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THE MANAGEMENT OF DIABETIC COMA IN THE AFRICAN

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Recent literature concerning diabetes seems to be focused mainly on the rôle of the oral hypoglycaemic agents. The treatment of diabetic coma receives scant attention. During the last few years, however, there have been important changes in the physician's approach to the management of diabetic coma which have not received the attention they deserve.

Reference to standard works[1-7] demonstrates this fact in the changes that have taken place between 1955 and 1957. The following statement, with reference to normal saline solution, appears in a 1955 edition:[6] 'Continue this until the patient is showing no signs of shock and is taking fluids well by mouth', and a reference in the same edition to the administration of potassium states: 'Never exceed 3 g. in 24 hours'. Yet in the 1957 edition[5] Duncan states: 'Do not give more than 24 g. of NaCl in the first 24 hours of therapy'. Again, in the same edition Palmer states, after having already given 25 mEq. of potassium, that '... one must consider additional administration of parenteral potassium, remembering that the potassium depletion in severe diabetic coma is apt to be very great'. This, to all intents and purposes, is a remarkable change in the therapy of diabetic coma in the space of 2 years — a veritable about-face. Notwithstanding this change, there are still books being published which advocate that saline be continued until the patient is able to take fluids freely by mouth.[7] There are other modern books that limit the amount of saline (Dunlop[1]) but some do so in terms that could be misinterpreted.[4,5]

Despite this lack of uniformity, the mortality of diabetic coma has decreased markedly throughout Western countries. The reasons given for this improvement, to quote a recent survey,[9] are: '... the employment of larger amounts of insulin, a better understanding of fluid and electrolyte derangements, and the "team" approach. On the other hand the lessened mortality could be related also to a decrease in the severity of the admission state'.

African patients often come into hospital after many hours have elapsed, so that their state on admission is usually very severe. Perhaps this may account for the high mortality rate, which was 100% for cases of coma (not acidosis) in King Edward VIII Hospital during 1957.

PRESENT STUDY

The results in this hospital for 1957 (when there was no organized method of therapy) are compared with those for 1959, by which time a rather more drastic approach was conceived. The results are not strictly comparable, since the 1957 results apply to the whole hospital and the 1959 ones to 1 medical unit. All cases in the second series, if not directly under my control, were seen by me at some stage of their illness.

Diabetes is uncommon in the African (especially when compared with Indian patients who also attend this hospital[8]) but diabetic ketosis and coma are relatively frequent. Thus out of 67 African diabetic admissions in 1957, 10 were in coma or severe keto-acidosis.

CASE REPORTS

1957 Series (Table I)

Six cases of diabetic coma (cases 2, 4, 5, 6, 8 and 9) were admitted, all of whom died. Of 4 cases of precoma (not in deep coma but mentally disorientated and clinically acidotic),

TABLE I. RESULTS AND MANAGEMENT OF ALL AFRICAN CASES OF DIABETIC COMA AND PRECOMA ADMITTED TO THE KING EDWARD VIII HOSPITAL DURING 1957

Case	Initial state	Initial blood sugar mg. per 100 ml.	Parenteral fluid in 24 hours (litres): Saline*	5% dextrose in water	1/6 molar sodium lactate	Insulin in 24 hours	Result
1	Precoma	727	1	5·5	1	715	Alive
2	Coma	903	4	—	—	250	Died - 7 hours
3	Precoma	1,100	6	—	—	240	Died - 4 days
4	Coma	770	9	—	—	1,000	Died - 24 hours
5	Coma	1,040	2	—	—	200	Died - 4 hours
6	Coma	930	2	—	—	280	Died - 4 hours
7	Precoma	540	Oral fluid			160	Alive
8	Coma	430	—	—	—	60	Died in surgical ward
9	Coma	850	5	—	—	400	Died - 6 hours
10	Precoma	440	3	2	—	305	Alive

* The term 'saline' includes physiological normal saline and 5% dextrose in normal saline.

3 recovered. *Cases 5, 6 and 8* were obviously moribund or inefficiently treated by any standards, and will not be discussed further here.

Cases 2 and 9 were more efficiently treated, receiving 250 and 400 units of insulin in 7 and 6 hours respectively. Both cases received quite large amounts of intravenous fluid therapy composed exclusively of solutions of normal saline or 5% dextrose in saline. Both died on the day of admission.

Cases 3 and 4 were treated more vigorously, receiving 240 and 1,000 units of insulin within the first 24 hours respectively. They were given 6 and 9 litres of intravenous fluid respectively, with potassium replacement as required; all the fluid was saline or dextrose saline. Both patients died.

Cases 1, 7 and 10 are the patients with precoma who survived. The contrast in fluid therapy is striking. Two patients received dextrose 5% in water in addition to saline and 1/6 molar sodium lactate. The third patient was treated with oral fluid. It should be noted that case 1 and 2 refer to the same patient treated by different methods, with a fatal outcome in the second admission. Although not conclusive, the fact that those receiving a solution without sodium chloride at some stage during treatment, recovered, is of interest.

1959 Series (Table II)

1959 started with 3 successive deaths.

Case 1. This patient died 2½ hours after admission, a few minutes after receiving a second dose of 100 units of intravenous insulin. A postmortem examination revealed no macroscopic abnormality.

TABLE II. RESULTS AND MANAGEMENT OF ALL CASES OF DIABETIC COMA AND PRECOMA ADMITTED TO A SINGLE AFRICAN MEDICAL UNIT OF THE KING EDWARD VIII HOSPITAL DURING 1959

Case	Initial state	Initial blood sugar mg. per 100 ml.	Parenteral fluid in 24 hours (litres): Saline*	5% dextrose in water	1/6 molar sodium lactate	Insulin in 24 hours	Result
1	Coma	1,160	1	—	1	200	Died - 2 hours
2	Coma	1,758	4	1	—	160	Died - 5 hours
3	Coma	620	0·4** 1·5	2	—	140	Died - 25 hours
4	Coma	1,060	2·6	9	1·3	1,980	Alive
5	Precoma	440	Oral fluid			120	Alive
6	Coma	590	7	4	3	1,060	Died - 4 days
7	Coma	700	4·5	8	—	1,200	Alive
8	Coma	580	3	5	—	1,300	Alive
9	Precoma	690	1·5	2	—	260	Alive
10	Precoma	700	2	3	—	200	Alive
11	Precoma	320	2	2·5	—	400	Alive
12	Precoma	315	Oral fluid			200	Alive
13	Coma	820	7	6	0·5	2,280	Alive

* The term 'saline' includes physiological normal saline and 5% dextrose in normal saline.
** 0·4 l. of 5% saline.

Case 2. This patient presented with the highest initial blood sugar found in 1959. Inadvertently 5% saline was given intravenously in place of normal saline. This was only detected after 400 ml. had been administered. A further 4 litres of 5% dextrose in saline and a litre of 5% dextrose in water was administered before she died in a convulsive seizure 5 hours after admission.

Case 3. This patient presented in coma, with the Benedict's test giving a 'brick' colour, but the urine was free of acetone. A Babinski response on the right side led us to conclude that the coma was due to a cerebrovascular accident. For this reason his diabetes was only perfunctorily treated. Since the postmortem examination revealed no cerebral lesion he is included in the series.

Cases 4, 5 and 6 (Fig. 1) refer to a single patient. This young woman was in deep coma on her first admission. She had been in coma for more than 12 hours, and was extremely dehydrated and acidotic. She did not respond in any way to painful stimuli. Within the first hour 1·6 litres of saline, 1 litre of 1/6 molar sodium lactate and 250 ml. of plasma were administered by the usual 'push-in' and a second drip in the femoral vein. On admission 300 units of insulin were given and were followed by further large amounts in the succeeding hours to a total of 1,980 units in 24 hours. Acetone had disappeared from her urine by the 14th hour. A total of 8 g. of potassium chloride was given intravenously during the first 24 hours resulting in a serum potassium of 4·6 mEq. per litre at the end of this period. Her serum sodium and chloride also returned to normal after 24 hours. Although she received 13 litres of fluid on the first day, she received only 1 litre of saline solution after the first hour, the balance being 9 litres of 5% dextrose in water. She made an uneventful recovery although she was unable to take fluids herself by mouth for 4 days because her mouth was severely traumatized by the prolonged dehydration. During this period she was fed by intragastric tube. She was discharged taking 40 units of lente insulin daily.

Her second admission was uneventful by comparison, but shortly after discharge she was admitted again for the third and last time. Although again in coma she was restless and responded to externally applied painful stimuli. This admission is compared with her first admission in Fig. 1. The differences in therapy, in brief, are as follows: She received a similar quantity of fluid but by far the largest proportion was saline (7 litres dextrose saline, 3 litres 1/6 molar lactate and only 4 litres 5% dextrose in water). She received a smaller

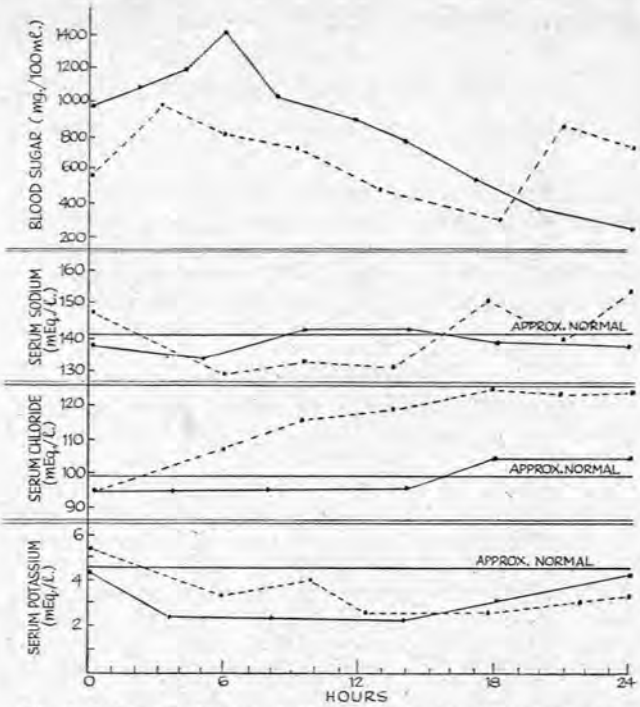

Fig. 1. Laboratory findings in case 4, 1959 series (continuous line: 1st. admission, successful result) and case 6, 1959 series (broken line: 3rd. admission, unsuccessful result).
Management, 1st 24 hours, case 4: Saline, 1·6 litres on admission, 1 litre at 18 hours; lactate, 1·3 litres; 5% dextrose in water, 9 litres; insulin, 1,980 units.
Management, 1st 24 hours, case 6: Saline, 3 litres on admission, 4 litres subsequently; lactate, 3 litres; 5% dextrose in water, 4 litres; insulin, 1,060 units.

amount of insulin, but her blood sugar was lowered quite effectively, at least in the early stages. Acetone had disappeared from her urine by the ninth hour. There was marked electrolyte imbalance and she died 4 days later after having first regained consciousness. The postmortem examination revealed pulmonary congestion.

Case 7. Here again was a patient in coma who was treated vigorously. He was due for the 'saline treatment' in full as directed by the textbook in current use. He had fortunately received only 4·5 litres of 5% dextrose in saline before his intravenous therapy was changed to 5% dextrose in water, of which he received a further 8 litres in the first 24 hours. Potassium was replaced as required (6 g.). He made a very good recovery and has not been admitted since.

Cases 8, 9 and 10 refer to a single patient. Coma in her first admission was treated by the now accepted routine, with saline administration limited to 3 litres. She made an uneventful recovery but failed to take insulin regularly and was admitted twice more in precoma. These episodes were treated in the usual manner except that intravenous insulin only was used, to ascertain whether the intravenous route was effective. The quick and excellent results prove that this is so. She has now learnt her lesson and attends the diabetic clinic regularly.

Cases 11, 12 and 13 also refer to a single patient. This young adolescent has been admitted 5 times in all. I treated her myself in her first 4 admissions. Saline therapy was limited. Her final admission is of interest. She received large quantities of saline and dextrose saline and 2,280 units of insulin in the first 24 hours, and made a successful recovery. This was rather slow since she was only really out of danger on the 10th day. She suffered severe electrolyte disturbances and also periods of hypoglycaemia. She is the only patient to recover who was not treated on the limited saline routine, although an attempt was made to correct this by the administration of 5% dextrose in water exclusively from the 4th day onwards, despite the fact that her electrolytes were almost normal.

DISCUSSION

Although it is realized that these 2 series were not run concurrently and strict comparison is not possible, our results for the 1959 series appear much more satisfactory (Table III). The major difference between the 2 series

TABLE III. MORTALITY IN THE TWO SERIES

Series	*Cases (admissions)*	*Precoma*	*Coma*	*Deaths*	*Percentage deaths*
1957	10	4	6	7	70
1959	13	5	8	4	30

is the administration of large quantities of 5% dextrose in water in the 1959 series as contrasted with purely saline intravenous therapy in the 1957 series.

In the 1957 series (Table I) the 3 patients who recovered received non-saline-containing fluid in addition to saline whereas those who died received saline only.

All 4 deaths in the 1959 series (Table II) received minimal quantities of 5% dextrose in water, the maximum being 4 litres in patient no. 6 who had also received 10 litres of sodium-containing fluid. Only 1 patient recovered after receiving a large amount of saline and this was a very slow and extremely hazardous recovery (no. 13 in Table II).

Basic Considerations in Treatment

There are 4 basic considerations in the management of diabetic coma: (1) early diagnosis and laboratory investigations, (2) insulin therapy, (3) fluid and electrolyte replacement and correction, and (4) treatment of concomitant infection.

1. *Early diagnosis and laboratory investigations.* Delay in diagnosis and delay in initiating therapy are the worst errors that can be committed in managing diabetic coma. I found that a common error was the delay in giving insulin while the staff were attending to the intravenous drip. Insulin should be administered, preferably by the intravenous route, as soon as the diagnosis has been made and only then the fluid requirements should be dealt with, since the administration of insulin is a far less time-consuming procedure. Apart from hourly urine testing, the investigations that I found necessary were the 2-hourly blood-sugar estimation, the 4-hourly electrolyte estimation and occasionally the CO_2 combining power. When intravenous insulin was used I found that the second electrolyte estimation should be made before 3 hours have elapsed, since the serum potassium sometimes dropped precipitously.

2. *Insulin therapy.* There is still some disagreement on this issue, but at least the days of small doses are past. No more will we read that 'no advantage accrues from giving a larger initial dose' than 50 units, a statement which appeared in a popular standard textbook only 12 years ago.[10] I have found intravenous insulin a considerable help, using it in doses varying from 100 to 300 units at 1 - 2 hour intervals. A few cases have been treated with insulin by the intravenous route only, with excellent results. Routinely, I use both the intravenous and intramuscular routes as follows: An initial dose is given by both the intravenous and intramuscular routes and thereafter the intramuscular route is not used for the next 6 hours, the intervening doses being intravenous. After a second intramuscular dose at 6 hours, intravenous insulin is continued for the next 6 hours until the third intramuscular dose at 12 hours. Thereafter a 4-hourly schedule by the subcutaneous or intramuscular route is usually possible. This tends to eliminate the 'build-up' of insulin in the tissues with the inevitable hypoglycaemia and uncertainty that follow. In all cases treated by this method I observed no periods of hypoglycaemia (cases 4, 8, 9, 10, and 11 — Table II).

3. *Fluid and electrolyte therapy.* Balance studies on electrolyte requirements in diabetic coma have been carried out by numerous authorities. Martin *et al.*[11] have estimated the required electrolytes down to the smallest detail. As fluids containing magnesium and phosphate are not always readily available, I will confine the discussion to sodium, potassium and chloride. Martin *et al.*[11] estimate the requirements per kg. bodyweight for the first 12 hours as: sodium 7 - 10 mEq., potassium 2 - 3 mEq. and chloride 5 mEq. On the question of sodium they also quote Butler[12] and Darrow[13] who estimated the lowest and the highest figures respectively, viz. 5·1 and 13·3 mEq. per kg. Working on 10 mEq. per kg., which facilitates calculation, a patient of 50 kg. would require only 500 mEq. Since a litre of normal saline contains 154 mEq. of sodium a little over 3 litres is required.

As regards potassium, Martin *et al.*[11] admit that the figure of 2 - 3 mEq. is too low since their patients' serum potassium was still low at the end of their 12-hour balance study. The amount of chloride required is exactly half that of sodium and therefore the administration of saline only would result in excessive replacement of chloride unless sodium were partly replaced in the form of sodium bicarbonate or lactate. There is still much controversy on whether these alkalis should or should not be used in the treatment of diabetic coma. I can only say that in my patients, provided the sodium-containing solution was limited, the patients apparently suffered no ill effects from either means of therapy. When excess saline was used, as in case 6, Table II, then both the serum sodium and chloride rose excessively.

Another factor of major importance in these patients was the number of deaths occurring within a few hours of admission. This may be attributed to the advanced state of metabolic imbalance on admission. For this reason I insist on a rapid rate of administration of intravenous fluid during the first hour — at least 2 litres, if not 3, including at least 1 bottle of plasma. As fluids have to be given at a rapid rate and, since an excess of sodium chloride is contra-indicated, dextrose water solutions have to be administered within an hour of initiating therapy. This was certainly frowned upon in the past and is still decried in some quarters today,[7] yet I found it a successful method of treatment. It does cause a rise in blood sugar initially, and an increase in diuresis, as well as a precipitous and sustained drop in the serum potassium; but these are factors that can be controlled, whereas an overdosage of sodium chloride and the cellular dehydration that ensues have to be corrected by the patient. Supplying excessive quantities of sodium for the sole use of the extracellular fluid compartment, simply increases

the already high osmotic pressure with further dehydration of the intracellular compartment of the body.

4. *Treatment of concomitant infection.* This must of course be carried out early by means of active antibiotic therapy.

SUMMARY

The results of 2 series of patients in diabetic coma are assessed and evaluated in the light of modern work. It is emphasized that insulin must be used in much higher doses in African patients, and that sodium-containing solutions must be limited to 3 litres of normal saline in the parenteral fluid therapy. Potassium replacement may be required as early as 3 hours after the commencement of therapy in patients on this regime.

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