

TITLE: THE EFFECTIVENESS OF CPR IN THE PRESENCE OF VENOUS AIR EMBOLISM

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Introduction. Venous air embolization (VAE) may produce cardiopulmonary insufficiency due to right ventricular "air lock." The object of this study was to assess the ability of external cardiac massage to break up the air lock and dislodge air from the right ventricle (RV) and to determine if gas exchange takes place with cardiopulmonary resuscitation (CPR) following VAE.

Methods. Fifteen mongrel dogs were anesthetized with pentobarbital (30 mg/kg) followed by a continuous infusion of pentobarbital and pancuronium. They were intubated and mechanically ventilated (Michigan Instruments). Femoral arterial and venous and peripheral IV forelimb catheters were inserted. Crystalloid solution was administered at a rate of 15 ml/kg/hr for 30 minutes to ensure normovolemia and heparin (300 units/kg) was given. Nine experimental (Group I) and seven control (Group II) animals were studied. Group I animals received 10 ml/kg of air/xenon (AX) over 25-40 seconds while the heart was still beating. This caused circulatory arrest in all animals. Group II animals received 10 ml of supersaturated KCl resulting in ventricular fibrillation. This was followed by injection of 7 ml of a saline/xenon (SX) mixture given through a catheter in the RV. CPR was mechanically delivered for 30 minutes to both groups of animals using a Michigan Instrument® timed piston and ventilator. The piston was adjusted to depress the sternum 3 inches and ventilation (FIO₂ 1.0) which had been adjusted before cardiac arrest to achieve a stable PaCO₂ of 26-35 torr was continued during all interventions. Arterial blood gases were sampled from both groups at time 0, every minute after circulatory arrest for 5 minutes and then every 5 minutes for 25 minutes. Arterial O₂ (PaO₂), CO₂ (PaCO₂) and pH were analyzed on an IL 713 analyzer. The control Group II then received the same dose of AX as given to the experimental group through the RV catheter. CPR was continued for a further 30 minutes. During each 30 minute period of CPR for both groups, sequential two minute oblique images of the heart and lungs were obtained using a Scintillation camera. Image data was collected and analyzed on a PDP 11/34 computer. Using Gamma II software, Xenon washin and washout, curves were generated from a selected region of the RV. Xenon washout was plotted using a semilog graph. Cardiorespiratory variables were reported as mean ± standard deviation (SD) and results were analyzed using students T-test with significance at 0.05 confidence limits.

Results. During CPR, in the group I (GI) and group II (GII) AX but not SX animals there was a precipitous decline in the PaO₂ (Fig I). In GI AX, the PaO₂ fell to a mean of 31 torr and in GII AX 56 torr. The pCO₂ rose to 70 torr (G I AX) and 53 torr (G II AX). In the GII controls during CPR, the PaO₂ was maintained between a mean of 173 and 200 torr and the PaCO₂ between 21 and 10 torr. Percentage washout for GI and GII AX and GII SX are shown in Table 1. The washout of SX was 85% in 10 minutes while the washout of AX in GI and GII was 47% and 23% respectively. Washout of SX & AX in single animals is seen in Fig. II.

Fig 1: Arterial Blood Gases

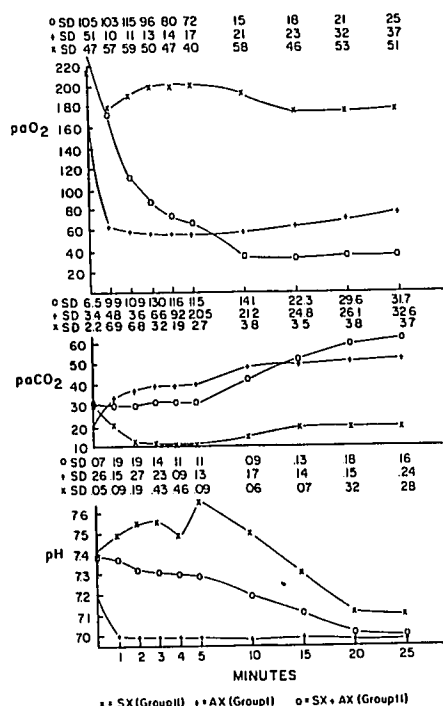
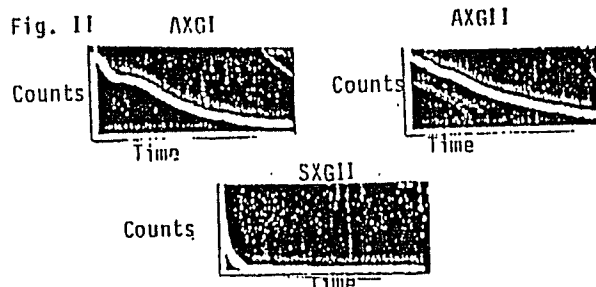


Table 1: Mean ± SD% washout of Xe during 10 mins CPR

Comp	4	6	8	10 mins
GIAX	19.1 ± 3.83	31.4 ± 18.26	39.6 ± 22.14	46.9 ± 24.5
GIIAX	4.4 ± 20.26	6.3 ± 24.63	14.7 ± 27.40	22.6 ± 29.5
GII SX	44.8 ± 25.18	65.4 ± 18.53	78.6 ± 11.54	85.4 ± 7.06
P	< 0.02	< 0.005	< 0.001	< 0.005



Conclusion. The presence of an airlock (AX) in the RV resulted in significantly reduced clearance of xenon compared with SX (Table I). In most animals the airlock in the RV was not dislodged in a period of time consistent with successful resuscitation. Hypoxia and hypercarbia developed in both AX groups. In the SX controls adequate PaO₂ and PaCO₂ were obtained.

References.

¹Benedetto AR, Hoff BH, Nusynowitz ML: Direct scintigraphic visualization of right ventricular airlock in fatal venous air embolism in dogs. Anesth Analg 62:250, 1983.