CRUSH INJURY WITH RENAL FAILURE AND RECOVERY

BY

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This paper gives an account of a case of crush injury with acute renal failure in which recovery occurred, although the injured limb had eventually to be amputated. An important part of the treatment was the use of sodium bicarbonate to restore the alkali reserve during the period of renal failure. The main clinical and biochemical data are summarized in the table and the chart.

Case History

As the result of a bomb explosion a man 58 years old lay for twelve hours with his left thigh crushed under fallen masonry. He remained fully conscious throughout this period and was able to converse with rescue workers. By the time he was released two superficial lacerations of the left hand and left eyebrow were giving him some pain, but his mind was still clear and the crushed limb painless.

On admission to the emergency hospital some twenty hours after the explosion the man's general condition was fair, without signs of shock. The apparent site of crushing extended from the level of the left great trochanter not more than four inches downwards, but there was no abrasion or demonstrable haematoma. The injured limb was anaesthetic and completely paralysed, and there was foot-drop. Good pulsation could be

felt in all the main vessels of the limb. X-ray examination showed no injury to pelvis or femur. Simple dressings to the lacerations of the face and hand and a plaster back splint for the left foot were all that seemed necessary.

Chart of case.

During the next three days—i.e., the second, third, and fourth days of illness—there was little change in the patient's general condition, but his output of urine fell sharply, being 34 oz. in the third day and only 7 oz. in the fourth. The urine was blood-stained and had to be withdrawn by catheter on two occasions. In our experience of air-raid casualties, no matter what the site of injury, and even in the absence of any form of urinary obstruction, inability of the conscious patient to pass

Table summarizing the Main Clinical and Chemical Data

Day of Illness	General Condition, Treatment, etc.	Blood Pressure		Fluids		Urine		NaHCO ₃ given (gm.)	Blood Urea (mg. per 100 c.cm.)	Urea Clearance % of normal	Plasma		Serum	
		Systolic (mm. Hg)	Diastolic (mm. Hg)	Intake (oz.)	Output (oz.)	Albumin	Blood, Casts, etc.				Alkali Reserve (vol. CO ₂ per 100 c.cm.)	Chlorides (mg. NaCl per 100 c.cm.)	Sodium (mg. per 100 c.cm.)	Potassium (mg. per 100 c.cm.)
0	Left thigh crushed for 12 hours													
1	Admitted to E.M.S. Hospital. No shock. General condition fair													
2														
3	Catheterized twice; urine blood-stained			11	34	+	Blood-stained							
4				25	7	+	"							
5	1,000 c.cm. 2% sodium bicarbonate given by rectal drip. Hb 90% (Haldane). Drowsy. Pain and oedema in limb	150	80	54	19			20	243		49	536		
6	General condition worse. 1,000 c.cm. normal saline I.V.	156	80	70	78	+	Granular casts		333		38	496	338	25
7	Improving. Eucortone given 5 x 1 c.cm.; 1,000 c.cm. 5% glucose in N/5 saline I.V.	195	95	60	68	Ft. tr.	"							
8	Sodium bicarbonate by mouth, and extra salt in diet, started Hb 80%	158	80	72	71	+	"	16	324		39	532	316	20.2
9				74	97	Ft. tr.	No Hb; no casts	20		9.3				
10	Electrocardiogram normal			69	73			12	270		60	520	331	17.6
11		100	66	70	68			12						
12				98	86			12	115		65	500	326	19.3
13				97	80			12		49				
14	Sodium bicarbonate stopped. Slightly jaundiced. Serum bilirubin 1.2 mg./100 c.cm.			90	50			12	72		89	504	333	14.8
15		135	80	90	89									
16		130	72	84	60				63	57	89	472	348	11.8
17		136	78	88	62									
18				84	70					58				
19				86	72				32		82	520	349	13
20				79	76									
21				80	74									
22														
23									27		63	540	332	20.4
24									22		63	516	336	18.4
25														
26														
27														
28														
29														
30														
103	Mid-thigh amputation	116	78											
120	Hb 94%	124	80						30	53				

urine voluntarily is not uncommon. This patient had no prostatic enlargement or urethral obstruction, and has passed urine without difficulty since the fourth day of his illness. On that day the main feature was a severe cough due to diffuse bronchitis, which cleared up after treatment with 10 grammes of sulphanilamide in the next forty-eight hours. It must be pointed out, however, that in view of the renal damage in this type of case it is generally desirable to avoid the use of sulphanilamide.

On the fifth day the injured limb was giving rise to much pain and showed deep oedema from the groin to the middle of the thigh. There were one or two vesicles in the skin below the apparent site of crushing. In other respects, however, the condition in the limb was unchanged, pulsation in the vessels being still apparently normal. This day's urinary output was 19 oz., which, together with evident dehydration, a blood urea of 234 mg. per 100 c.cm. (normal 25-40), a plasma alkali reserve of 49 volumes CO₂ per 100 c.cm. (normal 55-77), and plasma chlorides of 536 mg. per 100 c.cm. (normal 560-620), indicated severe impairment of renal function. Accordingly, 1,000 c.cm. of a 2 per cent. solution of sodium bicarbonate (equivalent to 20 grammes of NaHCO₃) was given by a rectal drip.

The next (sixth) day, however, the blood urea had risen to 333 mg., and the alkali reserve had fallen to 38 volumes CO₂, and the plasma chlorides to 496 mg. The urine contained albumin and granular casts, and the patient's general condition was obviously worse. Fluid administration by intravenous drip was therefore started, 1,000 c.cm. of normal saline, followed by 1,000 c.cm. of 5% glucose in one-fifth normal saline, being so given. In view of the low alkali reserve and the low plasma chloride content it would have been better to continue with normal saline until the chlorides were within normal limits, and to give sodium bicarbonate by mouth. The urinary output increased to 78 and 68 oz. on the sixth and seventh days respectively, and the patient seemed materially better. On the seventh day five injections of eucortone, each of 1 c.cm., were given.

On the eighth day, however, his blood urea was 324 mg. per 100 c.cm. and his alkali reserve still only 39 volumes CO₂. The condition of the lungs contraindicated the intravenous administration of fluids; the oral administration of sodium bicarbonate was therefore started in 4-gramme doses every four hours, being later reduced to 12 grammes a day, so that a total of 96 grammes was given in the course of the next seven days (see table and chart). In addition extra salt was given in his diet. The urinary output subsequently remained steady at 70 to 80 oz. a day, and progress in the clinical condition was steadily maintained. The blood urea fell gradually to normal and the alkali reserve rose to 89 volumes CO₂ per 100 c.cm. on the fourteenth day, when the sodium bicarbonate was stopped; after remaining high for some days it later became normal. The albumin and casts disappeared from the urine on the ninth day; and the blood pressure fell from 195 mm. Hg systolic and 95 mm. Hg diastolic on the seventh day to 135/80 mm. Hg on the fifteenth day. The degree of renal recovery is indicated by the rise in the urea-clearance value (calculated from twenty-four hours' output of urine) from 9.3% of normal average on the ninth day to 57% a week later. The present urea clearance, on a two-hour test, is 53% of normal average.

The changes in the plasma chlorides and serum sodium and potassium are shown in the table and chart. The chlorides fell early to subnormal levels and only slowly recovered. The serum sodium content has been normal throughout (325-350 mg. per 100 c.cm.), except for the value on the eighth day. The serum potassium content, however, was 25 mg. per 100 c.cm. on the sixth day (normal 16-22), and then fell steadily, becoming subnormal at 11.8 mg. on the sixteenth day before being stabilized at the normal level.

Mild jaundice—direct van den Bergh reaction weakly positive, serum bilirubin 1.2 mg. per 100 c.cm.—was apparent about the fourteenth day, but slowly cleared up without special treatment. As the patient had not had any blood transfusion, this was probably related to a low degree of liver damage associated with his toxic state.

The subsequent clinical course has not been uneventful. In the succeeding two months the injured limb showed little

change, the oedema subsiding slowly, only to be followed by gross wasting. Pain in the limb was persistent and severe, both at rest and on passive movement, and only 15 degrees of flexion were obtained in the hip and knee in spite of physical treatment. Then two sloughing ulcers appeared, one over the head of the fibula and the other at the heel, and showed little sign of healing in three weeks. In addition the limb, still paralysed and painful, appeared once more to be endangering the patient's life. Accordingly, after a period when the patient was too ill to operate on, a mid-thigh amputation was successfully performed, almost fifteen weeks after the date of injury.

Pathological Report.—Of the tissues of the injured limb Dr. Joan M. Ross reports: "The sciatic nerve shows some fibrosis of the interstitial tissue with slight lymphocytic infiltration. There is slight scarring of the individual nerve bundles. The vessels show the changes usual in peripheral vascular degeneration. There is some medial degeneration with calcification in the artery and an associated atherosclerosis. The veins are normal. Sections from the vastus muscle show a multiplication of muscle nuclei and a development of young fibrous tissue among muscle fibres. The appearance is consistent with a healing crush injury." It seems probable that the degree of arterial degeneration was an important factor in determining the need for amputation.

The change in the man's outlook since his operation has been very striking and satisfactory. In contrast with the early weeks, when his general condition, the severe pain in his injured limb, and the loss of other members of his family in the raid made him depressed and miserable, he now discusses the prospect of returning home and getting about on an artificial limb, and rarely complains at all.

Summary

A case of crush injury with renal failure and recovery is described.

The administration of sodium bicarbonate to raise the dangerously low alkali reserve and the giving of sodium chloride played a decisive part in restoring renal function.

Amputation of the injured limb ultimately became necessary, and should be taken into account in similar cases in assessing prognosis.

We are indebted to Mr. Basil Hume for permission to publish this case, which has been under his care, and for his advice and criticism; and to Dr. E. G. L. Bywaters for seeing the patient.

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The annual report for 1940 of the Henry Lester Institute of Medical Research, Shanghai, describes continued widespread activities, despite restrictions imposed by the war. Fifty-eight original papers were published during the year under review. Many cases of nutritional deficiency were investigated, chiefly beriberi and pellagra. During the latter part of the year a study was made of more than a hundred cases of ariboflavinosis. Various types of eye lesions were found; also mouth lesions and seborrhoeic dermatitis. The eye lesions responded most rapidly to riboflavin treatment, signs and symptoms beginning to recede within forty-eight hours. Several cases of pellagra were found to be suffering from fasciolopsis infection, while infestation with ascaris frequently, and with hookworm occasionally, was present in patients suffering from nutritional deficiency. The report states that evidence is being accumulated to test the theory that intestinal parasites may consume vitamins, especially the vitamin B groups, so that with a heavy infection and a low vitamin intake a condition of avitaminosis is produced in the host. Experiments were carried out on some four hundred children in a refugee camp to test the efficacy of soy-bean powder mixture. This substance contains soya bean powder, sugar, starch, sodium chloride, and calcium carbonate. After a period of four months it was found that children fed on this mixture showed greater growth and suffered less sickness than control children fed on ordinary diet.