TITLE: CAUSE(S) OF HYPOTENSION AFTER PNEUMOTHORAX EVACUATION

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Introduction. Rapid evacuation of pneumothorax of several days duration may be followed by pulmonary edema and severe hypotension.[1] In two such cases, we observed severe hypotension that was relatively resistant to fluid therapy. Both cases, and others reported in the literature presented initially with an elevated hematocrit prior to pneumothorax drainage. This suggested that hemoconcentration and volume depletion may have been caused by prolonged pneumothorax, and contributed to the hypotension subsequently observed. In the following experiments, we tested the hypothesis that hypoxia alone, or hypoxia caused by pneumothorax, may lead to volume depletion and thereby predispose to hypotension.

Methods. All experiments were performed in New Zealand white rabbits, 2.5 - 4.0 kg in weight of both sexes.

Animals were divided into 4 groups.

(1) Pneumothorax - F_IO_2 0.21. Pneumothoraces were created and maintained for 6-7 days in 8 air-breathing rabbits by repeated injections of air into the right pleural space.

(2) Pneumothorax - F_IO_2 0.4. Pneumothoraces were maintained in 6 rabbits for 6-7 days. Animals breathed 40% O_2: 60% N_2 during that time to prevent arterial hypoxia.

(3) Hypoxia alone - F_IO_2 0.1. Nine animals breathed 10% O_2: 90% N_2 for 6-7 days.

(4) Controls - F_IO_2 0.21. Nine rabbits were kept in the same chamber as in Groups 1-3, breathing room air for 6-7 days. Animals were housed in a large box in which temperature, humidity, and inspired gas concentrations were controlled. Arterial blood was sampled for various measurements in the baseline state (Day 1) and at the end of the 6-7 day treatment period (Day 7). CPV (circulating plasma volume) was measured as the volume of distribution in the plasma of a radio-iodinated serum albumin indicator (RISA): CPV (ml) = (RISA cpm injected)/(RISA cpm/mlplasma). Circulating blood volume was calculated as: CBV (ml) = CPV/(1-fractional Hct). Extracellular water (ECW) was estimated as being equal to the volume of distribution of a ^{24}Na indicator 1 hour after injection (assuming that the overall contribution of intracellular ^{24}Na was minimal): ECW (ml) = (^{24}Na cpm injected)/(^{24}Na cpm/mlplasma). Total extravascular, extracellular water (EVECW) was derived as follows: EVECW (ml) = (ECW - CPV). Red cell mass (ml) (RCM) was calculated as (CBV) x (Fractional Hct).

Results. Results, shown in Table 1, demonstrate that pneumothorax with hypoxia (F_IO_2 0.21) causes a significant reduction (36%) in EVECW with relative preservation of CPV (9% fall). The results with hypoxia alone were similar, with a significant fall (19%) in EVECW, a lesser drop in CPV (13%), but a significant rise in RCM (49%) such that Hct increased significantly. In the absence of arterial hypoxia in both the control group, and the pneumothorax group that breathed 40% O_2, there were no significant changes.

Discussion. We conclude that pneumothorax with hypoxia, or hypoxia alone, when sustained for 6-7 days, may lead to moderate volume depletion of the EVECW space, with lesser changes in CPV. If one were to subsequently evacuate a pneumothorax under these conditions, rapid transudation of fluid out of the vascular compartment into the lung may occur (re-expansion edema). Severe hypotension, relatively resistant to fluid therapy, may be the result when the ability to compensate for sudden fluid shifts is compromised by an underlying fluid deficit. We urge that re-expansion of persistently collapsed lung be undertaken with due regard for these potential hazards and the possible need for vigorous fluid therapy.

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Reference.

1. Shanahan MX, Monk I, Richards HJ: Unilateral pulmonary oedema following re-expansion of pneumothorax. Anaesth Intens Care, 3:19-30, 1975

TABLE I

Effect of Pnemothorax and/or Hypoxia on Fluid Balance and Red Cell Mass (Mean ± S.D.)

Group	Time (Day)	F_IO_2	Pneumo-thorax	PaO_2 (torr)	Hct (%)	CBV (ml)	RCM (ml)	CPV (ml)	EVECW (ml)
1.	1	0.21	No	72 (±11.2)	37 (±2.7)	138 (±21)	51 (±8)	86 (±14)	512 (±126)
	7	0.21	Yes	48* (±5.5)	39 (±7.7)	130* (±20)	51 (±13)	78 (±14)	326* (±127)
2.	1	0.21	No	82 (±6.5)	38 (±3.6)	134 (±45)	49 (±10)	84 (±35)	470 (±74)
	7	0.40	Yes	73 (±20.7)	32* (±3.4)	120 (±17)	41 (±4)	80 (±14)	519 (±120)
3.	1	0.21	No	82 (±8.8)	39 (±4.6)	110 (±10)	43 (±6)	68 (±9)	423 (±84)
	7	0.10	No	38* (±6.0)	52* (±2.4)	123* (±12)	64* (±6)	59* (±7)	342* (±31)
4.	1	0.21	No	69 (±9.9)	37 (±3.8)	135 (±15)	51 (±9)	77 (±28)	398 (±62)
	7	0.21	No	68 (±4.8)	39 (±4.7)	127 (±19)	49 (±8)	70 (±29)	425 (±48)

* Indicates significant differences ($p < 0.05$) between Day 1 and Day 7 values within a group.