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Weight, Pseudocholinesterase Activity, and Succinylcholine Requirement

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The duration of action of succinylcholine appears to be determined primarily by the level of pseudocholinesterase activity in the blood¹ and the volume of the extracellular fluid space.² Compared to nonobese patients, obese patients have both increased pseudocholinesterase levels^{3,4} and an increased extracellular fluid space.⁵ These factors should increase the succinylcholine dosage requirement of obese patients which is consistent with our clinical observations.

To investigate this observation, body weight was correlated with the activity of serum pseudocholinesterase in subjects of varying weight. Subsequently, an additional group of patients were given succinylcholine on the basis of total body weight and the duration of neuromuscular blockade was measured.

METHODS

Thirty healthy, consenting patients undergoing elective surgery were studied. Approval for this study was obtained from the Human Subjects Committee at the University of Arizona Health Sciences Center. All patients were premedicated with diazepam (10–15 mg, po) and glycopyrrolate (0.2–0.3 mg, im). Prior to induction of anesthesia a venous blood sample was drawn for subsequent serum pseudocholinesterase activity measurement by the method of Zapf and Coghlan.⁶ In 14 of these patients the duration of action of 1 mg/kg succinylcholine iv was determined utilizing a Grass S88[®] stimulator with a SIU5 isolation unit to stimulate the ulnar nerve with a supramaximal square wave pulse of 0.1 ms duration at 0.25 Hz. A Grass FT10[®] transducer was used to quantitate strength of thumb adduction. Anesthesia was maintained with 60 per cent nitrous oxide in oxygen and

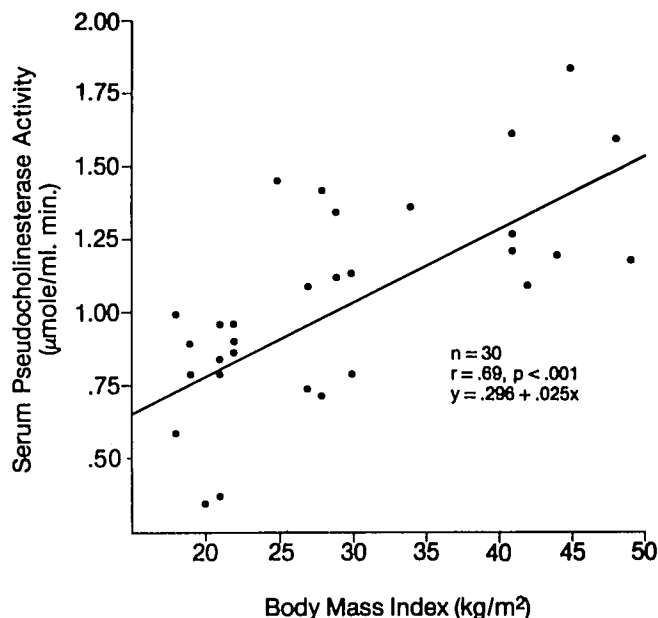


FIG. 1. The relationship of serum pseudocholinesterase activity and body mass index in 30 healthy patients.

intravenously administered fentanyl (10 µg/kg). Intermittant thiopental (25–50 mg) was given iv to ensure amnesia, as necessary. To facilitate data analysis, patients were divided into three groups on the basis of body mass index (BMI):⁷ obese, (BMI > 30, two times ideal body weight); overweight, (BMI 25–30); and nonobese, (BMI < 25). Analysis of variance combined with the student Newman-Keul test was used for intergroup comparisons. Linear correlation was used to compare body surface area, weight, and BMI with pseudocholinesterase activity. Significance was defined as $P < 0.05$.

RESULTS

The number of patients in each group, age, and height were similar in all three groups of patients (table 1). However as expected, body surface area, weight, and BMI differed between groups. In addition, mean values of serum pseudocholinesterase activity differed significantly in the three groups of patients (tables 1 and 2).

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§ BMI = wt (kg)/ht² (m).

This was reflected in a positive linear correlation between serum pseudocholinesterase activity and body surface area, weight, and BMI (fig. 1) ($r = 0.53, 0.60, \text{ and } 0.69$, respectively, $P < 0.005$). In contrast to serum pseudocholinesterase activity, no difference was found in time to 10, 50, or 90 per cent recovery of twitch height between the three patient groups when 1 mg/kg succinylcholine iv was administered (table 2).

DISCUSSION

This study demonstrates that increasing weight is associated with increasing pseudocholinesterase activity. This result has also been reported by others.^{3,4} The reason for this finding is not clear, particularly since the physiologic role of pseudocholinesterase is not known. However, increases in activity of this enzyme could be associated with the generalized increased metabolic activity that occurs in obesity. For example, obesity is associated with increased insulin levels, cortisol production, fatty acid turnover, the basal metabolic rate.⁵ Nevertheless, pseudocholinesterase activity in the obese patients in this study was two times that of the nonobese patients. This appears to be clinically relevant information since the obese patients received two times the absolute succinylcholine dose and yet had a similar duration of action to the nonobese patients. Wulfsohn also has reported increased succinylcholine requirements in morbidly obese patients.⁸ He administered the drug on the basis of lean body weight and noted that the duration of apnea was shorter in obese patients.

As noted previously, obese patients might be expected to have increased succinylcholine requirements because of an increased extracellular fluid space. Since there is a good correlation between body surface area and extracellular fluid volume, other investigators have corrected for changes in the extracellular fluid space by administering succinylcholine on the basis of body surface area. When given in this fashion (mg/m²), twitch depression and time to recovery are equal in newborns and adults.² However, in this study the obese patients were administered 51 mg/m² and the nonobese patients 36 mg/m² ($P < .001$), and yet the duration of drug action was the same in the two patient groups. Thus, obese patients

TABLE 1. Patient Characteristics (Means \pm SEM)

	Obese	Overweight	Nonobese
Number	9	9	12
Age (yr)	43 \pm 2	41 \pm 4	41 \pm 4
Height (cm)	162 \pm 2	161 \pm 2	163 \pm 2
Weight (kg)*	114 \pm 7	72 \pm 3	57 \pm 3
Body mass index (kg/m ²)*	43.2 \pm 2.1	28.0 \pm 0.6	21.3 \pm 0.6
Body surface area (m ²)*	2.10 \pm 0.05	1.76 \pm 0.04	1.58 \pm 0.04
Pseudocholinesterase activity* (μ moles/ml/min)	1.37 \pm 0.08	1.09 \pm 0.10	0.77 \pm 0.06

* Group means significantly different $P < 0.001$.

probably have increased succinylcholine requirements because of both increased extracellular fluid volume and increased pseudocholinesterase activity.

In summary, this study found a positive correlation between pseudocholinesterase activity and body surface area, weight, and body mass index. In addition, when succinylcholine was administered on the basis of mg/kg (total body weight) a similar duration of action was found in all patients regardless of weight. Succinylcholine should be administered on the basis of total rather than lean body weight in adult patients.

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TABLE 2. Pseudocholinesterase Activity and Twitch Recovery

	Number	Pseudocholinesterase Activity (μ mole/ml/min)	Per Cent Twitch Recovery to Control Height (min)		
			10 Per Cent	50 Per Cent	90 Per Cent
Obese	5	1.39 \pm 0.09*	5.7 \pm 0.2	7.8 \pm 0.6	10.6 \pm 1.6
Overweight	5	1.08 \pm 0.14*	5.0 \pm 0.7	6.7 \pm 0.7	8.1 \pm 0.6
Nonobese	4	0.73 \pm 0.06*	5.6 \pm 0.7	7.9 \pm 1.6	10.0 \pm 2.0

* Group means significantly different from each other $P < .001$.