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A Manometer to Measure Demand Valve Reference Pressure

To the Editor:—A demand valve functions as a pressurized high-flow reservoir in a continuous positive airway pressure (CPAP) system. The pressure differential across a one-way valve that separates the demand valve from the patient in a CPAP system is negligible before spontaneous inhalation. At the onset of inhalation, as airway pressure decreases, the pressure on the patient's side of the one-way valve also decreases, which causes it and the demand valve to open immediately. At end-exhalation, airway pressure increases (returns) to the expiratory pressure level set on the expiratory pressure valve, which terminates the pressure gradient across the one-way valve and, thus, gas flow.

A popular demand valve (J. H. Emerson Co., Cambridge, Massachusetts), that, in our experience, is both effective and reliable, heretofore has been available with the shortcoming of not allowing one to quantitate the reference pressure (*i.e.*, the critical opening pressure of the demand valve during spontaneous inhalation that corresponds to the onset of flow). By adjusting the reference pressure control, the reference pressure can be set to approximately the same level as the expiratory pressure and, thus, the demand valve can function at various levels of CPAP. In a report published previously, the demand valve reference pressure accidentally was set much greater than the expiratory pressure level during CPAP, which resulted in pulmonary barotrauma.¹ Because of the high reference pressure setting, a continuous flow of gas from the demand valve augmented the flow from the ventilator during intermittent mandatory ventilation, which resulted in dangerously high tidal volumes and peak inflation pressures. If the reference pressure in the demand valve could have been monitored, this situation might have been averted.

A subsequent recommendation to the manufacturer (J. H. Emerson Co.) prompted them to add a manometer to the demand valve to measure the reference pressure (fig. 1). When operating this demand valve CPAP system, the following procedure is recommended. First, with the "reference pressure" control knob, the demand valve pressure is set to approximately 2 cmH₂O above the desired expiratory pressure level (*e.g.*, reference pressure = 12 cmH₂O when a CPAP of 10 cmH₂O is desired). Second, the expiratory pressure valve then should be filled with water to the desired expiratory pressure level. Setting the reference pressure slightly higher than the expiratory pressure seems to increase the sensitivity of this demand valve (faster response

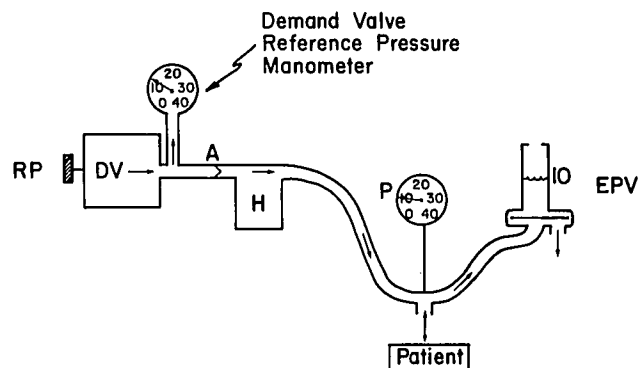


FIG. 1. An Emerson demand valve with a manometer to measure demand valve reference pressure within a continuous positive airway pressure (CPAP) system. The "reference pressure" control knob (RP) is adjusted on the demand valve (DV), while the user reads the reference pressure manometer. The reference pressure is set approximately 2 cmH₂O above the desired CPAP level. In this example, the reference pressure is set at 12 cmH₂O, while the expiratory pressure valve is filled with water to exert 10 cmH₂O pressure. Abbreviations: A = one-way valve, H = humidifier, P = airway pressure manometer, and EPV = expiratory pressure valve (threshold resistor).

time), which allows it to open with less effort during spontaneous inhalation.

Before the addition of the reference pressure manometer, the manufacturer's instructions for operating the demand valve were to "turn the demand valve (reference pressure) control knob clockwise until gas flow is felt only during exhalation." These instructions were ambiguous. The addition of the reference pressure manometer to the demand valve precludes any ambiguity and provides a safety factor, *i.e.*, the reference pressure of the demand valve can be set precisely for any level of CPAP.

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REFERENCE

1. Banner MJ, Boysen PG: Demand valve improperly set resulting in pulmonary barotrauma. *ANESTHESIOLOGY* 61:86-87, 1984

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