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Title : LUNG WATER DETERMINATION IN CRITICALLY ILL PATIENTS

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Clinical medicine currently has no direct means of quantifying extravascular lung water (EVLW). A recent modification of the double indicator dilution technique (thermodye) combined with a microprocessing computer may provide that information. Animal studies have demonstrated that the thermodye measurement ($EVLW_{td}$) is a reliable indicator of EVLW when compared to in vitro gravimetric analysis in models of high pressure, oleic acid and E. coli-induced edema.[1,2] We evaluated the accuracy of common clinical measurements in reflecting EVLW (as measured by thermodye) in a series of critically ill patients. This study was approved by the Human Subjects Committee at Stanford University and informed consent was obtained.

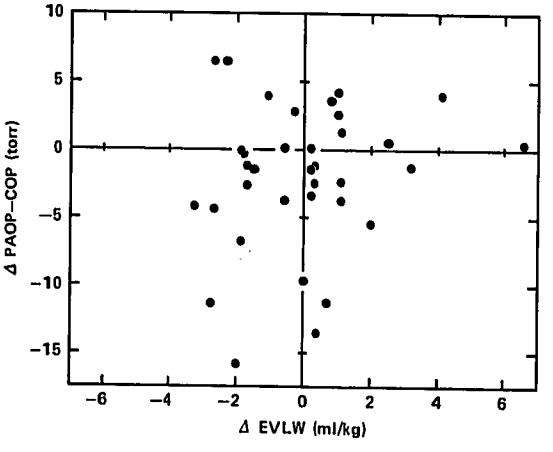
Methods: Seven patients were studied, five immediately before and after cardiac surgery. A 7F triple lumen pulmonary artery catheter and a 20cm 5F thermister-tipped femoral artery catheter were placed by the Seldinger technique. Before each series of $EVLW_{td}$ measurements, the following data were collected: temperature, heart rate, femoral artery pressure, pulmonary artery pressures (with occlusion pressure), right atrial pressure, colloid oncotic pressure, arterial and mixed venous blood gases (F_IO_2 = 1.0) and (for patients on mechanical ventilation) tidal volume, peak inspiratory pressure and plateau pressure. $EVLW_{td}$ measurements were then made by injecting 10ml of cold (0°C) indocyanine green dye (4mg) rapidly into the superior vena cava. Blood was withdrawn by syringe pump (30 ml/min) through a densitometer cuvette attached to the thermister-tipped femoral artery catheter. Curves of both blood temperature and dye concentration versus time were recorded while a microprocessor computer simultaneously processed this data. $EVLW_{td}$ was derived by mean transit times (MTT) of the two indicators ($EVLW_{td}$ = $C.O.x(MTT_t-MTT_d)x16.7$). The period of study ranged from 2 to 5 days and a total of 57 series of $EVLW_{td}$ measurements were made. Statistical analysis utilized the t-test, with level of significance at $p \leq .05$.

Results: $EVLW_{td}$ was expressed as the mean of each series of measurements (3-6). The coefficient of variation of $EVLW_{td}$ measurements varied from 1 to 16% (mean = 7%). The change in $EVLW_{td}$ was correlated with changes in physiological variables that may indirectly reflect changes in lung water: pulmonary artery occlusion pressure (PAOP), colloid oncotic pressure (COP), PAOP-COP gradient, alveolar-arterial oxygen gradient ($AadO_2$), intrapulmonary shunt ($\dot{Q}san/\dot{Q}t$), and static lung-thorax compliance (COMP) (see table).

Correlation of Physiologic Variables with Δ $EVLW_{td}$

	ΔPAOP	ΔCOP	ΔPAOP-COP	$\Delta AadO_2$	$\Delta \dot{Q}san/\dot{Q}t$	ΔComp
n	41	42	36	46	36	22
r	.03	.27	.17	.10	.20	.03

The number of data collected (n) and linear correlation coefficients (r) are shown. The p values for all correlations were >.05.



The data comparing $\Delta EVLW_{td}$ with ΔPAOP-COP is shown in the figure above.

Discussion: Two previous human studies have documented the feasibility and reproducibility of the thermodye technique in 21 patients.[3,4] Detailed correlation with physiologic variables has not been previously reported. Although this is a preliminary report, the $EVLW_{td}$ appears to be much more sensitive than PAOP, COP, PAOP-COP, $AadO_2$, $\dot{Q}san/\dot{Q}t$, and compliance in reflecting changes in lung water. Further evaluation of the thermodye technique is necessary to confirm the findings of this initial report; to define the limitations of this technique; and to document its accuracy in humans with the in vitro analysis of lung water.

References

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