II-S-O No.1 SYMPOSIUM ON ESTIMATION OF WORK OF BREATHING DURING PARTIAL VENTILATORY ASSIST

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A five part symposium of scientific work addressing the topic "Estimation of the work of breathing during partial ventilatory assist" was conducted on July 10, 1993. Participants included Drs. Kubuta, Ujike, Yamada, Takezawa, and Brochard. The symposium was co-chaired by Drs. Ohmura and Marini.

Dr. Kubota began the symposium with a paper entitled "Significance of the chest wall compliance and work of breathing in patients with respiratory failure after upper abdominal surgery". Twenty patients undergoing upper abdominal surgery were compared with seven control subjects regarding respiratory mechanics. Reduced compliance of both chest wall and lung, as well as increased work of breathing were detected in both successfully and unsuccessfully weaned post-operative patients. Successfully weaned patients had lower levels of oxygen consumption, ventilatory drive, work of breathing, and better chest wall compliance. The magnitude of work difference between success and failure itself did not appear to be sufficient to explain the difference in weaning outcome. These results demonstrate that reduced chest wall compliance appears to be a prominent factor in explaining respiratory failure that sometimes complicates upper abdominal surgery.

Dr. Ujike then presented his work regarding an intercomparison of various estimates of the subject's workload during partial ventilatory support. Changes in oxygen consumption were compared with external (mechanical) work values obtained by two methods under different respiratory conditions. Dr. Ujike made the important points that all available methods for estimating muscular effort require questionable assumptions, that mechanical work does not necessarily reflect effort, and that the work per minute may be a more helpful measure than work per liter. As others have shown, changes in total body oxygen consumption cannot be fully attributed to respiratory muscle activity following a step change in the loading conditions of the respiratory system. Similarly, it cannot be assumed that chest wall compliance remains the same under the passive and active conditions, an assumption required for the calculation of total mechanical work.

The third presentation, given by Dr. Yamada, illustrated the use of a technique he has developed to compute muscular work during partially assisted breathing. This method, based on the classical equation of the motion of the respiratory system, utilizes a "least squares" statistical fit of flow, volume, and proximal airway pressure to determine constants for subsequent breaths. In turn, these can be used to compute muscular pressure for subsequent breaths. Dr. Yamada demonstrated that this technique compares favorably with existing methods and, unlike other techniques for work calculation, is not constrained by the need for a specific flow profile, once its fundamental constants (for resistance and elastance) have been determined. This technique appears to have considerable potential for "on-line" assessment of respiratory work in the clinical as well as

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research settings.

Dr. Takezawa presented an interesting theoretical paper on "Patient-ventilatory synchrony in proportional assist ventilation (PSV) and pressure support ventilation (PSV)". Utilizing a single compartment mathematical model, Dr. Takezawa's group examined the hypothetical performance of these modes under varying impedance conditions. The PS level was selected to obtain the same tidal volume during both methods of ventilation. This work demonstrated that peak airway pressure should be higher for PAV than for PSV at a matched tidal volume in all experimental settings. Pleural pressure fluctuations were computed to be greater in PAV than in PSV when airway resistance was high, suggesting more efficient reduction in breathing effort by PSV under such conditions. Apart from illustrating the potential clinical value of mathematical modeling of ventilatory dynamics, Dr. Takezawa's work illustrated that PAV cannot be assumed to be superior to existing modes of partial support under all conditions. Moreover, PAV poses significant risks of artifact amplification. Therefore, to determine the potential value of PAV of its setting adjustments, it is important to understand how the ventilatory center responds to workloads under varying stresses.

The final presentation during this symposium was made by Dr. Brochard, who reviewed the impact of ventilator settings and circuit characteristics on the work of breathing during PSV. Many factors influence ventilatory drive and dyspnea during partially assisted breathing. Dr. Brochard described problems with delayed opening of the demand valve and with inappropriate rate of pressure rise in PSV. The expiratory circuit plays an important role in the breathing comfort of the partially assisted patient. He noted that frequency affects valve performance, that active deflation of the expiratory sensations influence the inspiratory work of breathing. It was concluded that all primary characteristics of the pressure support mode may influence the patient's perceived comfort and breathing effort.

The five papers constituting this symposium, as well as the stimulating discussion which surrounded them demonstrated that although the process of mechanical ventilation is generally well understood, many nuances of interaction between patient and ventilator remain to be exploited for the benefit of the patient.