

EDITORIAL

Assessment of respiratory muscle function

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In the last two decades, respiratory muscle function in patients has received considerable attention, particularly since ROUSSOS and MACKLEM [1] hypothesized that respiratory muscle fatigue may be responsible for the development of respiratory failure. Although subsequent research has hitherto largely failed to demonstrate the frequent occurrence of respiratory muscle fatigue [2], it is now clear that respiratory muscle weakness is present in many patients and that it represents a significant problem for various reasons [3]. Consequently, respiratory muscle function is frequently studied in patients, and a large variety of new techniques for examining respiratory muscle function have been developed in recent years. These techniques were reviewed in a postgraduate course on the occasion of the annual meeting of the European Respiratory Society in Florence, September 1993. The presentations of this postgraduate course form the basis of the present Review Series "Update on Respiratory Muscles".

Although maximal inspiratory and expiratory pressures represent simple measurements of respiratory muscle strength in patients [4], these measures are confronted by a number of problems, which limit the conclusions to be drawn from them. These predominantly include the fact that, occasionally, very low values may be due to inadequate effort by the patient. This consequently means that very low values are not always indicative of respiratory muscle weakness and that the scatter of normal values is relatively large [5]. To overcome this problem, several investigators have attempted to develop techniques not requiring patient co-operation. Essentially, two such techniques are presently available: electrical stimulation [6] and magnetic stimulation [7] of the phrenic nerves. The latter technique has the advantage of being entirely painless in contrast to the electrical stimulation, although it might provide diaphragmatic stimulation which is less specific [8]. The measurement of the mechanical outcome of contraction, however, remains to some extent problematic.

Indeed, adequate pressure measurement often still requires placement of an oesophageal or gastric balloon, or both. The placement of balloons is usually considered to be unpleasant by stable patients. In essence, two methods would allow this problem to be avoided. Firstly, measurement of mouth occlusion pressure during stimu-

lation might provide a reasonable reflection of the pleural pressure generated. This is the case in normal subjects [9], but may be difficult in chronic obstructive pulmonary disease (COPD) patients, since the time constant of equilibration between alveolar pressure and mouth pressure in these patients appears to be relatively long [10]. Secondly, a highly interesting approach still under development is phonomyography, which is the measurement of the sound signal produced by diaphragmatic contraction [11]. This sound signal, which can be recorded non-invasively with surface microphones, appears to be directly proportional to the tension developed during contraction. Although the technique is still under study, it may well become the standard investigatory method of respiratory muscle strength.

The development of measures of respiratory muscle function independent of patient co-operation is of particular significance in patients in intensive care units who are unable to co-operate during measurements. Investigation of respiratory muscle function is all the more important in these patients, since they are regularly operating at the limit of their endurance capacity, and may well develop fatigue during failure of weaning [12]. Since development of respiratory muscle failure is expected to be dependent on the load, it is relevant to measure the load put on the respiratory muscles as well. This usually requires measurement of the fractional duration of contraction and the force developed during contraction as a fraction of the maximal force that may be developed [13].

Assessment of respiratory muscle function and activity also appears of great importance in patients under partial ventilatory support, since under modes of partial ventilatory support, such as synchronized intermittent mandatory ventilation, the work actually performed by the respiratory muscles is often considerably greater than expected [14]. Moreover, it appears poorly predictable from ventilator settings. By contrast, respiratory muscle rest seems to be better obtained by inspiratory pressure support [15]. Assessment of variations in inspiratory muscle work with alterations in settings of ventilators, thus, seem, to be relevant to understanding the load an individual patient faces during the weaning process.

Finally, another particular circumstance during which assessment of respiratory muscle function poses particular problems is assessment in infants. In newborns, the respiratory muscles are often stressed to the extreme limits of their endurance capacity [16]. The newborn may be considerably more frequently confronted with respiratory muscle fatigue than the adult. Thoracoabdominal motion in infants is disturbed, in the sense that

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thoracic motion is much smaller than in adults. This is likely to reflect the structural immaturity of the infant rib cage, leading to far greater distortibility than in adults [17].

It is striking that virtually all of the contributions to this Series deal with the assessment of respiratory muscle strength. There is little discussion on measures of respiratory muscle endurance, although clinically this endurance may be significant, particularly in producing ventilatory limitation during exercise [18]. Measures of respiratory muscle endurance have been developed [19–22], but the relevance in the clinical setting remains only partly understood.

Along these lines, although respiratory muscle weakness is now clearly identified as a prevalent and significant problem, the consequences of respiratory muscle weakness have only scantily been studied.

It appears likely that respiratory muscle weakness is associated with complaints such as dyspnoea [23]. Moreover, it may be related to exercise limitation [24]. In COPD patients [25] and in patients with neuromuscular disease [26], respiratory muscle weakness appears to be related to the development of respiratory failure. Some indication is present that it may be related to the use of health care facilities in COPD patients [27]. Finally, if patients with weak respiratory muscles are not as well able to cope with an increased load as patients with strong respiratory muscles, the former may also have reduced survival. Prospective studies critically assessing the relationship between respiratory muscle weakness and survival in COPD patients still need to be performed. If survival were to be related to respiratory muscle function, its assessment in patients would be all the more important.

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