletal muscle enzymes”, or “symptomatic mild rhabdomyolysis”. A better, symmetrical classification would be mild, intermediate, and severe rhabdomyolysis, where mild covers subclinical muscle damage, intermediate includes an instance of darkened urine, and severe is accompanied by symptoms of compartment syndrome or additional evidence of acute renal failure (ARF), as suggested by Gardner in his Exhibit 7-5, p. 246.

Nonetheless, the Textbooks on Military Medicine provide a simple diagnostic standard:

Acute rhabdomyolysis is a condition that has historically been related to military recruit physical training. This injury syndrome is characterized by **myoglobinuria**, muscle pain, weakness, and soreness.²⁶

However, no threshold for myoglobin exists to accept or reject a diagnosis of rhabdomyolysis because it is not reliable. The kidneys remove myoglobin too quickly.²⁷

The inability of medicine to grade rhabdomyolysis in an individual, and to attribute it to the one hundred different causes, in no sense means the disease does not exist, nor does it lessen the importance of even vague symptoms of this disease that can lead to death. An individual can be in grave renal failure due to rhabdomyolysis and be relatively asymptomatic. Physical conditioning or PT is a screen for the considerable but unquantifiable number of individuals in the one and a half million active duty members of the armed forces who have one of the abundant causes of rhabdomyolysis. How many are caught in that screen with and without co-factors is today a statistical matter.

23 Robergs, R.A., F. Ghiasvand, D. Parker, “Biochemistry of exercise-induced metabolic acidosis”, *Am.J.Physiol.Regul.Integr.Comp.Physiol.* 287: R502–R516, 2004, p. R505.

24 Efstratiadis (2007), *id.*, p. 133, Figure 3, “Pathophysiology of ARF in rhabdomyolysis”, referencing a 2005 paper by Singh, Chander, and Chopra behind the paywall.

25 §4.2.5, below.

26 Bold added, Vogel, J.A., and J.F. Patton, “Physical Fitness and Physical Training for Military Performance”, *TMM, Rehabilitation of the Injured Combatant*, v. 2, (1999) Ch. 13. See Part IV, below, Vogel, Note 13.

27 Efstratiadis (2007), *id.*, p. 134.

As surely as the disease is "difficult to impossible" to diagnose in its milder forms, it exists and it is associated with exertion. This is clear in famous clusters of cases—the hospitalization in 1971 of 40 Marines in a single platoon in Beaufort, SC,²⁸ the hospitalization of 10 out of 28 seasoned NYPD officers in a three-day academy plainclothes training course²⁹, the hospitalization of 22 out of 43 members of the McMinnville High School, Oregon, squad following a one-week immersion football camp.³⁰ Examination of these clusters reveals, or strongly suggests, that the co-factor 6, "sporadic, strenuous exercise"³¹ is not just in play, but can be essential to the development of ER.

AFHSC reported 14 small clusters of exertional rhabdomyolysis in the military for 2005 through 2008.³² The criterion was three or more cases within seven days. These clusters were not well defined, involving 4, 5, or 6 cases spread over a week. In a later MSMR, AFHSC provided a chart showing clusters of notifiable heat injuries from a single southeastern training installation for 2011, accompanied by the heat index in °F.³³ The clusters were uncorrelated with temperature ($R^2 = 1.3\%$), but the size of the clusters were immense. The top two clusters were 94 and 91 cases, and the next five numbered 76, 71, 68, 50, and 48. The number of reporting days was 19 out of 95, leaving in question whether the 76 days with no reports had no cases or no training. The data did not include the number of participants in the training, so the rate could not be determined, and it provided no breakdown in rhabdomyolysis, heat stroke, and other heat injuries. The clustering needs further investigation.

By design, CrossFit provides several defenses against exertional rhabdomyolysis. Its exercises are brief, lasting less than about 20 minutes. With normal hydration before the workout, dehydration has little chance of developing. CrossFit's exercises mix anaerobic and aerobic pathways, tending to neutralize metabolic acidosis over time, reducing the level of lactic acid. Anaerobic exercise tends to produce lactate, while aerobic exercise absorbs it. Each CrossFit workout is a prescription for loaded movements, not a standard for total work done or maximum power developed. In this way CrossFit workouts are individualized, each to stress the individual to perform not to an external standard, but gradually to improve his "personal best". Many gyms conduct CrossFit classes where athletes learn safe and productive movements with a common workout, but each develops no more work or power than that which will just stress his own capabilities. CrossFit workouts also individualize by encouraging athletes to modify workouts by adjusting loads or substituting movements to suit their capabilities. CrossFit is not susceptible to the overexertion caused by group training where all athletes are held to the same standard of work produced or power demonstrated. CrossFit teaches its trainers and those who would self-train to be alert to the hazards of the untrained or deconditioned athlete.

28 Demos, M.A., Gitin, E.L., "Acute Exertional Rhabdomyolysis", Arch.Intern.Med. February 1974;133(2):233-239, Abs.

29 Bragdon, C., "Investigating Cases of Rhabdomyolysis Following a March 2002 New York Police Academy Training Course", 9/30/02. <http://www.slideshare.net/dangthanhtuan/36-investigating-cases-of-rhabdomyolysis>

30 Hedberg (2010), above.

31 §4.4.6.2-6, below.

32 MSMR, Vol. 16-3, March 2009, p. 12.

33 MSMR, Vol. 18-10, October 2011, p. 19.

1.2. Military heat illness reports confuse rhabdomyolysis and heat stroke, but support a finding that war and not ECPs is the cause of an overstated rise in injuries.

The online Merck Manual for professionals presumes the reader is familiar with rhabdomyolysis, referencing it many times but providing no explicit definition. The Manual divides *heat stroke* into two variants, *classic* and *exertional*, noting “some differences” in this table:

Table 2: Some Differences Between Classic and Exertional Heat stroke

Characteristic	Classic Heat stroke	Exertional Heat stroke
Onset	2 – 3 days [of exposure]	Hours
Patients usually affected	Elderly, sedentary people	Healthy active people (e.g., athletes, military recruits, factory workers)
Risk factors	No air-conditioning during summer heat waves	Intense exertion, particularly without acclimatization
Skin	Hot and dry	Often moist with sweat

Also, the Manual explains “rhabdomyolysis is common” in exertional heat stroke. The Merck Manual provides no guidelines by which a health care specialist might differentiate rhabdomyolysis with exertion from *exertional heat stroke*, a disease recognizable because it occurs among healthy, active people.

Merck does not rule out the possibility of a single risk factor being sufficient with minimal heat, a conclusion known by experience and confirmed in the data. A sufficiently intense exercise in a benign environment can induce rhabdomyolysis in anyone, but the intensity required is substantially reduced in hot and humid conditions. Military data on exertional rhabdomyolysis is sufficient to permit quantifying that amplifying effect of heat.

The Armed Forces Health Surveillance Center (AFHSC) publishes Medical Surveillance Monthly Reports (MSMRs), data on which the *Consensus Paper* relies. AFHSC began an annual series on “Heat-related Injuries, U.S. Armed Forces” in May, 2007 (Vol. 14-2), each report showing trends over the past five years. It began another series the next year on “Exertional rhabdomyolysis among U.S. military members” (Vol. 15-2), the first edition covering the previous four years, and thereafter each report covers five years. Until 2012 (Vol. 19-3), the MSMRs always referred to exertional rhabdomyolysis as *presumed*, explaining,

For several reasons, the findings of this report are difficult to interpret. For example, because there was not a diagnostic code specific for “rhabdomyolysis” prior to 2004, a reliable record of past experience is not available for assessing recent experience. Because of the recency of implementation of a specific diagnostic code, it is difficult to determine if the increase in reported cases of “rhabdomyolysis” from 2004 through 2007 reflects increasing awareness and use of the code in standardized reporting, the continuation of a trend of increasing incidence, or a recent increase in case incidence. Also, the diagnosis of “rhabdomyolysis” does not indicate the cause; in turn, it is difficult to discern cases that are “exertional” and/or heat-related from those with other precipitating causes.

Still, the findings of this analysis are informative and potentially useful for prevention. They confirm that, in U.S. service members, most cases of exertional rhabdomyolysis occur in mid-to-late summer at basic combat/recruit training installations and at home bases of major Army and Marine Corps combat units. They also suggest that service members who represent black and “other” non-white race/ethnic groups have relatively increased risks of exertional rhabdomyolysis during military service.

Individuals who suddenly increase overall levels of physical activity and/or increase stress on weight bearing muscles – particularly in high heat and humidity – are at increased risk of exertional rhabdomyolysis. Recruits who are not physically fit when they begin training have relatively high risks of training-related (including exertional heat) injuries, in general. Also, recruits from relatively cool and dry climates may not be acclimated to the high heat and humidity at training camps in mid-late summer. Finally, soldiers and Marines in combat units often conduct rigorous unit physical training, personal fitness training, and field training exercises regardless of weather conditions. It is not surprising, therefore, that recruit camps and installations with large combat units account for most exertional rhabdomyolysis cases.³⁴

Analysis of the logical combination of ICD codes used by AFHSC to distinguish exertional rhabdomyolysis from other heat injuries does not resolve the uncertainty in classification. For example, ICD-09 Code 992.0 is “Heat stroke and sunstroke”, under which are codes 992.3-5 “heat exhaustion” and 992.9 “effect of heat and light”. The latter two comprise AFHSC’s “Other heat injury”, and they overlap ICD-09 codes 992.0-992.9, sometimes termed “effects of heat”, which are a conditional part of AFHSC’s criteria for exertional rhabdomyolysis.

The contribution of exertional rhabdomyolysis is small within the spectrum of exertional heat injuries. See Figure 2. Therefore, a small misclassification of heat stroke or other heat injuries as exertional rhabdomyolysis has an exaggerated effect on the ER record.

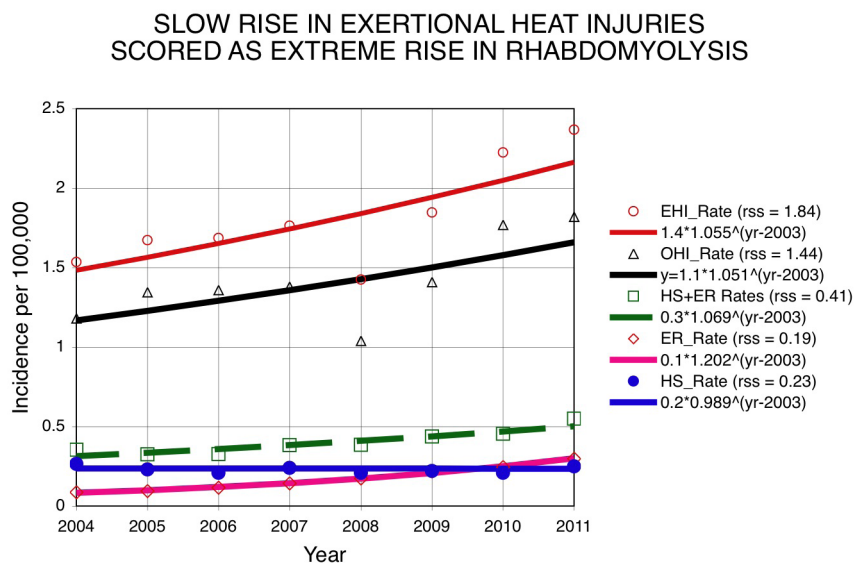


Figure 3
Exertional Heat Injury (EHI) rate, rising 5.5%/year, comprises a 5.1%/year rise in Other Heat Injuries (OHI), a 1.1%/year **decline** in Heat Stroke (HS), and a **20.2%/year rise** in Exertional Rhabdomyolysis (ER).

Since the addition of the 2004 diagnostic code, exertional rhabdomyolysis has been rising at 20.2% per year, while the incidence of heat stroke has been in decline at 1.1% per year. Because they are “difficult or impossible to distinguish”, the AFHSC fears that the ER increase “reflects increasing awareness and use of the [diagnostic] codes” has materialized.

AFHSC data show that the incidence of heat illness (HI) is greatest for the youngest, and decreases steadily with age. Figure 4, below. However, the AFHSC data have the properties that both the distribution by age group of cases and population are remarkably constant for empirical data. The distribution of cases is nearly constant year by year for the six years reported to date, 2006 to 2011. A mathematical model of the average of the cumulative number of EHI cases (HI + ER) over these years yields a model for the number of cases at every age:

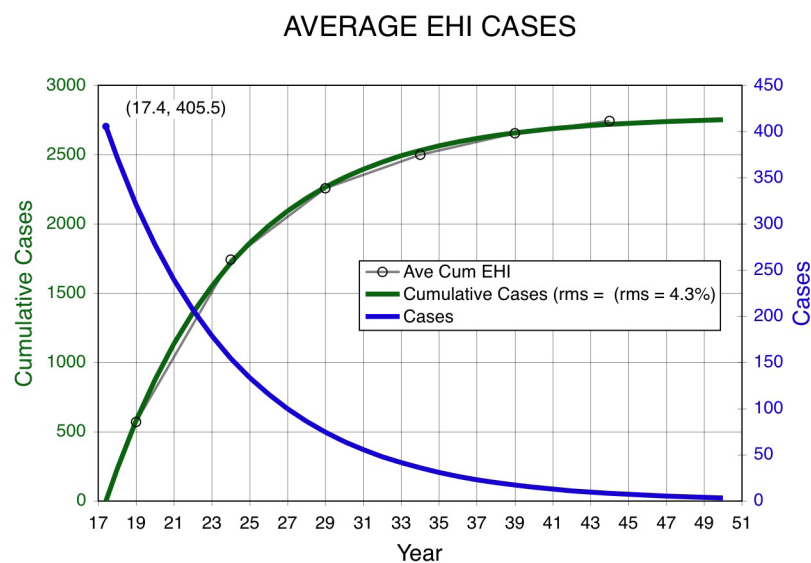


Figure 4

The smoothly increasing distribution (cumulative) of Exertional Heat Illness events is the result of a density that smoothly declines with age. The model is accurate without assuming other events, such as the acclimation of recruits.

The distribution at each age is well-modeled by the average of Figure 4 multiplied by a single scalar for each year. That factor shows that the number of EHI cases, representing the combination of increases in the incidence per capita of EHI plus the increase in population, has been increasing at 7.8% per year, as shown in Figure 5. The error in the representation of cases by a multiple of the average is 2.3% or less each year.

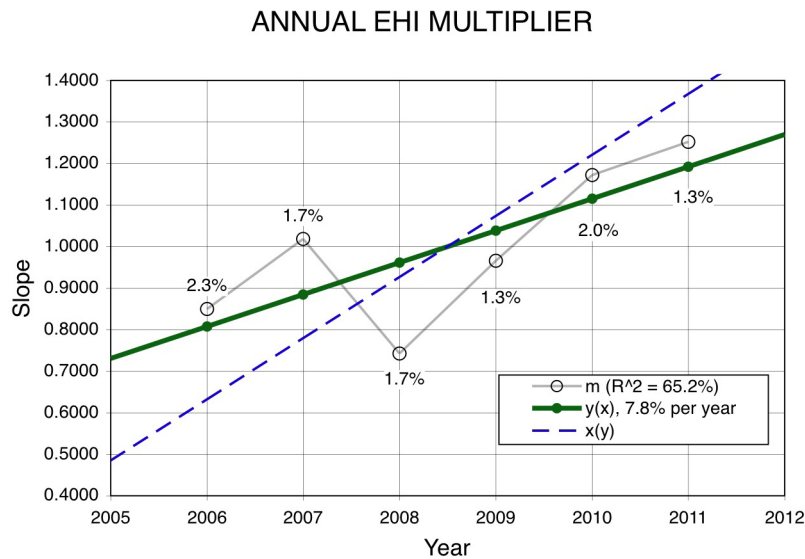


Figure 5
Cumulative Exertional Heat Illnesses is a distribution that has
been rising at 7.8% per year.

The AFHSC data include the number of cases by various categories along with the incidence or rate per 1,000 person-years. The ratio of cases to incidence is an estimate of the number of individuals in each category. The population by age in the military has a distribution exhibiting a remarkably constant pattern from year to year, a pattern that slowly increases with age. This pattern is the result of a density that smoothly declines with age. Both the distribution and density with age are in Figure 6, below.

MILITARY POPULATION BY AGE

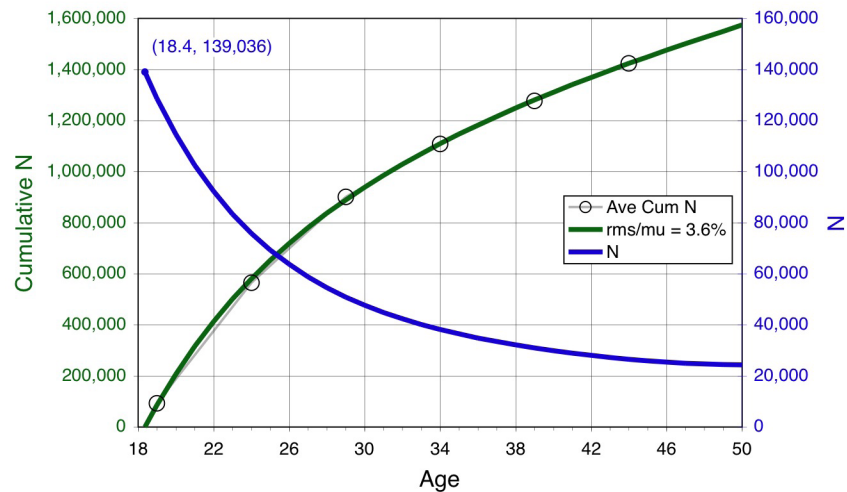


Figure 6

The distribution of the number of individuals in the military averaged over the six reporting years increases smoothly with age, yielding a smoothly declining population density with age.

ANNUAL POPULATION MULTIPLIER

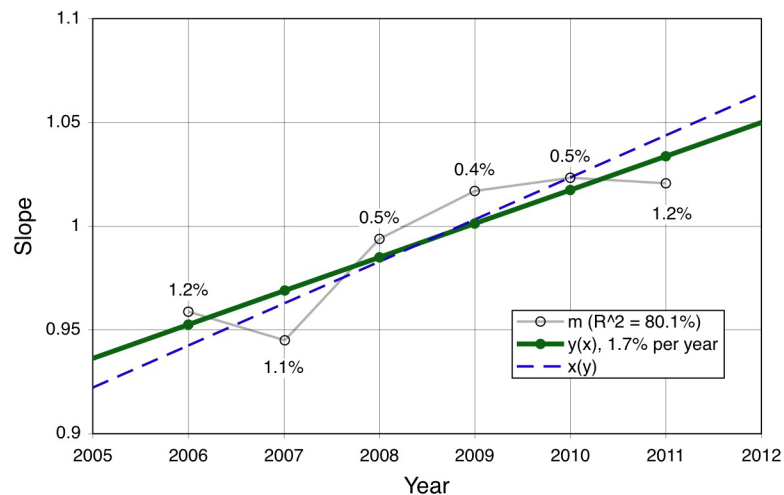


Figure 7

The population distribution each year has been a multiple of the average distribution over the years, accurate to within 1.2%, and increasing at 1.7% per year to add to the number of EHI cases. The rate of increase of EHI cases due to causes other than population growth is 6.1% per year.

The population distribution each year is the average over all years multiplied by a factor that increases every year. The reported rate of increase in military population is 1.7% per year.

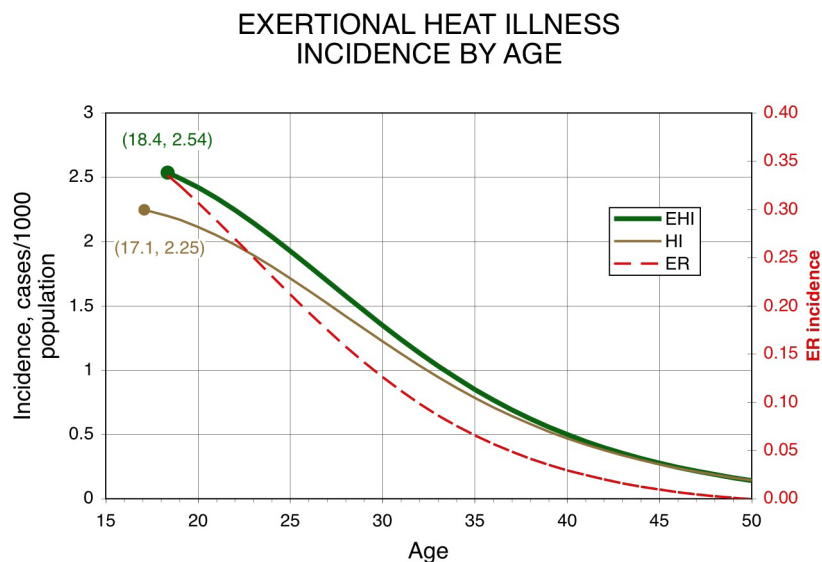


Figure 8

The incidence of both Exertional Heat Illness (EHI) and AFHSC's Heat Illness decrease smoothly with age, the difference attributable to Exertional Rhabdomyolysis (ER).

Combining the all-age models for both the number of cases and the total population yields a single model for the incidence of EHI per 1,000 individuals at every age. The ratio predicts that the vulnerability of individuals to exertional heat illness declines steadily with age from at least age 18.4 years to about 50 years of age. The reasons may be psychological, in particular learning to resist temptations to overexert. A corollary is the invulnerability of men around 19 years of age that makes them fearless warriors. The data need no other explanation peculiar to recruits.

1.2.1 Exertional rhabdomyolysis cases in the military are dominantly heat amplification of the effects of exertion.

AFHSC provided a seasonal chart for “presumed exertional rhabdomyolysis” for ambulatory visits and hospitalizations by month, totaled for the years 2004 through 2008 for all services.³⁵ The next figure contains the combined incidents from that report with a best-fit (least squares) estimate comprising a constant background rate as the base for a variable number of cases, seasonal effects represented by a cosine wave. The seasonal effect is obvious, but the curve fitting quantifies it. The record of presumed exertional rhabdomyolysis cases is 84.5% due to a seasonal effect, 11.1% from a constant background incidence, plus about 4.4% random effects that average zero.

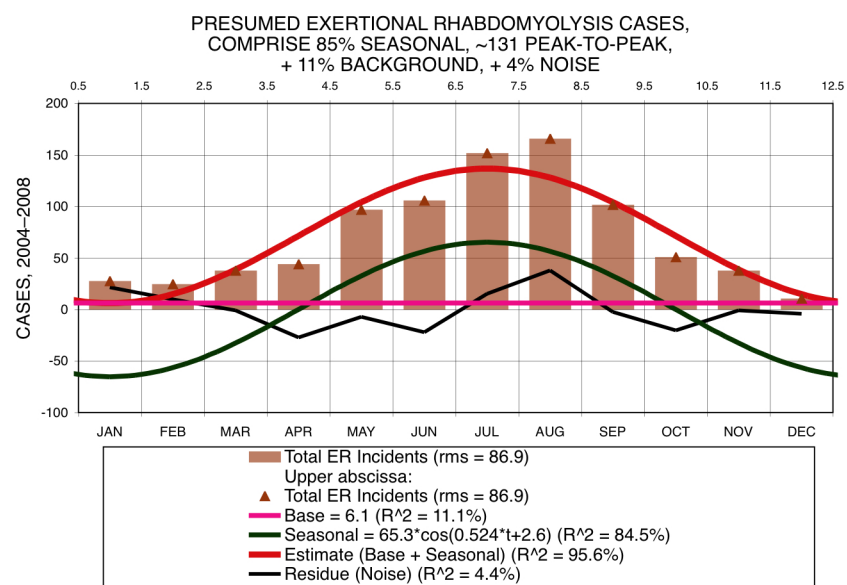


Figure 9
Exertional Rhabdomyolysis in military experience
is dominantly a heat effect.

One consequence of this seasonal dependence is that in the military experience, exertional rhabdomyolysis is as predictable as heat stroke from the total incidence of AFHSC heat injuries.

35 MSMR2009, v.16-3, figure 11, p. 22.

These four observations -- the broader category of Exertional Heat Illness (Gardner), the classification of Exertional Heat stroke in which rhabdomyolysis is a common symptom (Merck), the difficulty in differentiating between moderate heat illnesses (AFHSC), and that heat is the dominant cause of exertional rhabdomyolysis -- show that the separation of exertional heat illness into heat injury and exertional rhabdomyolysis is artificial. Furthermore, the division is misleading. These data contradict the conclusion co-authored by a CHAMP executive and *Consensus Paper* author, that

ER [Exertional Rhabdomyolysis] [occurs] unrelated to heat and humidity after strenuous exercise.³⁶

This article also says,

Unlike EHI/EHS, ER occurs in both cool and warm environments. *Id.*, p. 77.

The claim that ER is unique cannot be shown from the AFHSC data, even though ER can be induced with certainty in any environment. However, the data show that in the military experience, the odds are eight to one against heat not being a cause. Moreover, as Deuster, et al, note, "the true incidence of ER is unknown". *Id.*, p 75.

Military data on exertional rhabdomyolysis do not support the *Paper's* "potential emerging problem".

³⁶ Muldoon, S., P. Deuster, M. Voelkel, J. Capacchione, and R. Bunger, "Exertional Heat Illness, Exertional Rhabdomyolysis, and Malignant Hyperthermia: Is There a Link?," ACSM, Current Sports Medicine Reports, Abstract, March/April 2008.

1.2.2 The War on Terror is a probable cause for observed increases in heat illness.

The second confounding problem is that the *Paper* generalizes from CrossFit to a half dozen competing conditioning programs. One, Gym Jones, is a compromised, CrossFit knock-off which has been recommended as preferable to CrossFit for the US Army Rangers PT program, Ranger Athlete Warrior (RAW).³⁷ The others are unrelated programs, together featuring body-building with non-functional exercises, infomercial selling of equipment and exercise routines, and club membership sales.

The *Consensus Paper* deduced that the growth in ECP programs caused an increase in training injuries, relying on the facts of a growth in CrossFit concurrent with a hypothetical increase in heat-related injuries. At best, this deduction rests on a fallacy: the assumption that correlation proves causation.

With no other information, an explanation for the data is that the failure of conventional physical training, manifest in slowly rising injury rates, has caused trainees in need of better conditioning to turn to CrossFit. Whether CrossFit increased training injuries or the reverse depends in part on whether the growth in CrossFit popularity leads or lags the injuries, respectively. The data available are too few and too coarse for a meaningful estimation of the underlying lead-lag relationship. A reasonable conclusion, supported by the observations, is that inadequacies in the conventional physical training regimen, manifest in slightly higher injury rates, is causing the training commands to turn away from traditional callisthenic/running programs to commercial conditioning programs, and to CrossFit in particular.

Yet a third possibility remains with respect to causality. Two phenomena may be correlated, with or without one in the lead, when each is an effect from a third phenomenon, a common cause. For example, any two seasonal effects selected at random, however distant on Earth, are correlated.

Another profound event, namely war, is a candidate cause for increased exertion in military conditioning and training. Between 2000 and 2005, the number of military deaths from all causes increased by 150%.

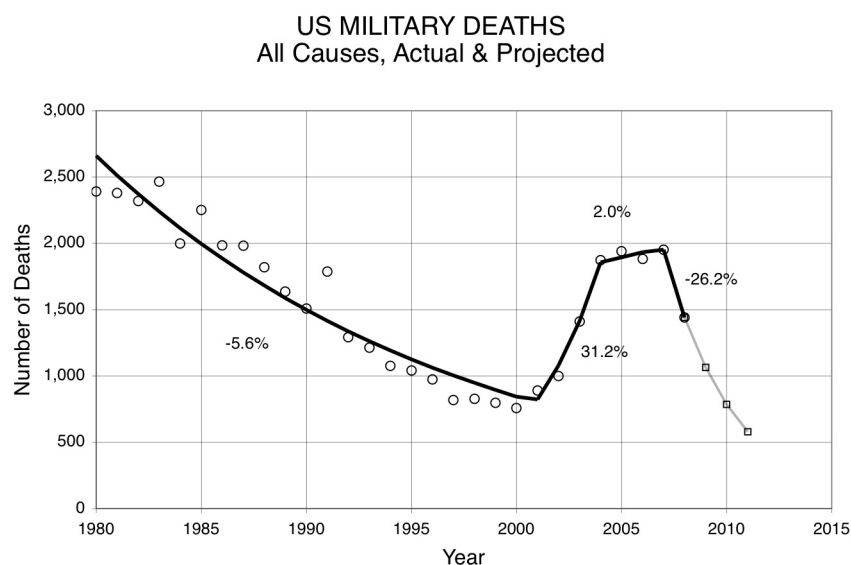


Figure 10
U.S. Active Duty Military Deaths, 1980–2008³⁸

37 Anonymous, "Are CrossFit and Gym Jones compatible with RAW?", <http://hprc-online.org/physical-fitness/files/are-x-fit-gymjones-compatible-with-raw>. An HPRC article entitled "RAW Assessments" refers once to "... hybrid workouts from X-Fit, Gym Jones ..." as equivalents. Ellipses in original, <http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&ved=0CEMQFjAA&url=http%3A%2F%2Fhprc-online.org%2Fphysical-fitness%2Ffiles%2Fraw-assessments-task-conditions-standards&ei=XQExUNaKNci-2gWty4HwBg&usq=AFOjCNH9LLf60LSJAT-HLFHBKV-z3kU8g>

38 Congressional Research Service, American War and Military Operations; Casualties: Lists and Statistics, 2/26/10, P. 7, Table 4.

For over 20 years, the period of eligibility for military retirement, US military deaths declined at 5.6% per year. Then with the attack on 9/11 and into the first three years of the War on Terror, military deaths soared at over 31% per year to remain elevated and rising at 2% per year for three more years.

Did this surge in casualties create a demand among recruits for better personal conditioning? Among drill instructors for more fit replacements? Among field medics for better survival rates? Among the services as a matter of policy? Does a more powerful incentive exist to train harder, to be better prepared?

At least the reverse conjecture, that what was good enough conditioning for peacetime is good enough for war, seems most improbable and contrary to history. If the war time conjecture is to be elevated to a hypothesis, the onset of war implicit in Figure 10, above, must be an event that reasonably leads the rise in military heat-related injuries. That criterion essential to raising the conjecture to a hypothesis is indeed satisfied, as shown in Figure 11 next.

CROSS CORRELATION OF EHI & PAST DEATHS

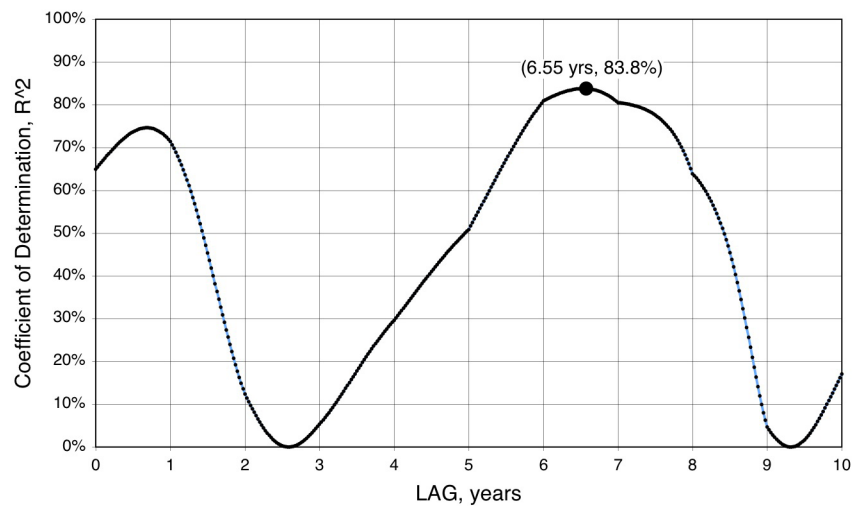


Figure 11

The cross-correlation function suggests Exertional Heat Injuries are responding strongly to the seven-year-old surge in military deaths from the War On Terror.

The surge in war casualties predicts 84% of the rise in training injuries with a lag of almost seven years.

Showing that one variable leads another is essential to the scientific investigation of causality, in which a model places the leading variable as the Cause and the lagging variable as Effect. The authors of the *Consensus Paper* speculated that the rise in ECP popularity was the cause of added injuries, but were unsuccessful for failing to establish that ECP popularity preceded the injuries. To the contrary, the War On Terror cannot be discounted as the cause of the increase in training and conditioning injuries, regardless of the number of cases involved in the increase.

1.2.3 How not to mistake correlation for Cause & Effect.

The CHAMP/ACSM authors, all credentialed scientists, are not alone in this failure to employ basic modeling precepts. Climatologists, for example, wrongly declared CO₂ to be the cause of global warming, instead of the reverse: global warming (which is due to the Sun) causes CO₂ to increase. This error stemmed from a failure ever to measure which leads which, or indeed that any of the dozens of relevant relationships in Earth's climate meet this essential criterion for establishing Cause & Effect. Further, the CO₂ would have had to lead by eons because of the massive heat capacity of the ocean making it take on the order of a century to respond. Heat capacity is not included at all in their Global Climate (Circulation) Models.

An immediately applicable error in Cause & Effect is the association of lactic acid or lactate with acidosis, generally and incorrectly called lactic acidosis.³⁹ Robergs, et al, establish that

metabolic acidosis is caused by an increased reliance on nonmitochondrial ATP turnover and not lactate production.⁴⁰

They conclude that the concept of lactic acidosis is invalid. They also conclude that aerobic exercise, which they refer to as mitochondrial respiration, controls the balance of protons within the cells, counteracting acidosis from ATP hydrolysis during anaerobic exercise.

A Nobel prize went to Hill and Meyerhof in 1922 for their earlier work linking lactic acid production and acidosis.

The unquestioned acceptance of a lactic acidosis is a hallmark of almost all of the basic and applied science research of muscle metabolism since the 1920s.⁴¹

Robergs, et al., show how investigators verified lactic acidosis by the strong correlation between declining muscle pH and increasing muscle lactate. Robergs also show how acidosis increases production of lactate.

Thus lactate formation and efflux from working muscles is more a consequence than a cause of acidosis.⁴²

The correlation was valid, but cause and effect have been reversed for 80 years. Robergs casts new light on CrossFit's three metabolic pathways, on the design of its workouts, and on implications for inducing rhabdo.

Because this deficiency in general science literacy is so commonplace, a couple of charts should help dispel the mystery in the simple but essential procedure of cross-correlation.

The classic problem is to analyze the relationship between two variables of a system, where each is observed only as it depends on yet a third, independent parameter, such as time, temperature, pressure, distance, mass, electric charge, and so on, singly or in combination, and without limit. The word parameter used in this sense has the same meaning as in the algebra of parametric equations. High school algebra includes the study of parametric equations, such as $x = \cos(t)$ and $y = \sin(t)$, which are the parametric form of a circle, $x^2 + y^2 = 1$. The cross-correlation process requires transforming a pair of numeric relations in coordinates (x,t) and (y,t) into a single statistical relation in the coordinates of (x,y), and while the process is numeric instead of algebraic, the process has a helpful graphical representation.

³⁹ Robergs, et al, *id.*

⁴⁰ *Id.*, p. R513.

⁴¹ *Id.*, p. R504.

⁴² *Id.*, p. R512.

Step one begins with assembling the relationships in their parametric form, as shown by the solid black circles in Figure 12. Next is to shift the candidate cause forward by an amount called the lag, conventionally designated by the Greek letter tau. To eliminate the independent parameter, the data samples often require adjusting to make them coincidental with respect to the independent parameter. The analyst does this by interpolation, often linear, but the method tolerates any form of interpolation, and is an art which affects the character of the cross-correlation curve but usually not the ultimate conclusion.

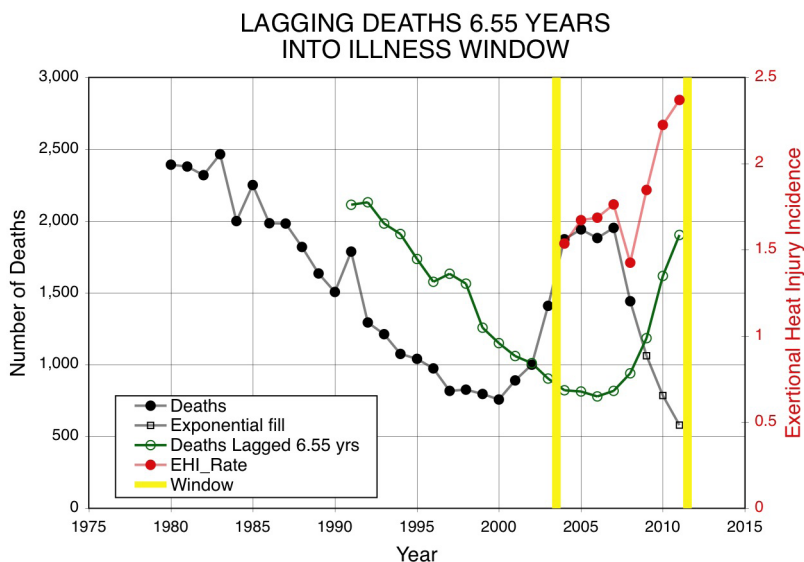


Figure 12

Parametric graphs of Exertional Heat Illness incidence (red), and original (black) and lagged (green) US Military Deaths, in preparation for cross multiplying in the window.

The curve in green in Figure 12 is the US Military Deaths record shifted by 6.55 years using two-point linear interpolation to integer years. Non-parametric data are now available as eight coincident pairs within the window of the shorter record. These coincident pairs are the hollow points in the next chart, Figure 13.

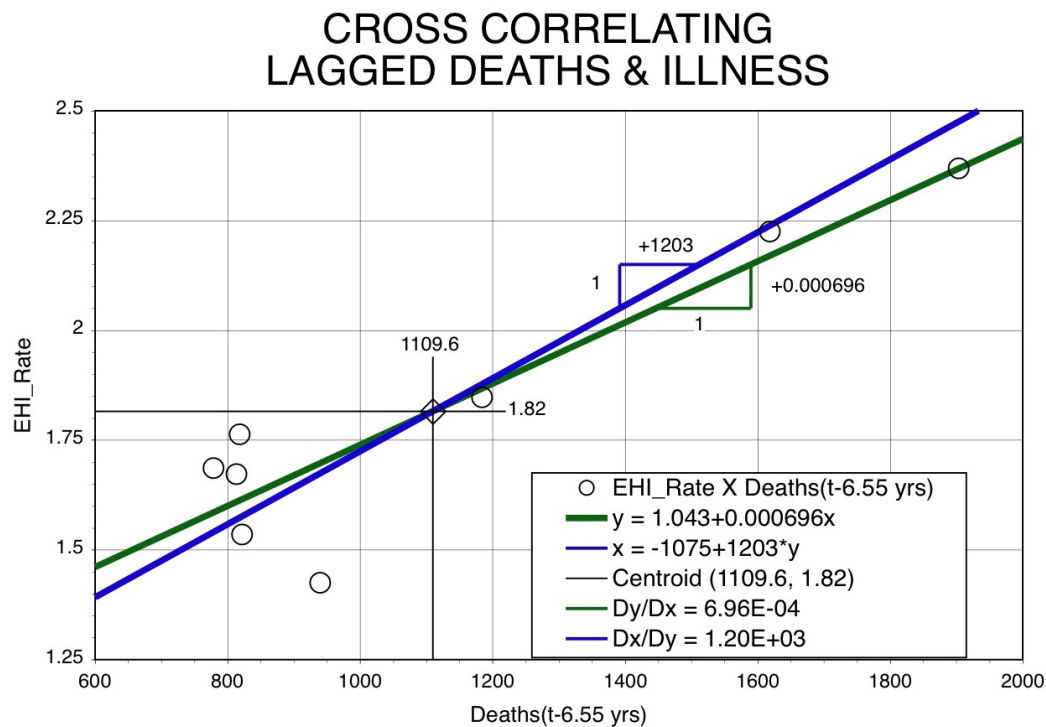


Figure 13

Coincident pairs of Exertional Heat Illness and lagged US Military Deaths with linear regression lines that show that the two records are well-correlated, but attributable to the two data pairs for 2010 and 2011.

This non-parametric chart—popularly though sometimes misleadingly called a scatter graph—often reveals algebraic relationships between the variables, and any randomness between them. The straight lines, called regression lines, are linear predictions of each variable created from the other. They cross at the averages. The product of their slopes, $1203 \cdot 0.000696 = 83.8\%$, is the Coefficient of Determination, better known by its symbol, R^2 , where R is the Correlation Coefficient, here for the lag of 6.55 years. The parameter R^2 shows how much of the energy represented in the record of one of the variables can be accounted for by a linear operation on the record of the other.

1.3. The Conclusions of the *Consensus Paper* must be rejected as unsupported and contradicted.

The *Consensus Paper* says of ECPs,

The increasing acceptance is reinforced by widespread anecdotal reports of marked gains in physical fitness and performance. In addition, some Warfighters believe these programs contain functional training that directly translates into more effective performance on the battlefield. However, physicians and other primary care and rehabilitation providers have identified a potential emerging problem of disproportionate musculoskeletal injury risk, particularly for novice participants, associated with ECPs (13,16).⁴³

The *Paper* makes no attempt to remove the anecdotal nature of these reports with data. Instead it asserts what “some Warfighters believe” only to caution against that belief with what it alleges is the work product of relevant medical practitioners without limit. In support, the *Paper* cites two inappropriate and irrelevant articles.

The *Consensus Paper*’s triply hypothecated “potential emerging problem associated with increasingly popularized extreme conditioning programs” in its first sentence has not materialized in either cause or effect. The *Paper* provides no evidence for the rate of “muscle strains, torn ligaments, [or] stress fractures”. No evidence exists for musculoskeletal injuries, and the March AFHSC Reports of an epidemic in exertional rhabdomyolysis are likely erroneous for the reasons included by AFHSC. The *Paper*’s references cited in the sentence proclaiming a “potential emerging problem”, references 4 and 27, provide no support for either assertion. For more detail, see Part III, below.

The reported rise in rhabdomyolysis is likely a categorizing error because it accompanies an improbable decline in heat stroke. The two are recognized in textbooks to be indistinguishable until they reach life-threatening stages, which are not among the data. The rate of increase of exertional rhabdomyolysis and heat stroke combined is 7% per year, within 1.5% of the rise in the rate of the parent class of exertional heat injuries.

The claims of the *Consensus Paper* must be rejected because the CHAMP and ACSM authors rely on anecdotal reports of exertional rhabdomyolysis, providing no data on the increase in popularity of ECPs. Nor do they provide any data on actual ECP participation in the military, much less a causal analysis showing from data that any increase leads the reported illnesses and alleged injury rates, as causality requires.

The *Paper* says,

For many Warfighters, the demanding exercise pace, overall difficulty, and perceived potential for “getting ripped” are appealing, exciting, motivating, and appear to target a niche of otherwise unmet training needs and desires.

There is no voice for the Warfighters here. This image invoked of a beauty contest is denigration, not self-deprecation. What is exciting, or better energizing, is the prospect of being deployed for multiple tours in a combat zone where the probability of becoming a sudden casualty is disproportionately high. That risk is quantified, and like a cause, leads both the rise in exertional heat illness and in the popularity of, especially, CrossFit.



43 *Consensus Paper, id.*, p. 383.

PART 2

PART 2:

THE CONSENSUS PAPER DISCLAIMS ITS OWN AUTHORITY

2.1. The *Consensus Paper* supports the conclusion that it is a mock interim consensus or final consensus of a mock conference.

Under the ambiguous subheading *Methods and Approach*, the subject *Consensus Paper* explicitly describes the consensus-seeking process of a

collaborative workshop, composed of [CHAMP], other members of the [DoD], and representatives of [ACSM]

of September 13 and 14, 2010. The full title of the conference was

HPRC & ACSM's *High Intensity Training Conference and Performance Optimization Workshop*, sponsored by Human Performance Resource Center [HPRC], September 13-14, 2010, Uniformed Services University for the Health Sciences [USU], Bethesda, MD.¹

HPRC is a daughter organization in the education arm of CHAMP within USU, all three DoD organizations.²

The *Consensus Paper* cites no publications relating to the High Intensity Training Conference and Performance Optimization Workshop. The *Paper* has no references to the workshop agenda, to its invitees, presenters, or attendees, to its proceedings, or to any deliberations. It has no reference to any work product beyond an anonymous name change from High Intensity Training (HIT) to Extreme Conditioning Programs (ECPs).

However, HPRC discusses the conference in an article entitled "Are high-intensity training programs safe and effective"³. In another called "High Intensity Training PowerPoints", HPRC provides links to eight presentations from the conference⁴. Seven presentations from the conference are available for public viewing on scrib.com (find via "Uploaded by: cwolf88"), where they are downloadable for a fee.

1 <http://www.scribd.com/doc/80586180/Hprc-5fhit-5ftemplate-2d1-5f1-5fwthompson>

2 <http://hprc-online.org/about-us/about-hprc#about-us>

3 <http://hprc-online.org/physical-fitness/hprc-articles/are-high-intensity-training-programs-safe-and-effective-2>

4 <http://hprc-online.org/physical-fitness/policy-and-standards-1#reports-1>

#	Title	Access	Scribd
1	HIT Executive Summary	Public	Bergeron, et al., "CHAMP/ACSM Executive Summary: High-Intensity Training Workshop", 4/4/11 [EXEC SummaryECP Final] ^(a)
2	Injury Prevention Considerations	Password	Bergeron, M.F. [HPRC_HIT_Bergeron-Injury Prevention] 2/6/12
3	Research Needs in HIT	Password	Bergeron, M.F. [HPRC_HIT_Bergeron-Research Needs in HIT] 2/6/12
4	HIT and Dietary Supplements	Password	Deuster, P.A., "Nutrition, Supplements, and [HIT] Programs" [100914 DEUSTER nutrition HITs.ppt (HIT Pad Final)] 2/6/12 ^(b)
5	Guidance Development Presentation	Password	Thompson, W.R., "Guidelines Development" [Hprc5fhit5ftemplate2di5f5fthompson], 2/6/12
6	High Repetition and Short Rest Intervals Exercise Training	Password	Triplett, N.T. & J.M. McBride, "High Repetition and Short Rest Interval Exercise Training (Circuit Training)" [Triplett Paper] 2/6/12. ^(c)
7	Baseline Fitness Requirements	Password	Zambraski, E.J. [HITEJZbaselinefitness] 2/6/12. ^(d)
8	Human Performance Optimization: An Evolving Charge to the Department of Defense	Public	O'Connor, F.G., P.A. Deuster, K.A. Henry, V.E. Martindale, L. Talbot, W. Jonas, & K. Friedl, <i>Military Medicine</i> , 172, 11:1133, November, 2007 ^(e)

(a) This Executive Summary is a 1,003 word extract from the 5,546 word *Consensus Paper*. The lists of authors are identical: Michael F. Bergeron, Bradley C. Nindl, Patricia A. Deuster, Neal Baumgartner, Shawn Kane, William J. Kraemer, Lisa R. Sexauer, Walter R. Thompson, and Francis G. O'Connor.

(b) Fakes a CrossFit affiliate advice to use "NO BS Dirty Recovery", a potentially dangerous product.

(c) Unaffiliated authors; unpublished, undated, and unpaginated paper.

(d) Claims CrossFit is "one size fits all" by extracting 237 words from CrossFit's 543-word guide "How to Start", omitting the CrossFit recommendation to use a professional trainer, ignoring CrossFit's three fitness categories for beginners, ignoring CrossFit's provisions for scaling, ignoring CrossFit's cautions to increase gradually, ignoring CrossFit's caution to master the movements before doing the workouts, and omitting CrossFit's free online help.

(e) "The MHS [Military Health System] has achieved unprecedented and dramatic results in combat casualty care: case fatality rates for combat injury during the Global War on Terror are roughly one-half that of Vietnam and one-third that of World War II." OCONNOR (2007) p. 1133

None of the websites of the organizations associated with the workshop contains any of the missing information on the workshop, though some of the HPRC pages closed to the public remain hidden. An extensive search for the missing data on the Internet proved unproductive beyond these presentations posted on scribd.com.

The *Consensus Paper* leaves the reader to infer that its *Methods and Approach* referred to objectives of the *Consensus*, and that the *Paper* was a product of the workshop. The *Paper* shows that it was either independent of the workshop, or that it was a planned extemporaneous document, intended to be incomplete, vague, and subjective. In the alternative, the description of the workshop in the *Consensus Paper* is consistent with the conclusion that the workshop was a sham.

2.1.1 Conference proceedings are missing.

The *HIT Executive Summary* is the authors' 20% condensation of their *Consensus Paper*, appearing to add only these three sentences of any substance:

Thirdly, military leaders should be strongly advised to consider the rigor of a unit's daily occupational and operational training, combined with medical, external, and environmental risk factors. This will ensure that planning for physical readiness training does not conflict with other injury risk magnifying factors. For example, extensive military training and same-day exhaustive physical training or fitness testing should be avoided, as this increases risk and demands controls to overcome the effects. *Id.*, p. 1.

The evidence that *HIT Executive Summary* was written last is that it corrected some grammatical errors, such as unreferenced pronouns and split infinitives, and removed superfluous words and phrases from the *Consensus Paper*. The *HIT Executive Summary* claims to be a summary of the Conference only in its title, and it contains no references, excluding especially all the papers listed by HPRC as conference presentations. The *Consensus Paper* implies that it is a summary, and it alone provides information on the proceedings, which are critiqued next.

2.1.2 Critical discussions once initiated went no further.

Participants discussed so-called high-intensity training (HIT) commercial programs, **began** a critical dialog on this important issue, developed **initial** consensus-based recommendations, and established research **objectives** to support **eventual** more comprehensive and definitive evidenced-based guidelines.⁵

The writer answered a "potential emerging problem" with a potential emerging conference. Some things started, vague things which had neither individuals responsible nor dates for completion, and which made no progress worth reporting.

5 Bold added, *Consensus Paper* p. 384.

2.1.3 The *Consensus Paper* may constitute the workshop’s “initial consensus-based recommendations”, an impromptu work of the nine authors.

Participants ... developed **initial consensus-based recommendations**. . . . Bold added, *id*.

The opinions and assertions contained herein are the **private views of the authors** and are not to be construed as official or as reflecting the views of the U.S. Army, the U.S. Navy, U.S. Air Force, U.S. Marines, U.S. Coast Guard, or the Department of Defense. *Id.*, p. 388.

The *Consensus Paper* must encompass the “initial consensus-based recommendations” because it is the only known work product of the conference. Its exclusion of DoD means that it cannot be a policy document for USU, CHAMP, or HPRC, in rank order. The *Paper* says, “With regard to the individual Services, each one has its own program and guidelines (Table 1)” (p. 386), so it is also not policy for the services.

2.1.4 The “initial consensus-based” document was neither comprehensive, nor definitive, nor evidence-based.

Participants ... established research objectives to support **eventual more comprehensive and definitive evidenced-based** guidelines. Bold added, *id*, p. 384.

The authors imply they were satisfied with neither the comprehensiveness nor the evidentiary support for their work product.

2.1.5 Promised final guidelines are chimerical, eventualities to reduce injuries.

These guidelines **would** serve to optimize the potential prescription and safe use of such program designs and reduce injury risk for those participating in these conditioning programs. Bold added, *id*.

The authors don’t say that their guideline **will** do as they suggest. Their use of *would* suggests that the guidelines are not likely to ever exist, or that such a use would never materialize. The latter is evidently the case since no evidence exists for any significant increase in injuries, much less such an event connected to ECPs or CrossFit.

Equally important is that the authors are optimizing, as they say, for low risk training. Their objective should be the same as conditioning programs—preparation for operational tasks, not just for training. Conditioning is a process causing minor muscle damage that induces natural rebuilding, and greater muscle resistance to risk in the field. The authors should change their focus from training for training’s sake, and instead seek an optimum balance between training injuries and injuries and survival in the field. A benign and safe training program has been the standard, but it has been rejected by Warfighters.

2.1.6 Missing from the conference by implication were representatives of the individual services, Warfighters, and subject matter experts other than the authors of the *Consensus Paper*.

The authors acknowledge that the DoD & ACSM workshop involved more than 50 professionals including not only speakers and the writing group but also experts and other guests from both the military and civilian sports medicine and training communities. *Id.*, p. 388.

Subject matter experts were assembled from the civilian sports medicine and research communities and joint representation from the Army, Navy, Air Force, Marines, and Coast Guard. *Id.*, p. 384.

With no list of attendees or records of the alleged discussions, these claims for breadth of representation cannot be validated. No evidence exists that a spokesperson for any Extreme Conditioning Program participated in any capacity.

2.1.7 Workshop discussions on producing a mere summary of the conference were inconclusive.

The workshop was structured into four primary topic blocks: definition of HIT, guidelines for safe implementation of HIT programs: part 1, guidelines for safe implementation of HIT programs: part 2, and future research considerations. During the subsequent and final session of the workshop, all speakers and other attendees participated in **discussions to determine a process** and select key writers to develop a summary paper on the topic for distribution and publication. Bold added, *id.*

The *Consensus Paper* could report no conclusions from the discussions, much less the actual production of a publication process or selection of its writers.

2.1.8 The sole accomplishment of the conference was to change the name High Intensity Training (HIT) in its title to Extreme Conditioning Programs (ECPs).

The “HIT” nomenclature was, by consensus, changed to “extreme conditioning programs” to more accurately describe the scope of conditioning programs being addressed. *Id.*

With nothing more to report, the *Paper* damns with faint praise.

2.2. While the authors have abundant official channels for their work product, they rely instead on unofficial channels.

Among the nine authors forming this consensus of joint CHAMP/ACSM policy are Col. Francis G. O'Connor, MD, and Patricia A. Deuster, PhD. They are the medical director and scientific director, respectively, of CHAMP, a subdivision of the Uniformed Services University of the Health Sciences [USU]. Title 10, USC, Chapter 104.

CHAMP directors command channels for the dissemination of official information. See, for example, O'Connor and Deuster, "Where We Have Been", Memorandum for CHAMP members, partners, and friends, undated.⁶ The Memorandum shows that CHAMP has a procedure by which the Directors might issue an official statement of policy. That Memorandum also announced the development of a CHAMP website, yet another official DoD outlet for health information.⁷

HPRC, sponsor of the HIT Conference, is organized under CHAMP. It is an official channel to disseminate health and fitness information to Warfighters and their families:

The Human Performance Resource Center (HPRC) is a DoD initiative under the Force Health Protection and Readiness Program. The HPRC serves as an educational clearinghouse that focuses on Human Performance Optimization. The Human Performance Resource Center (HPRC) collects, organizes, and disseminates the most current information available on all aspects of human performance. The focus is to gather, organize, categorize, and summarize actionable information related to the maintenance, optimization, and enhancement of human performance, in training and on the battlefield.⁸

HPRC is a broadband channel to speak to Warfighters, but appears to have neither authority nor mechanism to speak for Warfighters. It hosts an HPRC Forum on Twitter, inviting comments, but as of this writing none exists.

In addition, the Armed Forces Health Surveillance Center (AFHSC) has DoD-wide responsibility for collecting and disseminating "health surveillance data for both DoD and external analysts and researchers." DoD⁹. In this capacity, AFHSC publishes its Medical Surveillance Monthly Report (MSMR), which includes unrefereed analyses and data on exercise, information on which the *Consensus Paper* relies as its Reference 4.¹⁰

The availability of these channels and the responsibilities of CHAMP draw into question the authors' election to publish a statement of the authors' private views under the auspices of, and copyrighted by, ACSM. The *Consensus Paper* is a joint policy statement with ACSM, a private corporation, suggesting an arrangement between CHAMP and ACSM. It was printed by ACSM in its *Current Sports Medicine Reports*, an unrefereed journal. See AFHSC, Author Instructions. The *Consensus* values "peer-reviewed literature" (p. 384), an anonymous, gate-keeping imperative in academia reflected in neither DoD nor much of industry.

The disclaimer stating that the *Consensus Paper* (p. 388) reflects "opinions and assertions of the authors [that] are not to be construed as official or reflecting the views of [any of the services or DoD]" contradicts the title of the article, its pedigree, and any authority for its recommendations and conclusions.

6 <http://www.usuhs.mil/mem/CHAMPdirletter.pdf>

7 <http://www.usuhs.mil/mem/champ.html>

8 <http://csf.army.mil/links.html>

9 Directive 6490.02E, 2/8/12

10 Armed Forces Health Surveillance Center, "Update: exertional rhabdomyolysis among U.S. military members, 2009", MSMR 2010; 17:9–11.

2.3. ACSM has a dog in the fight.

Founded in 1954, The American College of Sports Medicine enjoys a reputation as a respected organization. Its mission statement reads,

ACSM promotes and integrates scientific research, education and practical applications of sports medicine and exercise science to maintain and enhance physical performance, fitness, health and quality of life.¹¹

The subject article, though, fails to meet the most elementary requirements for science or for objectivity, pretending to represent ACSM policy on ECPs with “the private views of the authors”.

In its official capacity, ACSM included CrossFit in two different sessions at its recent ACSM Health and Fitness Summit, March 27–30, 2012, which

gives students, fitness enthusiasts, personal trainers, certified professionals, and others the full spectrum of programming from scientific to practical application.¹²

Only outlines of the sessions are publicly available, accessible from an online list.¹³ Both sessions were scheduled for March 29, 4:30 pm–6:00 pm and in different rooms, even though both related to trends in the modern fitness business.

2.3.1 Helen Vanderburg, ACSM spokesperson and counterfeit CrossFit trainer, addressed the ACSM Summit on “How To Make the Most Of Top Global Fitness Trends in your Business”.

Vanderburg appeared to speak from personal experience. Her outline mentions CrossFit as follows: “Specialty facilities (Personal training, Indoor cycling, Pilates, TRX, Total Gym, Fusion, CrossFit . . .)”, ellipsis in original.

Staying current with the changes in the fitness industry is critical to the success of your business. In this session you will learn the top trends in the fitness industry and explore how these trends will impact you and your business. Learn how to evaluate the trends and determine ways to make these trends work for you to grow your business or fitness career.¹⁴

A little search of Vanderburg’s writings shows clearly how CrossFit met her concept of fitness and her own business, which includes owner of Heavens Elevated Fitness Club, aka Heavens Fitness, in Calgary, CA.¹⁵ Vanderburg speaks for ACSM, though without the initials after her name. She offers a course on “Extreme Interval Training–CEC Course” that gives ACSM Continuing Education Course credits. She also appeared as a panelist in the March Summit in a Student Session, which included “Ways ACSM is looking to serve you”.¹⁶

11 <http://www.acsm.org/about-acsm/who-we-are>

12 <http://www.acsm.org/attend-a-meeting/other-meetings/2011/09/17/acsm%27s-health-fitness-summit-exposition>

13 http://forms.acsm.org/_frm/Summit2012/12HFSESyllabusPage.htm

14 Vanderburg session outline.

15 http://heavensfitness.com/personal_training.html

16 http://forms.acsm.org/_frm/Summit2012/pdfs/31%20Vanderburg.pdf

Vanderburg is a fitness columnist for the Calgary Herald. She is rather ecstatic about CrossFit, writing

CrossFit is exactly that: crossing various exercises to maximize one's workout. ...

The CrossFit program is based on exercises and techniques an Olympic athlete would use—but the workouts are designed for all fitness enthusiasts. [¶] The exercises stay the same for everyone, but the intensity varies, depending on the individual. ...

If you are looking to improve both physical and mental toughness, you will like the CrossFit program. CrossFit can also be used for general physical preparation for most sports or as a sport itself.¹⁷

But continuing, she wandered into different territory. In context, she wrote

The CrossFit prescription is "constantly varied, high-intensity, functional movement." [¶] Some workouts are more strength-based, while others have a higher cardiovascular challenge, so the sweat factor will vary, but the intensity is always high.[¶] The general training philosophy is to train hard and fast. **The class format is** 60 minutes in length and begins with a 15-minute warm-up, followed by 15 to 25 minutes working on a technical component. This sometimes introduces a new movement or improves efficiency in an existing movement. [¶] The **rest of the time is spent on the workout of the day.** ... [¶] **Dress for a serious workout. Wear comfortable clothes that absorb sweat, as you will work hard. Fitness shoes are required.** Bold added, *id.*

Vanderburg is describing a particular class format and dress, which CrossFit does not prescribe. CrossFit prescribes workouts for individuals, and conducts corporate and affiliate training under whatever format suits the trainer. Vanderburg raises the suspicion that Heavens Fitness offers its version of CrossFit training.

Vanderburg is a highly honored, former world-champion synchronized swimmer, and clearly a CrossFit enthusiast. She has owned Heavens Fitness for over 25 years.¹⁸ One of her trainers is

J-me Hannay, MKin., BKin., BA (Distinction), NAIT PFT (Honours), CrossFit [sic], Kettlebell Certified; Specialty: Biomechanics, Bodybuilding, Kettlebell Training, Plyometrics.¹⁹

CrossFit records show Hannay holds a CrossFit Level 1 certificate. More importantly Heavens Fitness trainers include

Erin Watts, GENERAL MANAGER; CrossFit [sic], AFLCA, TRX, Kettlebell Instructor; Specialty: Metabolic Training, **Cross Fit** [sic] & Olympic Weightlifting. Bold added. *Id.*

CrossFit records do not show that either Watts or Vanderburg holds a certificate, nor that Heavens Fitness is a CrossFit affiliate, necessary for Vanderburg to claim that she is teaching CrossFit.

17 Vanderburg, H., Multiply fitness results by keeping workouts random, Calgary Herald, 6/10/2009
<http://www.calgaryherald.com/health/Multiply%20fitness%20results%20keeping%20workouts%20random/1675498/story.html>

18 <http://www.helenvanderburg.com/index.html>

19 Bold added. http://heavensfitness.com/trainer_profiles.html

2.3.2 Nora Constantino, PhD, FACSM, with Associate Professor and UNR recreation Director James Fitzsimmons, EdD, both CrossFit Games competitors and operators of CrossFit UNR, addressed the Summit on "CrossFit: Menace To Society Or Future Of The Fitness Industry?"

Nora Lucile Constantino is an Associate Professor in the School of Community Health Sciences, University of Nevada, Reno. She is an exercise physiologist and specialist in endocrinology. CrossFit records show a 50-year-old Nora Constantino competing in the annual CrossFit competition, having completed all five 2012 Reebok CrossFit Games Open workouts as a member of University of Nevada CrossFit (UNR CF) team.²⁰ That is a remarkable accomplishment even for a youngster.

Co-author James A. Fitzsimmons is Director, Campus Recreation and Wellness, in the Lombardi Recreation Center, UNR. CrossFit records show 45-year-old Fitzsimmons completing the five Open workouts, scoring eighth and ninth overall in two of the events.

Thus presenters responsible for the edgy alternative in the title are experienced CrossFit enthusiasts as well as qualified spokespersons for the ACSM! This casts a special light on their forked headline.

Academics find that to be published, their writings must be overtly obedient to the dogma of the day, and deferent to the papers of its priests published in sanctioned, peer-reviewed, professional journals. Constantino's headline to her session might foretell a defense of ACSM's model of fitness against an evil uprising, a Fitness Spring to be castigated and excommunicated. In this interpretation, CrossFit is a menace to society, and it is epidemic.²¹

But in light of the authors personal athletic achievements with CrossFit, the headline is a provocative teaser for a nonconforming article. A clinical parsing of the outline to her session can reinforce the promise that her article works to dispel the notion that CrossFit is harmful, and anything but the revolutionary paradigm for fitness and conditioning. Clicking on her session title on the Syllabus Page brings up the outline.²²

Constantino and Fitzsimmons kindly provided a copy of their 34-slide PowerPoint presentation as background for this critique. The slides contain bullet reminders for the presenter, but no text. One chart, however, did provide a useful datum: UNR CrossFit has records of 87,000 supervised workouts, with only one injury, and that was a strained ligament that had been surgically repaired just 36 months earlier.

20 <http://games.CrossFit.com/athlete/33170>; <http://unrCrossFit.typepad.com/>

21 "CrossFit: Menace To Society Or Future Of The Fitness Industry?" Nora Constantino, Ph.D.; James Fitzsimmons, M.S.
http://forms.acsm.org/_frm/Summit2012/12HFSESyllabusPage.htm

22 http://forms.acsm.org/_frm/Summit2012/pdfs/73%20Constantino.pdf

2.4. The *Consensus Paper* relies on inaccessible and unofficial citations.

In support of two key points about alleged ECP risk, the *Consensus* authors rely on three papers by one or both of the Directors, published by ACSM behind a paywall. Refs. (19-21). The first citation is in this sentence:

Other notable **clinical conditions that potentially increase the risks of ECPs** include, for example, cardiovascular disease (including hypertension) (23), a recent bout of exertional heat illness (i.e., heat exhaustion and exertional muscle cramps or heat stroke) (20), or a previous episode of exertional rhabdomyolysis (19).²³

The second citation is in the following pair of sentences:

Therefore, practical solutions **to effectively improve ECP implementation and reduce injury risk** are of paramount importance. This can begin with better functional and fitness screening and stratification for injury risk for all Warfighters prior to participation in any ECP (21).²⁴

Being written by the same authors citing them, these references on their face have no value to support the claims. Because the authors neither quoted from these references, nor made them freely available to the public, the suggestions in *Consensus Paper* of increased risk associated with the ECMs remains unsupported. Regardless, for the purposes of DoD, the information is problematic because it was not published under the authority of DoD's clearing house, AFHSC.

2.5. The *Consensus Paper* characterization of conditioning programs is exclusively subjective.

The article says in its Introduction,

Extreme conditioning programs (ECPs; e.g., CrossFit, Insanity, Gym Jones™, and others) are characterized by **high-volume aggressive** training workouts that use a variety of **high-intensity** exercises and often timed **maximal** number of repetitions with **short rest periods** between sets.²⁵

If the *Consensus Paper* had been a scientific paper, professional practices would have required a verbal scheme of classification based on measurements to support each adjective in bold. For example, Medical Director O'Connor himself in "How to Write an Exercise Prescription" recently classified physical activity in six categories, from *Very light* to *Maximal*, according to relative numerical scales of VO2max and Maximal heart rate achieved within 60 minutes of exercise.²⁶

Medical Director O'Connor did not follow his own prescription.

Not only does the article not provide any classification scheme, but it reports no quantified parameter by which to deem the targeted conditioning programs, classified as ECPs, as extreme or to rank them scored against what the article calls the "scientifically based training guidelines" embodied in the "other conditioning programs already in place." P. 385.

Science, by contrast, demands objectivity, verifiable facts in support of the reasonable Cause & Effect relationships of causation and causality. That is true notwithstanding the complete absence of Cause & Effect in the US Supreme Court's determination of five criteria for what constitutes scientific knowledge in Popper's post-modern world.²⁷ In an obvious contradiction to its own title, this article contains only "opinions and assertions". P. 388. Part 4, below, contains relevant and authoritative extracts from military textbooks maintained and disseminated by the U.S. Army for background in analyzing the claims in the *Consensus Paper*.

23 Bold added, *Consensus Paper*, p. 385.

24 Bold added, *id.*, p. 387.

25 Bold added, *Consensus Paper* p. 383.

26 Gauer, RL and F. G. O'Connor, "How to Write an Exercise Prescription", USU, Department of Family Medicine, 4/22/12, Table 16, p. 43.

27 *Daubert v. Merrell Dow*, 509 U.S. 579, 1993.

2.5.1 Edward Zambraski, PhD, FACSM, misrepresents CrossFit.

The 7th Conference paper from the table is "Baseline Fitness Requirements". The presenter is Edward J. Zambraski, PhD, FACSM, Division Chief, Military Performance Division, US Army Research Institute of Environmental Medicine (USARIEM), Natick, MA. First on his agenda is

What specifically do these commercial companies (e.g. CrossFit) say about baseline or minimal fitness requirements? *Id.*, Chart 2.

Chart 3 is "Options Offered by CrossFit.com Regarding Program Implementation". It is 237 of 543 words from CrossFit's "How to Start".²⁸ Zambraski added nothing, but here is what he deleted:

We offer two paths for someone new to the CrossFit methods:

1. Work out on your own or
2. Go to one of our growing number of licensed CrossFit affiliates worldwide.

For the person who endeavors to take on CrossFit without the guidance of a certified CrossFit trainer, we recommend three distinct approaches, depending on your fitness experience and available facilities:

What Zambraski deleted is that the remainder of his citation is a guideline for those who chose to workout on their own. He altogether lost the sense that the guideline is gradated in three degrees of skill. And he omitted the underlined hot link to CrossFit's affiliate locator page.

Zambraski omitted the following sentences from the requirement and instruction for the most qualified do-it-yourselfers:

If you've had exposure to Olympic weightlifting, powerlifting, and gymnastics, jump right in. If an exercise is unfamiliar, acquaint yourself with the movement through the video clip for the movement on the exercises section of the site.

He omitted that CrossFit teaches the beginner to become familiar with the movements before starting an unfamiliar exercise, and that it provides online video instructions for both movements and exercises.

Zambraski omitted the following resource for those in the middle zone of skills:

We are developing a Substitution Chart in the FAQ for replacing exercises for which you've not developed the skills or don't have the equipment.

He omitted that CrossFit provides graded exercises to develop skills incrementally.

28 <http://www.CrossFit.com/cf-info/start-how.html>

Zambraski deleted the following ultimate advice for the least-skilled beginner who is going to self-train:

This is a great place to begin for anyone with little or no experience with serious weightlifting or gymnastics.

He omitted CrossFit's **strongly emphasized** alternative characterization of where a self-trainee should begin.

Zambraski deleted the following advice and resource for the self-trainee to set up his own gym:

We are a "minimalist program" and this is reflected by the functionality and limited number of our exercises and the simplicity of the equipment we use compared to most commercial gyms. An Olympic weight set and a place to do pull-ups and dips is essential to doing CrossFit. Gymnastics rings and parallettes, plyometrics boxes, a Dynamax medicine ball, dumbbells, kettlebells, climbing rope, Concept II Rower, and a glute-ham developer will equip your garage with more than enough to follow the WOD very closely. (See CrossFit Journal, September 2002, "The Garage Gym" for information on building a world-class strength and conditioning facility in your garage.)

Including this paragraph would have tipped his hand that he was converting instructions for self-trainees into a recipe for a CrossFit of his own making. He removed the emphasis on developing movements before loading them for exercise. He removed the tailoring of workouts for the skill level of the trainee. He removed the graded exercises by which a trainee develops full skills.

"How to Start" explains that CrossFit workouts are world class, to be completed "comfortably and consistently". This statement was bracketed with these phrases:

In any case it **must** be understood that the [...] before "throwing" yourself at them 100%. Bold in original.

Zambraski deleted strongly worded warnings for the self-training newbie to create a false, out-of-context confession that CrossFit contains only extreme workouts.

Finally, Zambraski deleted this resource and invitation to use it:

The Message Board is a great place to find technical help, clear up confusions, or receive words of encouragement. One regular commented that hanging out on the message board for a week was more instructive than struggling with the WOD for a year. Don't be shy!

Zambraski deleted that CrossFit provides the self-training individual help at his fingertips.

In Zambraski's final chart, the Summary, he begins:

There is an apparent lack of concern about those entering these programs who may have a low level of fitness, strength, and/or other risk factors. "One size fits all."

It was Zambraski who intentionally deleted CrossFit's tailoring and scaling to individual skill levels and abilities. The residue of his concoction he presented as a false characterization of the CrossFit program.

To the extent that any "disproportionate injury" exists, it is the product of the traditional military training, a "one size fits all" program championed by ACSM, a regimented military program with tailoring to the individual relegated to a remedial program out of the mainstream for the nonconforming.

Zambraski discovered "How to Start" on the Internet at CrossFit.com. If he had searched a little further he might have found CrossFit Kids at CrossFit kids.com, CrossFit Longevity at CrossFit longevity.wordpress.com, or No Excuses CrossFit at noexcusesCrossFit.com. These are affiliates especially dedicated to bringing CrossFit conditioning to children, the elderly, and the handicapped. No one could deem CrossFit to be "one size fits all" having seen the images of Kyle Maynard and some of his clients at No Excuses CrossFit. See Kyle Maynard at Google Images.



PART 3

PART 3: BENEATH THE SURFACE OF THE *CONSENSUS PAPER*

3.1. The CHAMP consensus overlooked the military's extensive adaptation of CrossFit, its principles, and the objective studies into its efficacy by the US Army.

These recently **well-marketed** and popularized metabolically and physically demanding conditioning programs [ECPs] continue to generate **growing interest** and enthusiastic support among military and some civilian communities. The increasing acceptance is reinforced by widespread **anecdotal reports** of marked gains in physical fitness and performance. In addition, some **Warfighters** believe these programs contain functional training that directly translates into more effective performance on the battlefield.¹

CrossFit has gained immense popularity among military and law enforcement personnel; it has replaced or is used to augment traditional military physical training in many units. The U.S. Army conducted a recent CrossFit study wherein 14 men and women received initial and post-study physical assessments of their ability to perform a variety of functional movements. They then participated in CrossFit training for six weeks. Although most participants increased their power output and work capacity, the methodology of this study was weak: small sample size, no comparison training method or control group, and no injury or adverse data. Importantly, the results were not peer reviewed or published in the open scientific literature.

The issue of injury remains unresolved. There are no reliable published data on CrossFit-related injuries and no comparisons of injury rates with other demanding physical sports such as running and basketball, which are leading sources of military training injuries. HPRC, CrossFit.²

HPRC articles are not peer-reviewed, and many are not available to the public. For example, HPRC says "High Intensity Training (HIT) conference presentations are now available on our website. ... Click here to access the presentations."³ Clicking there provides eight links to "High Intensity Training PowerPoints".⁴ The first and last are publicly accessible, the remaining six papers are password protected, but have been otherwise posted on scribd.com.

HPRC provides a link to its two paragraphs quoted above under the heading "HPRC's Answer: High-intensity training programs."⁵ While HPRC minimizes the Army CrossFit study, it nevertheless confirms that the study is the best available.

1 Bold added, *Consensus Paper* p. 383.

2 <http://hprc-online.org/physical-fitness/hprc-articles/is-CrossFit-effective-for-warfighters>

3 <http://hprc-online.org/blog/high-intensity-training-hit-conference-presentations>

4 <http://hprc-online.org/physical-fitness/policys-and-standards-1#reports-1>

5 <http://hprc-online.org/search?SearchableText=HIT>

3.1.1 The USMC Has Adapted CrossFit as the Corps standard.

Following a two-year study, the Marine Corps adopted a new conditioning program for all Marines. See “An Evaluation of a Combat Conditioning Trial Program [CCTP]”⁶ and Marine Corps Order MCO 6100.13⁷. The *Consensus Paper* cites the latter, stating

Provides policy and procedural guidance for implementing the Marine Corps Physical Fitness Program, including both combat and physical fitness.⁸

The USMC Program comprises four sections: 1. Combat Conditioning Program (CCP); 2. Physical Fitness Test (PFT); 3. Combat Fitness Test (CFT), and 4. Remedial Conditioning Program (RCP). The role of CrossFit is principally in Section 1.

The study program concluded

Proper alignment of physical training practices with operational requirements is an ongoing concern for the U.S. Marine Corps. This alignment is being revisited in light of recent combat experiences. Greater emphasis on core strength and power are believed to be needed. **A program designed specifically to develop these areas of capability** was compared with usual conditioning practices. The Combat Conditioning Trial Program (CCTP) produced gains in core strength and power as intended, with no loss of cardiorespiratory fitness or upper body strength and power. The usual combat conditioning program did produce greater gains in cardiorespiratory fitness, but this trend may have been the result of relatively poor fitness when the study began. The CCTP produced a trend toward lower injury rates. The CCTP achieved its objectives of improving core strength and power without adverse effects on other areas of fitness or injury.⁹

That conditioning program was CrossFit, though not mentioned by name in official USMC documents. The NCO-in-Charge was Gunnery Sergeant Brandon Millsaps, USMC, holding CrossFit level 1 and 2 certifications.

6 Vickers, RR Jr, J.H. Reynolds, J.R. Jordan, L.K. Hervig, “An Evaluation of a Combat Conditioning Trial Program [CCTP]”, Naval Health Research Center, Doc. No. 09-02, 11/20/2008

7 Marine Corps Order—MCO 6100.13: Marine Corps Physical Fitness Program (August 2008)

8 *Id.*, Table 1, p. 385.

9 Bold added, Vickers, *id.*, Abstract, p. i.

The final report explains the new program as follows:

A **functional fitness** concept has been developed to provide the proper alignment of training with operational requirements. Functional fitness is the "...**ability to perform a broad array of natural or realistic physical work.** ..." (Amos, 2006). Key elements of the functional fitness concept include:

- Fitness follows combat function.
- **Physical training must develop power, strength, flexibility, speed, endurance, agility, and coordination.**
- **Physical training must have great intensity and variety.**
- **Physical training must be scalable to individual level and be progressive.**
- Training must emphasize "injury proofing" and active recovery.

The concept of functional fitness has been refined to define combat fitness as the goal of physical training. ... The present report compares this Combat Conditioning Trial Program (CCTP) with the usual combat conditioning. The CCTP was developed ... with input from ... **civilian physical training experts**. The Marine Corps Warfighting Laboratory (MCWL) developed and implemented the plan for evaluating the CCTP.¹⁰

CrossFit specifically introduced the parts in bold into its program, and its experts have observed that higher fitness always reduces injury rates, and improves recovery and survival. The definition of functional fitness is a paraphrasing of CrossFit's original definition of fitness and "work capacity across broad time and modal domains".

10 Bold added, Vickers, id., p. 1.

HPRC recognized the same evolution of the Marine Corps Combat Condition Program, and explicitly that it was based on CrossFit:

In 2006, Lt Gen James F. Amos, USMC, the 31st and current Assistant Commandant of the Marine Corps [now General Amos, and since October 22, 2010, Commandant, USMC], described Functional fitness as “the ability to perform a broad array of natural or realistic physical work that involves all tasks associated with performance in combat.” He emphasizes that operational and combat demands will vary regarding load and duration which in turn affects intensity of physical exertion, and that traditional training methods do not adequately prepare Warfighters. He further notes that functional fitness involves “multiple planes and joints” in the performance of a real life of combat task, therefore, the Marine Corp should incorporate elements of functional fitness training in their daily conditioning regimen. One approach that has followed this direction is the USMC’s Combat Conditioning Program which, although **not strictly based on** CrossFit, adheres to the functional fitness elements of the program and is adapted “For Marines By Marines,” using only that equipment that a Marine might find in the deployed setting.¹¹

Though not recognized by the *Consensus Paper* in its acknowledgements, HPRC was a sponsor of the conference, and it directs its work solely to “Warfighters, their families, and those . . . who support them”. However, while cautiously recommending CrossFit for Warfighters, it says

CrossFit is an **extreme exercise program** designed to promote functional fitness. There are no published data on CrossFit-related injuries and no comparisons of injury rates with other demanding physical sports, which are leading causes of Warfighter injury. **The program requires modifications for use by unfit and beginning exercisers.** Bold added, HPRC, CrossFit.¹²

CrossFit is an Extreme Conditioning Program by CHAMP and ACSM’s newly minted definition, which they applied as a pejorative. According to the Oxford Dictionaries, extreme is an adjective “denoting or relating to a sport performed in a hazardous environment and involving great risk”, and then gives as examples white-water rafting and snowboarding! Really? Did the lexicographers consider cave diving? High-altitude climbing? Free solo climbing? Base jumping? And for the shut-in, Russian roulette? An adult who put his child into such a sport might lose custody on the charge of child endangerment. Conversely, a parent who won’t let his child train under CrossFit Kids is not playing with a full deck. Perhaps the loophole here is that notwithstanding HPRC’s characterization, it considers CrossFit not to be a sport. What is extreme is CHAMP’s and ACSM’s inflammatory language.

As to modifications, the program can’t require what is already inherent, provided, and featured. HPRC needs to visit CrossFit Kids, CrossFit Longevity, and No Excuses CrossFit. It needs to read “How to Start” on CrossFit.com. It needs to note CrossFit’s warning that some movements are too intense for some individuals, and how to prepare for the full intensity. At the same time, no CrossFit exercise demands a specific amount of work. Each is a best effort at the specified intensity, if possible.

¹¹ Bold added, *HBRC*, CrossFit. <http://hprc-online.org/performance-optimization/physical-fitness/CrossFit>

¹² <http://hprc-online.org/physical-fitness/hprc-articles/is-CrossFit-effective-for-warfighters>

In 2008 Gen James T. Conway, Commandant, directed

Marines will participate in an organizational and individual Combat Conditioning Program (CCP). The PFT, CFT and Remedial Conditioning Program (RCP) are components of an effective organizational CCP. Recent trends and advancements in sports training and physiology as well as findings from the Center for Disease Control and the **American College of Sports Medicine recommend that aerobic and muscle-strengthening activities be conducted more frequently, under higher intensity and of shorter duration.** Doing so provides greater health benefits and results in higher levels of overall physical fitness. Reference (b) [MCRP 3-02A, Marine Physical Readiness Training for Combat] has adopted these recommendations and provides Commanders/Officers In Charge (OICs) and Marines a wide variety of options to select from in developing effective organizational and individual CCP.¹³

The new Marine Corps Physical Fitness Program follows the stated ACSM recommendation by adapting the CrossFit program for the Conditioning. It adds specific fitness standards to be met, which CrossFit does not do. The word **extreme** does not appear in MCO 6100.13 (2008). The Readiness Training manual uses the word **extreme** exactly nine times: “extreme physical demands of warfare”, “extremely hot temperatures”, “extreme cold”, “Grass drills are extremely strenuous”, avoid “extreme formality” in training, fartlek course training can work “extremely well”, orienteering “taken to the extreme” is conducted in full combat gear, obstacles in an obstacle course can be “extremely difficult”, and avoid “extremely hard ground” in combatives. These are all distinct from CrossFit workouts, but situations CrossFit conditioning anticipates.

CrossFit conditioning is gradual, at each stage safely challenging the individual athlete’s abilities in workouts well-mixed in stressing muscle strength, aerobic, and anaerobic responses, but setting no performance standards. CrossFit’s policy is reflected in this sample from affiliate Consent and Release Forms:

YOU ARE RESPONSIBLE FOR HEEDING YOUR OWN BODY’S LIMITATIONS. YOU ARE RESPONSIBLE FOR SETTING YOUR OWN LEVEL OF EXERTION. DO NOT EXCEED YOUR BODY’S LIMITATIONS. ONLY YOU KNOW WHAT THESE LIMITS ARE.¹⁴

13 Bold added, MCO 6100.13 (2008) ¶1b.

14 Caps in originals. http://www.CrossFit.unc.com/images/uploads/CrossFit_UNC_Consent.doc, www.brethrenCrossFit.com/wp./Rhabdo-waiverTC-docx-20121.pdf

The substance of the Marine Corps Combat Conditioning Program is in Section 3:

3. Components. Organizational CCPs will consist of the following:

- a. Commanders will ensure their unit CCP addresses the specific unit METL¹⁵ per reference (b)¹⁶ and consists of five 30 minute sessions per week. [CrossFit: **20 minute workouts, 3 days on/1 off.**]
- b. Strength training consisting of compound functional movements should be done at least twice a week, in combination with or separate from cardiorespiratory exercise. [CrossFit: **Functional exercises, mixed in strength, aerobic, and anaerobic, intra-workout and inter-workout.**]
- c. Exceeding the guidelines above will result in greater fitness and health benefits, but should be done in a manner that is progressive in nature and provides adaptations to additional physical demands. [CrossFit: **Progressive body adaptations.**]
- d. Physical conditioning programs should not be developed solely towards preparation for the PFT or CFT. [CrossFit: **Fitness is work capacity to respond to surprises.**]
- e. To the extent possible, commanders will allow Marines to conduct these conditioning sessions within normal working hours.
- f. Organizational CCPs will be developed to ensure Marines are able to meet the physical demands of their unit mission and the challenges posed by environmental and operational conditions.
- g. Every Marine will develop an individual CCP in order to enhance their ability to meet the physical demands of their military occupational specialty (MOS) while emphasizing the Marine Corps ethos of every Marine a rifleman. The individual CCP is meant to augment not replace the organizational CCP. Bold annotations added, MCO 6100.13 (2008).

In summary, unit commanders and individual Marines are free to design a conditioning program or select an existing program. For unit commanders, the program must meet the requirements of *a* through *d*, which happen to be essential elements of CrossFit, as shown. While the founder of CrossFit invented this method of conditioning, the information is open source on the CrossFit website for anyone to follow or imitate. Only the name CrossFit is proprietary and protected. At present, CrossFit is the only program meeting the conditioning standards above. Under the new Marine Corps program, organizational commanders and individual Marines may satisfy their CCP requirements by following a CrossFit regimen.

¹⁵ Mission Essential Task List, MCRP 3-0A, p. 5-1.

¹⁶ Ref. (b) is MCRP 3-02A, and doesn't mention MCRP.

3.1.2 The *Consensus Paper* confuses aggressively marketed conditioning programs with CrossFit, which does not advertise.

The *Consensus Paper* creates a straw man category of Extreme Conditioning Programs in order to criticize CrossFit with attributes taken from four other enterprises and with implied pejoratives. Being not just marketed, but “well-marketed” suggests an unwholesome, Madison Avenue-like campaign to sell by misrepresentation, as through exaggeration, repetition, or prestige. The *Consensus Paper* cites no reference for its allegation that CrossFit is “aggressively marketed”, and cannot for the simple reason that the CrossFit brand, while promoted, is not, and never has been, advertised. The distinction being made is that while both promotion and advertising involve publicity, promotion is to enhance the public image of the brand while advertising is to encourage sales. CrossFit has nothing for sale that it publicizes, and it gives away its primary product of conditioning knowledge.

By contrast, access to Gym Jones’ workouts requires individuals to buy memberships at \$50 month to \$500 per year.¹⁷ Insanity sells its ten workouts on ten CDs for “just 3 monthly payments of \$39.95 (+ \$24.95 s&h)”.¹⁸ P90X sells a Home-Fitness System for \$140 with a 90-day money back guarantee. (PT Pyramid appears not to be a conditioning program, but instead merely a pattern for mixing exercises and rest.¹⁹ As such, it would be analogous to Tabata used in CrossFit.)

The CrossFit corporation sells the unadvertised rights to the CrossFit name to affiliates, who must have an Internet presence, and may advertise gym membership. Some do, perhaps where competition exists, but for the most the CrossFit brand sells itself. It is the better mousetrap which the *Consensus Paper* characterizes as “well-marketed”:

If a man can write a better book, preach a better sermon, or make a better mouse-trap, than his neighbor, though he build his house in the woods, the world will make a beaten path to his door.²⁰

The *Consensus Paper* challenges the meaning of *marketing* itself. The authors imply that the ECPs market to the Warfighters. By contrast, CrossFit workouts are free. So are posting athlete’s workout results, participation in the CrossFit Discussion Board, and access to a large library of CrossFit’s technical articles. A CrossFitter may buy a subscription to the Journal for more extensive access to the library. He may buy a membership in an affiliate or join an affiliated club offering classes, but only if he wants the advantage of qualified CrossFit training.

CrossFit’s growth in affiliates, including its bottom-up penetration into the military, is not based on any program to market affiliate licenses, or to donate licenses to the military.

17 <http://www.gymjones.com/memberships/>

18 http://www.beachbody.com/product/fitness_programs/insanity.do

19 <http://mymadmethods.com/articles/conditioning-articles/1238-extreme-conditioning-pt-pyramid>

20 *Bartlett’s Familiar Quotations*, 14th Ed., p. 605a. Attributed variously to an 1871 talk by Ralph Waldo Emerson.

3.1.3 The *Consensus Paper* Claims Contrary Evidence To Be Anecdotal, Ignoring Well-designed Army Demonstrations of CrossFit Efficacy.

The bane of science is anecdotal evidence. The *Consensus Paper* authors summarily dismiss contrary evidence as anecdotal, and ignore factual evidence. This is the fallacy of the anecdotal accusation: imply your own writings are science by claiming that contrary factual evidence either does not exist, or that if it did, it would be “anecdotal”.

CrossFit is indeed growing in the military services. As of May two years ago, CrossFit non-profit affiliates on military installations numbered 58 worldwide. (See also HPRC report, above.) HPRC, sponsor of the HIT Conference, says,

CrossFit has gained immense popularity among military and law enforcement personnel; it has replaced or is used to augment traditional military physical training in many units. The U.S. Army conducted a recent CrossFit study wherein 14 men and women received initial and post-study physical assessments of their ability to perform a variety of functional movements.²¹

The Army study is Paine, J., J. Uptgraft, & R. Wylie, “CrossFit Study”, Command and General Staff College (CGSC), Department of the Army, May, 2010.²² From 2006 to 2008, the U.S. Marine Corps conducted an evaluation of CrossFit-style training, at its conclusion adopting it as the new standard for the Corp. MCO 6100.13, above. The reports of marked gains in fitness might be anecdotal in academe, but not to Warfighters.

In units across the U.S. Army, CrossFit is replacing or augmenting traditional physical training methods.²³

The effects among Warfighters and others has been that CrossFit affiliates increased overseas to 138 by May 2012, a growth of 56% per year—double the rate among all affiliates—and achieved just through testing the better mousetrap.

The Army CrossFit Study was a comprehensive program to measure the efficacy of CrossFit on a sample of 14 subjects from 150 volunteers at the CGSC Class 2010-2011. Nine male and five female officers with a wide range of CrossFit experience trained for six weeks according to the CrossFit Training Guide under a minimum of four one-hour sessions per week. The authors did not report any adverse effects, and concluded,

Generally the athletes in the study experienced relatively equal increases in power output in each of the assessments. Based on how we devised the assessments, this indicates a balanced increase in **performance across metabolic pathways** and across the ten general physical skills. We believe the consistency of improvement across assessments validates the CrossFit program’s claim that it produces a broad and inclusive brand of fitness. From the perspective of the U.S. Army, this is significant because capacity across metabolic pathways and modalities characterizes the type of versatility required of U.S. Army Soldiers.²⁴

The CGSC authors reported a similar but unpublished study the year before by the military affiliate CrossFit Centaurion Fort Hood. *Id.*

21 HPRC, “CrossFit”. <http://hprc-online.org/physical-fitness/hprc-articles/is-CrossFit-effective-for-warfighters>

22 <http://www.25idl.army.mil/PT/US%20Army%20CrossFit%20Study.pdf>

23 CGSC, “The CrossFit Study”, p. 1.

24 Bold added, *id.*, p. ii.

CGSC's CrossFit Study attributes the theory of conditioning across three metabolic pathways to the CrossFit *Training Manual*, accessed in 2010. The *CrossFit Journal* discussed these pathways in the article, "What Is Fitness", posted in October, 2002, shortly after CrossFit first appeared as an Internet entity, February 10, 2001. A U.S. Army source confirms that CrossFit is based on textbook physiology.²⁵

The Army's "CrossFit Study" reported,

In order to test the efficacy of the CrossFit program, this study measured the change in level of **physical fitness (defined as an athlete's work capacity across broad time periods and modal domains)** of fourteen athletes during eight weeks of physical training utilizing the CrossFit program.²⁶

That definition of fitness is correctly attributed to CrossFit:

We define fitness as **increased work capacity across broad time and modal domains**.²⁷

It is also fully consistent with Army teaching, and with the breadth of fitness required for unit readiness.²⁸

Secondly, the CGSC authors were the first to score athlete performance by estimating total work delivered. They applied static models for different events or exercises to estimate work and power. Because power is not additive here²⁹, a total power score is only a figure of merit. Work, however, is both additive and compliant with the definition of fitness. The Army's "CrossFit Study" evaluation contains a promising method for more advanced formulas and scoring multiple competitive events.

3.1.4 The *Consensus Paper* appeals to its fabricated opinions of Warfighters.

Having no Warfighters authoring the conference papers, including the *Consensus Paper*, and having supplied no quotations from any Warfighter, nor citing HPRC, the sponsor of the convention dedicated to supporting Warfighters, the *Consensus Paper* can only pretend to speak for Warfighters. Here is a critical sampling from among *Paper's* 16 references to Warfighters:

In addition, some Warfighters believe these programs contain functional training that directly translates into more effective performance on the battlefield. *Consensus Paper, id.*, p. 383.

To say Warfighters *believe* it to be true implies that their perception is mystical or based in faith, as in trust in the authority of charlatans.

The sentence is true, of course, in logic or in law, as in "men kill their wives!" The claim about Warfighters is unacceptably misleading as a scientific statement because it is vague (*some, believe*), factless, and a conclusion. The statement is improbable, and unlikely to have ever been asserted had the authors consulted with Warfighters, or relied on their investigations. At the unit level, all four combat services have introduced functional fitness as a means to increase combat readiness, as in the US Army Ranger Athlete Warrior [RAW] program, and service wide in the Marine Corps, above, and the Navy in its NOFFS [Navy Operational Fitness and Fueling Series] program.

25

26 Bold added, "CrossFit Study", p. 1.

27 "What is CrossFit ", 2011. <http://games2011.CrossFit.com/about-games/CrossFit.html>

28 See Vogel, Notes 1 ("energy generating capacity") and 5 ("mode ... and extent"), Part IV, below.

29 $W_1/T_1 + W_2/T_2 \neq (W_1+W_2)/(T_1+T_2)$

Each of many cognitive verbs—*assume, believe, bet, conjecture, consider, doubt, expect, fancy, feel, figure, gather, guess, imagine, judge, know, postulate, presume, reckon, perceive, sense, suppose, surmise, suspect, think, trust, and wonder*—which the authors might have assigned to the Warfighters' perception of the efficacy of physical training has its own subtle implications as to Warfighters thought processes and their residual doubt and feelings about the proposition. For example, had the authors said the Warfighters *think* the proposition is true, readers might anticipate a disproof or debunking would follow.

For the military, a higher incidence of musculoskeletal injuries resulting in lost duty time, medical treatment, and extensive rehabilitation is^(a) a significant and costly concern with regard to effectively maintaining physical and operational readiness^(b) of the Force. Unfortunately, to date, the short- and long-term physiological, functional, and readiness outcomes or safety of ECPs has not been carefully^(c) studied. Accordingly, the evidence-based, peer-reviewed literature^(d) does not yet support the efficacy for or clarify any notable injury risk potential with ECPs to validate or dismiss the claims, clinical observations, or media reports.³⁰

(a) To say "a higher incidence of [such injuries with attendant consequences] **is** a significant and costly concern" (bold added) implies the existence or truth of the proposition, which the rest of the paragraph denies. A higher incidence of the events described **would** be a concern, should they ever materialize.

(b) The Textbooks of Military Medicine state that better conditioning reduces the risk and cost of injuries, a fact because it agrees with experience. The *Consensus Paper* misses the trade-off between the training injuries incurred to harden the trainee as a warfighter.

(c) Reading the word **carefully** literally as in a scientific paper, the *Consensus Paper* implies that both the Army's "CrossFit Study" with its six-week trials and the Marine Corps's **Combat Conditioning Trial Program** were executed carelessly, a baseless charge. The *Paper* provides no evidence or critical analysis to show that these trials violated good military practices or scientific principles.

(d) The criteria of peer review and publication are peculiarly academic standards of post modern science by which to perpetuate and enhance doctrine. These are alien standards in both the military and most industrial science, where Cause & Effect is tested and exploited, objectively and usually in secret, in accord with the objective principles of modern science.

What "some Warfighters believe" is belittling on two grounds. It is procedurally demeaning because the authors provide no source, peer-reviewed or otherwise, for attributing the proposition to a belief. It is substantively disparaging because it suggests the proposition is not true. That is, the *Consensus Paper* implies either (1) "these programs" do not contain functional training, or if they do, that (2) functional training does not "translate into more effective performance on the battlefield."

Warfighters *know* that at least one of the so-called ECPs produces functional fitness, and that functional fitness is efficacious on the battlefield. They also know from experience that it is a high state of health that eases the transition out of warfighting. Once the efficacy of functional fitness is seen as knowledge, the ultimate of cognition—science—takes over. At this point, the information is suitable for scientific modeling to quantify the extent of the efficacy or benefits, the costs, the risks, and the probabilities, all to predict outcomes and postulate experiments to increase the quality of the knowledge. Is it a conjecture (incomplete in cause and effect), a hypothesis (complete with predictions yet to be validated), a theory (substantial, novel prediction validated), or a law (all consequences validated)? Having cast what Warfighters know as mere belief, the *Consensus Paper* had no need to challenge the proposition that functional fitness is efficacious.

30 Annotation added, *Consensus Paper*, p. 384.

The truth of the proposition is demonstrated by the facts of Military Medicine, the services trials, and the adoptions into new functional training regimens. While the *Consensus Paper* provides no facts attributable to the Warfighters themselves, an alternative authority does exist: HPRC, the education branch of CHAMP, which at least speaks *to* the Warfighters and so might presume to represent them.

HPRC is the Human Performance Resource Center, a searchable, web-based repository. It is a “DoD initiative under the Force Health Protection and Readiness Program”. HPRC asks “Are high-intensity training programs safe and effective?”³¹ and answers it as follows in its entirety and annotated:

Background

The Department of Defense (DoD) and American College of Sports Medicine (ACSM) convened a workshop at the Uniformed Services University, Bethesda, Maryland to address the issue of high-intensity training (HIT) programs. During this session, scientists agreed that it would be more appropriate to refer to HIT programs as Extreme Conditioning Programs (ECPs). [Click here] to read the executive summary of the workshop.^(a)

Myths^(b) and Claims

ECPs and their followers claim that these programs are safe, science-based, and able to produce a balanced physique that can perform across a number of occupational demands.

Facts

Participants are often encouraged to exercise until they “puke.”^(c) Yet many military physicians have cited anecdotal reports of a high injury rate with these programs.^(d) Many individuals may not have a sufficient level of fitness to engage in such high-intensity exercise without considerable risk of injury.^(e) The fact is that no published data exist that compare these programs to other high-intensity activities such as running and basketball, which are among the leading causes of musculoskeletal injuries in military personnel.^(f)

ECPs such as CrossFit, P90X, Insanity, Gym Jones, and PT Pyramid are multidimensional programs that use various training methods: repeated body weight exercises, resistance training with barbells and kettlebells, explosive movements, sprints, and flexibility training. This variety prevents boredom and targets an area of unmet training needs among Warfighters. Individuals often find these programs challenging, motivating, and exciting. Many testify that they have never been in better shape.

On the other hand, certain aspects of ECPs violate well-established safety and efficacy principles.^(g) This tendency^(h)—coupled with inadequate recovery time—promotes fatigue, a greater perceived exertion during the activity, and may possibly⁽ⁱ⁾ lead to overtraining consequences. When these programs are performed in military group settings, the less fit individuals can easily overreach their physical capacity and become injured. These programs are not always balanced to meet all training needs.^(j)

Cautions

Since the positive aspects of ECPs have been recognized, and since these programs appear to meet a perceived or actual unfulfilled training need, individuals and military units using them should proceed with caution. Research is needed to determine risk versus benefit of these programs, and modifications are needed to accommodate less fit individuals and prevent injury.^(k)

31 <http://hprc-online.org/physical-fitness/hprc-articles/are-high-intensity-training-programs-safe-and-effective-2>

(a) That some scientists did agree to the name change is clear, but no conference record exists to show exactly how that change evolved, nor why this was the only result reported from the conference. The Executive Summary lists the ECPs as including "CrossFit, P90X, Insanity, Gym Jones, and PT Pyramid", expanding the list in the *Consensus Paper* by two. However, under the topics of "functional fitness programs" and "functional fitness", the only program HPRC explicitly mentions is CrossFit. HPRC papers include the Army Ranger RAW [Ranger Athlete Warrior] Workout, a functional fitness program allegedly based on both CrossFit and Gym Jones, but with a stated preference for the latter.

(b) HPRC includes "Myths" only in the heading as if to suggest that the claims it shows are not valid.

(c) The alleged encouragement to vomit is false and unsupported. Vomiting like exertional rhabdomyolysis are realities of exertion, and CrossFit warns everyone about these possibilities with training and cartoon characters, Pukie and Uncle Rhabdo. Pukie is "a benchmark to measure your intensity and **reel it back before it's too late**".³² "Death is nature's way of telling you to slow down" goes the old saw. CrossFit adds that vomiting and discolored urine are signs that you have gone too far. CrossFit no more encourages participants to exercise until they vomit than it encourages them to exercise until they fall to rhabdomyolysis.

(d) HPRC appeals to alleged authority (*many military physicians*) and their alleged publications (*have cited*) to support claims from the rumor mill (*anecdotal reports*). The alleged *high injury rate* remains a fantasy, existing or in the future, for all conditioning and training programs under consideration, in particular including military PT and CrossFit.

(e) CrossFit prescribes nothing less in its article "How to Start", featured on its Internet home page, and fraudulently misrepresented by Zambraski in his presentation to the Conference.

(f) HPRC admits that no data exist, at least published, to support either that CrossFit is safe or safer than military PT, or the CHAMP/ACSM authors' claim that it is harmful. Instead the University of Nevada, Reno, CrossFit, informed its ACSM audience that in over 87,000 supervised CrossFit exercises, only one injury occurred (Chart 12), and by private communication, that that was to a tendon which recently had been surgically repaired. That datum was from UNR CrossFit affiliate Associate Professor Nora Constantino, PhD, FACSM, and presented at ACSM's 16th Health & Fitness Summit & Exposition, March 29, 2012.

(g) HPRC provides no example of either side of this violation: an aspect of an ECP, or a "well-established safety and efficacy principle" which might begin to support its claim that a plurality of such violations exists. CrossFit would not argue that its training principles are anything but a major departure from traditional military PT, but military PT is inadequate and dangerous, producing a grassroots revolt.

(h) What was certain with a multiplicity of aspects in the first sentence is contradicted as a "tendency" in the second.

(i) The notion of "inadequate recovery time" is a supposition. Coupled with alleged violations of "well-established ... principles" creates a mere possibility, casting everything said about harmful practices as hypothetical.

(j) Any training or conditioning undertaken in regimented military fashion, in unison, and by the numbers, is a "one size fits all" approach certain to produce either no results or injury. Textbooks on Military Medicine, like CrossFit, prescribe individualized training and conditioning.³³ No program can meet "all training needs" without individualization and the sacrifice of the balanced appearance of a drill team.

(k) Such modifications are essential features provided by CrossFit, and include scaling intensity to individual capabilities, substitute exercises as needed to accommodate physical or conditioning limitations, and mastery of movements before undertaking loaded exercises. In addition, while all workouts prescribe a nominal intensity, the work produced is always to the current capabilities of the athlete.

32 Bold added, comment explicitly endorsed by Greg Glassman, October 16, 2003. <http://board.CrossFit.com/showthread.php?t=468>

33 See Vogel, *id.*, Part IV, below, Note 8.

3.1.4.1 Gym Jones offers unauthorized and compromised CrossFit.

Gym Jones claims to be based on CrossFit, but it differs from CrossFit in the most important attributes. The difference arises principally from the definition of fitness, and as a result in the physiology of fitness and the degree of improvement that an athlete can attain. That difference is important because of the recommendation that the US Army RAW program prefers Gym Jones over CrossFit, and because the *Consensus Paper* has erroneously generalized from its group ECPs to CrossFit.

CrossFit defines fitness as “work capacity across broad time and modal domains”, and provides a conditioning program geared to increasing each person’s fitness gradually and proportionally, and then maintaining that fitness. Conditioning that promotes appearance, or that is sport-specific, as included in the Gym Jones program, must blunt the conditioning that can be achieved through dedication to general work capacity.

Mark Twight, Gym Jones owner and former CrossFit Level 1 trainer, explains his model in the Gym Jones Manual. The first chapter is *Define Fitness*, and it begins:

What is fitness, and why work for it?

Each individual must ask this question before engaging in a training program. Without a definition or stated objective no training program may ever be judged successful or not.

1) What am I trying to achieve with my training program?

a. Am I training for the sake of **appearance**?

b. Am I training for a general function with overall fitness high enough to do “**anything, any time**” (firefighting, military special operations, paramedic, martial arts, etc) i.e. **general physical preparedness (GPP)**?

c. Am I training for a **sport-specific** application where technique must also be refined and peak performances may be “scheduled” through periodization annually or biannually?

2) Once the objective is defined one must analyze the current program in relation to the goal. Program assessment must include an unsentimental (BS-free) analysis of one’s current fitness and overall health – without an understanding of the present it is difficult to prepare for the future.

a. If GPP is the goal, does my training program cause adaptation toward a balanced, general functionality, training all energy pathways **to a maximum concurrent capacity**?³⁴

Gym Jones’ GPP, which he also refers to as his Foundation Program, is CrossFit, rebranded, misunderstood, and ready to be compromised to include body building or sport-specific training. It says,

One training idea stands out as providing the best and broadest results within the context of general physical preparation (GPP). It’s called CrossFit and it may be quickly described as, “constantly varied, if not randomized functional movements executed at high intensity.”³⁵

³⁴ Underline in bold added, Twight, *id.*, p. 3.

³⁵ *Id.*, p. 16. The word *constant* has two primary meanings, (1) not varying or (2) unceasing. To avoid creating an oxymoron, “constantly varied” must mean unceasingly varied. “Collectively, these three attributes (load, distance, and speed) uniquely qualify functional movements for the production of high power. Intensity is defined exactly as power, and intensity is the independent variable most commonly associated with maximizing favorable adaptation to exercise.” Greg Glassman (2007), pp. 1-2.

The unattributed phrase in quotes is from the opening sentence of the CrossFit Journal Article, "What is CrossFit", of March 2004.³⁶ CrossFit restated that idea in 2007:

The CrossFit prescription is "constantly varied, high-intensity, functional movement." ... Collectively, these three attributes (load, distance, and speed) uniquely qualify functional movements for the production of high power. Intensity is defined exactly as power, and intensity is the independent variable most commonly associated with maximizing favorable adaptation to exercise.³⁷

Twight never defined intensity, but his usage is ambiguous. He says,

the ability to produce power or perform at high intensity for short periods of time.³⁸

High intensity here cannot mean high power, because that would render the final clause "for short periods of time" meaningless, tending to make the whole thought a tautology, i.e., "ability to produce power or perform at [high power]". He also refers to "repetitions of the movements at low intensity (load)". However, he also says "the short duration indicates a very high level of intensity" (*id.*, p. 44) and "intensity is inversely proportional to duration" (*id.*, p. 76). Power is work per unit time, suggesting he is thinking of intensity as power. He also has "work intensity" (p. 46), "aerobic intensity" (p. 45), and "anaerobic intensity" (p. 113).

One of the Textbooks on Military Medicine says,

By exercising at a level above "normal" (overload), the body responds physiologically to accommodate this greater load until that load becomes the norm. The overload must be presented progressively and with sufficient intervening recovery time to avoid damage or failure to the systems involved. The added load can be presented by increasing the intensity, duration, or frequency of the training activity. *Intensity* refers to the absolute level of exercise (strength of the stimulus), such as speed of running or the amount of mass lifted.³⁹

If intensity can be mass or weight, it is neither power, nor work, nor work capacity.

That misunderstanding from lack of a definition could lead Gym Jones to faulty execution of CrossFit, and it underlies CHAMP's and HPRC's mistaken characterization of CrossFit conditioning or workouts as extreme. CrossFit has defined intensity to mean within its articles as power, but at the same time, "high intensity".

On closer examination, CrossFit workouts are no more "high intensity" than they are *high frequency, long duration, low variability*, or *high power*. In its proprietary Level 1 training handbook, CrossFit says on the subject "High Intensity"

How Intense? Relatively intense. Intensity is relative to the individual's physical and psychological tolerances.

CrossFit's general prescription is to perform a wide variety of functional movements at (relatively) high intensity.⁴⁰

36 <http://www.google.com/url?sa=t&rc=j&q=&esrc=s&source=web&cd=3&ved=0CM0BEBywAg&url=http%3A%2F%2Fwww.CrossFit.com%2Fjournal%2FCrossFit%2F&ei=K-AIUPWKD8q7gAH3jIDYCO&usq=AFOjCNFDgQdvmQpiu1UYmYzsw-mopcZBQw>

37 Greg Glassman, "Understanding CrossFit", April 2007, p. 1.

38 Twight, *id.*, p. 10.

39 Italics in original, Part IV, Vogel, *id.*, Note 7, below.

40 Todd Widman, "A CrossFit Startup Guide: Part 2", CrossFit Journal, 2009, p. 6.

Whatever the verbal definition of intensity, the empirical definition is plain from the workouts, and CrossFit is nothing if not empirically developed. The rule is that CrossFit workouts prescribe movements and patterns, and they suggest loads, but they are as much or as many or as quickly as possible. No exercise is known that violates this rule. As a consequence, the workouts are open-ended with respect to both power and work. Alternatively, each workout is individualized. They are all high intensity in the sense that the individual performs to the maximum of his ability that he can muster at the time, and they are high intensity in the sense that the individual is encouraged to do more or do what is prescribed faster each workout—progressively more reps, greater weight, greater distance, less rest, faster time.

Gym Jones is different. For example,

Each workout is scaleable to an individual level of fitness: reduce loads and distances or number of reps. E.g. Day 10 could be modified to accommodate a deconditioned athlete by using a lighter ball and doing assisted pull-ups. This is preferable to reducing the number of reps prescribed for either movement.⁴¹

CrossFit workouts usually do not specify the total number of reps.

Each CrossFit workout in general has four intra-exercise attributes. First, the workouts prescribe one or several different movements to exhaust the whole body well before overstressing any single set of muscles or pathways. Second, instead of being *high*, the intensity of each movement is within the capabilities of a large majority of athletes to complete one full rep within a reasonable amount of time, say, 20 minutes. If not, CrossFit encourages substitutions within the same pathway. Third, the workouts prescribe rest at various points between rounds, sets, or movements.

Fourth, the workouts do *not* prescribe the energy (work) or power the athlete is to expend, but instead specify a parameter that would determine the work completed or the power delivered. The energy or power is the benchmark of fitness, the scientific parameter that measures ability and progress. Measured progress is what makes CrossFit safe, individualized, and effective. Each athlete learns what he can do with a reasonably strenuous exercise, and he can gradually increase his performance.

Conditioning activates natural processes that increase physical capacity. An overload triggers minor damage called microtears—a little bit of exertional rhabdomyolysis. The threshold amount required is a capacity that varies among individuals, and differs between environments, especially temperature and altitude. With CrossFit, it is learned by the athlete, and measured in open-ended workouts. What one athlete can do could be lethal to another, but that is irrelevant. CrossFit holds athletes to no work capacity standards.

CrossFit workouts are not tests to be passed. They are the core of a conditioning program, not a qualification program.

Gym Jones says,

To improve, individuals must accept that they haven't **reached their potential^(a)**, and be willing to take the cure. The **GPP goal^(b)** is achieved by training a wide variety of energy systems and movements, with emphasis on muscles, muscle groups and movements that are the foundation of daily functional and **athletic movements**. This same program may also be used to build a solid foundation and **starting point** for a periodized, sport specific application, which is designed to address the particular neurological and efficiency demands of the sport.
^(c) Such a GPP, or Foundation program **should** have a positive influence on all indicators of health (rather than slowly exhausting the athlete or causing injury or imbalance)^(d).⁴²

41 Twight, *id.*, p. 26.

42 Bold, annotation added, Twight, *id.*, p. 4.

- (a) CrossFit workouts provide no way to measure an athlete's *potential*, only to assess his current work capacity in a particular workout. The military and police set such qualifying standards, but they are often one dimensional while CrossFit workouts may include multiple pathways which are varied workout to workout.
- (b) CrossFit has no such discrete goal. It specifies familiar functional movements for the athlete to master and use in pursuit of the goal of continuous, measurable improvement. CrossFit's goal is not achieved; it is reset each workout.
- (c) CrossFit considers its program to be a sport of sorts. It is "of sorts" because it is unique among sports. Its "neurological and efficiency demands" are neither particular nor predictable. It is like the German Shepherd dog that does everything—second best. The CrossFit kennel has no one-trick dogs. It produces no particular physique, like that of the Sumo wrestler, the distance runner, or the body builder, characteristics that can be identified with a sport and which show obvious weaknesses for other sports.
- (d) The CrossFit program with its prescribed rest periods is designed for full-time, safe use. Concurrent sports specific-training may require cutting back on CrossFit, but the athlete might consult a CrossFit trainer so that any sports specific-training could be a replacement workout. The CrossFit program is gradual and maximal, while its workouts are quick and sudden. It is intended to exhaust, and to cause minor injury, i.e., microtears that induce natural rebuilding and super repletion⁴³, in a balanced program across the three metabolic pathways.

The Gym Jones Manual supplies no reason for making the benefits of CrossFit conditional ("*should* have a positive influence"). It is literally textbook conditioning guaranteed to work for a normal human being.

Summary. CrossFit is open-ended on the fitness scale, at least to the speculative limits of physiology and kinesiology. It creates a continuously measurable improvement, or maintenance, from an equally open-ended library of functional workouts, each lasting up to about 20 minutes, performed three days out of every four. Prescribed intervals between sets, rounds, circuits, and workouts are periods of rest. They are to allow repair and growth, and are not to be filled with other workouts or other physical exertion affecting the same groups of muscles or pathways. They are for eating, sleeping, sex, entertainment, earning money, and, if any time is left, don't forget mental exercise and training. Almost any sport-specific training added to the individual's conditioning program requires a sacrifice in CrossFit's broad spectrum training.

CrossFit conditioning features two major components: functional movements, and broad-spectrum (time and modal domains) fitness. Body building is non-functional in both its attributes of bulk and muscle definition. Sport-specific training sacrifices one part of the fitness spectrum for gains in another, and many of those trade-offs, such as those involving body mass distribution, are obvious. Upper-body development is a net liability for runners. If runners interbred only with runners, a new species of tailless Homoraptors would emerge. Weight loss for a well-conditioned wrestler or a 400-pound lineman is a liability. The force a wrestler can generate in a scissor hold would likely be compromised by training to develop a runner's stride.

Gym Jones adopted a different definition of fitness, one that accommodates non-functional movements to focus on sport-specific movements at the expense of others. Coupled with errors in understanding scalability and intensity, the Gym Jones GPP training, while claiming to be based on CrossFit, is not CrossFit.

⁴³ See Part IV, Vogel, *id.*, Note 8, below.

3.1.5 The *Consensus Paper* demeans Warfighters with subjective, unscientific conclusions.

The following two sentences already discussed for presuming to speak for Warfighters and for the *Paper's* failure to resolve anecdotal evidence.

[S]ome Warfighters believe these programs contain functional training that directly translates into more effective performance on the battlefield.

For many Warfighters, the demanding exercise pace, overall difficulty, and perceived potential for “getting ripped” are appealing, exciting, motivating, and appear to target a niche of otherwise unmet training needs and desires. *Id.*, p. 384.

Analysis of the Gym Jones program shows that the Warfighters’ alleged belief that the Extreme Conditioning Programs contain functional movements is true. It is so solely because the *Consensus Paper* included CrossFit in the mix. The phrase “some Warfighters believe” is not to introduce a fact, but a point that the authors want to convey as irrational. To reinforce an implied aura of objectivity for the *Paper's* pronouncements, it casts what Warfighters think as mere beliefs. Moreover, it inserts the adjective *some* to suggest that whatever beliefs Warfighters might hold are significantly less than unanimous.

The *Consensus Paper* belittles superior conditioning that might be achieved by novel programs as “getting ripped”, suggesting, with the support of neither analysis nor evidence, that any fitness gains by other than traditional military PT are merely cosmetic. To mask the reality that the authors have no data, they allege to speak for “many Warfighters”, buoyed by an alleged quantity. But this is analogous to the blank round in the firing squad’s load. If they had spoken for all Warfighters, that would be immediately seen as false and impossible to know. Speaking for some vague number as *many*, no one would be inclined to show that two or three such Warfighters did not exist within the ranks of tens of thousands of troops. However, a scientific article would quantify words like *some* and *many* with facts, and would not, outside of a study in psychology, rely on beliefs as evidence.

That is, more than just increasing physical fitness and work capacity, the assortment of specific exercises and challenging repetitions arguably addresses a broad range of “in-theater,” real-world operational physical activities and demands and psychological discipline that Warfighters believe will elevate combat readiness. When performed in group settings, ECPs also can promote unit camaraderie and teamwork.⁴⁴

Lacking any citation for “in-theater”, the authors apply scare quotes for subjective, editorial purposes. This is consistent with the article comprising authors’ individual opinions, but it is not objective. It is not acceptable in scientific writing, and out of place to set military doctrine and policy below the level of the President or Congress, where the bucks stop.

The authors impliedly concede evidence for “increasing physical fitness and work capacity”, but then cast these gains as only “arguably address[ing] real-world activities and demands”. They imply that these results are psychological, consistent with Warfighters’ beliefs, as opposed to knowledge about combat readiness. ECP marketing has thus managed to pull the wool over Warfighters’ eyes. To the contrary, these principles and attributes of fitness – only believed to be true by Warfighters according to the *Consensus* – are taught as fact in the Textbooks of Military Medicine.⁴⁵

In the beginning stages and throughout the program, in the absence of individual fitness- and experience-based guidelines, Warfighters can arbitrarily do as much as they want and feel they should.⁴⁶

44 *Consensus Paper, id.*

45 See Part IV, Vogel, *id.*, Note 1, below.

46 Italics in original, *Consensus Paper*, p. 384.

According to Textbooks on Military Medicine, physical conditioning must be tailored to the individual, to his body type, health, conformity, conditioning, and exposures to harmful agents.⁴⁷ But no personal trainer or drill sergeant can determine whether a trainee is in all respects ready for a specific exertion. Because PT, comprising group or synchronized calisthenics and group running, is a one-size-fits-all program, it cannot be challenging, but must instead be limited to some minimally fit but acceptable level, lest the drill sergeant experience embarrassing injury rates.

CrossFit is fully individualized. It differs from military PT and is perhaps unique among all so-called ECPs in that every CrossFit workout, whether used in training or in competition, is open-ended in some essential work parameter, a point missed in the *Consensus Paper* and apparently missed in its supporting papers.

CrossFit workouts call for no more than best effort as determined by the athlete, and it then measures his progress, not his attendance. At all times, the CrossFit athlete decides the intensity, duration, frequency, and mix of his workouts as he is ready to perform them. CrossFit does not drill athletes in unison, or “by the numbers”. It is the antithesis of one size fits all and the regimented drill of police academies, football squads, and the military. CrossFit prescribes certain minimum standards for workout parameters, as in heights, weights, or distances, but even these are nominal. CrossFit encourages athletes to tailor their workouts to their individual needs and physical capabilities, and examples are abundant, as for children, and for recuperating or handicapped athletes.

The *Paper’s* ultimate complaint, above, that Warfighters might adapt their conditioning “arbitrarily” suggests that the authors object not to the resulting gains in individual fitness or unit readiness, but to the lack of regimentation and submission to their control and authority.

3.2. The *Consensus Paper* claims ECPs are responsible for a potential emerging, disproportionate injury risk and increased rate of rhabdomyolysis cases, based on a coincidence from health reports and a rise in ECP popularity at policy levels.

The *Consensus Paper* states its worries in the penultimate sentences of the Introduction, introduced in Part I:

However, physicians and other primary care and rehabilitation providers have identified a potential emerging problem of disproportionate musculoskeletal injury risk, particularly for novice participants, associated with ECPs (13,16). Muscle strains, torn ligaments, stress fractures, and mild to severe cases of potentially life-threatening exertional rhabdomyolysis are reportedly occurring at increasing rates as the popularity of ECPs grows (4,27).⁴⁸

The following sections investigate the four references, 13 (“Hadeed”), 16 (“Mimm”), 4 (“MSMR 17-3”), and 27 (“Tilghman”), showing that they have little to no relationship to the *Paper’s* claims, and one actually contradicts its primary thesis that CrossFit in particular is dangerous.

⁴⁷ See for example, Part IV, Vogel, Notes 3, 4, and 9, below.

⁴⁸ *Consensus Paper* p. 383.

3.2.1 Hadeed is an ACSM-sponsored case study of an isolated occurrence of rhabdomyolysis and compartment syndrome for an out-of-condition athlete.

Hadeed (Ref. 13) is a two-page reprint titled “Clinical Case Slide—Heat Illness”.⁴⁹ This is from an ACSM journal, and the article is sponsored by one of its authors, Diane Elliot, FACSM. It contains no references. The case summary included the following history in its entirety:

HISTORY: A 33-year-old **previously** healthy and **physically fit** law enforcement officer complained of fatigue, muscle soreness and swelling after a **high intensity** CrossFit **exercise workout**. He reports having had **5 previous days of exercise** but did not involve CrossFit type training. After a **prolonged and extreme** CrossFit **exertional program**, patient reported fatigue, shortness of breath, muscular weakness, and sleep disturbance, and went to the ED 3 days later. ...

DIFFERENTIAL DIAGNOSIS:
Exertional Rhabdomyolysis
Compartment Syndrome of upper extremity
Muscle Diseases and Myopathy
Acute Kidney Injury
Metabolic disorders ...

TREATMENT AND OUTCOMES: Admitted to hospital for fluid IVF. Daily monitoring of CK, muscle soreness.

After 6 days, patient was discharged from hospital with a CK of 995 IU/L.

Returned to high intensity training after 4 months of mild to moderate aerobic training with appropriate instruction on high intensity workout recovery and hydration. Bold added, Hadeed (2011).

As in the *Consensus Paper* itself, ACSM characterizes CrossFit workouts as “high intensity” and “prolonged and extreme” with neither quantitative nor definitional support. By implication but providing no analysis, the previous five days of exercise “did not involve CrossFit type training”, as if they were less intense and therefore not significant.

This case is about a police officer who was “previously fit”, implying that he was no longer. It implies that he had had no reportable exercise prior to the six days of intense exercise, and only after another three days did he seek medical help. It further implies by the prescription given him on discharge that he had undertaken his six days of high-intensity workouts without “appropriate instruction”. This case fits a pattern of once well-conditioned athletes trying to return to their old forms too quickly, a condition for which the Textbooks provide an explicit warning.⁵⁰

This is an isolated case of rhabdomyolysis, a disease difficult to impossible to diagnose except in clusters.⁵¹ The “differential diagnosis” included compartment syndrome, which is difficult to differentiate from rhabdomyolysis, and it may accompany rhabdomyolysis so it cannot aid in differentiating exertional rhabdomyolysis from other etiologies.⁵² The case study contains no medical history, and fails to answer obvious questions prompted by the few facts reported. Why had the officer not been exercising? Had he been ill or injured? Had he been, or was he now, on any medication? Had he previously had a case of rhabdomyolysis? Could genetic disorders be implicated? What were the workouts over those six days, and how did they compare with what he had previously been able to do?

49 Medicine & Science in Sports Exercise, v. 43, no. 5, May 2011, pp. 224-225.

50 See Part IV, Vogel, *id.*, Note 13, below.

51 Part IV, Gardner, Note 1, below.

52 Part IV, Walsh, Notes 2, 3, below.

But regardless of whether he was ever in shape, or had other uninvestigated cofactors for rhabdomyolysis, at face value the evidence is that he undertook excessive exercise too quickly for his state of health and fitness. Clusters of rhabdo cases among whole squads of military recruits, football teams, and police academies are legend, brought on by classical physical training imposed after layoffs as brief as summer vacation. This is a case “associated with ECPs” only because ECPs are defined to include CrossFit.

The prescription by the Emergency Department indicts the police officer’s trainer. The case study indicts itself or the Emergency Department. Either the reporting or the diagnosis was incomplete to the point of missing the obvious: the athlete was injured by overexertion following a layoff.

3.2.2 Mitchell is a journalist’s view of the outcome of a civil lawsuit for damages from a single incidence of rhabdomyolysis alleged to have been induced from CrossFit exercises, a suit to which CrossFit was not a party.

The *Consensus Paper* relies on not just a news article, but one about a civil lawsuit for damages.⁵³ It is a typical news piece, written by a layman for a lay audience and subjective. It has no authoritative value beyond facts reasonably supported by citations from authorities or witnesses.

The court proceedings were not before a fact-finding body. The verdict in a civil suit is by a preponderance of the evidence, including experts sworn to tell the whole truth selected by adversaries to tell partial truths only favorable to their clients. The decision is reached by a lay trier of fact. This kind of trial weighs evidence subjectively, on believability, sympathy, responsibility, and financial disparity, leading to a decision for one party or the other. These proceedings are not objective, and so are not based on science. Books, equally as authoritative as news articles and packed with anecdotal accounts, are available about such proceedings, calling the physically impossible results “junk science”.⁵⁴ The legal process comes to a conclusion even when both the cause and the alleged effect are uncertain and statistical.

Mitchell’s case is not science. It fails to support the *Consensus Paper’s* claim that “physicians and other primary care and rehabilitation providers . . . identified a potential emerging problem of disproportionate musculoskeletal injury risk, particularly for novice participants, associated with ECPs”. It is a single incident, an outlier report, supported with no facts, and contains testimony from not one physician nor one health care worker.

Lawsuit plaintiff Makimba Mimms claimed he was permanently injured by defendants whose negligence caused him to suffer rhabdomyolysis from a CrossFit exercise. He pled legal proximate cause. Even assuming for the sake of argument that a civil lawsuit could establish either scientific facts or Cause & Effect, the article states that this particular lawsuit asserts those defendants’ negligence. The lawsuit did not name either CrossFit, the fitness program, or its owner as a defendant. CrossFit was not a party to the suit, and did not participate even to defend its brand.

The article provides no evidence supporting a differential diagnosis of exertional rhabdomyolysis. It includes no case history to show that plaintiff was not susceptible to rhabdomyolysis by his habits or genetics, or whether he had a history of rhabdomyolysis. It had no information as to his present or past conditioning, or to his recent exercise and health history, beyond admitting that he was “unprepared”, making him susceptible to heat injury. The information in the article provides no evidence to contradict the possibility that plaintiff contracted rhabdomyolysis immediately prior to exercising under defendants’ care, and took his damaged body to their gym for the purposes of a lawsuit.

The news article has no information as to which CrossFit workout plaintiff thinks caused his injury, or its parameters of intensity, duration, frequency, mix of movements, or rest periods beyond saying that he “endure[d] the extreme exertion prescribed by the CrossFit regimen”. The article provides no evidence that CrossFit prescribes “extreme exertion”, that it is any more strenuous than any alternative program, that its workouts are not open-ended, scaled to the abilities and condition of the individual athlete.

The news article refers to plaintiff’s complaint, but not once to defendants’ answers. Instead, Mitchell provides the

53 Mitchell, B., staff writer, “Lawsuit alleges CrossFit workout damaging”, Navy Times, 8/16/2008, Ref. 16.

54 Huber, PW, “Galileo’s Revenge: Junk Science in the Courtroom”, Basic Books, 1993. Kitaeff, J., “Malingering, Lies, and Junks Science in the Courtroom”, Cambria Press, 2007.

authority for the dangers in CrossFit alleged in the *Consensus Paper*, saying

The lawsuit is part of an emerging body of evidence that CrossFit may be damaging to participants' health, perhaps even causing death—a possibility acknowledged by its founder as early as 2005.⁵⁵

This is the source of the *Consensus Paper's* claim of

A potential emerging problem associated with increasingly popularized extreme conditioning programs (ECPs) has been identified by the military and civilian communities.⁵⁶

and the "identified [] potential emerging problem of disproportionate musculoskeletal injury risk ... (13,16)". *Id.* An old saying is "everything after the word *essentially* is a lie." *Potential* and *emerging* would play the same role here separately, but compounded into the phrase *potential emerging* are even further from fact. They signify that the evidence does not yet exist, but is a possibility in the authors' minds. An emerging problem would not yet constitute fact, but a *potential emerging problem* is one yet to even emerge. The evidence does not exist.

For writer Mitchell's claim, he supports Mimms' complaint with out-of-context misquotes from Greg Glassman and Eugene Allen in the CrossFit Journal, former commander of the Navy's Center for Personal and Professional Development Capt. Jonathan Picker USN, Mimms's expert Dr. Priscilla Clarkson, along with other experts. As shown next, none of these citations support Mitchell's or the *Consensus Paper's* claims of the emerging problem, or even the *potential emerging problem*.

55 Mitchell (2008).

56 *Consensus Paper*, Abstract, p. 383.

3.2.2.1 CrossFit Is the Safest of All Fitness Programs.

Mitchell asserts,

[CrossFit founder Greg] Glassman posted a warning on the CrossFit site in October 2005 labeled “CrossFit induced Rhabdo,” telling participants about the potential problems associated with the unforgiving workout . . . [¶] “With CrossFit, we are dealing with what is known as exertional rhabdomyolysis,” he wrote. “It can disable, maim and even kill.”

To be clear, what Glassman said can “disable, maim and even kill” refers to rhabdomyolysis, not CrossFit. Furthermore, the article does not use the word *unforgiving* or a synonym in any context, nor any phrase analogous to “unforgiving workout”.

The 2005 Glassman article described the five then-known cases of rhabdo associated not with CrossFit workouts, but deviations from them:

1. Rhabdo from “a fast-moving, hard-hitting group workout that included high-rep assisted team pull-ups”. Even in competitive CrossFit Games, workouts are to the individual’s best effort. Group exercises replace that CrossFit limit of the individual’s current state with a drive to keep up with those more fit. This is the danger that induces rhabdo even in the relative benign physical training, not conditioning, of the military, football teams, and police academies.
2. Rhabdo from CrossFit on Monday, CrossFit on Wednesday, several hours of tennis on Friday, Saturday, and Sunday, hospitalized on Monday. A differential diagnosis of exertional rhabdo would have been well-supported, but not the differentiation of CrossFit rhabdo versus tennis rhabdo.
3. Rhabdo from attempting 50 consecutive kettlebell swings. The closest CrossFit workout to this athlete’s ill-advised experiment is sensible. It is Helen, comprising three rounds **for time** of 21 kettlebell swings sandwiched between a 400-meter run and 12 pull-ups. The work CrossFit asks of the athlete in the Helen is spread over different sets of muscles and different metabolic pathways, and with power according to the athlete’s fitness because the time the athlete requires is measured, not specified.
4. Rhabdo from an attempt to “Tabata” an unknown workout challenge of a friend. To Tabata a CrossFit workout is to repeat it 8 times with 10 seconds between, scoring the least number of reps in any interval. It includes a CrossFit multiplier but not the multiplicand, so whatever induced this case of rhabdo is unknown.
5. Rhabdo in a bodybuilder and runner who ignored warnings to initiate himself to CrossFit on two consecutive days of unknown workouts. Rhabdo is preventable.⁵⁷ It is preventable in any program by limiting exertion to the individual’s state of conditioning. It occurs frequently among athletes who remember a previous level of conditioning, and attempt to demonstrate it after a layoff. This case is a corollary of that deconditioning problem that the athlete may never have achieved the fitness he imagined from his bodybuilding and running regimen.

The lesson learned according to Glassman, but not reported by Mitchell was the following:

What the rhabdo outbreak teaches us is that CrossFitters are trained to perform more work, more effective work, and more work **more safely over a given time period than any other athletes.**⁵⁸

When the authors of the *Consensus Paper* relied on Mitchell, they inherited as fact what Mitchell had inherited: CrossFit is the safest of all training or conditioning programs.

⁵⁷ Part IV, Vogel, *id.*, Note 13, below.

⁵⁸ Bold added, Glassman, G. “CrossFit Induced Rhabdo”, October 2005, p. 3 of 3.

3.2.2.2 Mitchell Misrepresents CrossFit and 'Killer Workouts'.

Following the lead of Dr. Priscilla Clarkson (October 7, 2008, below) but without mentioning her name, Mitchell juxtaposed Greg Glassman's comments about allegedly unforgiving workouts and the sometimes lethal characteristics of rhabdomyolysis with "Killer Workouts", an article by Eugene Allen, a law enforcement officer and CrossFit affiliate.⁵⁹ Mitchell, not satisfied with Allen's title, "Killer Workouts", placed Glassman's "can ... even kill" observation out from under Allen's name:

Eugene Allen—a Washington State law enforcement officer who runs a CrossFit blog—posted an even less ambiguous warning in May 2005 titled "Killer Workouts."

"With CrossFit, we are dealing with what is known as exertional rhabdomyolysis," he wrote. "It can disable, maim and even kill."⁶⁰

The *he* originally was Glassman, not Allen, and *he*, Glassman, was speaking about rhabdomyolysis, not Allen's alleged killer workouts.

As Mitchell failed to discover that Glassman warned about CrossFit in the context of being the safest program, Mitchell omitted this qualification from Allen:

Apparently, one of the three CrossFit pillars (functionality, intensity, and variance) done, **in extremis**, can introduce a character to the scene whom we have dubbed "Uncle Rhabdo".⁶¹

Surely Allen did not intend *in extremis*, meaning *at the point of death*. He couldn't have meant that CrossFitters were gladiators, unexploded bomb diffusers (*Danger UXB*, 1979), or Chernobyl firemen. Allen is saying that reckless approximations to CrossFit can cause rhabdo. That is consistent with the five known cases by Glassman, above.

Rhabdomyolysis, as the textbooks affirm, is a broad spectrum of diseases. Autism, too, is a spectrum disease, running, on the one hand, from a little, subjective attention deficit disorder (ADHD) (just being a two-year-old) or less likely to "prodigious savants" like Daniel Tammet, to catatonia on the other, a near vegetative state, which, like rhabdo, can be aggravated by certain medications. As the textbooks show, a little muscle damage, the low end of rhabdomyolysis, is the **intent** of all physical conditioning. Also as the textbooks show, exertional rhabdomyolysis is preventable at any level, meaning that it is a consequence of other factors. The objective of conditioning is to induce a little rhabdo.

What the *Consensus Paper* has established from Allen via Mitchell is that the so-called Extreme Conditioning Programs (ECPs), like the military Physical Training they might replace, are dangerous because of trainer malpractice, whether the trainer be a drill sergeant, a personal trainer, or the do-it-yourselfer.

59 CrossFit Journal, *id.*, May 2005.

60 Bold added, *id.*

61 Bold added, ALLEN (2005) p. 2 of 3.

3.2.2.3 Mitchell relies on another news article without confirming the source.

To illustrate official reaction to the growth of CrossFit in the military, Mitchell said,

Following a June story on the popularity of CrossFit in Military Times newspapers, Capt. Jonathan Picker, commander of the Navy's Center for Personal and Professional Development, posted a story that raised concerns about CrossFit in the July issue of the center's internal magazine.

"Several [experts] in the sports medicine field (military and civilian) have addressed a concern that the program has the potential for causing an increased incidence of musculoskeletal injuries and even muscle breakdown (rhabdomyolysis) and therefore is not supported by [Navy Center for Personal and Professional Development]," the story states. "Granted, anyone can develop a program that's very intense, but there's a safer way of doing this for our sailors." Picker could not be reached for comment.

Other reports of this passage attribute it to the July 2008 issue of CPPD Encompass newsletter, which is unavailable online to validate in its context. Capt. Picker served as commanding officer of CPPD from October 24, 2007 to July 1, 2010. The Navy has taken no action in response to his concerns.

Compared to other citations of Capt. Picker's remarks, Mitchell deleted the last sentence:

"Additionally, any program that names exercises after women is contrary to our Core Values."

This tongue-in-cheek remark minimizes the seriousness of Picker's remarks, so they need to be seen in a context greater than Mitchell provides. CrossFit is punctuated with humor, as in the cartoon characters Pukie and Uncle Rhabdo, and the naming of exercises after women. "A buck well-spent on a Springmaid Sheet" was a slogan too racist, too sexist, and too politically incorrect for anything but the humor to survive. Regardless, instead of trying to reach Capt. Picker, Mitchell should have contacted Capt. Chuck Hollingsworth, the present CPPD commander, for the official position of the US Navy and Marine Corps on CrossFit.

Capt. Picker's concerns in 2008 were the express topic of the "High Intensity Training Workshop" at USU, Bethesda, on September 13 and 14, 2010, chaired by CHAMP, sponsored by HPRC, a branch of CHAMP, where attendees reportedly included representatives of the Navy and Marine Corps. Perhaps the official Navy position was to defer any decision until after the results of the workshop could be considered. In the meantime, the growth in CrossFit affiliates continues unabated, as can be seen by searching for CrossFit at .mil.

3.2.2.4 Mitchell relies on Dr. Priscilla Clarkson, FACSM, a policy level spokesperson for ACSM, and an activist and courtroom expert for the dangers in eccentric exercises.

Mitchell's article features Priscilla Clarkson, mentioning her by name. He said in its entirety,

Dr. Priscilla Clarkson of the University of Massachusetts contends that Lopez encouraged Mimms to perform exercises known to produce rhabdomyolysis. "Adequate precautions to prevent such a condition from occurring were not taken," Clarkson wrote in documents prepared for the lawsuit.

Dr. Clarkson is important to the *Consensus Paper* for her influence as an expert on the Mimms lawsuit, directly and indirectly for her influence on Mitchell, for her influence on co-author ACSM as a current editor of one of its publications, and as a former officer of that organization at its highest policy level. Here are her bona fides:

A Distinguished Professor of Kinesiology, Professor Clarkson is a fellow in the American College of Sports Medicine (ACSM), and she has served as a member of the Board of Trustees. She served as President of the New England Regional ACSM Chapter, Vice-president of the National ACSM, President of the National ACSM, and President of the ACSM Foundation. She received the 1997 ACSM Citation Award, the 1999 New England ACSM Honor Award, the 2001 Excellence in Education Award from the Gatorade Sport Science Institute, the University of Massachusetts Chancellor's Medal in 1997, the 2005 National ACSM Honor Award, the University of Massachusetts Award for Outstanding Accomplishments in Research or Creative Activity, 2005, and the University of Massachusetts Graduate School Centennial Award, 2008. In 2007, she presented the keynote plenary Wolffe Lecture at the National ACSM meeting in New Orleans, attended by 5000 members.⁶²

Priscilla M. Clarkson is Dean of Commonwealth Honors College and Distinguished Professor of Kinesiology. Professor Clarkson has published over 200 scientific articles and has given numerous national and international scientific presentations. The major focus of her research is on how human skeletal muscle responds to environmental challenges such as over-exertion exercise resulting in muscle damage and disuse resulting in atrophy. She has also published in the area of sport nutrition. Professor Clarkson served as the Editor for the International Journal of Sport Nutrition and Exercise Metabolism for 8 years, serves on the editorial or advisory boards for several other scientific journals, and is currently the Editor-in-Chief of Exercise and Sport Science Reviews. Muscle Biology and Imaging Lab, University of Massachusetts Amherst.⁶³

Exercise and Sport Sciences Reviews is an ACSM publication.⁶⁴

The sentence Mitchell placed in quotations, above, is from an attachment to Plaintiff's Designation of Expert Witnesses, July 14, 2008, posted online in a package of available documents filed in the case.⁶⁵ Plaintiff Mimms said this of her anticipated testimony:

In general terms, she is expected to address the subjects of the effects of exercise on muscle tissue, exercise induced Rhabdomyolysis, CK levels in the blood, the physiological causes therefore, the risks, the pain, the discoloration found in urine, the effects on the kidneys, the need for medical treatment, the known protocols and methodologies for preventing and avoiding Rhabdomyolysis (including warning the client, assessing the client, reduced intensity of exercise for novices to that particular exercise, observation of the client good hydration, monitoring of urine and the need to seek immediate medical care) and the standard of care expected of persons acting as personal trainers or physical trainers.

62 <https://www.honors.umass.edu/dean-priscilla-clarkson>. May 21, 2012.

63 <http://www.umass.edu/mbil/>

64 <http://journals.lww.com/acsm-essr/pages/default.aspx>

65 <http://media.CrossFit.com/cf-video/MakimbaPkg.pdf>

This is the inflated promise of expert testimony, not fact. It is neither testimony, nor the testimony of a percipient witness, as reported by Mitchell. Clarkson should not have been permitted to testify to any of the parameters of the exercise Mimms alleged, to his mental or physical condition at the time, to the environmental conditions at the time, or to his coaching. As an expert she may testify to her opinion on the statistical or physiological, Cause & Effect consequences of hypothetical exercises under hypothetical circumstances as might be described to her.

Any testimony by Clarkson that Defendant trainer Javier "Lopez encouraged Mimms" to act in any way should have been struck by the court as a matter of law on the grounds she did not witness the alleged encouragement, essential to the legal case. She might have testified legitimately that under the circumstances given, encouragement would have been a cofactor tending to induce rhabdo, if that was indeed her opinion. Further and regardless of Lopez's actions, she should not have been allowed to testify as a matter of science that "Mimms [did] perform exercises known to produce rhabdomyolysis". She could have testified to specific exercises and circumstances that might be known to induce some specific range of exertional rhabdomyolysis, and how that might have been known by Lopez. It was for the trier of fact to determine whether her opinion applied to the facts separately established.

In her letter of July 12, 2008, Clarkson concluded with the following recommendations:

1. Mr. Mimms should have been warned about the possibility of developing rhabdomyolysis and its potentially fatal outcome,
2. An assessment of Mr. Mimms's fitness to participate in such a stressful exercise session should have been made prior to the training session.
3. Because muscle damage is experienced when exercises are unaccustomed, care should have been taken to ensure that, as a novice to these exercises, Mr. Mimms did not overexert himself. This care should have been manifested by:
 - 3.1 reducing the intensity of the work out compared to what would be recommended to experienced resistance exercisers. Reducing the intensity means to have fewer repetitions and sets and to include adequate rest periods.
 - 3.2 observing Mr. Mimms for signs of undue fatigue, such as falling and instability, at which time the exercise session should have been stopped.
 - 3.3 informing Mr. Mimms to maintain good hydration in days (up to 5 days) following the session and to monitor urine color (providing instructions to go to the emergency room at the first sign of discolored urine). Numbering added.

These are sound recommendations in all physical training, essential in physical conditioning, and they are neither original to Clarkson, nor peculiar to Mimms, nor specific to either CrossFit or military PT. No evidence in the case showed that Mimms did not receive any of these recommendations, nor that any omission was a proximate cause of his illness.

In her conclusion, Clarkson had no recommendation for any exercise regimen, nor warning to exclude CrossFit workouts.

Regardless, the fact of the Mimms' lawsuit, and the facts included in it, are irrelevant to the *Consensus Paper*. The *Paper* relied on Mitchell's account of the trial for this claim that

physicians and other primary care and rehabilitation providers have identified a potential emerging problem of **disproportionate** musculoskeletal **injury risk**, particularly for novice participants, associated with ECPs (13,16).⁶⁶

First, Clarkson was none of the listed specialists. Second, she testified to certain exercises being known to produce rhabdomyolysis, not as if they were proportionate, but instead as if they were a certainty. Mimms' trial papers incorporated other writings by reference, but Mitchell's article, on which the Consensus relied, did not.

In Clarkson's court paper, above, she falsely alleged,

It is clear from CrossFit publications (CrossFit Journal issue 38, October 2005 *CrossFit Induced Rhabdo*, authored by Greg Glassman, President and Founder of CrossFit) and CrossFit Journal issue 33, May 2005 "Killer Workouts", authored by Eugene Allen) that CrossFit was aware that their exercise regimens could induce rhabdomyolysis. The October 2005 article described 5 cases of rhabdomyolysis that resulted from participation in a CrossFit training regimen.⁶⁷

CrossFit Induced Rhabdo in its first sentence explains the article is "not only to repeat our warning [in "Killer Workouts"] but to share the lessons we've since learned about 'exertional rhabdo.'" "Killer Workouts" is not about "their exercise regimens" as CrossFit prescribes, but about those exercises **done to excess**:

Apparently, one of the three CrossFit pillars (functionality, intensity, and variance) done, **in extremis**, can introduce a character to the scene whom we have dubbed "Uncle Rhabdo".⁶⁸

Glassman cited all five known cases "**associated** with CrossFit workouts", not a reference to five cases *induced by CrossFit workouts*, to use the Clarkson revision. These five cases were unauthorized exercise experiments that went beyond any CrossFit prescription.

An expert may testify based on a scientific model or on a statistical model. The scientific model would be able to estimate the stress of a workout, the condition of the athlete, including environmental conditions, and combine the three in formula to predict the outcome using validated Cause & Effect relationships. That is far from the state of the art today in physiology or kinesiology. A statistical model is best based on properly analyzed data, but could be more qualitative based on the experience and opinion of the expert. In either case, statistical models implicitly assume that the underlying, unknown, Cause & Effect relationships are unchanging to make the data from a large number of similar situations applicable. Those data might show the proportions between clinically observed outcomes relative to different combinations of conditions—exercise, athlete condition, environment. No one has accumulated such statistics:

Accordingly, the evidence-based, peer-reviewed literature does not yet support the efficacy for or clarify any notable injury risk potential with ECPs to validate or dismiss the claims, clinical observations, or media reports.⁶⁹

66 Bold added, *Consensus Paper* p. 383.

67 Clarkson, *id.*, July 12, 2008. See discussion by Mitchell, above.

68 Bold added, *id.*

69 *Consensus Paper*, p. 384.

This statement by CHAMP/ACSM shows that their own claim that health care workers “have identified . . . disproportionate musculoskeletal injury risk” (P. 383, above) is at best guesswork even in the doctrinaire world of peer-reviewed professional journals.

CrossFit is watching for its first case of even mild exertional rhabdomyolysis that can be attributed solely to a CrossFit workout. Since 2005 and the two CrossFit articles above, the University of Nevada, Reno reports it has conducted 87,000 supervised workouts in its CrossFit gym at the Lombardi Center, and in that time incurring one injury resulting in lost time. That injury must be discounted, however, because it had a major cofactor: the athlete strained an MCL in a box jump, a ligament that had been surgically repaired 36 months earlier.⁷⁰

Clarkson blindly joins Mimms in claiming he was injured by CrossFit workouts, then as an expert links his workout to rhabdomyolysis as if the disease and connection were certain. Lacking any supporting model, scientific or statistical, she converts two CrossFit warnings about rhabdomyolysis into an alleged admission that CrossFit workouts cause lethal rhabdomyolysis.

CrossFit does, of course, induce rhabdomyolysis, recognizing that the disorder is a syndrome that includes the muscle microtears essential to all physical conditioning, damage produced to cause the normal reaction of muscle repair and rebuilding. So does military PT, and to a far greater extent as shown by AFHSC in their Medical Surveillance Monthly Reports. CrossFit rhabdomyolysis has been limited to a few anecdotal cases, mostly abusing CrossFit prescriptions. AFHSC has erroneously reported military rhabdomyolysis increasing at about 150% per year, which on closer examination is more likely close to 7% per year, and at that, far outstripping CrossFit experience. CrossFit is replacing traditional military PT because it produces results, and an ancillary benefit is that CrossFit is far safer.

Clarkson also claims in her paper,

Mr. Mimms was taking a multivitamin/mineral supplement with added amino acids and other ingredients, none of which have been associated with exertional rhabdomyolysis.⁷¹

This opinion is in part a tautology, and in part false. Exertional rhabdomyolysis is a differential diagnosis that rules out other causes. However, if the word *exertional* were struck to clear the tautology, the passage would be false.

Rhabdomyolysis is a rare condition in which muscle cells break down and release a substance into the blood that can lead to kidney failure. Most often, it's seen in people who have suffered major injuries or trauma.

Rhabdomyolysis may also develop in response to certain medications, **dietary supplements** or drugs. In some cases, rhabdomyolysis may affect athletes such as weight lifters and marathon runners.⁷²

The U.S. Food and Drug Administration is warning consumers to immediately stop using Hydroxycut products by Iovate Health Sciences Inc., of Oakville, Ontario and distributed by Iovate Health Sciences USA Inc. of Blasdell, N.Y. Some Hydroxycut products are associated with a number of serious liver injuries. Iovate has agreed to **recall** Hydroxycut products from the market.

70 Constantino, N.L. and J. A. Fitzsimmons, “CrossFit: Menace to Society or the Future of Fitness”, ACSM Health and Fitness Summit, March 29, 2012, and private correspondence.

71 Clarkson, July 12, 2008, *id.*, p. 2 of 3.

72 Bold added, Mayo Clinic, “Variety of Causes Can Be at Root of Rhabdomyolysis”, October 21, 2011.
<http://www.mayoclinic.org/medical-edge-newspaper-2011/oct-21b.html>

The FDA has received 23 reports of serious health problems ranging from jaundice and elevated liver enzymes, an indicator of potential liver injury, to liver damage requiring liver transplant. One death due to liver failure has been reported to the FDA. **Other health problems reported include** seizures; cardiovascular disorders; and **rhabdomyolysis**, a type of muscle damage that can lead to other serious health problems such as kidney failure.⁷³

Furthermore, Vitamin B12 can cause darkened urine.⁷⁴ Discolored urine was a symptom in the Mimms diagnosis of rhabdomyolysis. Mimms, Designation of Expert Witnesses, above, confirmed by Clarkson:

Two days after the exercise training session, Mr. Mimms experienced severe muscle pain and dark colored urine - both classic signs of rhabdomyolysis. Clarkson (2008) p. 1 of 3.

Clarkson is enforcing ACSM, which is fighting incringement by alien exercise programs. This policy is revealed in its conclusions in the *Consensus Paper*.

[Tautology] Many strengths and weaknesses are inherent to ECPs. **[Compound tautology, scare, passive voice; hypotheticals]** However, a measurable and costly increase in injury risk could arise when ECPs are performed inappropriately, with an anticipated consequent reduction in individual and unit operational and combat readiness when one or more injuries are sustained. **[Tautology]** Warfighters should approach and participate in any ECP with prudence, recognizing the limitations and challenges. **[Encourage but do not permit]** Although innovative approaches to military physical training should be encouraged, it is critical for these approaches to be consistent with accepted exercise prescription guidelines. **[Doctrine according to ACSM]** Military leaders should ensure that their unit's physical training program is aligned with their Service's established and accepted training doctrine, as well as with position statements from recognized authoritative relevant organizations. **[Study controlled by ACSM]** Military leadership, in collaboration with health care providers and other scientifically trained clinical and fitness support personnel, also should responsibly, objectively, and comprehensively monitor and evaluate ECPs and all other conditioning programs to determine their strong points and pitfalls. **[t = ∞]** The aim is to ultimately endorse, refine, or develop new safe, effective, and attractive, evidence-based conditioning strategies and programs for all personnel to meet their occupational and operational demands and expectations. Bold, bracketed comments added, underscoring added, *Consensus Paper*, p. 388.

Clarkson, an officer of ACSM at a policy-making level, relied on her credentials to influence Mimms' lawsuit in keeping with ACSM policy. This was not her first such venture. She reported two previous experiences, but with no references:

Recently, one of the authors (PMC) was involved as a consultant/expert witness in two legal cases in universities in different states where an exercise protocol using eccentric contractions, which are known to cause muscle damage, resulted in rhabdomyolysis and hospitalization of the research subjects. Sayers, Clarkson, et al., (1999).⁷⁵

73 Bold added, FDA, "FDA Warns Consumers to Stop Using Hydroxycut Products: Dietary Supplements Linked to One Death; Pose Risk of Liver Injury", May 1, 2009.

<http://www.fda.gov/NewsEvents/Newsroom/PressAnnouncements/ucm149575.htm>

74 Vanholder, R., M.S. Sever, E. Ere, and N. Lameire, "Rhabdomyolysis", J.Am.Soc.Nephrol. 11: 1553-1561, 8/1/2000, p. 1557.

75 Sayers, S.P., P.M. Clarkson, P.A. Rouzier, G. Kamen, "Adverse events associated with eccentric exercise protocols: six case studies", ACSM, Medicine & Science in Sports & Exercise, v. 31(12) December 1999 p 1697, p. 2 of 10.

In Clarkson's letter of July 12, 2008 for Mimms, she remarked that the exercises in the case involved "eccentric contractions", that

Strenuous eccentric exercises can damage the membrane of muscle fibers and release muscle fiber contents (like proteins and electrolytes) into the bloodstream.

And that

These exercises emphasize eccentric contractions that are known to produce rhabdomyolysis, especially in those unaccustomed to these exercises.

Clarkson has written frequently about eccentric exercises. However, with Sayers (1999), above, she concluded,

It is generally understood that high-force eccentric exercises pose little threat to otherwise healthy individuals with no history of musculoskeletal disease or injury. However, our laboratory has observed a 3% incidence of extreme responses to high-force eccentric exercise that result in extended decrements in muscle function, pronounced swelling, and greatly elevated CK levels in the blood.⁷⁶

Nowhere does she define "high-force eccentric exercises", nor does she claim that Mimms' exercise was high-force to go with eccentric. According to her research, Mimms exercises, even if deemed "high force", posed "little threat" to him.

Before CrossFit emerged to threaten ACSM's dominant position in the fitness market, Clarkson wrote

Although numerous cases of exertional rhabdomyolysis have been reported in the literature, these cases mostly involve individuals who were inexperienced exercisers, uneducated in fitness and health principles, dehydrated or heat stressed, taking drugs, ill, or military recruits in basic training.

We report here two cases where individuals, both well educated and experienced in fitness, were encouraged by exercise leaders in a local health club to overexertion during their exercise routine leading to rhabdomyolysis.⁷⁷

"Mostly involve" is casual English that does not survive parsing. The first sentence might mean that the majority of cases had some of the listed cofactors to exertion. As realistic as that would be, the reading is belied by the choice of **mostly involve** instead of **most cases**, and the author's likely intent. On the other hand, the sentence might mean that in every one of the numerous cases, one of the cofactors dominated exertion. This latter possibility has no objective foundation because the state of the art in epidemiology provides no method by which to assign contributory weights to a set of factors and cofactors, as, for example, drugs:exertion:heat = 50:40:10.

In inference is that the authors suggest that in the history of exertional rhabdomyolysis, the principal ultimate cause was rarely the exercise itself. This was reinforced by adding two new cases to the record, cases which happen to add the new cause of high-force eccentric exercises to the list of observed dominating alternatives.

But that was then, and now, since CrossFit, the cause of exertional rhabdomyolysis is the exercise itself.

⁷⁶ Bold added, *id.*, p. 6 of 10.

⁷⁷ Springer, B. L., P. M. Clarkson, "Two Cases of Exertional Rhabdomyolysis Precipitated by Personal Trainers", ACSM, Medicine & Science in Sports & Exercise, 35(9) September 2003 - pp 1499-1502 (Abstract).

3.2.2.5 Other physicians, referenced by Mitchell, do not say what the *Consensus Paper* claims.

Mitchell wrote,

Several physicians, including Walter Reed Army Medical Center neurophysiologist Lt. Col. Mark Landau, concluded that Mimms suffered severe injuries following his intense CrossFit workout, according to court records.⁷⁸

The court records include Plaintiff's "Designation of Expert Witnesses", July 14, 2008, which listed Jason Koskien, D.O.; Valerie O'Brien, M.D.; Mark E. Landau, M.D.; John Capacchione, M.D.; Jeffrey H. Phillips, M.D.; and Richard S. Meyer, M.D. along with summaries of their testimony and areas of expertise. The *Consensus Paper* cited Mitchell, ref. (16) for the following proposition:

However, physicians and other primary care and rehabilitation providers have identified a potential emerging problem of disproportionate musculoskeletal injury risk, particularly for novice participants, associated with ECPs (13,16).⁷⁹

Each of Mimms' experts was to testify regarding specifics of his exercise and resulting injury. Plaintiff's promise of expert testimony said nothing about any emerging problem, real or potential, or of the consequences of any of the *Consensus Paper's* designated ECPs.

Mitchell supports none of what the authors attribute to it.

3.2.3 The *Consensus Paper* relies on an AFHSC Medical Surveillance Monthly Report for information not in the Report.

The *Consensus Paper* claims,

Muscle strains, torn ligaments, stress fractures, and mild to severe cases of potentially life-threatening exertional rhabdomyolysis are reportedly occurring at increasing rates as the popularity of ECPs grows (4,27).⁸⁰

Reference 4 is AFSCM Medical Surveillance Monthly Report (MSMR), v.17, no. 3, March 2009, pp. 7-9. Neither it, nor any other volume, nor the Tilghman reference (27), below, reports on "muscle strains, torn ligaments, [or] stress fractures". Specifically, pages 7 to 9 refer to "Update: Exertional Rhabdomyolysis among U.S. Military Members, 2009", which says,

To exclude cases of rhabdomyolysis that were secondary to traumatic injuries, intoxications, or adverse drug reactions, medical encounters with diagnoses in any position of ICD-9-CM: 800-999 "injury, poisoning, toxic effects" (except ICD- 9-CM: 992.0-992.9, 994.3-994.5, and 840-848 **"sprains and strains of joints and adjacent muscles"**) were excluded from consideration as "exertional rhabdomyolysis" case defining encounters. Bold added.

78 Mitchell, *id.*, p. 2 of 4.

79 *Consensus Paper*, p. 383, above.

80 *Consensus Paper*, p. 383.

This volume 17-3 contains four articles on “Motor vehicle-related deaths”, “Heat injuries”, “Exertional rhabdomyolysis”, and “Exertional hyponatremia”, none of which addresses strains, tears, or fractures. The articles do not grade rhabdomyolysis as “mild to severe” and include no rhabdomyolysis fatalities. The articles refer to volume 16-3 for additional information, which includes the following:

In the United States, case fatality with rhabdomyolysis is less than 5% and depends on the nature of the precipitating cause, the severity and clinical effects of co-morbid conditions, and the prior state of health of affected individuals. Most otherwise healthy individuals recover with aggressive hydration and management of metabolic, renal, and systemic complications.⁸¹

Also, the diagnosis of “rhabdomyolysis” does not indicate the cause; in turn, it is difficult to discern cases that are “exertional” and/or heat-related from those with other precipitating causes.⁸²

While the MSMRs show an epidemic in exertional rhabdomyolysis, neither this volume nor any other, nor the Tilghman reference (27), below, contains any quantifiable data on the growth on which the *Consensus* rely in the popularity of the ECPs, nor specifically on the growth of any aspect of CrossFit.

The authors attempt to link ECPs as a causative factor for the military’s cases of exertional rhabdomyolysis fails, unsupported by analysis, by reference, or by any ECP data.

The precepts of science require the authors to have first established a measure of the popularity of, say, CrossFit, then to estimate the cross-correlation function between that measure and the record of illnesses. To support CrossFit as the cause, its measure must be shown to precede the illnesses. To the extent that CrossFit growth lags the disease suggests that other factors are creating a demand from the military for better conditioning. To the extent that the two measures are correlated with neither leading the other suggests a common cause for both. A candidate cause that meets these technical requirements is the Global War on Terror, as shown in Part I.

3.2.4 The *Consensus Paper* relies on a news article by Tilghman whose source appears to be the authors of the *Consensus Paper*.

Tilghman, reference 27, is an Air Force Times staff writer who wrote about “The hidden danger of extreme workouts: Intense regimens are all the rage, but fitness experts have concerns”.⁸³ He wrote,

Many on-base gyms have CrossFit trainers on staff, and most military towns now have a gym dedicated to the CrossFit exercise methodology. Units are adopting CrossFit as their PT program—because it gets results.

“During the time that I have been using CrossFit on a regular basis, I have been and am currently in the best shape of my life” at age 33, wrote Army Capt. Robert Pettigrew, and that sentiment was echoed in many similar e-mails.⁸⁴

81 MSMR, v. 16-3, p. 10.

82 MSMR 2009 v16-3, p. 13.

83 Air Force Times, 9/30/2010. It is *Consensus Paper* ref. (27).

84 Tilghman, “Hidden danger of extreme workouts”, September 30, 2010.

The total of his support is an unquantified observation about the presence of CrossFit in military gyms plus a single testimonial. He uses the terms “high intensity” and “extreme” with no objective standards.

To introduce a recent conference, Tilghman begins

But as the popularity of CrossFit and other high-intensity fitness programs has grown, so have concerns about their safety. [¶] Some troops are reporting injuries serious enough to land them in the hospital, and the military wants to take a formal look at all of the so-called “high-intensity training” programs and their impact on force fitness and readiness.

This is the unscientific claim repeated in the *Consensus Report*: the writers’ subjective perception of correlation in injuries and ECP popularity suggests causation. That correlation does not establish causation is trite. That correlation can only suggest where cause might lie is true even when the correlation is rigorous, that is, measured and objective. Here the *Consensus* claims a subjective correlation—CrossFit and ECP popularity growing vs. concerns about ECP safety and phantom injuries on the rise. The safety concerns are, as the *Consensus Paper* says, the authors’ opinion. The alleged injuries are from “[s]ome troops” and undocumented. AFHSC Medical Surveillance Monthly Reports on which the authors rely are silent on “sprains, torn ligaments, [or] stress fractures” and warn that their rhabdomyolysis data is the *Paper’s* “potentially life-threatening rhabdomyolysis” but merely “presumed rhabdomyolysis”, as shown in Figure 1, above.

Nonetheless, the writers urge their subjective notions are evidence of a Cause & Effect sufficient to warrant “a formal look”. The formal look will fail to resolve their subjective expectations. Any objective study will confirm what is given in the textbooks, revealed by the data, and well-known to the Warfighters who are demanding CrossFit instead of ACSM-endorsed military PT. A one size fits all program for group conditioning standards produces higher injury rates and lower readiness than does an individualized program for maximal fitness.

Continuing, Tilghman says,

Dozens of military doctors and fitness experts attended a conference in September at the Uniformed Services University of the Health Sciences outside Washington, D.C., to talk about programs such as CrossFit, P90X, Insanity and other off-the-shelf commercial exercise programs.

“The reason we’re here is because of all the anecdotal reports of injuries,” said Col. (Dr.) Francis O’Connor, associate professor of military and emergency medicine at the university.⁸⁵

This passage establishes first that the reports of ECP-induced injuries are anecdotal, meaning **scientifically unreliable**. Tilghman further undermines the urgings of the *Consensus* by saying

But the Pentagon is worried that there is insufficient evidence to back up such assertions. [¶] “There’s no research on these programs,” physiology professor William Kraemer said at the Sept. 13 USUHS conference.

Professor Kraemer is a member of the *Consensus*.

Secondly, Tilghman establishes in the preceding quotation that his authority is none other than the Medical Director for CHAMP, who, like Kraemer, is a co-author of the *Consensus Paper*. The *Paper’s* reliance on this Tilghman piece is a self-reference, a bootstrap. Tilghman’s sources are the authors of the *Consensus Paper*.

85 Tilghman, *id.*

3.2.4.1 CrossFit Is Safer than Traditional PT.

Tilghman further undercuts the *Consensus Paper*, saying

[Greg] Glassman addressed safety concerns in an e-mail to Military Times. [¶] “CrossFit is safer, more efficient, and more effective than the physical training it replaces,” he wrote.

If this were a defendant’s claim in answer to *Consensus* accusations, it, too, would have been a bootstrap by implication (neither CrossFit nor Greg Glassman was a defendant). But by referencing Tilghman, *Consensus* concedes authority to the article. Tilghman shows that whatever the founder of CrossFit says about its dangers or misuse, it is opinion within the context of the belief that it is the safest of all programs, including no fitness training at all. Indeed, immobility is a cause of compartment syndrome and rhabdomyolysis.⁸⁶

3.3. The *Consensus Paper* confesses that its subject is not ripe for academia.

Accordingly, the evidence-based, peer-reviewed literature does not yet support the efficacy for or clarify any notable injury risk potential with ECPs to validate or dismiss the claims, clinical observations, or media reports. *Consensus Paper*, p. 384.

Richard Horton, MD, editor, *The Lancet* (2000), provides a response:

The mistake, of course, is to have thought that peer review was any more than a crude means of discovering the acceptability - not the validity - of a new finding. Editors and scientists alike insist on the pivotal importance of peer review. We portray peer review to the public as a quasi-sacred process that helps to make science our most objective truth teller. But we know that the system of peer review is biased, unjust, unaccountable, incomplete, easily fixed [*jiggered, not repaired*], often insulting, usually ignorant, occasionally foolish, and frequently wrong.⁸⁷

Science nonetheless demands evidence. Scientific knowledge is a mapping from facts to future facts through Cause & Effect. Where the facts are incomplete, the model is but a conjecture. In Modern Science, the predictive power of models trumps any matters of publication of consensus.

The peer-review criterion is peculiarly academic, a tenet of Post Modern Science and now the Law in the US federal courts⁸⁸, and unrelated to Modern Science. It is not a criterion in the military, nor in industry, except where regulation and legal technicalities demand it.

Search where objects might repose, not necessarily where the light appears brightest.



86 Vanholder, R., et al, “Rhabdomyolysis”, *J.Am.Soc.Nephrol.* 11:1553-1561, 2000. Also, see Danzl and Lloyd, ¶4.5.1, below.

87 http://en.wikipedia.org/wiki/Richard_Horton_%28editor%29

88 See *Daubert v. Merrill Dow*, 509 US 579, for the five criterion, all derived from Karl Popper’s writings, four accepted by the Court for the standard of scientific knowledge, and one explicitly rejected.

PART 4

PART 4: APPENDIX. TEXTBOOKS ON MILITARY MEDICINE, SELECTED EXCERPTS AND FACTS

The Textbooks on Military Medicine (TMM) is an online series promulgated by the US Army Medical Department, Borden Institute.

4.1. Vogel, J.A., and J.F. Patton, "Physical Fitness and Physical Training for Military Performance", TMM, Rehabilitation of the Injured Combatant, v. 2, (1999) Ch. 13.

4.1.1 Fitness is work capacity.

"Thus, we define and use the term physical fitness as the *energy generating capacity to perform physical effort*." Original italics, bold added, p. 782. That energy is applicable because

"the military profession remains physical in nature. Considerable emphasis is placed on physical training, physical capacity, and ultimately, on physical readiness, regardless of the specific role or occupation that the service member may fill. Irrespective of peacetime or wartime, service members must be prepared to defend themselves and others about them, and to react to emergencies as they may occur. ... [¶] ... Individual members must possess the stamina and strength to perform successfully **any potential mission**. These qualities, together with weight control, form the basis of the DoD physical fitness program." Bold added, Vogel, id., p. 782.

Energy and work are manifestations of the same parameter, and so share common dimensions. Work is action to change energy, and energy is the capacity to do work, as in kinetic, including thermal, or potential energy. Work is the exchange of energy, as in Earth's collisions with asteroids or its warming from the one true source, the Sun, or the application of force through distance to change the energy of bodies.

Compare this definition with the CrossFit definition:

Our very public and constant claim is that fitness is best defined as work capacity across broad time and modal domains...¹

At each duration, we average your power capacity across a variety of modal domains (skills and drills). This creates a power curve, the area under which is your work capacity across broad time and modal domains (aka fitness).²

¹ Coach, Comment #62, November 8, 2008. <http://board.CrossFit.com/showthread.php?p=441535>

² Glassman, G., "CrossFit's New Three-Dimensional Definition of Fitness and Health-1", February 21, 2009. <http://journal.CrossFit.com/2009/02/CrossFit-s-new-definition-of-fitness-volume-under-the-curve-1.tpl>

4.1.2 Intensity is power, or perhaps speed.

"If an individual runs at the level of his maximum oxygen consumption (VO₂max), that exercise intensity can only be maintained for 5 to 10 minutes after which he must stop or reduce the intensity level, again referred to as a loss in capacity or fatigue." Vogel (1999) p. 786.

4.1.3 Cells generate power from three metabolic pathways.

Energy is released from a continuum of three overlapping metabolic processes, immediately through the phosphagen system, in the short-term (on the order of 10 to 180 seconds) through anaerobic glycolysis, and in the longer term through the aerobic system.

"The Energy Continuum of Exercise

"Figure 13-7 illustrates the relative contribution of the three energy sources during various durations of exercise."
Vogel, *id.*, pp. 787-788.

4.1.4 Power capacity is a matter of individualized conditioning.

"Therefore, the relative contribution of the body's various means for energy transfer can differ markedly, depending on **the intensity and duration of exercise, and the power capacity (fitness) of the participant.**" Bold added, *id.*, p. 787.

Vogel switches fitness from energy to power.

4.1.5 Intensity is energy.

"Physical activities of short duration and high intensity, where the power developed by the exercising muscle is near or at maximal level, require an immediate and rapid supply of energy." Vogel (1999) p. 787.

The consequence of high (here maximal) power must be from high energy for a short duration, not high load for a short duration. Pounds per second is mass flow, not power.

4.1.6 Intensity has meaning in context with duration and frequency.

"Training Principles

"Overload

"To achieve an adaptation or ability to handle greater amounts of exercise, the body must be challenged with a load greater than that to which it is accustomed. **By exercising at a level above "normal" (overload), the body responds physiologically to accommodate this greater load until that load becomes the norm.** The overload must be presented progressively and with sufficient intervening recovery time to avoid damage or failure to the systems involved. The added load can be presented by increasing the **intensity, duration, or frequency** of the training activity. **Intensity refers to the absolute level of exercise (strength of the stimulus), such as speed of running or the amount of mass lifted.** Load can also be modified by adjusting the *duration* of the training bout (minutes that the stimulus is applied) and by the *frequency* (bouts of training per week) of training. Frequently, a combination of intensity, duration, and frequency are used over the course of a formal training program to produce a training overload. Application of these three methods of load adjustment will be discussed at the end of this section.

"Progression ...

"For optimum results, **training progression should be individualized** . . ." Bold added, footnote deleted, *id.*, p. 807.

A better measure of intensity in running would be distance as opposed to speed. Speed is derived from distance by the independent parameter of duration.

4.1.7 Conditioning entails muscle damage and repair.

Physical training is the activity of overloading the body's systems to bring about adaptive responses that permit the handling of increased loads with less strain and stress, individualized for the body type and conditioning to avoid detraining or overtraining, with varying intensity, duration, and frequency to challenge each of the three metabolic processes. "The adaptive response appears to have two components; (1) an initial one of depletion or **breakdown**, which in turn, triggers (2) **rebuilding and super repletion** . . ." Vogel, *id.*, p. 807, 808.

4.1.8 Fitness extends over broad time and modal domains.

The "gain resulting from a training program depends on the **mode** [e.g., 'running, cycling, swimming, rowing'] **and extent** of the stimulus which is applied." Original italics, bold added, Vogel, *id.*, p. 810.

4.1.9 Training maintains what conditioning creates.

"Training . . . to achieve general fitness and health should be perpetual." Vogel, *id.*, p. 811.

4.1.10 Fitness has an economy.

"Greater gains can be achieved by training up to five times weekly, but this must be weighed against time requirements for other training activities and the potential cost in increased injuries." Vogel, *id.*, p. 812.

4.1.11 Training must stress all three domains.

"The objective of most military physical training programs is to achieve and maintain fitness in all three categories of exercise capacity: aerobic, strength, and muscular endurance. The next step is to develop a mix of activities during the week to train all three categories." Vogel, *id.*, p. 813.

4.1.12 Exertional rhabdomyolysis results from trainer miscalculation of individual conditioning coupled with environmental stress.

"*Exertional Rhabdomyolysis* [¶] Acute rhabdomyolysis is a condition that has historically been related to military recruit physical training. This injury syndrome is characterized by myoglobinuria, muscle pain, weakness, and soreness. It occurs with the sudden onset of intense or excessive exercise, a situation that has previously been common in military recruit training. It **can be prevented by a graduated program of exercise intensity in those recruits who are unfit or inactive**. Severe rhabdomyolysis can have fatal consequences if it progresses to renal failure secondary to marked myoglobinuria and tubular necrosis. In 1988, cases of death and hospitalization due to exertional rhabdomyolysis (brought on by inappropriately sudden and intense physical training) were reported in police trainees in New York City and the state of Massachusetts." Bold added, footnotes deleted, Vogel, *id.*, p. 818.

4.2. Gardner, J. W., and J.A. Kark, "Clinical Diagnosis, Management, and Surveillance of Exertional Heat Illness", TMM, Medical Aspects of Harsh Environments, v. 1 (2002).

4.2.1 Exertional rhabdomyolysis is difficult to impossible to diagnose in individual cases.

"Exertional heat illness (EHI) encompasses a **spectrum of disorders** deriving from the combined stresses of exertion and thermoregulation. These include exertional dehydration, heat cramps, heat exhaustion, heat injury, heat stroke, **rhabdomyolysis**, acute renal failure, and hyponatremia. Early in the course of EHI it may be **difficult or impossible to distinguish** these entities and, in fact, they often overlap and are differentiated as the clinical manifestations evolve. They represent primarily a **continuum of multisystem illnesses** related to elevation of body core temperature and the metabolic and circulatory processes (including changes in fluid and electrolyte balance) that are brought about by exercise and the body's thermoregulatory response." Bold added, Gardner, *id.*, p. 232.

4.2.2 Mild to severe rhabdomyolysis is equivalent to intermediate to severe Exertional Heat Illness.

"We include all of the exertion-related heat illness syndromes within the term EHI. These **syndromes** form a continuum of multisystem illnesses, which may be divided into three main levels:

1. *Mild* EHI, which includes heat exhaustion, mild dehydration, and heat cramps;
2. *Intermediate* EHI, which includes exertional heat injury and **mild rhabdomyolysis**, renal insufficiency, orthostatic hypotension, heat-related syncope, and reversible electrolyte and metabolic disturbances; and
3. *Severe* EHI, which includes heat stroke, **severe rhabdomyolysis**, liver necrosis, acute renal failure, cardiovascular collapse, and marked electrolyte or metabolic disturbances." Bold added, italics original, Gardner, *id.*, p. 233.

4.2.3 Severe rhabdomyolysis includes life-threatening complications.

Gardner, *id.*, Exhibit 7-1, Clinical Features of Exertional Heat Illness, p. 234.

4.2.4 Exertional rhabdomyolysis is a problematic diagnosis in an individual case because of the large number of possible and unknowable cofactors or alternative causes.

"The differential diagnosis of symptoms associated with EHI is broad and varies with locality and time. Most of the clinical findings associated with EHI are also found in other diseases. These diseases may provoke or accompany EHI, thus increasing the severity of the illness and the risk of serious complications. Infectious diseases are likely to provoke EHI by contributing to dehydration and hyperthermia. It is particularly important to consider meningitis, sepsis, pneumonia, myocarditis, viral infections, asthma, drugs and toxins, sickle cell disease, and cardiovascular or cerebrovascular disease. The differential diagnosis list for patients with high body temperature also includes malaria, Rocky Mountain spotted fever, other infections, anticholinergic poisoning, neuroleptic malignant syndrome, and thyroid storm." Citations deleted, Gardner, p. 235.

4.2.5 Exertional rhabdomyolysis is a syndrome caused by the release of the contents of skeletal muscles.

"Exertional rhabdomyolysis is the syndrome caused by skeletal muscle damage with release of cellular contents into the circulation, including myoglobin, potassium, phosphate, creatine kinase (CK), lactic acid, and uric acid. Manifestations of rhabdomyolysis can vary from asymptomatic elevation of serum skeletal muscle enzymes to muscle weakness, pain, tenderness, and stiffness with associated myoglobinuria with or without acute renal failure. In its most severe form obvious muscle necrosis can be demonstrated, but marked laboratory abnormalities can occur without extensive cell necrosis. Severe rhabdomyolysis may present without early muscle pain or tenderness, and muscle numbness may be the only symptom in the first few hours (documented in approximately one third of severe cases)." Citations deleted, Gardner, *id.*, p. 240.

4.2.6 Individuals can maintain good hydration by keeping their urine volume, color, and density at normal levels.

"Each individual must be responsible to maintain adequate water intake, which requires drinking when not thirsty and monitoring urinary volume and color, weight changes, and so forth. Individuals must be aware of the need to hydrate ahead of thirst and before and during exercise." Gardner, *id.*, pp. 259-260.

4.2.7 A cluster of rhabdomyolysis cases can provide a statistical solution to the differential diagnosis dilemma.

"Monitoring of cases and medical outcomes involves assessment of triage and immediate care by an assigned acute care or surveillance officer. Each case must be reviewed and classified as to type and severity, with attention given to risk factors and training circumstances. Patterns of illness and relation to training activities can then be evaluated and trends analyzed. **Clusters of cases can be explored to determine the specific circumstances that have produced these casualties.**" Bold added, Gardner, *id.*, p. 261.

4.3. Cowan, D. N., B. H. Jones, and R.A. Shaffer, "Musculoskeletal Injuries in the Military Training Environment", TMM, Medical Aspects of Harsh Environments, v. 1 (2002).

4.3.1 Running is a predictor of physical injuries.

"Military training usually involves substantial amounts of running and marching. Some aspects of training, particularly running, are associated with increased risks of overuse injury." Cowan, *id.*, p. 197.

Part of the problem with running is the group cross-country run or march where the trainees are coerced to keep up, and committed to the return at the half-way point.

4.3.2 Annual heat-related injuries amount to about one eight-hundredth of total exercise related injuries.

"Among Army and Marine Corps **trainees**, rates of outpatient visits due to injuries of 20% to 40% per month have been observed, and rates of 20% per month have been reported among trained infantry soldiers." Bold added, Cowan, *id.*, p. 197.

MSRM reports heat-related injuries for all active components of the US armed forces. In 2011 they were 362 for heat stroke (0.25 per 1,000 person years), 2,652 for "other heat injury" (1.82 per 1,000 person years), and 435 for rhabdomyolysis (29.9 per 100,000 person years). Medical Surveillance Monthly Report (MSRM), Armed Forces Health Surveillance Center (AFHSC), v. 19, no. 3, March 2012. The rates are for all active duty components of the U.S. armed forces.

Cowan's data for exercise-related injuries are monthly rates, so annual rates are 12 times greater. Using the lower of Cowan's rates and the total active duty population of 1.45 million derived from the 2011 MSRM report, the ratio of heat-related injuries to total exercise-related injuries is 1:805. By categories of EHI, the ratio is 1:6,385 for presumed exertional rhabdomyolysis, 1:7,673 for heat stroke, and 1:1047 for "other heat injuries".

4.3.3 Between 16% and 45% of military trainees will suffer an exercise-related injury each month, more than two orders of magnitude more common than EHI.

"Numerous studies of military trainees have documented the high risk of exercise-related injuries, ranging from 14% to 42% among men and from 27% to 61.7% among women. Most injuries are to the lower extremities, and most of these are overuse injuries." Citations deleted, Cowan, *id.*, p. 198.

The number of males in the armed forces is 1.25 million and the number of females is 0.21 million, numbers derived from 2011 MSRM illness rates. *Id.* With these rates, Cowan's total injury rates for both sexes are between 15.9% and 44.8% per month.

4.3.4 Knee injuries rank third among injuries to male trainees.

"The types of injuries experienced by military populations have been examined in several studies. Jones and colleagues found that pain due to overuse was diagnosed in 24% of male trainees, muscle strains in 9%, ankle sprains in 6%, overuse {199} **knee injuries in 6%**, and stress fractures in 3%." Footnote deleted, bold added, Cowan, *id.*, pp. 198-199.

The data are ambiguous, and Jones, et al., is not available online. The four categories appear to account for the 24% of injured male trainees, and knee injuries are third in prevalence.

4.3.5 Active duty statistics are available from the US Army.

In 1994, the Army experienced 350 deaths, 4,500 disabilities, 20,000 hospitalizations, and 400,000 sick-call visits among active duty personnel, a ratio of 1:15:60:1100. Cowan, *id.*, p. 199.

4.3.6 Exercise injury rates depend on body type.

"In US Marine Corps trainees, males diagnosed with stress fractures were shorter, lighter, and smaller in most bone structural girth dimensions than were uninjured trainees. In addition, bone structural geometric properties, such as cross-sectional areas, moments of inertia, section moduli, and width, were significantly smaller in those with stress fracture." Cowan, *id.*, p. 201.

4.3.7 Infrequent exercise and not the work expended leads to injury.

"Exercise frequency less than 1 day per week ($RR^3 = 1.5$) was a significant predictor, but investigator-estimated energy expended per week in exercise (based on the reported intensity of exercise) was not associated with risk of injury." Cowan (2003) p. 202.

Note that Cowan equates intensity with work (energy), which is neither power nor force (load, weight) nor distance.

4.3.8 Fitness reduces injury risk.

"Past physical activity and preexisting physical fitness are both important predictors of risk of training injury, and this is reflected in repeated findings that persons who enter military service with a history of high levels of activity and fitness are at significantly lower risk of injury. There are several health-related parameters of fitness, including cardiorespiratory endurance, muscle endurance, strength, flexibility, and body composition." Citations deleted, Cowan, *id.*, p. 202.

4.3.9 Exercise as infrequent as once a week is a predictor of injury.

"Exercise frequency less than 1 day per week (RR [relative risk] = 1.5) was a significant predictor, but investigator-estimated energy expended per week in exercise (based on the reported intensity of exercise) was not associated with risk of injury." Cowan, *id.*, p. 202.

4.3.10 Running injuries are a measure of lack of fitness.

"Based on the available evidence, it appears that endurance (as measured by run times) is the best fitness predictor of injury, with risks substantially higher among the worst performers." Cowan, *id.*, p. 202.

4.3.11 The rate of change of training predicts injuries.

"Training itself has been identified as a risk factor for injuries. Rapid increases in the amount and intensity of training are postulated to be associated with increased levels of injury. ... [¶]... As with any physical training program, the **frequency, intensity, duration, and type of activity** must take into account the physical condition of the trainees entering the program to prevent 'training error,' which increases the risk of injury. Military trainees who enter service with a history of being physically active are at reduced risk of injury, while those who have been more sedentary, and thus experience a rapid acceleration in activity when they enter the military, are at significantly higher risk of injury. These populations must have gradual and appropriate 'ramp-up' of physical activity with adequate rest included." Citations deleted, Cowan, *id.*, p. 205.

4.3.12 Training injuries are the cost for the payoff of reduced active-duty injuries.

"Injuries in general, and training related injuries in particular, are a major cause of morbidity, lost duty time, and financial costs to the military. ... Several modifiable risk factors have been identified, including physical fitness, cigarette smoking, and fitness training. It is known that training programs can be modified to prevent injuries yet still produce physically fit soldiers, sailors, airmen, and marines." Cowan, *id.*, p. 207.

3 RR stands for Relative Risk, defined as the ratio of the probability of an event in an exposed population to the probability of that event in a non-exposed population.

4.4. Walsh, J.J., and S.M. Page, "Rhabdomyolysis and Compartment Syndrome in Military Trainees", TMM, Medical Aspects of Harsh Environments, v. 1 (2002).

4.4.1 All basic training produces muscle injuries.

"All basic trainees, to some degree, experience muscle injury below the threshold of permanent damage." Walsh, *id.*, p. 166.

4.4.2 Urine darkens as serum myoglobin exceeds 100 mg/dL.

"Normally, myoglobin is not detected in the blood until levels exceed 1.5 mg/dL, an amount equal to the dissolution of approximately 100 g of skeletal muscle. After injury, however, myoglobin concentrations rise in the plasma. Myoglobin is then excreted in the urine as concentration exceeds 21 mg/dL. When plasma concentration rises above 100 mg/dL, urine quickly turns a dark color." Footnote deleted, *id.*

4.4.3 Rhabdomyolysis and compartment syndrome are closely related.

"The purpose of this chapter is to highlight two closely related problems that occur within the training environment: rhabdomyolysis and compartment syndrome. These conditions develop as a result of a physiological cascade of metabolic abnormalities that occurs when the body is no longer able to compensate for the demands placed upon it." *Id.*

4.4.4 Exertional rhabdomyolysis is commonplace, but requires differentiation from other factors.

"Current studies recognize that, among a wide range of individuals, acute exertional rhabdomyolysis is a fairly common complication of strenuous physical activity. This condition has been documented in military recruits, professional and amateur athletes, weight lifters, firefighter trainees, and law enforcement trainees. Olerud et al [1976] found that, during the early training phase, 40% of 337 military recruits had myoglobin in their urine, which is evidence of rhabdomyolysis. Line and Rust [1995] described a study of 50 law enforcement trainees who had levels of creatine phosphokinase consistent with rhabdomyolysis. In a study by Sinert et al [1994], nearly half of the hospital admissions for rhabdomyolysis were exercise induced. The common theme present in these studies is that the participants exerted effort above their usual maximum effort. For physically unconditioned recruits entering training, the increased level of activity may actually be quite modest. There are numerous examples, however, of well-conditioned athletes (e.g., marathon runners) who developed some degree of rhabdomyolysis after a supramaximal exercise session. . . . Muscle pain, weakness, swelling, and burning in the involved extremity are common complaints, as well as a history of voiding dark urine. Critical information to elicit from the patient includes noting the environment and circumstances when the injury occurred; the hydration status; a history of sickle cell trait; and use of any medication, laxative, or supplement. If an herbal medication has been used, a sample is needed by the physician to check for ingredients such as caffeine, aspirin, ephedrine.

"Findings on physical examination consist of muscle swelling, tenderness, and edema. The muscles involved may be quite isolated, such as the pectoralis major or the triceps. Neurological function is usually normal." Footnotes deleted, Walsh, *id.*, pp. 166-167.

4.4.5 Compartment syndrome cannot assist in the differential diagnosis of exertional rhabdomyolysis because rhabdomyolysis itself can cause edema and compartment syndrome.

"Compartment syndrome is a painful condition in which increased pressure within a muscle compartment causes a decrease in blood supply to the affected muscles, and it can present in a variety of ways. Because of the potentially catastrophic consequences if left untreated, it is important to recognize it promptly. Compartment syndrome reflects ischemia at the cellular level. Basically, it **occurs when an inciting event produces edema within a muscle compartment. Causes include blunt trauma, fractures, burns, muscular exertion, or muscle swelling and edema (such as that occurring with rhabdomyolysis).**" Walsh, *id.*, p. 169.

4.4.6 Acute exertional rhabdomyolysis is a spectrum of symptoms usually requiring no more than rest, but requiring differentiation from about 100 known causes and cofactors.

"Acute exertional rhabdomyolysis exists as a spectrum of physiological changes that might develop after excessive exercise. The extent to which systemic and renal toxicities develop is dependent on various cofactors, including baseline fitness, recent weight loss, hydration status, viral illness, stimulant use, and the presence of sickle cell trait. Prompt recognition and aggressive treatment usually prevent serious complications. Military personnel usually recover without ill effects after treatment, rest, and a gradual return to activity." Walsh, *id.*, p. 173.

Alternative causes of rhabdomyolysis or cofactors of exercise rhabdomyolysis to be differentiated include the following. Source: Craig, S., "Rhabdomyolysis", eMedicine Specialties, Emergency Medicine, Trauma and Orthopedics, August 14, 2008, footnotes deleted. Craig shows the etiologies divided into traumatic, exercise induced, toxicologic, environmental, metabolic, infectious, immunologic, and inherited classifications (numbering added):

4.4.6.1 Rhabdomyolysis may occur after traumatic events, including:

1. Significant blunt trauma or crush injury
2. High-voltage electrical injury
3. Extensive burns
4. Near drowning
5. Prolonged immobilization (e.g., after excess alcohol or drug consumption, after an unwitnessed incapacitating stroke, following prolonged surgical procedures)

4.4.6.2 Rhabdomyolysis may occur after excessive muscular activity, such as:

6. Sporadic strenuous exercise (e.g., marathons)
7. Status epilepticus
8. Status asthmaticus
9. Severe dystonia
10. Acute psychosis
11. Excessive computer keyboard use

4.4.6.3 Toxin-mediated rhabdomyolysis may result from substance abuse, including abuse of:

12. Ethanol
13. Methanol
14. Ethylene glycol
15. Isopropanol
16. Heroin
17. Methadone
18. Barbiturates
19. Cocaine
20. Amphetamine
21. Phencyclidine
22. 3,4-methylenedioxymethamphetamine (MDMA, ecstasy)
23. Lysergic acid diethylamide (LSD)

4.4.6.4 Toxic-mediated rhabdomyolysis may result from prescription and nonprescription medications, including:

24. Antihistamines
25. Salicylates
26. Caffeine
27. Fibric acid derivatives (e.g., bezafibrate, clofibrate, fenofibrate, gemfibrozil)
28. Neuroleptics
29. Anesthetic and paralytic agents (the malignant hyperthermia syndrome)
30. Amphotericin B
31. Quinine
32. Corticosteroids
33. Atorvastatin
34. Fluvastatin
35. Lovastatin
36. Pitavastatin (marketed in Japan, South Korea, India)
37. Pravastatin
38. Rosuvastatin
39. Simvastatin
40. Cerivastatin (recalled from US market)
41. Theophylline
42. Cyclic antidepressants
43. Selective serotonin reuptake inhibitors (the serotonin syndrome)
44. Aminocaproic acid
45. Phenylpropanolamine (recalled from US market)
46. Propofol (continuous infusion)

4.4.6.5 Rhabdomyolysis may be caused by other toxins, including:

47. Carbon monoxide
48. Toluene
49. Hemlock herbs from quail (rhabdomyolysis after the consumption of quail is well known in the Mediterranean region; it occurs as the result of intoxication by hemlock herbs that the quails consume.)
50. Snake, spider (e.g., black widow spider), and massive envenomations of Africanized honey bees

4.4.6.6 Environmental causes of rhabdomyolysis include:

- 51. Hyperthermia
- 52. Hypothermia

4.4.6.7 Metabolic causes of rhabdomyolysis include:

- 53. Hyponatremia or hypernatremia
- 54. Hypokalemia
- 55. Hypophosphatemia
- 56. Hypothyroidism or hyperthyroidism
- 57. Diabetic ketoacidosis
- 58. Nonketotic hyperosmolar diabetic coma

4.4.6.8 Viral infectious disease agents may cause rhabdomyolysis, including:

- 59. Influenza types A and B (most common)
- 60. HIV
- 61. Coxsackievirus
- 62. Epstein-Barr virus
- 63. Echovirus
- 64. Cytomegalovirus
- 65. Adenovirus
- 66. Herpes simplex virus
- 67. Parainfluenza virus
- 68. Varicella-zoster virus
- 69. West Nile virus

4.4.6.9 Bacterial infectious agents may cause rhabdomyolysis, including:

70. *Francisella tularensis*
71. *Streptococcus pneumoniae*
72. Group B streptococci
73. *Streptococcus pyogenes*
74. *Staphylococcus epidermidis*
75. *Escherichia coli*
76. *Borrelia burgdorferi*
77. *Clostridium perfringens*
78. *Clostridium tetani*
79. Viridans streptococci
80. *Plasmodium* species
81. *Rickettsia* species
82. *Salmonella* species
83. *Listeria* species
84. *Legionella* species
85. *Mycoplasma* species
86. *Vibrio* species
87. *Brucella* species
88. *Bacillus* species
89. *Leptospira* species

4.4.6.10 Fungal infectious agents may cause rhabdomyolysis, including:

90. *Candida* species
91. *Aspergillus* species

4.4.6.11 Causative connective tissue diseases that can cause rhabdomyolysis include:

- 92. Polymyositis
- 93. Dermatomyositis

4.4.6.12 Inherited disorders may cause rhabdomyolysis, including:

- 94. Enzyme deficiencies of carbohydrate or lipid metabolism
- 95. Myopathies

4.4.6.13 Rhabdomyolysis also has been reported in patients with sickle cell anemia and has mistakenly been identified as a pain crisis.

To this list might be added Haff Disease, which is rhabdomyolysis developed from the ingestion of certain fish, including buffalo fish, burbot, eel, and pike. The cause is an unknown toxin, but may be thiaminase, which degrades to thiamine (vitamin B1). Wikipedia, Haff disease. Entry 6 for “sporadic strenuous exercise” contains within its vague, relative boundaries the athlete who is unprepared or de-conditioned, or who adds to a maximally designed conditioning program intense outside activities such as manual labor or sport.

4.5. Danzl, D.F. and E.L. Lloyd, “Treatment of Accidental Hypothermia”, TMM, Medical Aspects of Harsh Environments, v. 1 (2002) Ch. 16.

4.5.1 Immobility induced rhabdomyolysis.

In situations of enforced immobility, extremities may develop compartment syndromes after perfusion is reestablished in frostbitten (i.e., frozen) extremities. Danzl, *id.*, p. 498.

