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The use of calcium chloride in edema due to heart failure.

By HAROLD J. STEWART.*

[*From the Hospital of the Rockefeller Institute for Medical Research, New York City.*]

This study concerns the reduction of edema in heart failure especially in those patients in whom the effort to increase the amount of diuresis by digitalis, theocin and diuretin fails. Blum[1] and his coworkers have made efforts in this direction, using calcium chloride as an agent and giving it by mouth. Singer,[2] basing his observations on Loewi's experiments, reported striking successes by giving calcium chloride and digitalis together intravenously. It may be recalled that Loewi[3] believes he has shown that calcium and digitalis have identical effects, the function of digitalis being merely to sensitize the heart muscle to the action of calcium. In one patient whom we have observed over a long period of time digitalis, theocin and diuretin produced a diuresis but not to the extent of freeing the patient of edema. She was, on the other hand, on repeated occasions made edema free by using calcium chloride. We did not make studies to determine the mechanism by which this diuresis was brought about. The results are summarized in Table I. Obviously calcium chloride produces diuresis both when given alone and when combined with digitalis. At times the diuresis continues from one to two days after calcium chloride has been discontinued. Of a total of 16 observations in which calcium chloride was given by mouth to five patients only once did it fail to produce some degree of diuresis. In two patients the diuresis resulting from the calcium chloride was effective in freeing them of edema,

* Introduced by Alfred E. Cohn.

[1] Blum, L., and Schwab, H., L'action du chlorure de calcium, dans les hydropisies cardiaques. Les dangers de l'administration prolongee de fortes doses de ce sel. *Bull. et. Mem. Soc. Med. d. Hop. d. Paris.*, 1922, No. iv, 214-220.

[2] Singer, R., Das Kalzium in der Herztherapie. *Therap. Halbmonatsh.*, 1921, xxxv, 758.

[3] Loewi, O., Über den Zusammenhang zwischen Digitalis—und Kalziumwirkung. *Arch. exp. Path. u. Pharmakol.*, 1917, lxxxii, 131, and 1918, lxxxiii, 366.

TABLE I.

Patient	Calcium chloride				No. of observations on each patient.
	With digitalis		Without digitalis		
	Diuresis	No diuresis	Diuresis	No diuresis	
F.	3*	0	4	0	7
C.	2	0	3	0	5
A.	1	1	0	0	2
K.	1	0	0	0	1
B.	0	0	1	0	1
Total	7	1	8	0	16

*Refers to number of separate observations.

but in the three remaining cases the diuresis was not sufficient to make any impression on the degree of the edema.

Before giving calcium chloride intravenously to patients we took the precaution of making preliminary observations on dogs with the view to learning the dose with which toxic effects on the heart are induced.

We have injected 0.5 to 1.1 gm. of calcium chloride (10 per cent solution) intravenously in dogs without the appearance in electrocardiograms of ventricular premature contractions or ventricular standstill. In one dog we injected intravenously at the same time 0.5 gm. calcium chloride and 30 per cent of the calculated lethal dose of digitalis. About 40 minutes after the injection numerous ventricular premature contractions appeared and were still present 1½ hours after the injection, but had disappeared the next day. One week later the experiment was repeated with the same results. One week after this a smaller dose (25 per cent of the calculated lethal dose) of the same tincture was given with the same amount of calcium chloride but without causing an irregularity. A second dog was given 25 per cent of the calculated lethal dose of the tincture of digitalis intravenously without causing an irregularity. Two hours later 0.5 gm. of calcium chloride was given intravenously and ventricular premature contractions failed to develop. One week later when 30 per cent of the calculated lethal dose was injected, followed by the same amount of calcium chloride, a slight extrasystolic irregularity developed. It appears then that about 30 per cent of the calculated lethal dose of digitalis is critical when combined with calcium.

On the basis of this experience we have given 0.1 to 0.2 gm. of calcium chloride each day for two to six days to three patients on six occasions. It was found that no definite change in the urinary output took place, although in one patient (F) it had been found repeatedly that when calcium chloride was given by mouth diuresis occurred. At this time the difference between the effects obtained by administration by mouth and by the intravenous method is not discussed but is reserved for a future occasion. A short time after calcium chloride was injected the radial pulse usually became more forcible. Calcium chloride in these doses did not produce any change in the form of the electrocardiogram. In the patient (F) mentioned above, 0.5 gm. of digitalis was given by mouth on the day following the last intravenous calcium chloride injection, and then the output increased and remained elevated until the patient was free of edema. With this the pulse rate slowed and the electrocardiogram showed changes in the T-wave. Before this the patient had many times been given much larger doses of digitalis, but these had never been followed by a diuretic effect which continued long enough to free the patient of edema as has followed this small amount (0.5 gm.) of digitalis when combined with calcium.

It appears then that diuresis can be obtained by the administration of calcium chloride by mouth although the amount is small. It appears also that when combined with digitalis the amount of this drug required to bring on diuresis may be reduced.

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A method for obtaining samples of mixed venous blood in intact dogs.

By HAROLD J. STEWART.*

[*From the Hospital of the Rockefeller Institute for Medical Research, New York City.*]

In order to estimate the oxygen and carbon dioxide in mixed venous blood in intact dogs two methods are in use: (1) a tonometer method in which alveolar air and pulmonary venous blood

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