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Cardiovascular Changes in Neonatal Swine.* (31652)

WILLIAM R. GRAY,[†] NICHOLAS H. BOOTH, AND M. LLOYD HOPWOOD

Department of Physiology, Colorado State University, Fort Collins

During the early postnatal period certain alterations occur in the cardiovascular system which enable the newborn to adapt to the changes from intra-uterine aquatic conditions to the terrestrial existence of a free living adult. In spite of several investigations on the right and left ventricular myocardial weights in human subjects at birth and in the neonatal period, opinion is still divided as to which is heavier and to whether or not an atrophy of the right ventricle occurs after birth. Keen(1) found that, at birth, the left and right ventricle weighed approximately the same and that during the first month of

life an atrophy of the right ventricle occurred. Recavarren and Arias-Stella(2) found that the right ventricle outweighed the left at birth and continued to do so for 7 days. They also noted that the right ventricle atrophied during the first 4 months of life. Emery and Mithal(3) found that, at birth, (the right ventricle outweighed the left but that at the end of 4 weeks the left outweighed the right. They found no evidence for postnatal atrophy of the right ventricle.

Booth *et al*(4) found that in the pig, the ratio of the left ventricular weight to the right ventricular weight (LV/RV) increased from 0.86 at birth to 1.81 at 7 days of age and that the 7-day value approximated the adult ratio. There was no evidence that the right ventricle atrophied during the postnatal period. Hultgren *et al*(5) showed that the

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[†] W. K. Kellogg Foundation Fellow. Present address: Dept of Veterinary Physiology and Biochemistry, University College, Dublin, Ireland.

TABLE I. Changes in Ventricular Weight and Carotid Arterial Blood Pressure in Neonatal Swine.

Age in days*	Weight ratios (%)					Carotid pressure, mm Hg
	RV/T	S/T	LV/T	(LV+S)/T	LV/RV	
Birth	42.8 (6.1)	24.8 (1.4)	32.4 (7.2)	57.2 (6.1)	.78 (.2)	72.2 (13.9)
1	38.9 (2.4)	23.2 (1.7)	38.3 (2.0)	61.1 (5.9)	1.07 (.10)	75.2 (14.7)
2	33.1 (.8)	22.5 (1.4)	44.4 (1.6)	66.8 (.8)	1.34 (.07)	82.0 (18.3)
3	31.6 (2.2)	24.4 (2.1)	43.9 (3.6)	68.3 (2.2)	1.40 (.18)	85.4 (19.5)
5	27.7 (1.3)	23.9 (2.4)	48.1 (2.5)	72.2 (1.3)	1.74 (.14)	89.7 (12.1)
7	26.0 (.6)	23.3 (3.9)	50.6 (4.1)	73.9 (.6)	1.94 (.18)	90.3 (5.8)
14	25.9 (.9)	23.7 (2.3)	50.9 (1.7)	74.2 (.9)	1.97 (.06)	101.1 (20.8)

* Six animals per group.

Values in parentheses are standard deviations of mean.

right ventricle, calculated as a percentage of total ventricular weight (T), was 23.3% in the adult pig at sea level and increased to 26.7% at 10,500 feet.

Evans *et al*(6) in 35 pigs, suggested that aortic blood pressure increased and right ventricular pressure decreased during the first 14 days of life. They found that the ductus arteriosus closed structurally at about 14 days of age. Averill *et al*(7) found a significant correlation between the decrease in the RV/T ratio and right ventricular pressure in puppies during the first week of life.

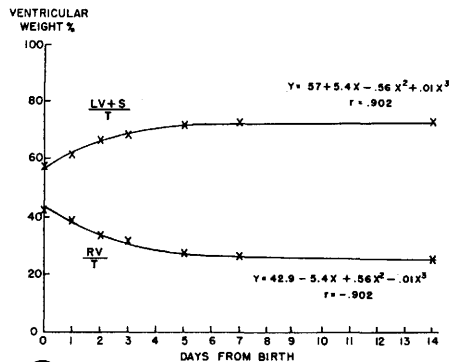
The purpose of this investigation is to determine if there are any correlations between blood pressure changes and ventricular myocardial weight changes that occur during the early postnatal period in the pig. The ductus arteriosus is examined for structural patency.

Materials and methods. Forty-two Yorkshire-Hanford cross, miniature pigs from the specific pathogen-free colony at Colorado State University were used in this study, carried out at approximately 5,000 feet above sea level. The pigs were restrained in dorsal recumbency and carotid arterial pressures were recorded by direct cannulation under local anaesthesia. The recording system was a size 50 polyethylene catheter connected to a Statham strain-gauge pressure transducer which, in turn, was connected to a Honeywell 1508 Visicorder. The fluid in the catheter was heparinized 0.85% sodium chloride and the Visicorder was calibrated through the transducer with a mercury manometer. After recording pressures, the pigs were slaughtered and the heart dissected according to the method described by Müller(8). The left ven-

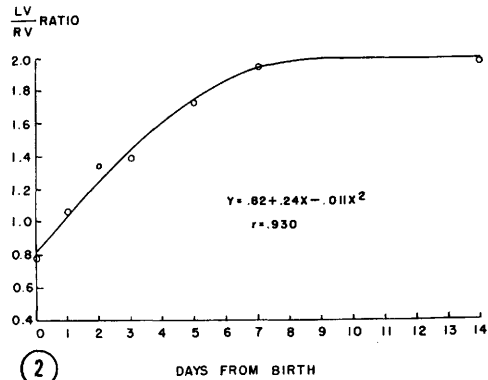
tricle (LV), right ventricle (RV), and septum (S) were weighed to the nearest 0.01 g and calculated as percentages of the total ventricular weight (T). The left ventricular and septal weights were combined because of the possibility of error in separating these two portions. The patency of the ductus arteriosus was determined by passage of a fine probe.

Results and discussion. The data, summarized in Table I, were analyzed in the statistical laboratory at Colorado State University. Heart weight changes agreed very closely with those recorded by Booth *et al*(4). The right ventricle (RV) was heavier than the left ventricle (LV) at birth and at 1 day of age they weighed approximately the same. RV to total weight (T) continued to decrease as the ratio of LV and septum (S) to total weight (T) increased (Fig. 1). There was no evidence of atrophy of RV which increased in weight but at a slower rate than LV. LV/RV ratio reached a plateau of 1.94 at 7 days of age (Fig. 2), which approximates the adult level.

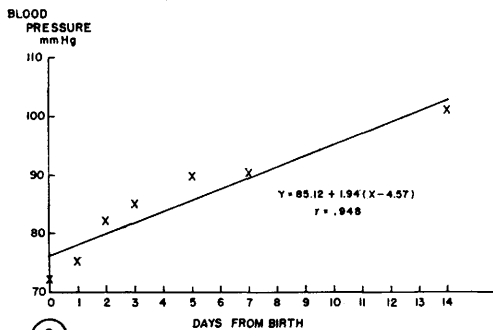
Carotid arterial blood pressure increased from a mean of 72.2 mm Hg at birth to 101.1 mm Hg at 14 days (Fig. 3). This increase had high linear correlation (0.948) to age. However, the points on the line describe a curve during the first 7 days. When the pressures for the first 7 days were plotted against LV + S/T (Fig. 4) a very high correlation (0.993) was obtained. The increase in blood pressure, which continued to rise after the LV/RV ratio attained the adult value, is probably due to an increase in arteriolar peripheral resistance. This can be caused by maturing of the autonomic nervous system as described



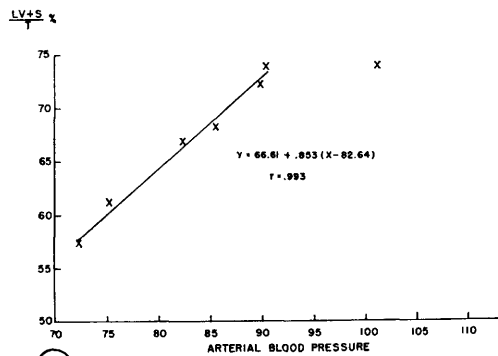
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FIG. 1. Relationship of age to RV/T% and LV+S/T% changes in neonatal swine.

FIG. 2. Relationship of age to LV/RV ratio changes in neonatal swine.

FIG. 3. Relationship of age to mean arterial blood pressure changes in neonatal swine.

FIG. 4. Correlation of LV+S/T% changes with mean arterial blood pressure changes from birth up to 7 days in swine.

by Clark(9) and to an increased tissue mass due to growth.

The ductus arteriosus was structurally closed on the 14th day, in agreement with the findings of Evans *et al*(6).

Summary. Cardiovascular changes were measured in 42 pigs using groups of 6 animals at birth as well as 1, 2, 3, 5, 7 and 14 days. Mean arterial pressure was recorded directly under local anaesthesia by cannulation of the carotid artery. At 7 days, weight ratios of right to left ventricle were established at the adult value but pressure continued to rise, probably due to an increase in arteriolar peripheral resistance. The ductus arteriosus was structurally closed by the 14th day.

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