AUTOMATIC COMPUTATION OF SINGLE BREATH NITROGEN TEST

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Single breath nitrogen test (SBN) provides a considerable amount of information about different indices of lung function: closing volume (CV), slope of alveolar plateau (ΔN₂%1t), total lung capacity (TLC) and derived indexes (functional residual capacity and residual volume). CV and ΔN₂%1t are considered suitable to detect early stages of airways obstruction. Thus they have been proposed for epidemiological studies.

Automatic determination of CV remains a problem because of difficulty in detecting the take off of phase 4 on the N₂ curve ("closing point"). The contour of the N₂ curve is variable from patient to patient, and within the same patient is strongly dependent on the way the manoeuvre is performed. The different shapes of the N₂ curve are empirically grouped in five classes: 1. curves with phase 3 and closing point clearly detectable; 2. curves with superimposed noise from cardiogenic oscillations at the onset of phase 4; 3. curves with different levels on the alveolar plateau; 4. curves with continuous rather than abrupt slope change in the region of the closing point, and 5. curves with steep alveolar plateau, with or without detectable closing point. Current computer programs detect a closing point only when very evident.

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We propose a different approach based on the selection of a limited number of possible closing points. The computer analysis of the N₂ curve includes two successive steps. A "significant edge" of the curve occurs when the derivative calculated on the points belonging to it stays with the same sign at least for a 300 ms interval; the longer the interval, the more significant the edge. In the first step a searching interval (SI) containing the most significant edges, to be further analysed, is defined. In the second step a regression line is calculated over the main portion of the alveolar plateau. Finally each onset of the edges, up to a maximum of 5, within the SI having the largest areas delimited by the extrapolated regression line, is considered for selection as possible closing point. The N₂ curve is displayed on a CRT with markers on the possible closing points, a special marker indicates the most significant edge selected by the computer (Fig. 1).

At this stage the operator may interact with the computer. If he does, he may choose only one out of the possible points. Thus standardisation may be achieved even in this case despite operator variability. He will have to choose a point in the region of the closing point, because of the constraint of choosing only one closing point.

54 manual and computer determinations of CV, ΔN₂%/lt and TLC were compared in 20 subjects selected to yield all the defined 5 classes of N₂ curve. Closing point was selected entirely by computer in 42 instances, in 7 closing points was chosen by the operator among the possible closing points and in 5 curves the operator judged inadequate the computer selection and chose his own closing point.