THE METABOLIC EFFECT OF DAILY ICU CARE

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There has been a recent resurgence of interest in measuring metabolic rate, due to the recognition of the need to provide adequate but not excessive nutritional support to the critically ill patient. Measurements of basal metabolic rate (BMR) are traditionally performed in the "basal" state, which is defined as the minimal energy expenditure in a thermoneutral environment of a supine, resting subject who has fasted for the previous 12 hours. Such conditions are extremely rare in the critically ill patient, because such patients are receiving some form of continuous nutrition, e.g. 5% dextrose. Energy expenditure in subjects receiving continual nutrition is ordinarily called resting energy expenditure (REE); REE measurements are usually about 10% above BMR since they include the specific dynamic action of food. They are performed in an awake, resting, supine subject. Measuring energy expenditure in mechanically ventilated critically ill patients poses a variety of problems. The first is defining a reference state, whether it be resting or basal, for which to calculate nutritional ranges. This is of great importance, since the patient may be comatose, may have received narcotics or muscle relaxants (both of which can alter metabolic rate), or may be disoriented and thus unable to follow verbal commands to remain awake, but still. These patients also receive continuous intensive nursing and medical care.

This study examines the metabolic activity pattern of a group of mechanically ventilated, hemodynamically stable, noncomatose ICU patients in an attempt to define a resting metabolic state, and to observe the variations in metabolic parameters caused by daily ICU care. The study was approved by the Institutional Review Board of Columbia University.

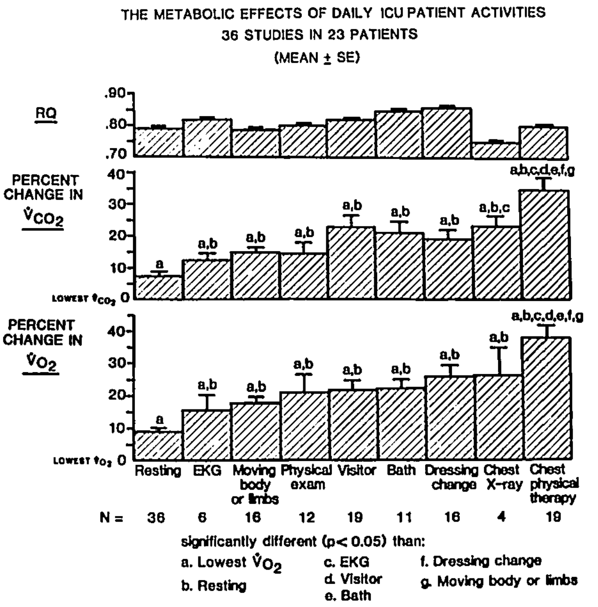
Methods: Twenty three patients were studied for periods of up to 8 hours on 36 occasions. Measurements of oxygen consumption ($\dot{V}O_2$), carbon dioxide production ($\dot{V}CO_2$), and respiratory quotient (RQ) were made using a Beckman Metabolic Measurement Cart; these measurements, along with heart rate and blood pressure, were made every 15-30 minutes. They were correlated with observations of the patient's activity. For the purposes of the study, resting was defined as lying motionless with open eyes, responsive to surrounding events, sleeping as a state where the patient was not aroused by surrounding events. Values of the metabolic and hemodynamic parameters during lowest, rest, and peak $\dot{V}O_2$ were calculated for all 36 studies (Table 1). The percentage increase above lowest levels of $\dot{V}O_2$ and $\dot{V}CO_2$ for specific activities was also examined (Fig. 1). Not all activities were observed in each study.

Results: (n=36) TABLE 1

	$\dot{V}O_2$ (ml/min)	$\dot{V}CO_2$ (ml/min)	Heart rate (bpm)	Systolic blood pressure (torr)
Lowest	204±57	156±32	95±15	129±22
Rest	222±53*	168±30*	96±16	129±25
Peak	285±72*,†	217±55*,†	104±16*,†	138±19*,†

*significantly different than lowest values (p<0.005)
†significantly different from rest values (p<0.005)
Mean ± SD

FIGURE 1



Discussion: Three distinct levels of metabolic activity, other than resting awake, were identified. a) The lowest $\dot{V}O_2$ and $\dot{V}CO_2$, occurring during sleep in 86% of the studies, averaged 9.1±7.5 (SD)% and 7.5±7.3% below resting awake levels ($p < 0.001$) respectively. This is consistent with the observations made during sleep by others (1). b) Routine daily care - $\dot{V}O_2$ and $\dot{V}CO_2$ were significantly greater than both the lowest and resting levels (14-26% greater). The increases seen here are probably due to arousal from the resting state, and limb movements. In fact, movements of the patient's body or limbs produced increases of similar magnitude in $\dot{V}O_2$ and $\dot{V}CO_2$. c) Chest physical therapy. This patient care activity was associated with the greatest alterations in gas exchange. The increase is probably due to a variety of factors such as pain, movement and muscular tension.

The study demonstrates that knowledge of the patient's activity level is vital for interpretation of gas exchange measurements, since routine daily activity can cause variations in metabolic rate. It also quantifies the changes which may be effected in these parameters under varying conditions.

References:

1) Ravussin E, Burnand B, Schutz Y, Jequier E: Twenty four hour energy expenditure and resting metabolic rate in obese, moderately obese and control subjects. A J Clin Nutr 35:566-73, 1982.