

Title: THE INFLUENCE OF RAISED AIRWAY PRESSURE ON EXTRAVASCULAR LUNG WATER

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**Introduction.** The purpose of the study was to determine the influence of raised airway pressure therapy (CPAP) on extravascular (interstitial) lung water (EVLW). Many forms of adult respiratory distress syndrome (ARDS) are characterized by increasing EVLW and worsening of intrapulmonary shunt (Qsp/Qt). Although CPAP returns Qsp/Qt to normal levels and reverses the hypoxia of ARDS, there has been little data demonstrating the concomitant changes in EVLW.

**Materials.** Twenty-four healthy adult mongrel dogs were anesthetized with a continuous infusion of pentobarbital. Mechanical ventilation ( $F_{I}O_2 = .5$ ) with a tidal volume of 12 ml/kg and a rate of 8 min<sup>-1</sup> maintained PaCO<sub>2</sub> at 36 - 42 mmHg. CPAP was not initially instituted. Monitoring including an indwelling thermister tipped femoral artery catheter (American-Edwards®) and a balloon-tipped, thermodilution pulmonary artery catheter (American Edwards®) placed via the femoral vein. All vascular pressures were transduced (Gould-Statham, #P23) and displayed (Grass Polygraph RPS-111B). Airway pressure was determined with an air-filled transducer (Gould-Statham P-50) connected to the proximal tip of the endotracheal tube and also was displayed on the polygraph. A heating blanket maintained body temperature at 37°C. All animals received a fluid infusion of D5 in 0.45 normal saline at 3 ml/kg throughout the entire study. Cardiac output was determined by thermodilution and EVLW was calculated by using the thermal dye technique as described by Lewis and Eling.<sup>1</sup> pertinent data collection included mean arterial pressure (MAP), pulmonary capillary wedge pressure (PCWP), EVLW, and EVLW index (EVLW<sub>I</sub>) (EVLW/body weight in kg). Also measured were PaO<sub>2</sub>, pH, and Qsp/Qt. After baseline determinations during anesthesia, 0.075 ml/kg of 80 per cent oleic acid was infused into the right atrium of each animal. The animals were then divided into three groups of 8 each. Group A served as the control group and was kept on baseline ventilatory support for 6 h. Group B was maintained for 90 min on the same ventilatory settings as Group A. After that interval, Group A had no further increase in EVLW<sub>I</sub> or shunt; therefore, at 90 min for Group B, CPAP was added in 5-cm H<sub>2</sub>O increments up to a level of 10 cm H<sub>2</sub>O. A 20-min equilibration period was permitted before determinations were made at each new level of CPAP. Group C had 10-cm H<sub>2</sub>O CPAP applied immediately after the introduction of the oleic acid. This

level was maintained for 90 min and then compared with Group A at 90 min. Student's paired t-test was used to compare Group A to Groups B and C. Group B was also compared to Group C.

**Results.** In Group A, 90 min after oleic acid infusion, EVLW<sub>I</sub> increased from 122 ± 46 to 535 ± 92 (P < .001). Simultaneously, Qsp/Qt increased from 11.2 ± 2.4 per cent to 38 ± 6.3 per cent (P < .001). There were no further changes in either value for the remaining 270 min of the study. In the table, the results at 90 min from Group B and Group A are compared. Incremental increases in CPAP significantly decreased Qsp/Qt but had no effect on EVLW<sub>I</sub>. In Group C, 10 cm H<sub>2</sub>O was applied immediately after oleic acid infusion and the results at 90 min were compared to those in Group A at 90 min. The EVLW<sub>I</sub> of Group C was significantly less than that of Group A (402 ± 62 ml vs 535 ± 92 ml, P < .001) and likewise the Qsp/Qt in Group C was 22 ± 4.6 per cent vs 38 ± 6.3 per cent in Group A (P < .001).

**Discussion.** The results indicate that once EVLW<sub>I</sub> had increased significantly after oleic acid infusion, CPAP did not help to remove EVLW. Improvements in Qsp/Qt appear to be independent of EVLW<sub>I</sub>. CPAP applied immediately after oleic acid infusion decreases both the accumulation of water and the degree of Qsp/Qt.

**Reference**

1. Lewis FR, Elings VB, Sturn JA: Bedside measurement of lung water. J Surg Res 27:250 - 261, 1979.

Table. Cardiovascular values for dogs treated with CPAP compared with untreated dogs 90 min after infusion of oleic acid into the lungs of all dogs\*

	Controls	CPAP (cm H <sub>2</sub> O)			
		5	P	10	P
EVLW <sub>I</sub>	535 +92	606 +56	>.4	688 +49	>.4
Qsp/Qt (%)	38.0 +6.3	24.0 +4.2	<.001	15.2 +4.2	<.001
PaO <sub>2</sub> (mmHg)	68 +11	134 +25	<.001	165 +23	<.001
PCWP (mmHg)	4.2 +0.6	6.8 +0.6	>.8	6.2 +0.8	>.8
MAP (mmHg)	110.0 +8.1	104.0 +11.3	>.7	103 +12	>.7

\*Values are presented as means ± SD.