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Intrapleural Pressure in Orthopnea.

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Among the various theories concerning the etiology of orthopnea much support has been given to the idea that pulmonary ventilation is facilitated by the upright position. It has been shown that the vital capacity is generally higher,[1] that the total volume of the lung is greater,[2] that the mid capacity is greater,[3] that the accessory muscles of inspiration can be used to better advantage,[4] and that the diaphragm is lower[5] than in the recumbent position.

Aron[6] found in one normal individual that the intrapleural pressure was less negative when he was recumbent. There has, however, been no systematic study of the intrapleural pressure in pathological states leading to orthopnea. For this reason, we have taken intrapleural pressures in both the recumbent and upright positions in 13 individuals, 6 of whom were without orthopnea. Of 7 patients with orthopnea, 3 had cardiac decompensation, 2 were asthmatic, one had extreme pulmonary emphysema with bronchitis and one had marked ascites due to cirrhosis of the liver.

In all cases we found the intrapleural pressure to be less negative in the recumbent than in the upright position. This shift was more marked in the patients with orthopnea than in the control group. Occasionally the intrapleural pressure rose above atmospheric pressure in the recumbent position.

These observations support the mechanical theory of orthopnea. A less negative intrapleural pressure will limit the pulmonary ventilation and, according to the work of Starling,[7] interfere also with pulmonary circulation. By such a mechanism a vicious circle may be established, further congestion leading to greater interference with the ventilation of the lungs. In those cases in which a positive intrapleural pressure occurred during recumbency, direct pressure on the heart might interfere with its action.

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[1] Christie, C. D., and Beams, A. J., *Arch. Int. Med.*, 1923, **31**, 85.

[2] Hurtado, Alberto, and Fray, Walter W., *J. Clin. Invest.*, 1933, **12**, 825.

[3] Bohr, C., *Arch. f. klin. Med.*, 1907, **88**, 385.

[4] Hewlett, A. W., *Monographic Medicine*, **1**, 375.

[5] Hofbauer, L., *Z. f. klin. Med.*, 1907, **61**, 389; 1914, **19**, 128.

[6] Aron, E., *Virchow's Arch. f. Path. Anat.*, 126, 517, 189, quoted from Emerson, *Bull. Johns Hopkins Hosp. Reports*, 1903, **2**, 193.

[7] Wright, S., Applied Physiology, 3rd Edition, 1929, 299.

TABLE I.

Sex	Age	Diagnosis	Orthopnea	Intrapleural Pressure				Aver. Change
				Upright		Recumbent		
				Insp.	Exp.	Insp.	Exp.	
F	49	Asthma and Emphysema	Moderate	— 8 cm. H_2O	0 cm. H_2O	—10 cm. H_2O	+ 6 cm. H_2O	+ 4 cm. H_2O
M	26	Asthma	Marked	—16 "	—12 "	— 8 "	— 4 "	+10 "
					one minute later	— 6 "	— 2 "	
M	43	Emphysema	"	— 4 "	— 1 "	— 2 "	+ 1 "	+ 2 "
M	65	Cardiac	Moderate	— 8 "	— 6 "	— 3 "	— 2 "	+ 4.5 "
M	60	"	Marked	— 7 "	— 4 "	— 2 "	0 "	+ 4.5 "
M	50	Cardiac Marked Ascites	Moderate	— 6 "	+ 4 "	— 4 "	+ 6 "	+ 2 "
		Aver. for group—4.5 cm. H_2O more positive in recumbent position.						
M	26	Case 2 (without asthma)	No	— 5 "	— 2 "	— 3 "	— 2 "	+ 1 "
M	33	Tb with Pneumothorax	"	— 8 "	— 2.5 "	— 3.5 "	— 1.5 "	+ 2.75 "
M	25	" " "	"	— 5 "	— 1 "	— 3.5 "	+ 1 "	+ 1.75 "
M	27	" " "	"	—14 "	— 4 "	— 8 "	— 1 "	+ 4.5 "
M	30	" " "	"	— 7 "	— 2 "	— 6 "	0 "	+ 1.5 "
M	35	" " "	"	—14 "	— 4 "	— 8 "	0 "	+ 5 "
M	30	" " "	"	— 4 "	0 "	— 2 "	+ 3 "	+ 2.5 "

Aver. for group— +2.7 cm. H_2O more positive in recumbent position.
Total aver.— +3.5 cm. H_2O more positive in recumbent position.