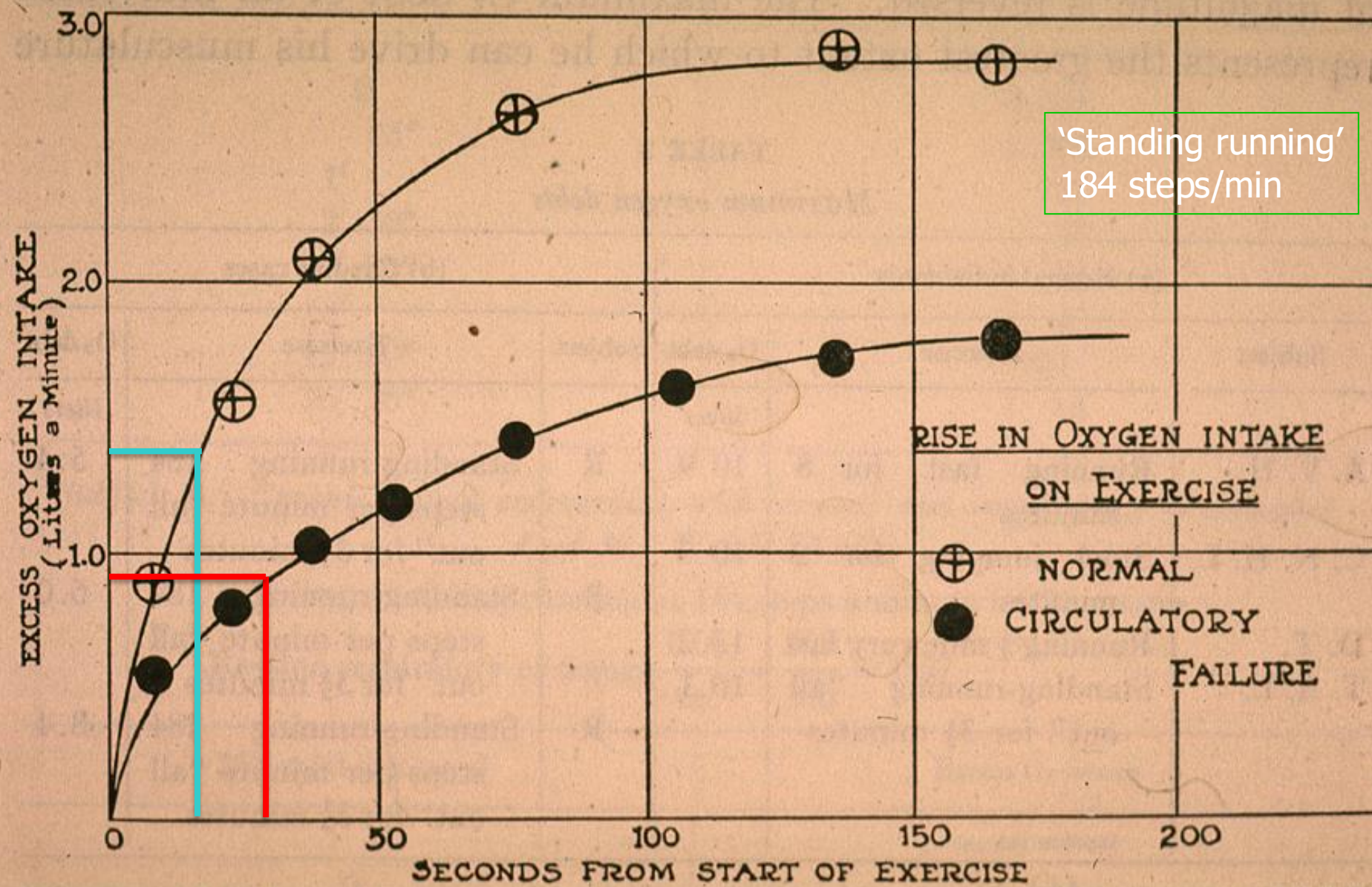


Exercise Test Design: Ramp and Constant Work Rate

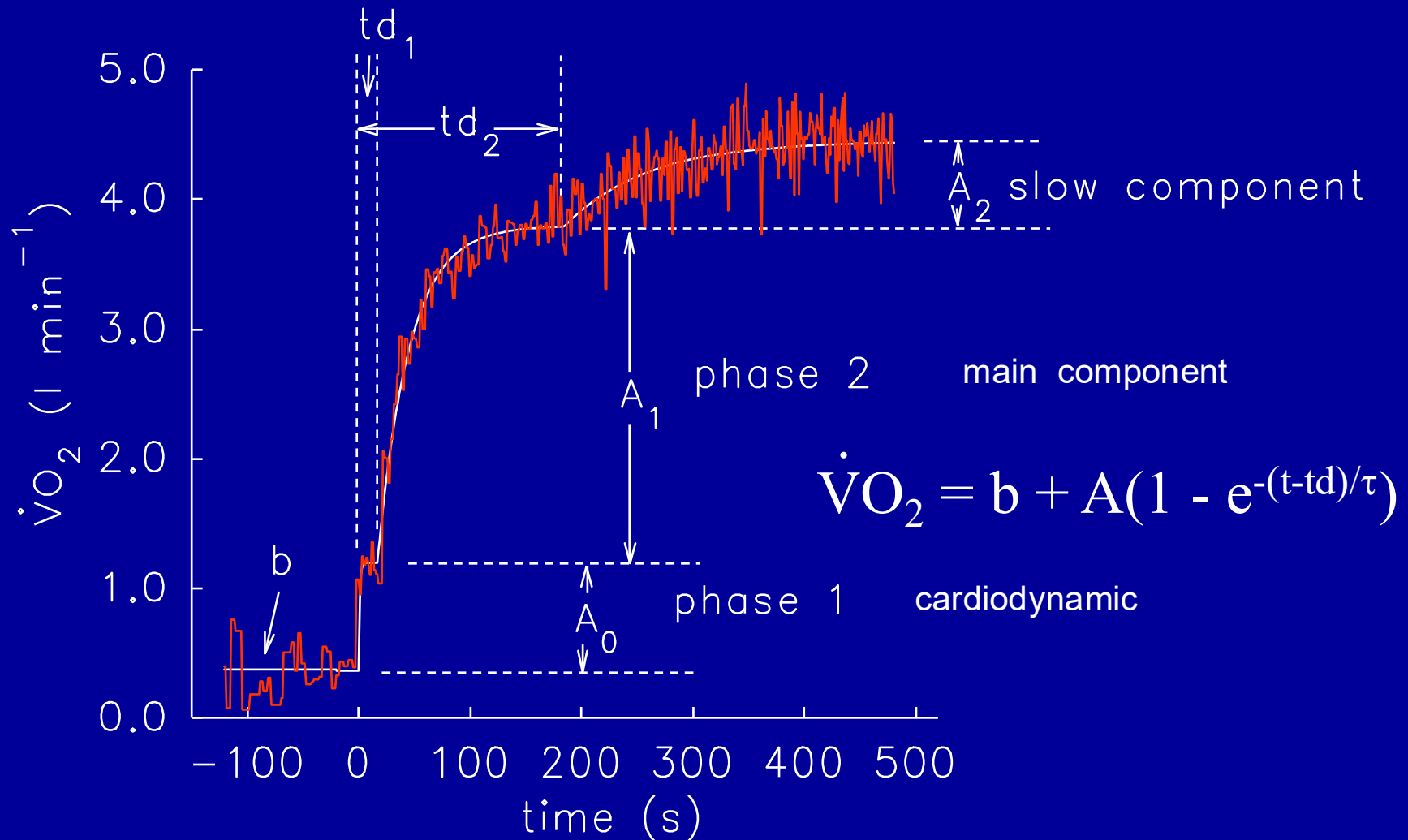
M. Riley



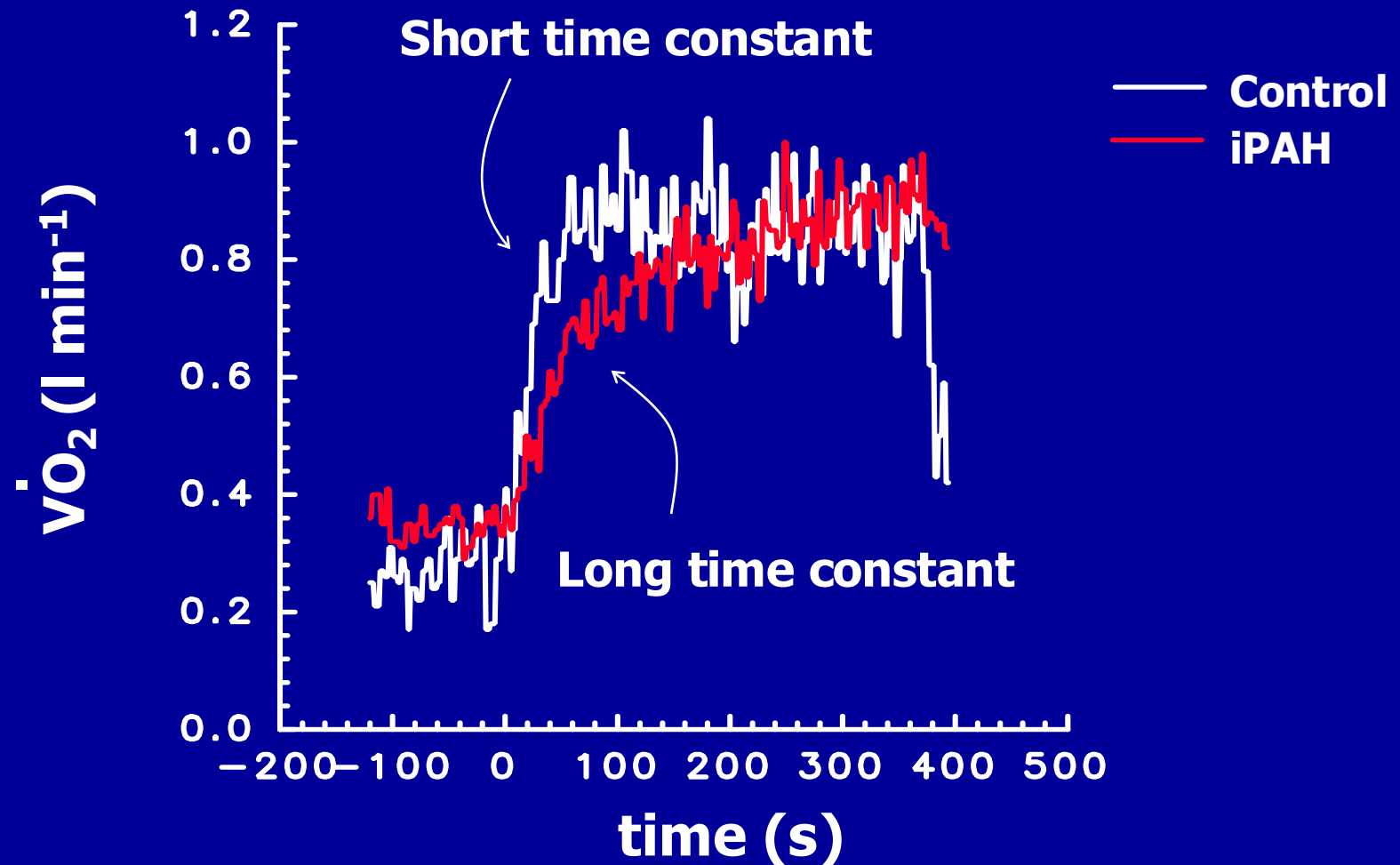
Dr. James E. Hansen 1926-2017



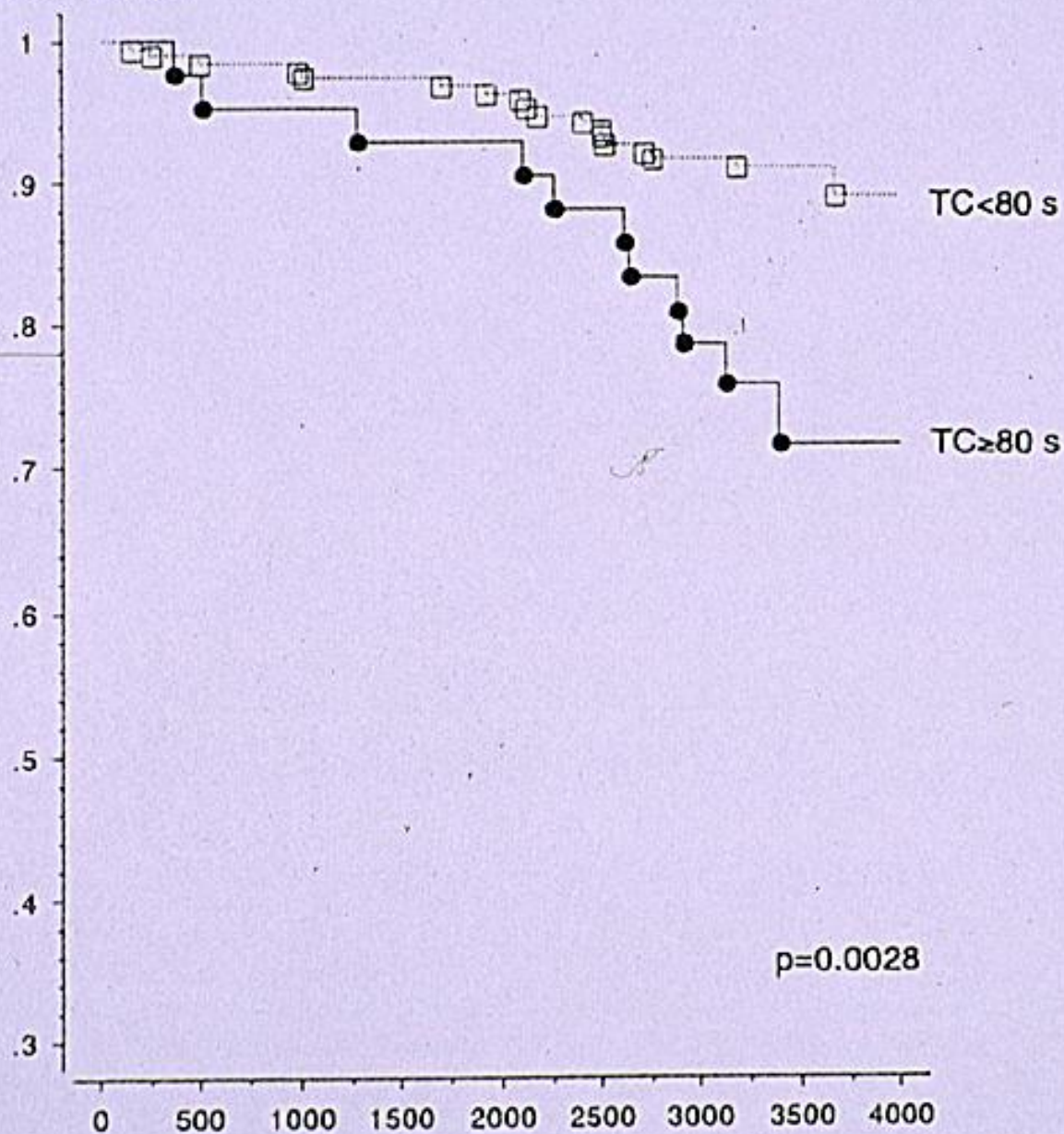
Components of response



40W constant work rate

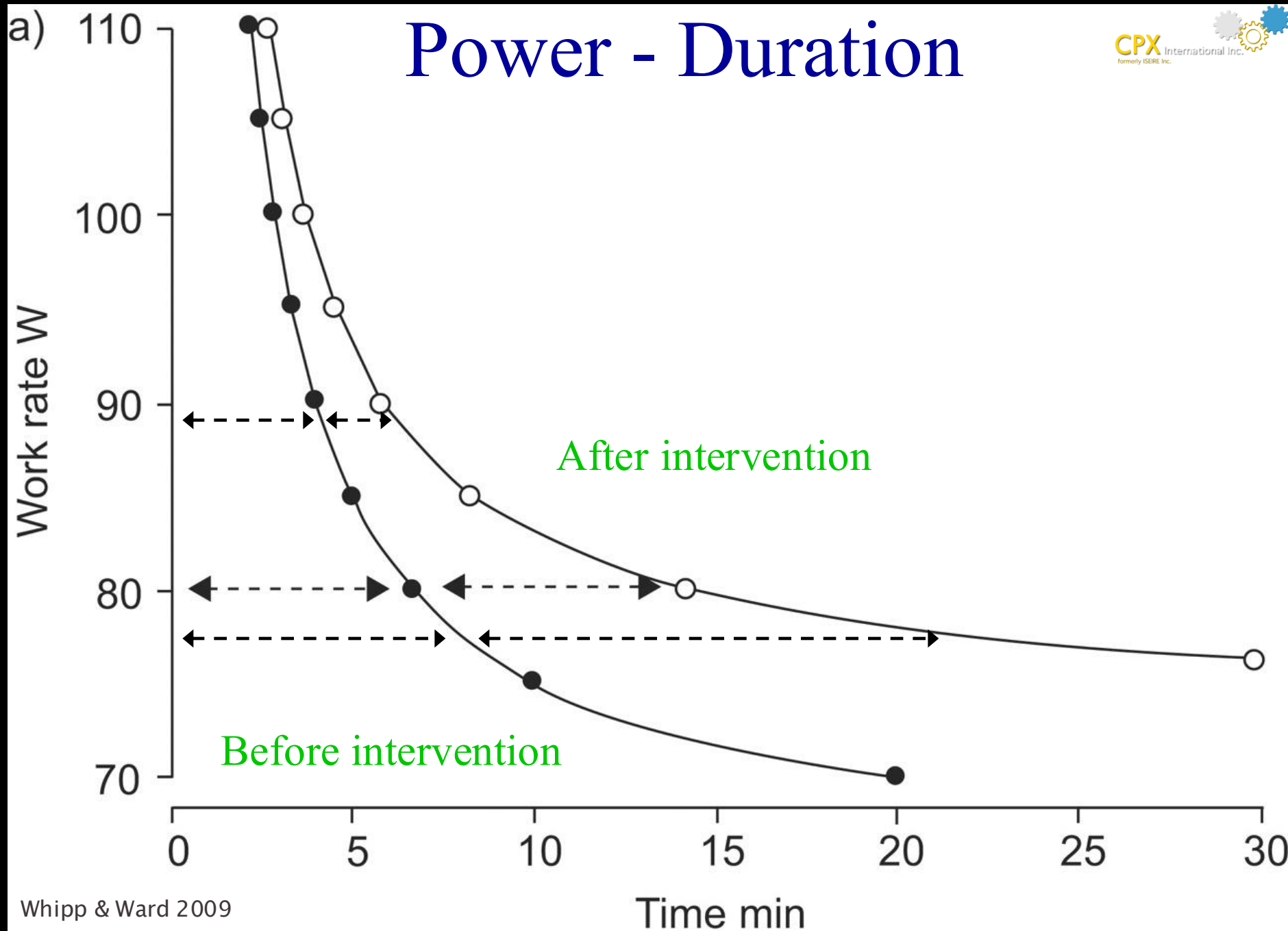


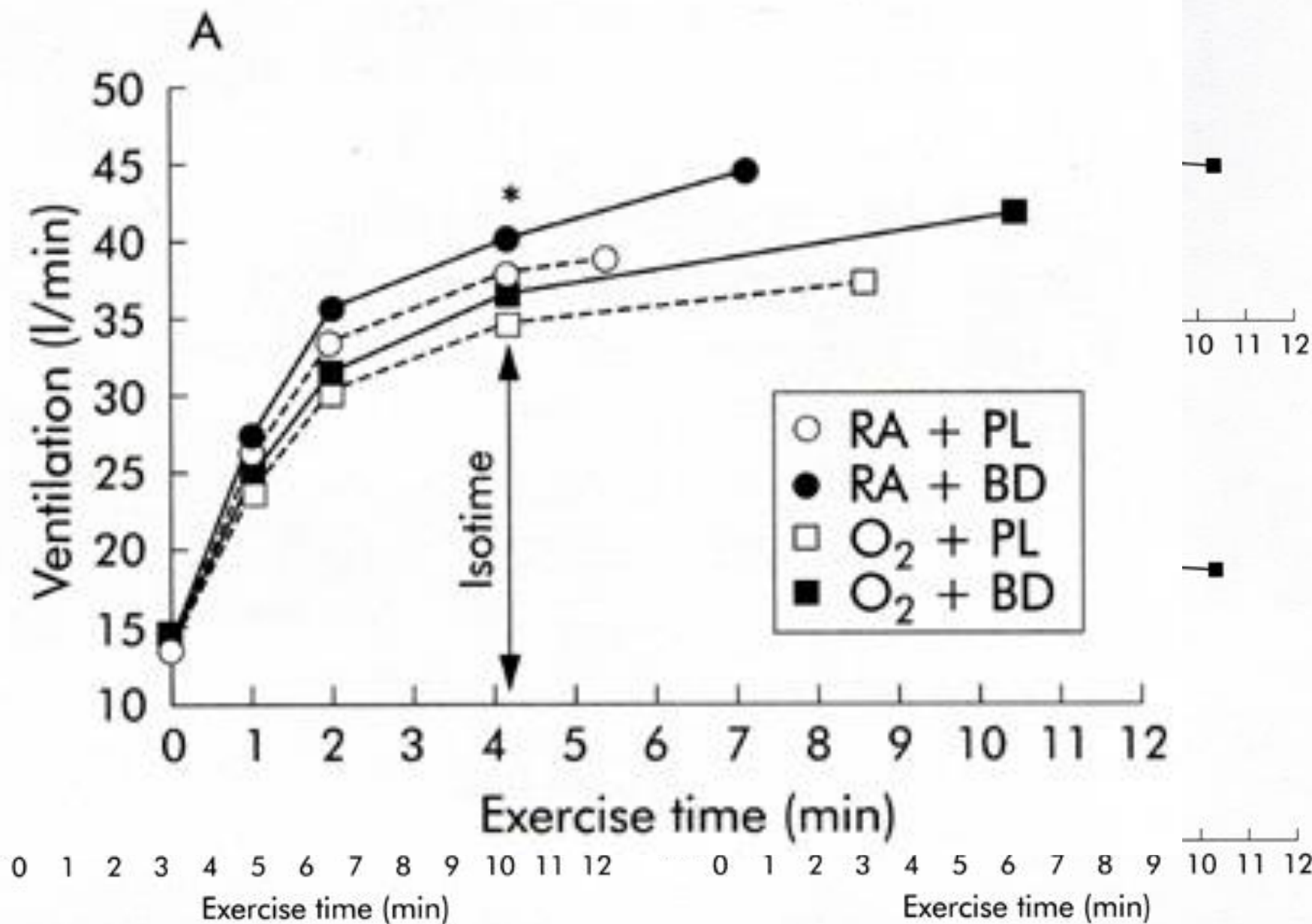
Survival Fraction

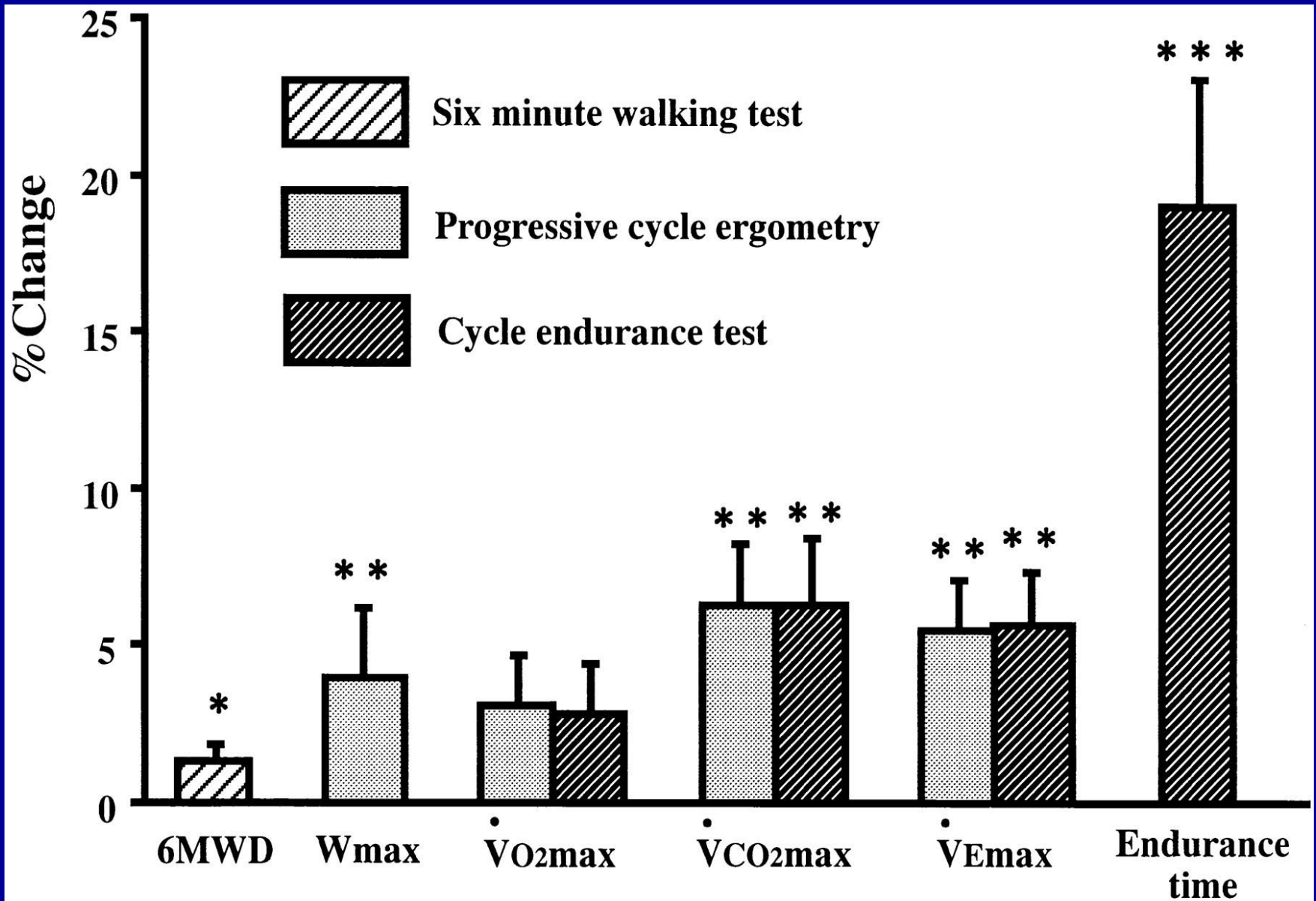


Koike et al. 2000

Duration of Follow-up (days)





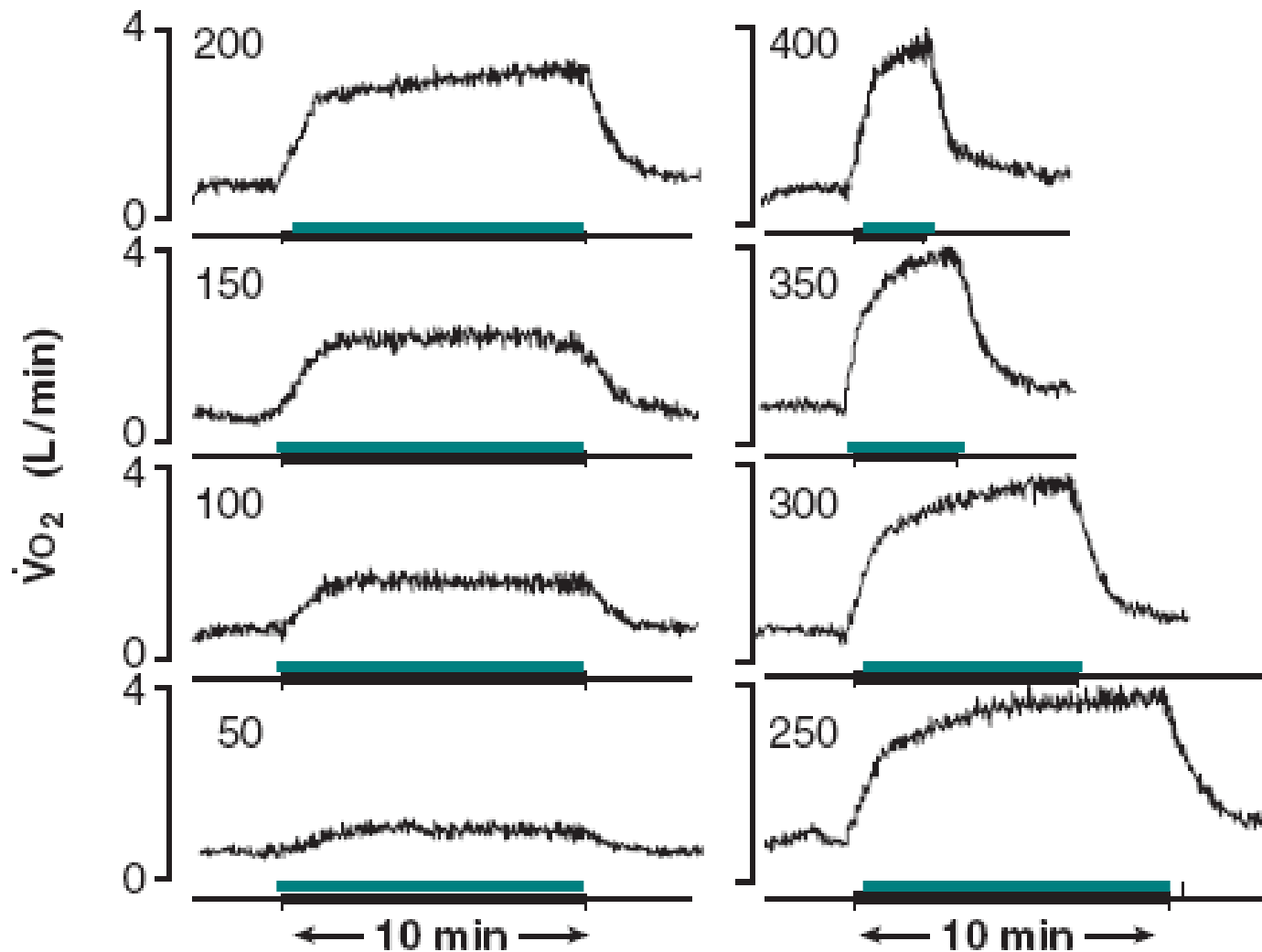


Oga et al. 2000

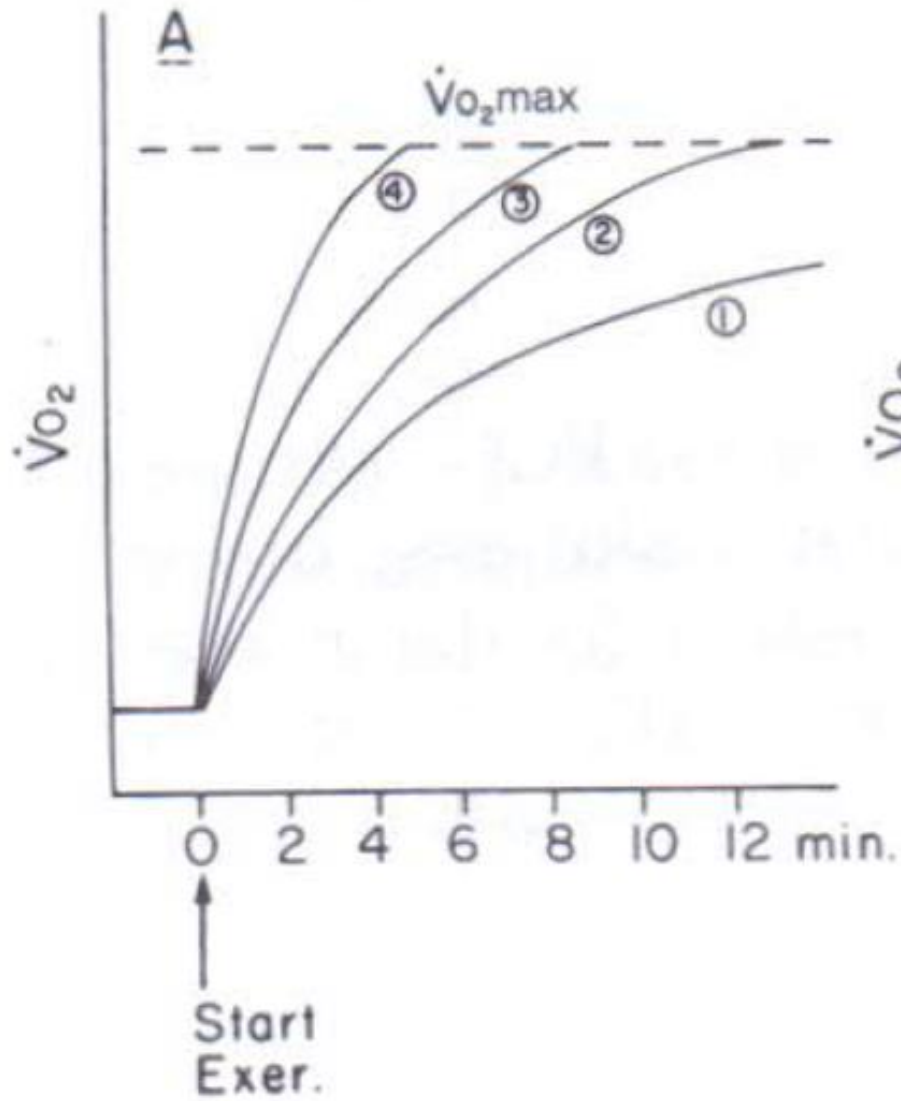
Constant workrate exercise tests

- Simple concept
- Everyday life work rate domain
- Interventions can cause large changes in exercise duration
- Physiological comparisons at 'isotime'

Oxygen uptake for 8 different work rates of exercise



Constant WR



Increasing WR

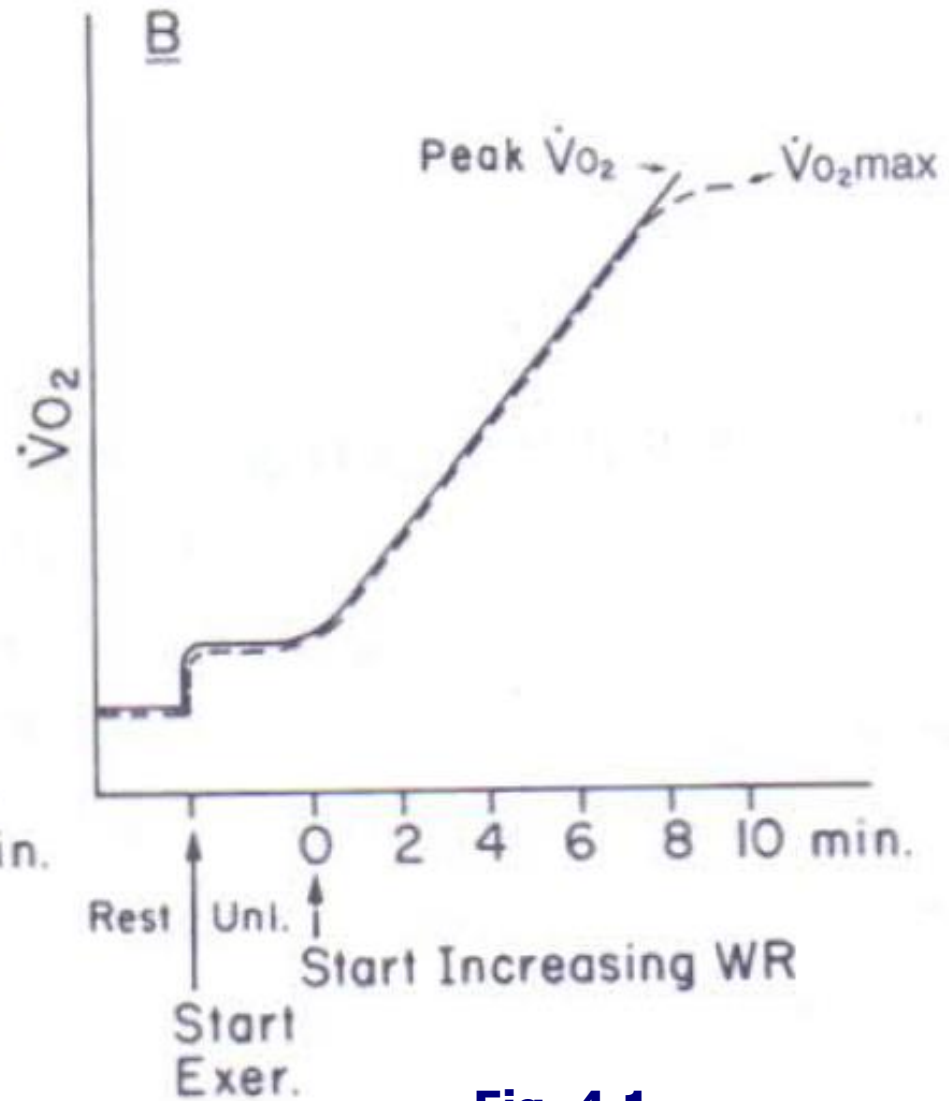
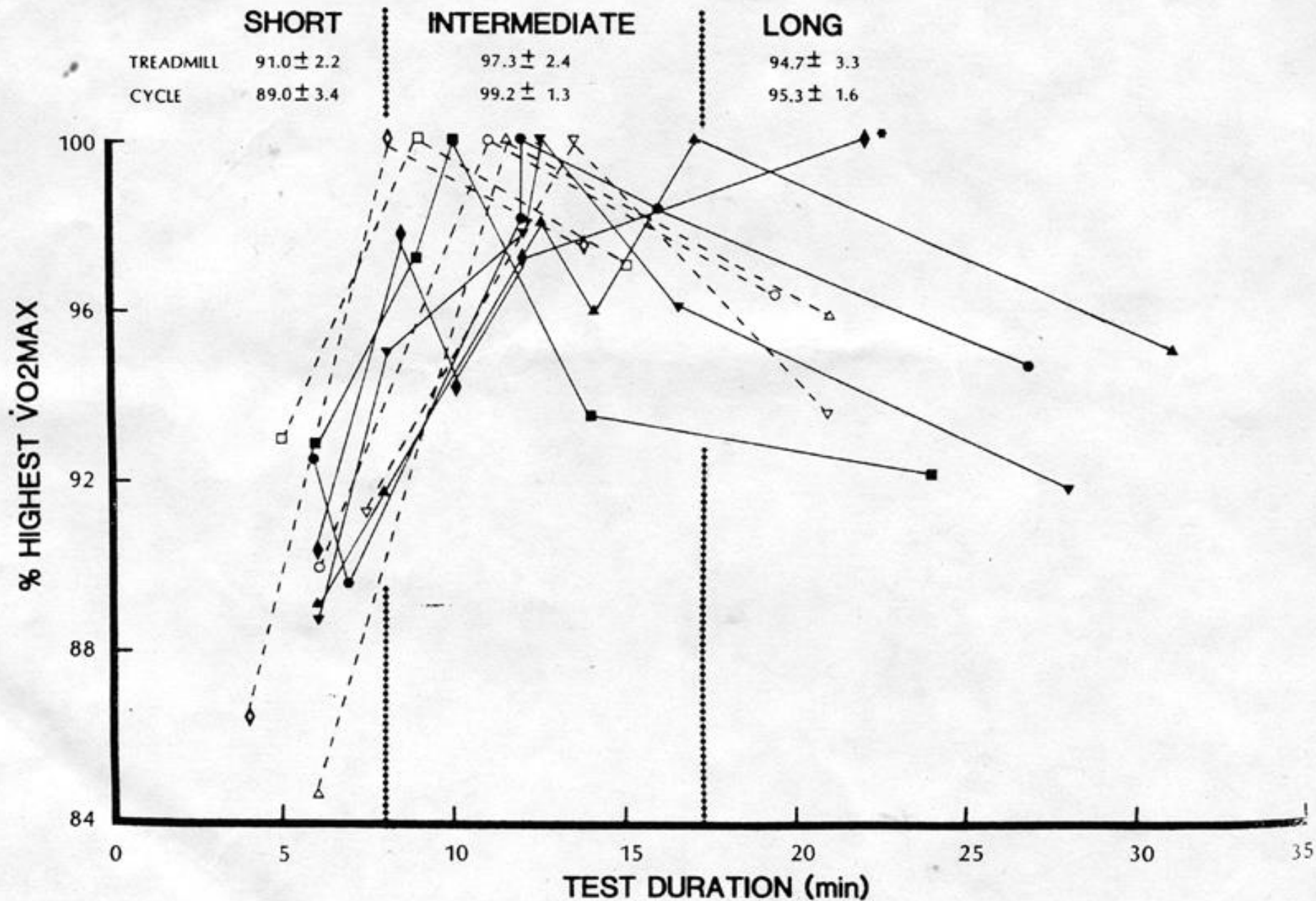


Fig. 4.1

Incremental exercise test

- Starts at low workrate
- Short period at relatively high workrates
- Fast recovery
- Peak or maximum $\dot{V}O_2$
- $\dot{V}O_2$ – workrate relationship
- Precise AT
- Other well characterised response patterns
- Continuous incremental (ramp): no 'jumps' in workrate



Modes and Protocols

Advantages of different ergometers

Leg Cycling

- Quantifiable work
- Less ECG motion artefact
- Quieter
- Ease for ABG or ELG
- Automatic BP
- Safer, less apprehension
- Smaller space
- Less expensive

Treadmill

- Easy to calibrate
- Familiar and natural activity
- Larger muscle mass
 - $\dot{V}O_2\text{max} \sim 10\%$ greater than cycle
- Rate-responsive pacemakers

Treadmill protocols

BRUCE PROTOCOL

Stage	kph	%	VO2	METS
1	2.7	10	17.2	4.9
2	4.0	12	26.0	7.4
3	5.5	14	34.8	10.0
4	6.7	16	43.6	12.5
5	8.0	18	52.4	15.0
6	8.8	20	61.3	17.5

1 MET = 250ml/70kg = 3.5 ml/min/kg

Bruce et al. Bull N Y Acad Med 1969;45:1288-1305.

Modified Naughton

Time (min)	Speed (km h ⁻¹)	Slope (%)
0	1.6	0
2	2.4	0
4	2.4	3.5
6	2.4	7.0
8	2.4	10.5
10	3.2	7.0
12	3.2	10.5
14	4.8	12.5
16	4.8	15.0
18	5.6	14.0
20	5.6	16.0
22	6.7	16.0

Naughton JP et al. 1973

STEEP Treadmill

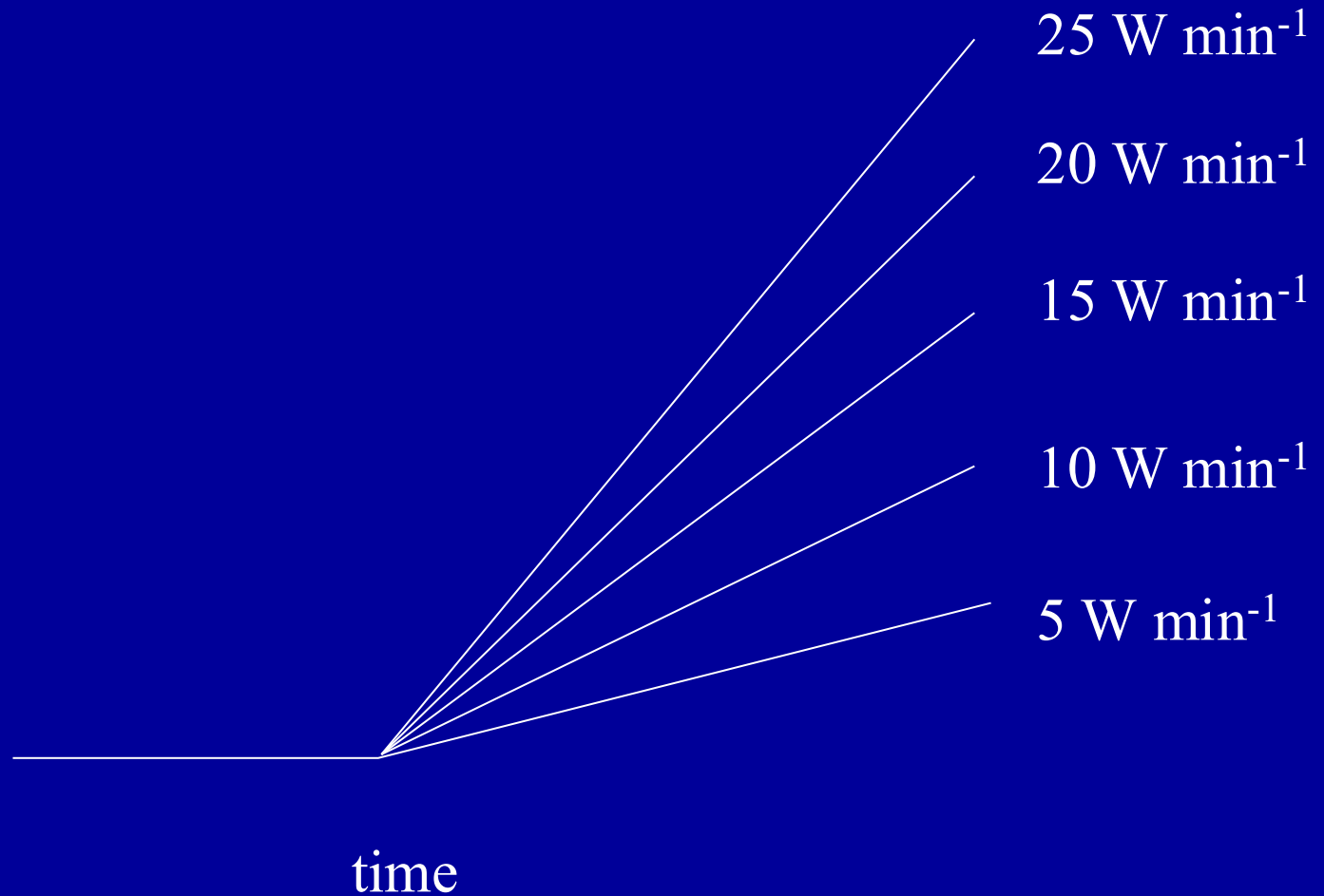
<u>Time (min)</u>	<u>Speed (km/h)</u>	<u>Slope (%)</u>
1	2.4	0
2	3.2	0
3	3.2	1.5
4	3.2	3.0
5	4.0	3.0
6	4.0	5.0
7	4.0	7.0
8	4.8	7.0
9	4.8	9.0
10	4.8	11.0
11	5.6	11.0
12	5.6	13.0
13	5.6	16.0
14	8.0	16.0

Northridge et al. Br Heart J 1990;64:313-316

Jamison JP, Megarry J et al. Eur J Appl Physiol 2010;107:1183-6

Bicycle ergometer protocols

Linear bicycle protocols



SUGGESTED INCREMENTAL PROTOCOL FOR THE VERY *INFIRM* OR THE VERY *OBESE*

1. Preparation and resting measures as usual
2. 3 min unloaded cycling at about 20 rpm
3. 1 min unloaded cycling at about 40 rpm
4. 1 min unloaded cycling at 60 rpm
5. Begin incrementing work rate at 5 - 10
Watts/min while cycling continues at 60 rpm
6. Continue as long as safely able
7. Collect 2 – 3 min of recovery data
8. Irregular cycling OK at 20 – 40 rpm.

Leg cycling: Work rate increment

From prediction equations & adjustments

$\sim 500 \text{ ml min}^{-1}$

$$\text{Ramp slope} = \frac{\text{Predicted } \dot{V}O_2 - \text{Unloaded } \dot{V}O_2}{100}$$

10 minutes at
10 ml min⁻¹ W⁻¹

The Rough Guide to WR increments

- 5 W min⁻¹ Very impaired
- 10 W min⁻¹ Impaired or elderly
- 15 W min⁻¹ Mildly impaired. 60-75 y/o
- 20 W min⁻¹ Sedentary young adult
- 25 W min⁻¹ Young adult
- 30 W min⁻¹ Fit young adult
- 35 W min⁻¹ Very fit young adult
- 40 W min⁻¹ Athlete