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Glossary of Specialized Terms and Units

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THE use of abbreviations is becoming increasingly widespread in medical science. To the expert in a particular field, they represent a useful form of shorthand, and to the harassed editor they represent a vital economy in space. However, to the general reader, an array of symbols differing in subtle details from paper to paper can be a source of confusion. In some areas, particularly respiratory physiology,[1,2] there have been welcome efforts to provide a standard and internationally accepted vocabulary. Unfortunately, this is not yet true for physical activity. Different contributors to this symposium have described the same phenomena by differing symbols and differing terms. In the absence of international agreement, it would be churlish to make all conform to the editor's views. This glossary thus explains the equivalence of the various synonyms which are in current use, indicating personal preferences only as a basis of discussion towards international agreement.

Units of 'work'. Kgm/min; Kpm/min; Watts; ft.Lb/min; Kcal./min

Activity is usually expressed as a rate of working (i.e. a power), and involves the units of force, distance, and time, or the equivalent electrical or heat energy. Electrical and thermal units are relevant mainly to rather specific techniques of measurement, and the metric units of *Kgm/min* seem most suitable for international acceptance. In a gravitational field of 1 g, *1 Kgm/min* (Kilogram metre per min) is exactly equivalent to 1 Kpm/min (kilopond metre per min); in view of the relatively small variations of gravity with latitude, and the potential confusion of pond with pound, the added precision of Kpm/min is hardly warranted for terrestrial studies.

427 Kgm/min = 427 Kpm/min = 71.5 Watts = 3088 ft.Lb/min = Kcal./min

Aerobic power. $\dot{V}O_2$ max, maximum oxygen intake, ~~aerobic power, aerobic capacity~~.

The *maximum oxygen intake* is widely described as the *aerobic capacity*, but this is dimensionally incorrect; it is essentially a unit of *power* rather than capacity. It refers to short periods of effort (5-10 min) and may be measured directly to within specified limits (for example, agreement of the oxygen intake at three graded work loads to within 0.15 l./min), or predicted from the pulse rate and oxygen consumption or rate of working in a sub-maximal test. It may be expressed as an absolute rate of gas transfer (l./min), or it may be related to body weight or fat free weight (ml./Kg min).

$\dot{V}O_{2,170}$, PWR_{170}, PWC_{170}, Kgm/min, W_{170}, Kpm/min; PWC_{150}, Kgm/min, W_{150}, Kpm/min

If it is not possible to measure the $\dot{V}O_2$ max directly, some investigators prefer to state the oxygen consumption ($\dot{V}O_{2,170}$) or the rate of working which will produce a pulse rate of 170/min, or in the elderly and infirm a pulse rate of 150/min. This is determined by interpolation or extrapolation of a pulse/work rate graph to the selected pulse rate, and is thus a predicted work rate (PWR_{170}) rather than a physical working capacity (PWC_{170}) as it is commonly termed. The PWR_{170} has several disadvantages relative to a prediction of $\dot{V}O_2$ max: (a) it includes a proportion of anaerobic power which varies with age and fitness, (b) it is not comparable in subjects of different ages owing to the decrease of maximum pulse rate with age, and (c) some older subjects are unable to reach a pulse rate of 170 (hence the need for a PWR_{150}).

LPI, Oxygen Pulse

The Leistungspulsindex (*LPI*) is the increment of pulse produced by an increment in work load of 60 Kgm/min. It is normally measured on the bicycle ergometer at a pedal speed of 60 revolutions per minute; the subject starts at zero load, and progresses in 10 equal steps to a maximum load of 600 Kgm/min. In the average subject, a load of 600 Kgm/min is associated with an increase of 1.2 l./min in oxygen consumption.

Thus $O_2\,pulse \approx 8.33\,LPI$

The O_2 pulse and LPI should not be confused with the recent concepts of measuring the pulse rate at a fixed work load (Shephard) or a fixed oxygen consumption (Cotes). In a homogenous population, these last two approaches each give as much information on cardiorespiratory fitness as many more complicated manipulations of the data.

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MR; Met.

In studies of thermal stress, two additional terms that are found include *MR* (metabolic rate), and *Met* (ratio of observed metabolic rate to the basal value).

Anaerobic power and tissue metabolism

$ATP \rightleftharpoons ADP + P$; $CP \rightleftharpoons C + P$;
PG, GP ; LA, XL ; $d\dot{W}/dg$;
En ; mM ; mE ; R, RQ ; $NADH \rightleftharpoons NAD$

The anaerobic power of the body is derived partly from the high energy phosphate bonding of adenosine triphosphate (*ATP*) and creatine phosphate (*CP*). In some books CP is also known as phosphagen, *PG, or GP*, but Margaria uses PG in the sense PG = ATP + CP; conversion of one gram molecule (M) of *ATP* to adenosine diphosphate (*ADP*), or one gram molecule of CP to creatine (*C*) is associated with the transfer of 10-12 Kcal. of energy (*En*) to muscle proteins. Anaerobic power also results from incomplete oxidation of glycogen to lactic acid (*LA*); blood and tissue levels of LA are commonly expressed as mg/100 ml., *nM*.l. or *mE*.l. (lmM = lmE = 90 mg LA). According to the concept of Margaria (pages 770 to 774), LA formation does not occur until the rate of working reaches a critical level corresponding to the $\dot{V}O_2$ max; thereafter, the formation of LA (dg) is linearly related to the increase in the rate of working ($d\dot{W}$), the normal value for the constant $d\dot{W}/dg$ being 220 calories per gram of LA. Huckabee has proposed that the excess lactate (*XL*) has greater significance than the absolute LA; however, this view is not shared by most of the contributors to this symposium.

Anaerobic work is usually associated with an increase of respiratory quotient (ΔR, or ΔRQ, usually measured from an arbitrary resting level, 0.75 in the work of Issekutz and collaborators).

$NADH \rightleftharpoons NAD$. Nicotinic acid dehydrogenase, an important hydrogen acceptor in the metabolic chain.

Static and dynamic work. MVC ; V_v ; W_v ; MWT.

Static contractions are commonly expressed as a percentage of the maximum voluntary contraction (*MVC*); a given percentage of the MVC has roughly equivalent hemodynamic consequences in muscles of differing strength.

In measuring dynamic power, it may be useful to record vertical velocity (V_v) or vertical work (W_v) on a flight of stairs.

Endurance fitness is sometimes measured in terms of performance (such as maximum walking time, *MWT*) rather than maximum oxygen intake. The MWT depends markedly on motivation of the subjects.

Ventilatory capacity.

VC ; MC ; FRC ; TLV ; TLC ; V_T

VC = vital capacity (maximum volume that can be expired after maximal inspiration).

MC = pulmonary mid-capacity (the average lung volume at which respiration is being carried out).

FRC	= functional residual capacity
TLV, TLC	= total lung volume
V_T	= tidal volume

Ventilatory power. PEF, $\dot{v}_{max}$, $\dot{V}_{max}$; $\dot{V}_E$ max ; MVV_{100}, MBC_{100} ; $FEV_{1.0}$; MVV_{40}.

MVV_{100} = maximum voluntary ventilation performed at the rate specified by the subscript, usually for 15 sec (occasionally 12, 20, or 30 sec). Also described as the maximum breathing capacity (*MBC*) in many older papers. The MVV_{100} exceeds by a substantial margin the maximum expired minute volume during exercise ($\dot{V}_E$ *max*). The time derivative in litres per minute ($\dot{V}_{E\ max}$) must be distinguished from the instantaneous maximum flow (Peak expiratory flow rate, usually *P.E.F.*, but sometimes $\dot{v}_{max}$, or less clearly $\dot{V}_{max}$).

$FEV_{1.0}$ = forced expiratory volume, measured over the interval specified by the subscript (normally 1.0 sec, but occasionally 0.5, 0.75, 2.0, or 3.0 sec).

MVV_{40} = (usually) an approximate and indirect estimate of the maximum voluntary ventilation, obtained on multiplying the $FEV_{0.75}$ by an arbitrary constant (40).

STPD BTPS ATPS.

Terms relating to ventilatory capacity and power, such as VC and MVV_{100}, are normally expressed at body temperature and pressure, saturated with water vapour (*BTPS*), although in some older reports they are expressed at atmospheric temperature and pressure, saturated with water vapour (*ATPS*), yielding an 8-10% smaller volume. Volumes relating to gas transfer (such as $\dot{V}O_2$, max) are normally expressed as an equivalent volume of dry gas under standard conditions of temperature and pressure (*STPD*).

Gas transfer.

$\dot{V}_E$; $\dot{V}_A$; $\dot{D}_L$; $D_{L,CO\ max}$, $D_{L,CO} \geq 120$; $\dot{Q}c$; $\lambda\dot{Q}$; $\dot{D}t$; C_{I,O_2}; F_{I,O_2}; P_{I,O_2}; $\dot{U}O_2$.

In general, the system adopted by respiratory physiologists is preferred. The *dot* above a symbol

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implies a time derivative; thus $\dot{V}_E$ is the volume of gas expired per minute, $\dot{V}_A$ the alveolar ventilation per minute, $\dot{Q}$ the cardiac output per minute, and $\dot{Q}c$ the pulmonary capillary flow, marginally less than $\dot{Q}$ owing to pulmonary 'shunts'. The term λ is the physiological air/blood partition coefficient; its value depends upon the hemoglobin content of the blood and the slope of the oxygen dissociation curve.

'Diffusing capacity' is commonly written without a dot above the D; however, to be dimensionally compatible with the other links in the gas transfer system, the dot should be included for both lung 'diffusing capacity' $\dot{D}_L$ and tissue 'diffusing capacity' $\dot{D}_t$. Cotes has argued that pulmonary 'diffusing capacity' should be called 'transfer factor', but the term 'diffusing capacity' has now become hallowed by long misuse, and in any event 'transfer factor' is a generic term which could be applied to any and all stages of gas conductance. Some authors believe that diffusing capacity reaches a maximum at a pulse rate $\geq$120/min, hence D_L, co $_{max}$, and D_L, co $\geq$ *120*.

The primary symbol *C* refers to concentration of a gas in ml./l. (the units compatible with an overall conductance measured in l./min) or ml./100 ml. (the units often used in the Fick equation for cardiac output). *F* refers to fractional concentration (ml./ml.), and *P* to the partial pressure (mm Hg, or torr). The first subscript refers to the phase where the concentration is measured (I = inspired gas, E = expired gas, A = alveolar gas, a = arterial blood, v = venous blood, t = tissues), and the second subscript to the chemical nature of the gas. A bar above a symbol implies a mean value. Thus $C\bar{v},O_2$ is the mean concentration of oxygen (ml./l.) in mixed venous blood. Some cardiologists use the symbol *Pa*, or less correctly the symbol P_A to represent the hydrostatic pressure in the pulmonary artery, and *Pc* to represent the hydrostatic pressure in the pulmonary capillary bed; the fact that the total pressure is implied can be deduced from the absence of a second subscript.

$\dot{U}O_2$ is the symbol which the present author has proposed to represent the overall transfer coefficient for oxygen uptake. Numerically,

$$\dot{V}O_2 = \dot{U}O_2\,(C_I,O_2 - C_t,O_2)$$

Circulatory Capacity. Q, SV ; f, F, HR ; THb ; $\dot{Q}$, $\dot{Q}_{max}$, CO,q; BV ; CBV ; HV ; AVD.

The stroke volume (*Q, SV*) should preferably be written in terminology compatible with the gas transfer expression for cardiac output ($\dot{Q}$ rather than *CO* or *q*). Similarly, the heart rate (*f, F, HR*) should have an analogous symbol to the respiratory rate; where the possibility of confusion exists, they could be represented by f_h and f_v respectively.

THb seems a well-established abbreviation for total body hemoglobin. It is normally measured by a carbon monoxide rebreathing technique, and should be distinguished from the total hemoglobin content of a given volume of blood, also measured by a carbon monoxide technique.

BV = blood volume
CBV = central blood volume
HV = heart volume
AVD = arteriovenous difference

Heat transfer. T_r ; T_s

Heat transfer is regulated by the average thermal gradient from the body core to the skin surface. The rectal temperature T_r is one common index of core temperature, and the gradient to the skin is then $T_r - T_s$.

Mathematical and statistical terms

$\sim$; $\approx$; $\bar{X}$; S.D., S.E. ; R^2 ; S^2 ; r ; F ; t ; N, n.

The statistical terms here defined are all estimated values, with limits imposed by the sample size and the assumption of a normal distribution curve.

$\sim$ about $\approx$ approximately equal
$\bar{X}$ = mean of data

S.D. The standard deviation of a single observation

S.E. The standard error of the mean

R^2 The ratio of the sums of squares explained by a multiple regression equation to the total sums of squares.

S^2 The sums of squares not explained by a multiple regression equation, equivalent to the $(S.E.)^2$ of predictions using the equation.

r The coefficient of correlation

F The variance ratio

t The t ratio

N number of degrees of freedom (sometimes also used for number of subjects)

n number of subjects (sometimes also used for number of degrees of freedom).

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