Objectively Assessing Impairment in cases of Chronic Fatigue Syndrome

Chronic Fatigue Syndrome Advisory Committee

U.S. Department of Health & Human Services

Dr. Theodore J Becker

EPI Rehabilitation
and
BEC Biomechanical

Overall Goal

- *To understand the scientific principles of work physiology in regards to fatigue.*

What is fatigue?

- Fatigue is nature’s warning signal that the limit of activity is approaching exhaustion or over-fatigue follows when the warning is disregarded and the organism is pushed beyond it’s limits by further forced exertions.

Josephine Goldmark, “Fatigue & Efficiency” 1912

What is fatigue continued…

- Fatigue let run is a debt to be paid at compound interest. Maggiora showed that after a doubled task muscle requires not double, but four times as long a rest for recuperation, and a similar need for more than proportionally increases rest after excessive work is true also of our other tissues and of our organism in it's totality.

Josephine Goldmark, "Fatigue & Efficiency" 1912

Profile of fatigue in work physiology

- The onset of fatigue can be predicted from heart rate recovery curves. When satisfactory recovery does not take place between a series of successive operations, the initial pulse rate after work becomes progressively higher and the heart rate during the recovery period remains at an elevated level for progressively longer period of time. A return toward the resting level that is very slow, shows the existence of “physiological fatigue”.

Lucien Brouha “Physiology in Industry” 1960

Objective 1

- To learn what supports an opinion of full time work vs. an opinion of fatigue and inability to work full time.

Objective 2

- To learn the key points of work physiology science related to work tolerance/ endurance and fatigue.

Reference Materials:

The Rehabilitation Professional

15 (4); PP 45-56

“Applications of work physiology science to capacity test prediction of full time work; Eight hour work day”

Becker, Morrill, Stamper

Background & History of FCE/PBPCE applied to Work Tolerance

Background

- Since the mid 1980’s, FCE processes have experienced general and sometimes specific criticism.
- Most notable criticism is from the work of King, Tuckwell and Barrett, 1998.

THE KING RESEARCH GROUP CONCLUDED….

- There were no scientific applications identified regarding a prediction to an 8-hour work tolerance, revealing the tests were not standardized, lacked comprehensiveness, and objectivity in data collection.

Other professionals commenting on the FCE process have said:

"Little to no data or formulas have been documented to support the contention that subjective measurements are superior to the Physiological indicators" (Reneman 2002, Saunders 1997)

Continued….

Scientists making ‘endurance projections' to predict full time 8 hour work have done so without documenting prediction formulas (Lechner 1994).

The need for a formula…

Hale (2004), King (1998), Matheson (2002), Simmons (2006) have each called for a definite method for using data to project an 8 hour work day which utilizes a reliable and accurate scientific formula because none were currently available.

Exercise vs. Work Physiology

- The main barriers to using work physiology in FCE/PBPCE has been a lack of understanding of the differences between exercise and work physiology (Davies 1966)

- There was a failure to appreciate the underlying physiological principles upon which work was based (Davies 1966)

Work Physiology Science

Heart Rates and Work Classifications

Astrand et al (2003)

Workload	Heart rate, (beats/min)
Light	up to 90
Moderate	90-110
Heavy	110-130
Very heavy	**130-150**
Extremely heavy	150-170

Williams (1964)

Workload	Heart rate, (beats/min)
Very low	5
Low	75-100
Moderate	**100-125**
High	125-150
Very high	150-175
Extremely high	175

Heart Rates and Work Classifications

Kroemer & Grandjean (2001)

Workload	Heart rate, (beats/min)
Very low	60-70
low	75-100
Moderate	100-125
High	125-150
Very high	150-175
Extremely high	175+

Wilson and Cortlett (1995)

Workload	Heart rate, (beats/min)
Light	up to 90
Moderate	90-100
Heavy	110-130
Very heavy	130-150
Extremely heavy	150-170

Work Physiology Science Continued

Jiang (1984)

Workload	Percent Work*	Work Duration	Heart Rate
Moderate	< 33%	8 hours	90-110
Heavy	33-50	8>1 hours	110-130
Very heavy	50-75%	1 hr> 20 min	130-150
Extremely heavy	>75%	<20 min	>150

* Percent work = % maximal oxygen consumption (ml/kg/min)

Kodak (1986)

Duration	Percent Maximum Aerobic Capacity	Heart Rate Elevation (bpm) above rest
8 hours	33	+35
1 hour	50	+55
20 min	70	+75
5 min	85	+90

Calculation of HR Response for Percentage of Aerobic Capacity

(AHRJ-RHR)/(PHRM-RHR) = % Max VO required

(Average HR on Job–Resting HR)/(Predicted HR Max-Resting HR)

Example:

Work requirement = 33% (% MaxVO)

Age = 50

Resting HR = 70 bpm (RHR)

Calculate average HR on the job AHRJ = (X)

(AHRJ-RHR)/(PHRM-RHR) = % Max VO required

(X-70)/([220-age]) – 70) = .33

(X-70)/(170-70) = .33

(X-70)/100 = .33

X-70 = **(.33)*100**

X-70 = 33

X = 33 + 70

X = 103 bpm

Conclusion: An average HR of 103 bpm is expected for this individual to participate in 8 hours of continuous work.

EPI REHABILITATION HDP® for Work Physiology

(Hard Data Protocol)

HDP® Principle 1

- There is a direct correlation regarding oxygen consumption and heart rate

HDP® Principle 2

- Heart rate monitoring has been established as an effective and reliable method of determining the energy demands of work (Kodak 1986, Rodahl 1989)

HDP® Principle 3

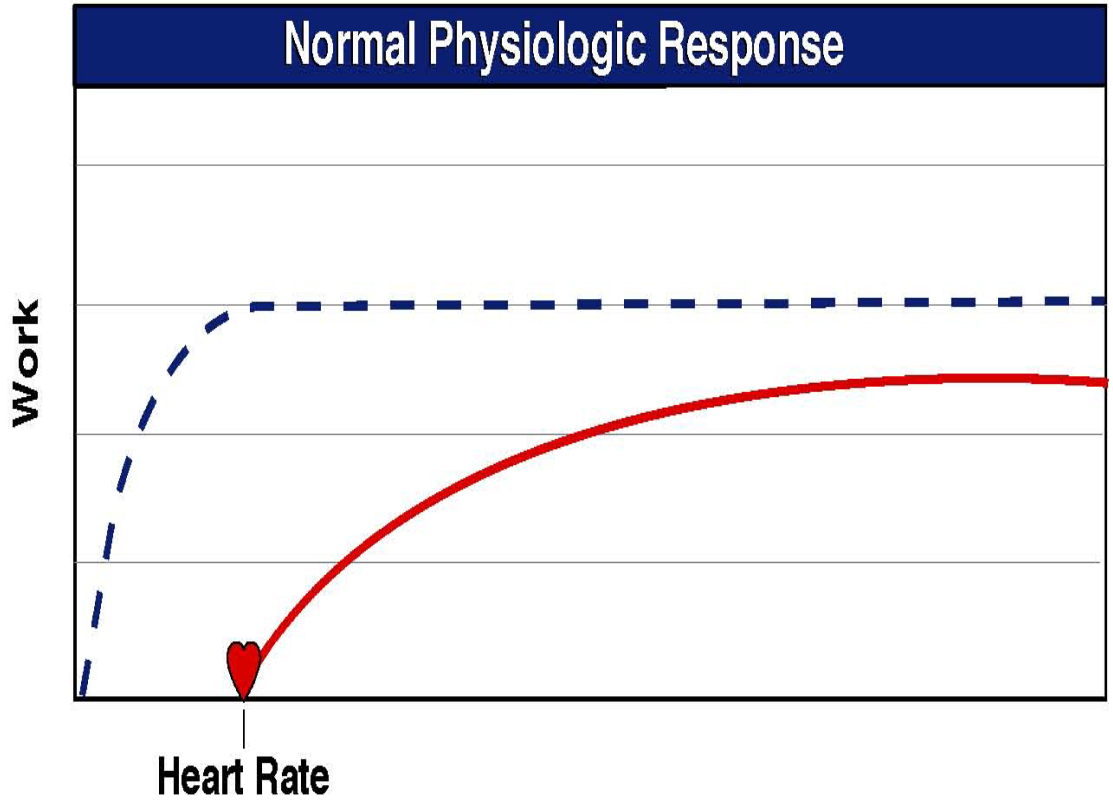
- Once work has been commenced in a range of tolerance, the motor speed reaches the steady state function in a range of 30 seconds to 3 minutes

- The heart rate response reaches steady state within 4-5 minutes

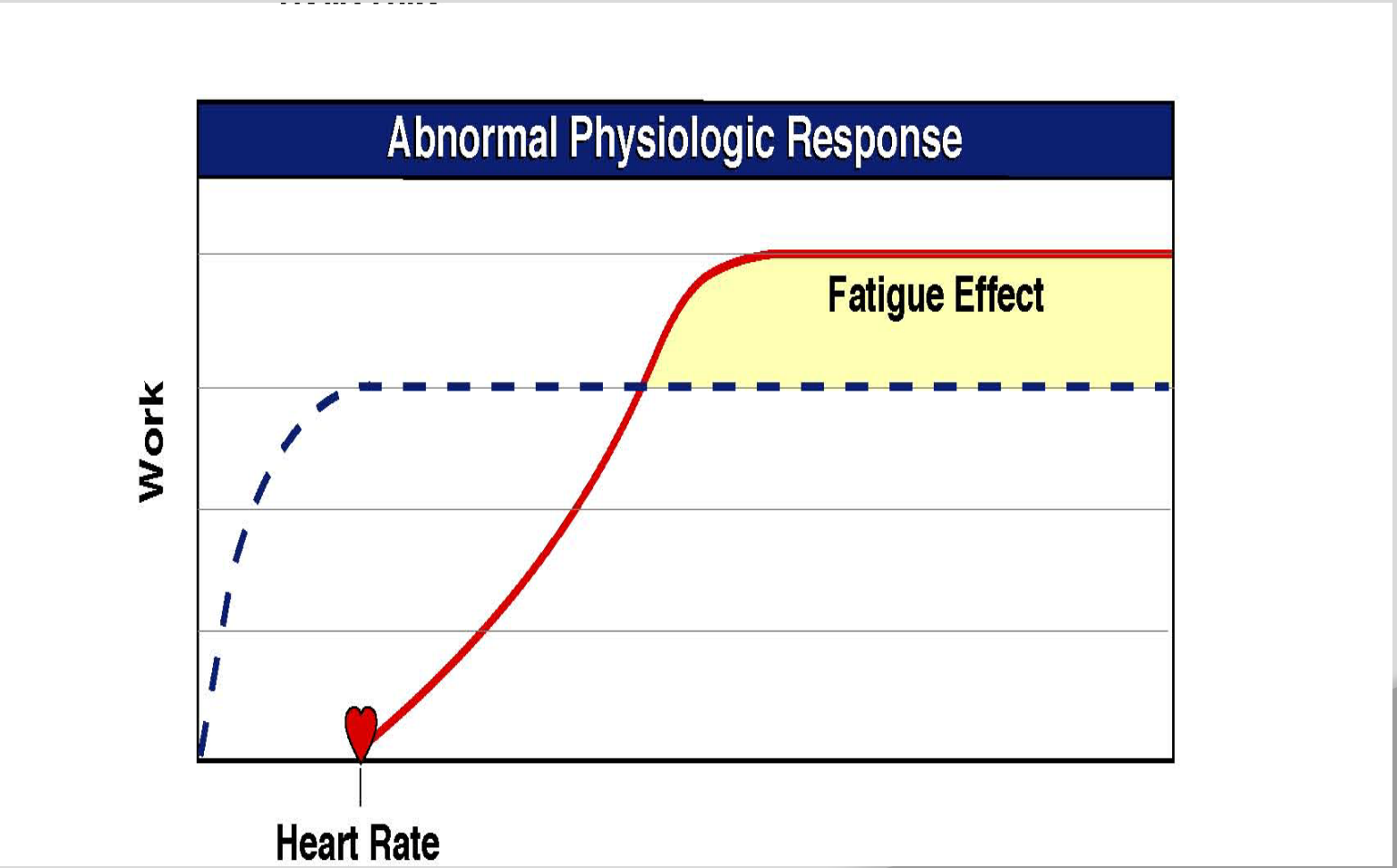
HDP® Principle 4

- The linear association between oxygen consumption and heart rate from the 1st to 5th minute of work would indicate that the stimulus and resultant are closely related and the degree of demand will depend on the rapidity of the work requirement and the output

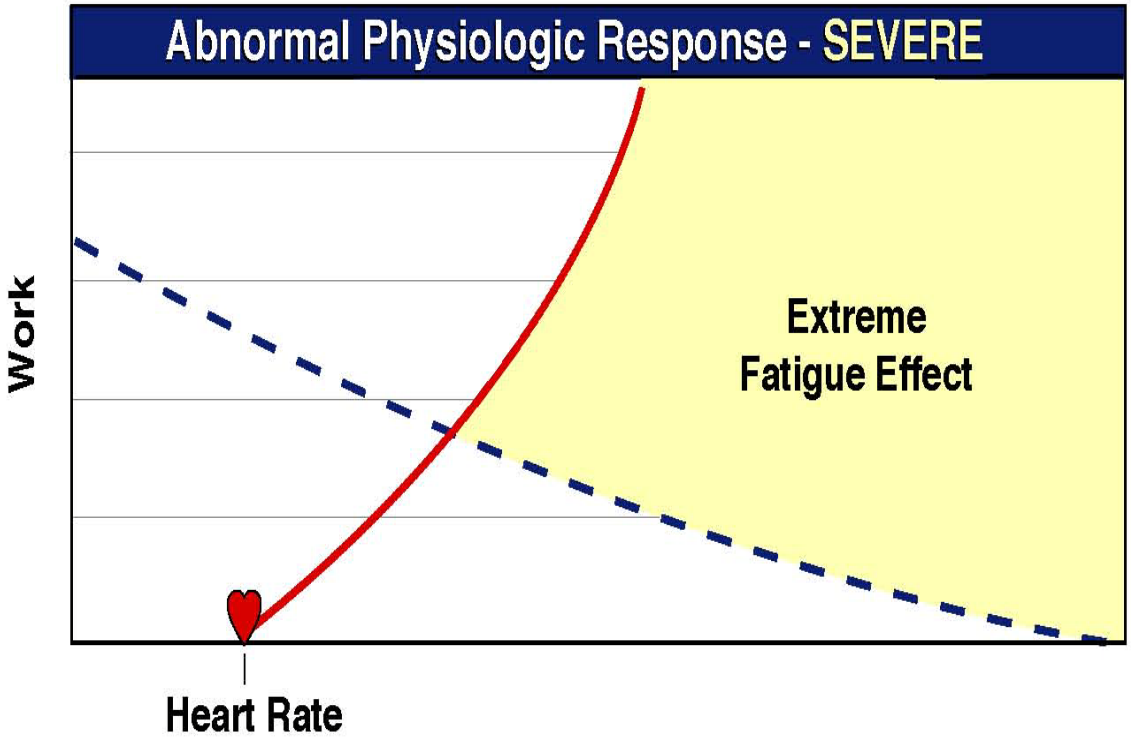
Normal Physiological Response



Abnormal Physiological Response



Extreme Physiological Response



Objective profile fatigue

- Slower work
- Progressively elevated heart rate
- Progressively longer recovery to rest times

Full time work tolerance is:

- SUSTAINABLE
- PREDICTABLE
- COMPETITIVE

Research Conducted by:

Becker, LaBrie, Morrill

Work physiology applied in FCEs

Preliminary Review Results:

(Sample = 125)

- Number of Physical Therapists (PT): 36…28.8%
- Number of Occupational Therapists Registered/Licensed (OTR/L): 37… 29.6%
- Both (PT/ OTR/L) : 43… 34.4%
- Other or not stated: 9… 7.2%
- Number of WA state samples: 102… 81.6%
- Number of out of state samples: 18… 14.4%
- Number of samples from Canada: 2… 1.6%
- No location indicated: 3… 2.4%

Preliminary Results of use of Commercial Products

(Sample = 125)

- Number of citations for commercial software: 44… 35.2%
  - Arcon: 6… 13.63%
  - Matheson: 11… 25%
  - Blankenship: 13… 29.5%
  - Valpar: 1… 2.27%
  - Isernhagen: 2… 4.5%
  - ErgoScience: 4… 9.1%
  - Other: 7… 15.9%
- Locations that **DID NOT** cite commercial software: 82… 65.6%

Preliminary Results Continued

(Sample = 125)

- Number reporting resting heart rate: 86…68.8%
- Number reporting inconsistent resting heart rates: 41… 32.8%
- Number reporting work physiology calculation: 8… 6.4%
- Number reporting work physiology prediction: 17… 13.6%

Preliminary Results Continued

(Sample= 125)

- Number providing incorrect application of 65% age-predicted comparative HR: 5… 4%
- Number providing incorrect application of 75% age-predicted comparative HR: 6… 4.8%
- Number providing incorrect application of 85% age-predicted comparative HR: 2… 1.6%
- Not providing age-predicted comparative HR: 112… 89.6%

Ms. Simons Stated:

“Studies have not been adequately extended to the reliability of using extrapolation methods to predict work tolerance for an 8 hour day.”

Lack of Scientific Foundation

- Prediction of work tolerance in the FCE has relied more on SUBJECTIVE estimates rather than OBJECTIVE DATA
- The subjective determination of a safe and dependable performance level is placed upon the clinician to use their **professional judgment**
- The examinees potential for sustained work is estimated rather than directly measured or accurately predicted

(Hart,1993; Isernhagen,1992; Matheson, 2001).

Summary and Conclusions

Summary & Conclusions 1

- Work physiology does have scientific foundation for predicting full time work.

Summary & Conclusions 2

- Work physiology has definite criteria for a finding of fatigue.

Summary & Conclusions 3

- Typical FCE/PBPCE protocols do not have a work physiology component for identifying fatigue.

Summary & Conclusions 4

- Predominance of FCE/PBPCE providers do not apply scientific work physiology when they conduct their tests.

The End