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Challenges in the estimation of tidal volume settings in critical care units

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Sir: Ventilation with lower tidal volumes (6–8 vs. 10–12 ml/kg) reduces mortality in acute lung injury and acute respiratory distress syndrome [1, 2]. Body weight for setting the tidal volume should ideally be predicted from body height with a gender specific formula for ideal body weight: 50 kg + [0.91 × (cm height – 152.4 cm)] for males and 45.5 kg + [0.91 × (cm height – 152.4 cm)] for females [3]. In critical care settings, however, ideal weight is often estimated according to the patient's morphological appearance, which is generally thought to be biased and inaccurate [4, 5]. We hypothesized that *estimated* ideal weight is not an accurate surrogate for *calculated* ideal weight, and that tidal volumes derived from estimated weights differ considerably from the target ideal tidal volume.

Patients were enrolled into this prospective analytic observational study over a period of 3 months. We included all patients requiring mechanical ventilation in the respiratory intensive care unit of Tygerberg Academic Hospital, Cape Town, South Africa. Thirty-six experienced staff members were independently asked at the bedside to estimate patients'

ideal body weights and to calculate the tidal volumes for the initiation of ventilation in these patients. These estimations were concealed. The 36 staff members included 21 intensive care nurse practitioners, 2 critical care technologists, 9 medical registrars, and 4 ICU consultants. The patients' ideal body weights were calculated by means of the Devine formula and measuring tape (Stanleyworks, New Britain, Conn., USA) [3], similar to the method used in the ARDS network study [1]. Tidal volumes were categorized arbitrarily as: less than 6 ml/kg (too low), 6–8 ml/kg (target), or more than 8 ml/kg (too high). Proportional data were compared by the χ^2 test and continuous variables by t-test (Statistica 6 software, StatSoft, Tulsa, Okla., USA). The study was approved by the local ethics committee.

A total of 545 weight estimations were obtained from 40 ventilated patients (22 women). Mean estimated weight was 68.3 ± 19.1 kg and mean ideal weight was 57.2 ± 11.2 kg. Nurses tended to estimate higher ideal weights than nonnursing staff (69.7 ± 20.1 vs. 65.9 ± 16.9 kg, $p = 0.02$). Considerable variations in the estimated weights were observed in most patients with a median range of 31 kg. Overall only 240 weight estimates (44%) resulted in tidal volumes within the target range of 6–8 ml/kg when calculated with the ideal weight accord. Off-target tidal volumes were too low in 25.5% ($n = 139$) and too high in 30.5% ($n = 166$). No single patient escaped at least one estimate outside the target range. Of the 139 estimations that that led to tidal volumes of less than 6 ml/kg 101 were observed in men and 38 in women ($p < 0.01$). An even higher number ($n = 166$) of estimations led to calculated tidal volumes greater than 8 ml/kg: of these, 143 were women ($p < 0.01$). Of the 166 estimations 59 resulted in calculated tidal volumes greater

Table 1 Ideal body weight calculated from body height [3]

Height (cm)	Men (kg)	Women (kg)
140	38.72	34.22
145	43.27	38.77
148	46.00	41.50
150	47.82	43.32
151	48.73	44.23
152	49.64	45.14
153	50.55	46.05
154	51.46	46.96
155	52.37	47.87
156	53.28	48.78
157	54.19	49.69
158	55.10	50.60
159	56.01	51.51
160	56.92	52.42
161	57.83	53.33
162	58.74	54.24
163	59.65	55.15
164	60.56	56.06
165	61.47	56.97
166	62.38	57.88
167	63.29	58.79
168	64.20	59.70
169	65.11	60.61
170	66.02	61.52
171	66.93	62.43
172	67.84	63.34
173	68.75	64.25
174	69.66	65.16
175	70.57	66.07
176	71.48	66.98
177	72.39	67.89
178	73.30	68.80
179	74.21	69.71
180	75.12	70.62
181	76.03	71.53
182	76.94	72.44
183	77.85	73.35
184	78.76	74.26
185	79.67	75.17
186	80.58	76.08
187	81.49	76.99
188	82.40	77.90
189	83.31	78.81
190	84.22	79.72
191	85.13	80.63
192	86.04	81.54
193	86.95	82.45
194	87.86	83.36
195	88.77	84.27
196	89.68	85.18
197	90.59	86.09
198	91.50	87.00
199	92.41	87.91
200	93.32	88.82
205	97.87	93.37
210	102.42	97.92

that 10 ml/kg, again with a marked female predominance (20.1% vs. 0.4%, $p < 0.01$).

This prospective observational study clearly demonstrates that the practice of estimating weight informally at the bedside to set a tidal volume is flawed. The average estimated ideal weight was 19% too high. Nurses tended to estimate higher ideal weights than technologists and physicians. Short women and tall men were particularly at risk of receiving too high and too low tidal volumes, respectively. Estimating weights of patients at the bedside is common practice, and we believe that these results are relevant to many other intensive care units [4, 5]. We therefore conclude that safer mechanical ventilation could be achieved using the simple and low-cost method of measuring a patient's height to calculate accurate tidal volumes. We recommend that every ventilator should be equipped with a measuring tape and that a gender-specific table (Table 1) that links body height to ideal body weight should be readily used in critical care units.

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