

Title: SUPERIORITY OF COLLOID OVER CRYSTALLOID RESUSCITATION: A STUDY OF HYPOVOLEMIC SHOCK AND VOLUME RESTORATION

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Introduction. To clarify the controversy of crystalloid vs colloid resuscitation¹ the following investigation was undertaken: 1) dogs were subjected to sequential bleeding until death; 2) the effectiveness of Proctinate^R (P) or Ringer's Lactate (RL) during each stage of hypovolemia was studied. Observations were made on hemodynamics, oxygenation, survival rate and autopsy findings.

Methods. Healthy mongrel dogs were anesthetized (pentobarbital 30 mgm/kg + Pavulon^R 0.1 mg/kg) and ventilated with air. Catheters were placed fluoroscopically to obtain hemodynamic, oxygenation and metabolic data (CO, BP, HR, PAP, RAP, PCWP, pH, PCO₂, PO₂, VO₂, SVO₂, SaO₂, CaO₂, CVO₂, P₅₀, lactates and pyruvates) including coronary sinus (CS) flow by thermodilution. In Part I (n=10), after control measurements, hemorrhage in aliquots of 20% blood volume (BV= 80 ml/kg) was produced until death. Data was collected 3 min after each bleed and after a 45 min stabilization period. In Part II the dogs were resuscitated after each bleed with RL (3:1, n=4; 6:1, n=6) or P (1:1, n=5). Data collection and stabilization were similar as in Part I. However, after each resuscitation since BV was assumed to be ≥ adequately replaced, bleeding aliquots were 20% (20H), 40% (40H), 60% (60H), or 80% (80H) of the BV instead of in 20% BV aliquots. At autopsy wet weight:dry weight ratio was determined for the heart and lung. Data was analyzed by the Mann-Whitney and t-tests (p < 0.05 = significant).

Results. (Only highlights summarized in this abstract) Part I: All dogs survived 60H; 8 died during 80H; 2 during > 80H (Fig.). This suggests good physiological homogeneity of the preparation. CI, CVO₂, LVSWI decreased steadily with bleeding. CS flow did not change markedly until just before death (Table). VO₂ decreased significantly after 20H (156 ± 11 to 141 ± 10 ml/min; p < 0.05) but did not significantly further decrease after 40H (131 ± 12) and 60H (110 ± 15). In Part II, RL and P resuscitation effectively improved hemodynamics and maintained oxygenation after 20H and 40H (Table). However, during 60H, 70% of the RL treated dogs died because of inability to sustain hemodynamics and oxygenation. Survival was significantly better (p < 0.05) in the P group: 100% survived 60H; fatalities occurred during 80H exsanguination (Fig.). After 60H resuscitation, the P group demonstrated a CI, LVSWI and CS flow which were significantly increased from control unlike the survivors in the RL group (Table). V lactates increased

significantly after 40H and 60H in both Part I and Part II. At autopsy, both the myocardial and lung fluid content were significantly increased in the RL treated dogs only.

Conclusions. During hypovolemia 1) CI, LVSWI, CVO₂, decrease linearly; 2) RL and P are effective resuscitating fluids if hemorrhage is mild or moderate; 3) the tolerance (survival) to massive bleeding is increased if P is the resuscitating fluid; 4) myocardial and lung water are significantly increased if RL is the resuscitating fluid.

References.
1. Monafò WW: Volume replacement in hemorrhage, shock and burns. Adv Shock Res 3:47-56, 1980.

TABLE
CHANGES IN CI, LVSWI AND CORONARY SINUS FLOW IN PARTS I AND II*

PARAMETER	Steady State Readings After (%) Blood Volume Loss ± Resuscitation				
	Control	20%	40%	60%**	
CI (L/min/m ²)	Part I	5.0 ± .25	3.2 ± .25†	2.2 ± 0.13**	1.7 ± 0.06**
	Part II RL	4.5 ± 0.18	5.6 ± 0.37†	5.2 ± 0.55	6.1 ± 1.4
	Part II P	4.9 ± 0.3	4.9 ± 0.2	6.0 ± 0.5	7.4 ± 0.6†
LVSWI (gm.m./m ² /beat)	Part I	54 ± 3.2	32 ± 2.8†	19 ± 1.6**	12 ± 2.5**
	Part II RL	47 ± 3.3	59 ± 7.2	44 ± 7.0	57 ± 25.0
	Part II P	46 ± 3.2	47 ± 2.9	58 ± 3.2**	66 ± 4.1†
Coronary Sinus Flow (%)	Part I	100	79 ± 0.06†	83 ± 0.12	86 ± 0.17
	Part II RL	100	147 ± 18.5†	191 ± 41	200 ± 32
	Part II P	100	131 ± 22	158 ± 38	218 ± 44**

††All values mean ± SEM
**Numbers for the RL group represent survivors only
*P at least < 0.05 when compared with control value
*P at least < 0.05 when compared with preceding steady state value

FIGURE

Graphic Representation of the Tolerance to Hemorrhage
H = Sequential Hemorrhage (no resuscitation)
RL = Following Ringer's Lactate Resuscitation
PPF = Following 5% Plasma Protein Fraction Resuscitation

