Work Capacity Evaluation

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DEA 3250/6510

Estimating Work Energy Demands

- All mechanical work involves muscles.
- Muscular effort depends on:
  - ❖ Duration – how long the continuous period of muscle contraction is (total time per minute that muscles are contracted)
  - ❖ Frequency – how often the muscle contracts (number of work cycles per unit time).
  - ❖ Intensity – the strength and oxygen requirements of work (light, moderate, heavy).
- Together, the above define the pattern of work.

Energy Demands and Blood Flow

- Dynamic work requires more blood but muscle activity aids blood flow to meet demand.

Static Work

- Muscle strength diminishes rapidly with static loading.

Energy Processes

- Carbohydrates and fats are necessary for work and are “burned” to produce energy.
- Aerobic processes (aerobic glycolysis) - biochemical energy generating processes that require oxygen (O_2).
- Anaerobic processes (anaerobic glycolysis) - biochemical energy generating processes that don’t require oxygen.
- Myoglobin – molecule in muscle that stores oxygen that can be utilized for short, intense periods of work < 1 minute.

Oxygen Debt

- Oxygen debt is the demand for oxygen at the start of muscle activity > oxygen from the circulatory system alone, because it takes time for the circulatory system to increase it’s supply.
- Oxygen debt is “repaid” after work ceases during a recovery time.
- Successful work design incorporates appropriate rest breaks.

Energy Expenditure

- Energy expenditure is measured in kilocalories (kcal) per minute [70kcal = 1 watt]
- Energy expenditure is ~ 5 times oxygen consumption in liters.
- Oxygen consumption correlates with work effort.

Energy Demands of Work

- Examples of typical energy demands of work (kcals/ minute)

Energy Demands and Posture

- Work posture has a substantial effect on the energy expenditure of performing the same task.
- Use of supports reduces energy demands.

Energy Demands and Posture

- How work is done determines the energy expenditure required by the activity.

Energy Costs of Grades of Work

- Estimated basal metabolic rate for an adult male is ~ 2,300 kcal/day.
- Estimated maximum energy output for an adult male is ~ 4,800 kcal/day.
- Consequently, estimated maximum work output for an adult male is ~ 2,500 kcal/day, which is ~ 5 kcal/minute.
- Recommended maintainable daily work output is 4 kcal/minute.

Calculating Work and Rest Duration

- Many work activities exceed 5 kcal/minute, so rest is needed to compensate.Rest time can be calculated from:

$$R = (T(K-S))/(K-1.5)$$

R = rest required (minutes)
T = total working time (minutes)
K = average kcal/min. work
S = kcal/min chosen as desirable standard
1.5 = ~ resting level (kcal/min)

Calculating Work and Rest Duration

- Example: How much rest is needed per hour (60 minutes) for someone sawing wood at 7 kcal/min? Assume that 4 kcal/min is the desirable standard.

$$R = (T(K-S))/(K-1.5)$$

$$R = (60\ (7-4))/(7-1.5) = 180/5.5$$

$$R = 33 \text{ minutes}$$

Calculating Work and Rest Duration

- Rest requirements for different energy expenditures