PLASMA POTASSIUM CONTENT OF CARDIAC BLOOD AT DEATH[1]

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Potassium changes the properties of the surface layers of plant cells when its concentration passes a certain point (Osterhout, 3). The effects of lower concentration of potassium chloride on Nitella are perfectly reversible even after several hours of contact. With 0.05 M potassium, however, this reversibility ceases (Osterhout, 3).

The animal cell seems to be more sensitive to potassium as judged by the effects of lower concentrations on the electrocardiograph tracings in the dog (10), the cat (2), and the human (7). In the dog cardiac arrest occurs at a concentration between 0.014 and 0.016 M. It has been suggested that this is the critical concentration of potassium at which the heart stops, the evidence being obtained from intravenous injections of potassium salts into healthy dogs.

In pathological states caused by intestinal obstruction, intestinal fistulae, hemorrhage, and various types of trauma (table 1), the concentration of potassium in cardiac blood at the time of death varied between 0.0095 and 0.0114 M. in the cat (5, 6, 11, 12). In four dogs poisoned with potassium this average concentration was a little higher, 0.0152 M (4).

Winkler, Hoff and Smith (10), on the basis of their work on dogs, in which cardiac arrest was shown to be associated with a concentration of potassium between 14–16 mM. per liter suggested that there is a wide margin of safety for the human being, "since serum potassium would have to be increased by some 9 mM. per liter to reach a fatal level."

No such potassium concentration in the cardiac blood of humans has been found in a series of cases studied during the past eighteen months.

METHOD. At the time of death, heart's blood was withdrawn by cardiac puncture into a sterile dry syringe. From 5 to 6 cc. of this sample were introduced into a Sanford-Magath hematocrit tube containing heparin (Connaught); gently mixed, capped, and centrifuged at 2,000 r.p.m. for one hour. The plasma was removed *immediately* from the cells, and the

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potassium content of 0.5 ml was determined by a modification of the argenticobaltinitrite method (8, 9), the final color being read on the Evelyn Photoelectric Colorimeter with the appropriate filter.

With this method 17.2 mgm. per cent (0.0044 M) represents our normal value derived from determinations done on sixty healthy voluntary donors (table 2).

TABLE 1

Cardiac blood potassium

NUMBER OF ANIMALS	LESION	RANGE	AVERAGE	AVERAGE	AVERAGE M
		Cats			
		mgm. per cent	*mgm. per cent*	*mM./l.*	
4	Intestinal obstruction	33.8–66.6	44.5	11.4	0.0114
2	Intestinal fistula	40.6–45.5	43.1	11.0	0.0110
4	Hemorrhage	25.0–57.4	46.5	11.9	0.0119
4	Trauma	30.6–41.0	37.2	9.5	0.0095
14			42.8	10.9	0.0109
		Dogs			
4	Poisoned with intravenous isotonic KCl	26.0–99.5	59.5	15.2	0.0152

TABLE 2

*Plasma potassium of normal venous blood**

Sixty donors

Average (mean)	17.2 mgm. per cent
Median	17.2 mgm. per cent
Range	13.5–21.5 mgm. per cent
Standard deviation	0.33 mgm.
Coefficient of variation	1.9 per cent

* This group comprised 50 males and 10 females. Each value represents the mean of two aliquots of the original sample, 0.5 ml. of plasma being used.

DISCUSSION. Cardiac arrest appears to be associated with different concentrations of potassium, not only for different species but also for different individuals within the species. Plant cells seem to withstand higher concentration of potassium than do animal cells.

The narrow range of potassium between 17.2 mgm. per cent (0.0044 M) for normal circulating venous blood and 29.8 mgm. per cent (0.0076 M) for cardiac blood plasma at death indicates possibly that human cardiac

muscle is more susceptible to variations in concentration than certain plant and animal cells.

TABLE 3

Potassium content of cardiac blood at death

NUMBER	DATE	INITIALS	AGE	SEX	HOSPITAL NUMBER	DIAGNOSIS	OPERATION	PLASMA K
								mgm. per cent
1	8/20/37	W. N.	62	M	527186	Multiple fractures and contusions; laceration of aorta	Debridement	28.5
2	9/23/37	V. M.	9	M	530304	Multiple fractures. Hemoperitoneum	None	29.5
3	10/14/37	N. L.	28	F	530206	Idiopathic gastro-intestinal hemorrhage	Exploratory	24.0
4	11/23/37	F. F.	58	M	536668	Perforated duodenal ulcer	None	31.9
5	2/24/38	D. P.	25	F	542006	Paraganglioma of adrenal cortical tissue	Partial resection. Operative death	34.1
6	5/ 5/38	M. L.	45	F	374560	Chronic cholecystitis, cholelithiasis, subphrenic and subhepatic abscesses	Cholecystectomy, incision and drainage abscesses	28.6*
7	9/12/38	J. Mc.	70	M	556217	Carcinoma of colon with metastases to liver	Exploratory	26.3
8	9/27/38	M. K.	26	F	550662	Intestinal obstruction complicating pregnancy	Ileostomy	28.9
9	11/ 4/38	L. W.	31	F	549037	Mesenteric thrombosis	Enterectomy	38.0
10	11/ 7/38	E. Mc.	62	F	564918	Acute pancreatitis	None	31.6
11	12/13/38	L. V.	73	F	560067	Diabetic gangrene	Amputation	32.6
12	2/17/39	L. H.	58	F	566522	Carcinoma of breast	Mastectomy	26.1
13	2/24/39	A. M.	55	M	572368	Pneumonia, type III		27.9
Average								29.8

* Not separated from cells immediately.

Standard deviation from the mean 3.6 mgm. Coefficient of variation 14.5 per cent.

SUMMARY

1. In cats dying from varied types of induced shock, the average concentration of potassium in the heart's blood taken at the time of cardiac arrest was 42.8 mgm. per cent (0.0109 M).

2. In dogs following intravenous injections of isotonic potassium in lethal doses, the concentration amounted to 59.5 mgm. per cent (0.0152 M) (table 1).

3. The average venous plasma potassium in sixty young human adults was 17.2 mgm. per cent (0.0044 M) (table 2).

4. The average plasma potassium of cardiac blood taken at death was 29.8 mgm. per cent (0.0076 M) (table 3).

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