may therefore be assumed that his heart was normal before the accident.

Condition on Examination.—The patient was pale but not distressed. There were some abrasions and a slight swelling in the precordial region. The cardiac impulse was weak and there was a faint systolic thrill to be felt over the fourth intercostal space just to the left of the sternum. The apex beat was situated one-quarter of an inch internal to the nipple line in the fifth space. The area of cardiac dullness was not enlarged. There was a very loud blowing systolic murmur audible all over the praecordium and conducted round to the left base. It was maximum in the fourth space just to the left of the sternum. No second sound was audible except in the pulmonary area, where it could just be detected. The pulse was regular, 92 per minute, and of poor value, the blood pressure being 88/74. The lungs were clear. The electrocardiogram showed the RS-T complex elevated above the base line in all three leads—the elevation being maximum in Lead II—and a deep Q wave and inverted T wave in Lead III.

He was kept at complete rest in bed and was given tab. digitalis folia 1/2 grain t.d.s. During the following week he ran a slight irregular temperature and had some cough. On April 21 the signs in the heart were unchanged, but the blood pressure had risen to 114/76. There was an area of impaired percussion note and diminished air entry at the right base and rales were heard at both bases. The liver edge could be felt one inch below the right lower costal margin in the nipple line, but there was no oedema. The electrocardiogram now showed that T_1 was of low voltage and that T_2 was becoming inverted. The dose of digitalis was increased to 1 grain t.d.s. On April 24 radiographs (Dr. S. L. Mucklow) showed that the heart shadow was greatly enlarged in all diameters, the shape of the shadow suggesting enlargement of the heart rather than pericardial effusion. On April 26 the patient had two syncopal attacks. The blood pressure had fallen to 100/64 and pericardial friction was heard over the apex of the heart. On April 28 T_2 was definitely of coronary type. On May 5 pericardial friction could be heard over the whole of the lower half of the praecordium. Although his blood pressure was only 96/64 his general condition had improved, and from that time he continued to make steady progress, although he still had occasional syncopal attacks after meals. On May 12 the pericardial friction was no longer audible. After eight weeks in bed he was allowed up. His blood pressure was still low—97/70—but he was able gradually to increase his exercise. On October 31 radiographs showed that there was only slight enlargement of the left ventricle. On April 3, 1940 (a year after the accident), it was reported that he was taking all ordinary exercise without shortness of breath or discomfort. The heart signs were unchanged, except that no systolic thrill could now be detected. The blood pressure had risen to 115/85 and exercise tolerance was good. The electrocardiogram was approaching normal, although the RS-T complex in Lead II was still slightly elevated, T_1 was large and peaked, and T_3 was still inverted.

Discussion of Case

There seems little doubt that this accident resulted in more than one lesion of the heart. The appearance of a systolic thrill and a loud systolic murmur after the accident might be accounted for by a rupture of the mitral valve or a perforation of the interventricular septum. It is impossible to say with certainty which of these two lesions was actually present. The marked dilatation of the heart which occurred might have resulted from one of these lesions or might correspond to the acute dilatation which has been observed in animals after trauma to the heart. It is interesting that the clinical findings did not lead one to expect the great dilatation which the radiographs revealed.

The finding of electrocardiographic changes resembling those of coronary thrombosis suggested that there was contusion of the myocardium in addition. It is true that coronary changes of T_2 type (in which the elevation of the RS-T segment and later the inversion of T are

maximum in Lead II) are found in association with pericarditis; but pericarditis was probably not the cause of the changes in this case, as they were found as early as the third day after the accident, whereas pericardial friction was not heard until twelve days later.

Summary

Injury to the heart due to non-penetrating blows is commoner than has been supposed and is not necessarily fatal. From a consideration of the cases already published and of animal experiments a brief description of the morbid anatomy, symptoms, signs, and treatment of the condition is given. A new case is recorded.

I wish to thank Dr. G. A. Allan of Glasgow for kindly supplying the final report and electrocardiogram.

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INSULIN TREATMENT OF SCHIZOPHRENIA IN WARTIME

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Recent correspondence in the columns of the *British Medical Journal* has raised two questions in connexion with the continuation of the insulin treatment of schizophrenia in wartime. The first of these throws some doubt on the value of the method as a cure, and the second points out that it requires the use of large amounts of both sugar and insulin. This, it has been said, is not justified in view of the shortage of sugar and the difficulties that may be encountered in importing the raw materials required for the manufacture of insulin.

It is not our intention to discuss the former question in this paper. The last word has yet to be said on this subject, but we do not doubt its value in certain cases of this disease, for we have seen patients respond to insulin treatment who had previously failed to respond either to cardiazol or to electrical convulsion therapy. Furthermore, we have seen cases in which combined insulin and convulsion therapy met with complete success after failure of either alone to influence the course of the psychosis. With the latter question we concerned ourselves at an early date after the introduction of sugar rationing, for it was obvious to us that the allowance of half a pound of sugar a week would in no manner meet the requirements of patients undergoing this form of therapy. With the problem of economy in the amounts of insulin used we did not concern ourselves until a later date.

The technique of insulin treatment adopted at most hospitals is somewhat as follows. The patient is given intramuscular injections of insulin. Starting at 15 to 20 units, the dose is increased daily until it induces hypoglycaemic coma. If there are no contraindications the patient is allowed to remain in coma for one and a half to two hours, after which time the coma is terminated by feeding seven ounces of sucrose in solution into the stomach through a nasal tube. Recovery usually takes

place within half an hour, and the patient is then given a sweetened drink of tea or other beverage. To prevent the occurrence of a late coma or shock during the night a sweetened drink is given before retiring. By this method each patient requires about one pound of sugar a day. This amount is greatly in excess of that allowed by the Government's sugar-rationing scheme, and although provision has now been made for this we determined to find a more economical method.

Economy in Sugar Consumption

First of all the quantity of sugar given by nasal tube to terminate the coma was reduced, but it was found that any amount less than seven ounces was uncertain in its action, recovery being delayed in some cases for an hour or more, and in those patients who did regain consciousness there was a tendency to lapse into coma again very soon after recovery. When the amount of nasal sucrose was reduced to four ounces, only one of our ten patients undergoing treatment recovered without an intravenous injection of 33% glucose. Our next experiments were with sugar substitute. For this purpose we chose potatoes. These were mashed and mixed into a "soup" of the consistency of a thin gruel with milk and water. The potatoes, however, tended to block the nasal tube or even a size 20 stomach tube by precipitation, and had to be forced into the stomach by means of a glass syringe. Here the same difficulties of delayed recovery and a tendency to lapse into coma again were encountered, and the method was abandoned. It was now decided to administer 20 c.cm. of 33% glucose intravenously to terminate the coma, and to follow this, on recovery, with a pint of the potato soup. This has been invariably successful. After the injection of glucose recovery is rapid, and within one to three minutes the patients are able to respond to questions and to drink the soup. This is much liked by them; they prefer it to the sucrose drinks previously administered. We have not had one instance of the vomiting that was quite common after the sugar solution had been drunk. The potato soup is prepared as follows. Twelve ounces of potatoes are boiled and mashed for each patient on treatment. This is beaten to a consistency thin enough to be readily drunk by mixing it with milk, with the addition of the water in which the potatoes were boiled. More water may be added if required. Each patient gets one pint. Three hundred and one comas have been terminated in this way. No late shocks have occurred, and in only four instances has it been necessary to give an additional injection of glucose. One of these was after the patient had had an epileptiform fit. In two the patient was excited and would not drink. In the fourth no cause was ascertained; the patient was drowsy, and was given another 20 c.cm. of glucose. The veins are still patent and show no sign of thrombosis or occlusion from repeated venepuncture. The patient is allowed a sweetened drink from his own sugar ration after the soup. In the evening potatoes are again substituted for the sweetened drink, half a pint being allowed. In this way the carbohydrate intake is adequate; late comas are avoided, and the patients keep to their allowance of eight ounces of sugar weekly. Since tea rationing cocoa has been substituted for the morning drink of tea. The amount of sugar contained in the 20 c.cm. of intravenous glucose is approximately 7 grammes.

Economy of Insulin

Having effected considerable economy in the amounts of sugar used we next turned our attention to the possibility of effecting some economy in the amounts of insulin.

By the ordinary intramuscular method of administering insulin for shock therapy doses varying within very wide limits for different patients are required. In our experience 18 units successfully induced a deep coma in one patient, while 384 units failed to affect another patient. At the extreme end of this scale large amounts of insulin are therefore being used daily. We decided accordingly to administer the insulin intravenously and to determine whether or not any saving could be effected in this way. In our first experiment a female schizophrenic patient aged 36 was given 6 units of ordinary insulin intravenously, and blood-sugar estimations were carried out to determine the effect on the blood sugar. The blood sugar reached a hypoglycaemic level of 14.5 mg. per 100 c.cm. within half an hour, and gradually increased from that time, until one and a quarter hours after the injection it was nearly as high as the fasting level. There was, however, no sign of the patient's becoming comatose. On the following day 12 units were given, and lumbar puncture was performed to determine what change, if any, in the C.S.F. sugar level had taken place. This is illustrated in Chart I.

CHART I.—Curves showing the effect on the blood and C.S.F. sugar of ordinary insulin and protamine-zinc-insulin given intravenously. Curve A = C.S.F. and blood sugar after 12 units ordinary insulin intravenously. Curve B = C.S.F. and blood sugar after 10 units protamine-zinc-insulin intravenously. There were no comas.

The behaviour of the blood sugar was similar to that when 6 units were given. It is clear, therefore, that although 6 units of insulin were sufficient to reduce the blood sugar to a hypoglycaemic level, this amount was not sufficient to keep it at that level long enough for the sugar present in the cerebrospinal fluid, and therefore in the nervous system, to be oxidized. It has been shown by Day and Niver (1937) that coma does not supervene until the C.S.F. sugar has reached a low level, and that this does not occur for an hour after the blood sugar has come down and has been kept down. We therefore increased the dose of insulin given intravenously until an amount was reached that induced coma. This is approximately 25 to 70% of the dose required by intramuscular injection. It was confirmed that there was a marked decrease in the C.S.F. sugar when the patient was in coma. The accompanying table gives the doses of insulin required by intravenous injection and by intramuscular injection to produce coma.

Case No.	Coma Dose of Intramuscular Insulin	Coma Dose of Intravenous Insulin	Net Saving
1	28 units	16 units	43%
2	122 "	70 "	43%
3	120 "	90 "	25%
4	80 "	40 "	50%
5	48 "	28 "	42%
6	124 "	76 "	39%
7	116 "	36 "	69%
8	116 "	44 "	62%
			Av. 46.6%

In another attempt to reduce further the amount of insulin required we decided to use protamine-zinc-insulin intravenously because of its reputed prolonged action in depressing the blood sugar. We thought that it might bring this down to hypoglycaemic level and

maintain it there until the C.N.S. sugar was oxidized. Chart I also shows the effect of 10 units of protamine-zinc-insulin on the blood sugar and the C.S.F. sugar of another schizophrenic patient. We found the fall in blood sugar after the injection to be as rapid and profound as with ordinary insulin, but the remainder of the curve is flatter and the blood sugar remains depressed for a longer period. This suggests that when given intravenously this substance is less stable than when given subcutaneously. The blood sugar eventually rose to its original level although no sugar had been given, indicating that when exogenous insulin has been administered the forces concerned in keeping the blood sugar at a constant level are called into play to overcome the action of the insulin. The C.S.F. sugar is also unaffected until a dose large enough to induce coma has been given. The other points already noted about the C.S.F. sugar are also illustrated. In actual practice we found that the coma dose of intravenous protamine-zinc-insulin was about the same as that of ordinary insulin given intravenously, and that nothing was gained by its use.

CHART II.—Comparative blood sugar curves in the same patient. Curve A = Blood sugar after 30 units ordinary insulin intramuscularly. Curve B = Blood sugar after 18 units ordinary insulin intravenously. Curve C = Blood sugar after 18 units protamine-zinc-insulin.

Chart II is a composite graph showing the effect on the blood sugar of ordinary insulin given intramuscularly and intravenously and of protamine-zinc-insulin given intravenously in the same patient. In Curve A 30 units of ordinary insulin were given by intramuscular injection. The blood sugar did not reach its lowest level until one and three-quarter hours after injection, and coma intervened about three hours after injection. Note the slow rise in the blood sugar in this case. The C.S.F. sugar before coma was terminated was 28 mg. per 100 c.cm., and rose to 30 mg. five minutes after 33% intravenous glucose was given. Coma therefore does not intervene until the sugar in the brain cells has been metabolized under the influence of insulin—a condition reflected in the C.S.F. sugar. The C.S.F. sugar in coma is about 30 mg. below the fasting blood-sugar level, and is little changed, showing either a slight rise or a fall, as noted above, by the intravenous injection of glucose, even though the patient is out of coma. It is to be presumed that the C.S.F. sugar does not rise for some time, although the brain cells are being adequately supplied from the blood stream.

In connexion with lumbar puncture we invariably found that the cerebrospinal fluid was under increased pressure while the patient was in coma, being 350 mm. in one patient. Within a minute of giving 20 c.cm. of 33% intravenous glucose to terminate the coma the pressure had fallen to 180 mm. After five minutes the pressure was 75 mm., which is within normal limits. Chart I also shows the effect on the C.S.F. sugar when 20 c.cm. of 33% glucose was given intravenously. The lumbar puncture needle was left *in situ* and the 20 c.cm. of intravenous glucose was administered. At the end of

this injection cerebrospinal fluid was collected for two minutes, and this specimen showed a fall in the C.S.F. sugar. A third specimen was taken five minutes later; this showed in some cases a slight rise in the C.S.F. sugar and in others a fall. The behaviour of the C.S.F. sugar following intravenous glucose is therefore not constant.

Methods of Administration Compared

Some questions may be raised as to the comparative safety of giving insulin, both ordinary and protamine-zinc, intravenously, as against giving it intramuscularly. The ordinary insulin used by us has an acid pH of 3.7. No ill effects have been observed from its use intravenously, as such a small quantity is rapidly buffered by the blood withdrawn into the syringe and in the veins after the injection. The pH of protamine-zinc-insulin is 7.1, and therefore about the same as the body fluids. The question of anaphylactic shock after the intravenous injection of protamine-zinc-insulin must be considered. We may say that we have not encountered any sign of it, and in spite of the manufacturer's advice against its use intravenously it appears perfectly safe to administer by this route. The Folin-Wu method of estimation of the blood sugar was used, in which there is a basal level of about 9 mg. per 100 c.cm., due to other reducing substances in the blood. We have often had blood sugars of 9 and 10 mg. half an hour after the injection of the intravenous insulin while the patient was well and talkative, only later relapsing into coma. This means that the sugar can be totally removed from the blood without the patient showing any ill effects, and until the C.S.F. sugar falls coma does not occur. Only one epileptiform fit has occurred in the course of this work. This was in a patient who was given 20 units more than her coma dose of intravenous protamine-zinc-insulin. She readily recovered after the injection of 20 c.cm. of intravenous glucose.

In general, we found that the coma produced by intravenous insulin is much quieter than that induced by intramuscular insulin. The general appearance of the insulin room during intravenous treatment is extremely quiet. It appears to us that there is less likelihood of the patients relapsing again into coma after their glucose injections on intravenous insulin, as there is no continued absorption of insulin which takes place for many hours after an intramuscular injection. We had no cases of relapse into coma after the intravenous glucose injection on this treatment.

Summary

A method of carrying out the insulin treatment of schizophrenia has been described which does not necessitate the use of large quantities of sugar. The substitution of intravenous for the ordinary intramuscular method in general use has been shown to effect an average saving of 46.6% of insulin.

We are indebted to Dr. T. P. Rees, medical superintendent at Warrlingham Park Hospital, for his active interest and practical advice in this work and for his permission to publish this report. Our thanks are also due to Mr. E. J. Bishop, laboratory technician at the hospital, who carried out the numerous blood-sugar estimations for us, and to Messrs. Allen and Hanburys for a generous supply of protamine-zinc-insulin.

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G. L. Hallez (*Nourrisson*, 1940, **28**, 22) records a case of paratyphoid A in a male infant aged 1 year, which is remarkable owing to the rarity of the disease at that age. The fever continued until the ninth day, when some rose spots appeared. There were no other signs of the disease and the spleen remained normal. Recovery took place. The father, who was a nurse in a fever ward, may have acted as a carrier.