equal numbers at risk, four in each group were in remission, six on cortisone and five on aspirin were "very active," 14 on cortisone and 13 on aspirin were regarded as capable of doing their usual work and of taking normal physical recreation, nine on cortisone were still gravely incapacitated and seven on aspirin (including here the two unsuccessful cases lost to sight in the first year). As at the end of one year the two groups retain their equality.

Summary

A further report is made on 61 patients who were allocated at random to treatment with either cortisone (30 cases) or aspirin (31 cases) while they were still in the early stages of rheumatoid arthritis. In their second year of therapy treatment with one or other agent has been continuous, and "individualized" by the physician in charge of the patient to meet each patient's needs. At approximately the end of two years of treatment 58 of the original 61 patients have been reassessed clinically, submitted to some simple objective tests, had x-ray films taken of their hands and feet, and had their haemoglobin levels and blood sedimentation rates measured. In no respect do the two groups differ by more than might easily be due to chance, and in most respects they are distinguished more by their equalities than by their differences. At the end of two years, therefore, as previously reported at the end of one year, it appears that for practical purposes there has been remarkably little to choose between cortisone and aspirin in the management of this group of patients.

INTRAMUSCULAR IRON IN INFANCY

BY

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A good doctor will always be chary of using, or recommending, parenteral therapy when oral treatment can lead to equally good results less unpleasantly. Iron has been given by mouth for many years with excellent results, both in the ferric state as iron and ammonium citrate, and more recently as ferrous sulphate, which has been used increasingly since it has been recognized that only in the ferrous state can iron be absorbed and that ferric salts have to be reduced by the acid gastric juice before they can be utilized. Naturally, iron has been used particularly in paediatrics for the treatment of iron-deficiency anaemia—that is, of nutritional origin—and in infants so affected the associated hypochlorhydria can only act as a deterrent to full utilization of ferric salts. In any case, it is well known that only a portion, even of the ferrous salts, is absorbed when given by mouth, and the size of this portion depends on the physiological functioning of the gastro-intestinal secretory and absorptive mechanisms. With ferrous sulphate it is usually considered that not more than 14% utilization can be obtained. A utilization coefficient of 28% is given for ferrous gluconate (Haler, 1952). Although oral iron is usually effective, it has certain disadvantages. It is unpleasant, and may cause vomiting and intestinal upsets. In some cases the parents do not

give the prescribed dose, or give it only irregularly, and if it causes any upset they stop further treatment without informing the doctor, and so the desired effect is not achieved. It is probable that the intestinal mucosal barrier prevents the absorption of iron in excess of immediate haemoglobin requirements, so that adequate stores are never accumulated. In addition, it takes some time for the effects of oral iron to be evident clinically, and this time factor is of great importance. Often infants with nutritional anaemia are not seen until the anaemia is well developed, and, as anaemia probably represents a final stage of a general tissue depletion, an affected infant will have been disturbed metabolically for some time previously. He may have been unwell generally, and, when exposed to the hazards of infection, reacted less well than a normal infant. Any increased speed of response to treatment would therefore be most valuable.

Intravenous iron preparations are utilized completely and rapidly. But, as is to be expected from the difficulty of the administration of these substances, they are not often used in practice. Several observers have reported their experiences with small groups of children (Granrud and Øster, 1950; Hanna and Shehata, 1951; Beaujon, 1951; Hagberg, 1951; Schöner, 1952; Stransky and Daus-Lawas, 1952; Wiesener, 1952). The largest series was that of Dickstein and his colleagues (1952), who treated 80 infants and children, of whom 66 were suffering from nutritional anaemia.

The introduction of an active, efficient, relatively painless intramuscular preparation, free from undesirable side-effects, would be a welcome advance in therapy for infants unable to tolerate or utilize oral iron and for those in whom rapidity of response was important, or in those in whom transfusion was difficult technically and iron might be a fair substitute.

There is, of course, already a British Pharmacopoeial preparation of iron for injection. It is, however, very painful and requires the addition of a local analgesic with every injection.

Present Investigation

This report describes the use of a new product—"inferon"—which is a stable, non-irritant preparation of an iron-dextran complex, containing 50 mg. of elemental iron per ml. Treatment of adults with this preparation has already been described (Baird and Podmore, 1954; Cappel *et al.*, 1954; Scott and Govan, 1954; Jennison and Ellis, 1954), but there have not so far been any reports of its use in infants.

We have treated more than 100 infants and children with this preparation, but we are here reporting only the results with initial groups who have been followed up for some months. The first infants treated were suffering from nutritional anaemia. Included among these were a few infants who had been premature at birth and who presented at 10–12 months of age with the "anaemia of prematurity." They responded so well to treatment that we next treated a group of infants attending the follow-up clinic for premature infants, many of them irregular attenders who, on being rounded up, were found to be anaemic. We then decided to try the effect of the prophylactic use of intramuscular iron in premature infants in the hope of preventing the otherwise almost inevitable anaemia of prematurity from developing later. In addition, there were several other infants who were anaemic as a result of haemorrhage, and these we have grouped as surgical cases.

Results

All haemoglobin values are on the scale 100% = 14.8 g. Sideroblasts were looked for in methanol-fixed films and

stained with equal parts of 5% HCl and 5% potassium ferrocyanide for 10 minutes at 56° C. in Coplin jars.

Nutritional Anaemia

There were 21 infants in this initial group (Table I). All were in-patients who had been admitted for various reasons—for example, failure to thrive, pallor, splenomegaly, bronchitis—and in whom examination of their peripheral blood

TABLE I.—Nutritional Anaemia

Case No.	Age (Months)	Dose (mg.)	Haemoglobin %						
			Initial	Weeks					
				1	2	4	6	8	10+
1	24	250	50	64	—	—	—	—	86
2	9	150	66	82	—	—	86	—	80
3	6	225	48	—	68	—	—	86	94
4	4	300	46	—	82	—	—	—	88
5	19	200	56	—	82	—	—	80	94
6	14	250	50	—	80	—	—	—	98
7	21	225	56	—	—	—	—	—	94
8	19	250	58	—	80	—	—	92	86
9	13	300	52	—	78	—	74	—	80
10	7	400	58	82	—	84	—	88	90
11	12	250	52	—	62	80	—	—	—
12	10	300	38	—	80	—	—	—	—
13	2	175	60	—	—	80	—	—	86
14	18	300	68	—	—	—	—	—	80
15	24	500	46	—	—	68	76	—	—
16	14	200	70	—	—	85	—	—	—
17	19	250	64	—	80	—	—	—	80
18	20	150	58	66	72	—	—	—	—
19	10	150	48	60	80	—	—	—	—
20	3	150	68	—	76	—	—	—	82
21	27	400	30	38	56	76	—	80	86
Average	14.5	256	54.5	65.3	75.1	78.8	78.7	83.2	87

showed anaemia with a low colour index. Marrow specimens were taken from the iliac crests of these infants before treatment was begun and showed the typical features of a nutritional iron-deficiency anaemia. Sideroblasts were looked for but rarely seen, and did not exceed 2% in any marrow. The amount of imferon injected at any one time was usually 50 mg. (1 ml.), and the total dose varied from 150 to 500 mg. The average number of injections was five. There was obvious rapid clinical improvement in all cases, as shown by the return of appetite, change of disposition, improvement in colour, and gain in weight. The average haemoglobin level before treatment was 54.5%; after two weeks this had risen to 75.1%, and at ten weeks or more was 87%. This improvement has been maintained, and some of the infants seen many months later still have normal blood pictures. The daily rise in haemoglobin during the first two weeks after treatment was almost 1.5%.

Some of the infants underwent marrow examination after treatment, and sideroblasts were seen in all of these, the number varying from 6% to 46% of the total nucleated red cells. The distribution of the haemoglobin levels before

FIG. 1.—Nutritional anaemia. Haemoglobin levels before and after treatment.

and after treatment is shown in Fig. 1. A typical case in this series is illustrated in Fig. 2. This patient was a boy of 2 years and 3 months who was admitted with marked pallor and hepatomegaly. He had developed normally since birth, but had never eaten any form of meat or fish. Rapid improvement followed the injection of 400 mg. of imferon in four doses on alternate days.

FIG. 2.—Nutritional anaemia. Illustrative case.

Anaemia of Prematurity—Treatment

The 14 babies in this group are shown in Table II. Most of these cases were infants whose mothers had failed to bring them regularly to the premature baby clinic and were

TABLE II.—Anaemia of Prematurity—Therapy

Case No.	Age (Months)	Dose (mg.)	Haemoglobin %						
			Initial	1	2	4	6	8	10
1	15	400	50	64	64	68	—	—	—
2	14	300	56	64	70	80	—	—	82
3	11	150	54	68	—	—	—	—	74
4	10	300	40	58	70	76	—	—	—
5	10	300	50	62	72	76	74	—	78
6	7	300	48	66	72	76	—	78	80
7	7	200	48	—	—	66	—	78	—
8	7	150	52	66	74	—	—	—	—
9	6	200	58	—	—	80	80	—	82
10	6	150	52	—	64	78	—	78	82
11	5	150	50	62	74	72	—	—	—
12	5	150	48	50	68	76	—	—	66*
13	4	100	46	58	62	66	68	—	76
14	2	150	40	58	76	—	—	78	—
Average	8	214	49.3	61.4	69.6	74	74	78	77.5

* This infant had bronchitis at the eighth week.

found to be anaemic when they eventually attended. A few had had oral iron prescribed but for various reasons had not responded. Marrow examinations were not carried out in this group. Again the usual dose was 50 mg. (1 ml.), but some received an injection of 100 mg. (2 ml.)—1 ml. into each buttock. The total dose varied from 100 to 400 mg.

The average haemoglobin before treatment was 49.3%, which rapidly increased to 69.6% at two weeks and was 77.5% when the infants were seen at ten weeks or later. The average daily rise in haemoglobin was more than 1.4%. Fig. 3 shows the distribution of the haemoglobin levels before and after treatment, and Fig. 4 shows the response of a typical case.

FIG. 3.—Anaemia of prematurity. Haemoglobin levels before and after treatment.

Since this new preparation was first tried, more than a year ago, our figures for these two groups have more than doubled and the results remain consistently good.

FIG. 4.—Anaemia of prematurity. Illustrative case.

Anaemia of Prematurity—Prophylaxis

Two groups of 10 premature babies were used. Alternate admissions to the premature baby unit were given injections during the third week after birth and the others were observed as controls. The treated babies with birth weights of less than 4 lb. (1.8 kg.) were given 250 mg. and those between 4 and 5 lb. (1.8 and 2.3 kg.) 150 mg. in 50-mg. (1-ml.) doses. The doses were based on the rapid increase in weight that was to be expected during the first six months of life. The results are shown in Table III and in Fig. 5. Although parenteral iron does not prevent the fall in haemo-

FIG. 5.—Anaemia of prematurity. Effect of the prophylactic use of intramuscular iron.

globin during the first few weeks of life any more than does oral iron, a significant difference in favour of the treated group has appeared by the 16th week and persists.

Marrow biopsies of the tibiae were carried out on some of the infants before treatment and on all of them at 16 weeks. No sideroblasts were seen in the specimens obtained before treatment, but were present in those examined at 16 weeks after treatment, varying between 6 and 10% of the total nucleated red cells seen.

In this group were included two sets of twins, and one of each pair was treated, the results being shown in Fig. 6.

FIG. 6.—Twins, treated and untreated. Effect of prophylactic treatment.

Surgical Cases

There were 10 cases in this group, and although all showed dramatic improvement the surgical conditions were too varied to allow of a detailed analysis. Injections were given both pre-operatively and post-operatively, and with effect occasionally instead of transfusion. For example, two infants with harelip were given 300 mg. of iron pre-operatively: one, a year old, had a haemoglobin of 68%, which fell to 50% after the operation, but had reached 74% four weeks later; the other, aged 8 months, with a haemoglobin of 54% pre-operatively, reached 84% at five weeks. An infant with a bleeding rectal polyp whose haemoglobin was 52% was given 200 mg., and two weeks later his haemoglobin was 95%.

Discussion

There is no doubt that this preparation produces a rapid clinical and haematological response and that the improvement is maintained for many months. Infections, both

TABLE III.—Anaemia of Prematurity—Prophylaxis

Untreated									Treated								
	Birth Wt. lb. oz.	Haemoglobin %								Birth Wt. lb. oz.	Haemoglobin %						
		Initial	Weeks								Initial	Weeks					
			4	8	12	16	20	24				4	8	12	16	20	24
1	4 8	128	62	66	66	66	—	64	1	4 5	110	64	68	72	80	—	78
2	4 4	118	66	64	72	64	60	60	2	4 7	114	68	66	80	84	—	78
3	4 4	102	92	86	86	74	58	64	3	3 12	96	—	62	72	68	86	—
4	4 13	112	86	64	70	—	86	80	4	3 5	98	—	70	74	86	80	78
5	3 14	102	82	78	74	58	60	60	5	4 1	134	64	66	84	76	74	86
6	3 15	—	92	—	74	68	—	76	6	4 5	128	—	72	84	86	88	90
7	4 12	130	—	—	—	66	—	60	7	3 2	—	—	—	78	74	86	84
8	4 6	130	96	70	—	74	—	62	8	3 7	140	90	—	80	76	—	80
9	4 11	126	—	86	86	—	—	72	9	4 2	116	86	74	70	88	82	82
10	4 7	—	—	64	64	—	—	58	10	4 2	116	—	—	—	—	—	84
Average:	4 6.2	118.3	82.3	72.2	74.0	67.1	66.0	65.6		3 14.4	116.8	74.4	68.3	77.1	79.7	82.7	82.2

Difference of means: Initial 1.7%: $0.5 < p < 0.6$. 8 weeks 3.9%: $0.2 < p < 0.3$. 16 weeks 22.6%: $p < 0.01$. 24 weeks 26.6%: $p < 0.01$.

in medical and in surgical conditions, prevent the utilization of parenteral iron just as they do when oral iron is used in such cases, and, furthermore, when used in infants with an infection reactions are more likely. The adverse effect of infection during treatment is illustrated by infant No. 12 in Table II. No more than the amount calculated to make good the iron deficit should be given.

This dose was calculated from the formula :

Fe required in mg. = $1.31 \times (17 - \text{Hb in g.}) \times \text{Wt. in lb.}$
The 1.31 is a constant based on the iron content of haemoglobin (0.34%), which gives 20 mg. of Fe per lb. at a haemoglobin level of 14.8 g.%. $\frac{20}{14.8} = 1.31$, and is the number of mg. of Fe required to raise the haemoglobin 1 g. per 100 ml. for each pound of body weight. The figure 17 was chosen arbitrarily to allow for depleted iron stores (14.8 + 2.2). This was later increased to 19 with even better and more rapid response as more complete saturation of the tissues was obtained.

The injections, given deeply, were not unduly painful and the discomfort was short-lived. No staining of the skin occurred. The upper and outer quadrant of the buttock is the most suitable site in infants; the arm is not suitable and the thigh less so than the buttock. No pyrexia or other side-effect was noticed. Injections were given to in-patients or out-patients daily, on alternate days, or weekly, as was convenient. A few in-patients received two injections a day—that is, 100 mg. of Fe—thus considerably reducing their stay in hospital, which is an important point in the age group concerned.

The average rate of response was between 1.4 and 1.5% haemoglobin a day, which is better than Dickstein and his colleagues obtained—which was 1% a day, using intravenous iron.

FIG. 7.—Iron deposits in marrow 48 hours after injection of 50 mg. of imferon. ($\times 160$.)

Imferon contains two and a half times more iron than the usual saccharated iron oxide preparations; larger doses of elemental iron can therefore be given at each injection. This is shown by the very rapid response during the first two weeks of treatment. In the nutritional anaemia cases the average increase was 20.6% and in the treated anaemia of prematurity 20.3%. The over-all increase in haemoglobin was 32% in the nutritional anaemias and 28% in the anaemias of prematurity. Hanna and Shehata (1951) found an average increase of 30% in 35 cases treated with intravenous iron, and noted that the more severe the anaemia the more rapid the response—a finding we also observed, the average daily increase in our infants whose initial haemoglobin was below 50% being 2%. This swift response is due to the very rapid absorption of the iron from the tissues, as shown in Fig. 7, which illustrates the appearance of iron in the marrow of an infant within 48 hours of a 50-mg. injection.

The actual utilization was not calculated, but is obviously very high. An increase of approximately 12% Hb was obtained for 100 mg. of iron injected, whereas only 4% is the calculated increase in adults, although adults and infants cannot be strictly compared in this respect.

Thrombosed veins, syncope, and other side-effects were reported in about 10% of all the series treated with intravenous iron, and, of course, accidental extraveneous injection

of the saccharated iron oxides is very painful, and damaging to the tissues. No side-effects were noted in any of our cases.

The indications for parenteral iron are limited. Hagberg (1951) concluded that it was indicated in cases of intestinal disorders such as coeliac disease or ulcerative colitis, and in any patient with nausea and vomiting.

It is particularly useful for infants whose home conditions are poor and who otherwise would have to be admitted to hospital for treatment, and for those infants in whom more rapid haemoglobin regeneration is required than can usually be obtained by oral therapy. Dickstein and his colleagues pointed out that a course of intravenous iron could often replace a blood transfusion and so reduce the risks attached to transfusion, although the technique, involving venepuncture, is similar in both. In our series there were premature twins who attended the clinic at the age of 10 months, obviously anaemic and with hepatosplenomegaly. One had a congenital heart lesion, and for this reason we preferred intramuscular iron to transfusion; he was given 300 mg. of imferon. His haemoglobin, 38% on admission, rose to 80% in two weeks. The second was transfused (with 200 ml. of blood), and the haemoglobin rose from 34% to 60%, where it remained. Thereafter he too was given iron (100 mg.), and his haemoglobin reached 80% two weeks later; the twins then progressed in parallel.

With reference to the use of blood transfusion in premature infants in order to prevent anaemia, Wolman (1953) stated that, although there were certain objections to transfusion, these were "counterbalanced by the general clinical impression that transfusions, when given to subthreshold infants, improve the general nutritional status, rate of weight gain, and perhaps resistance to infection." Rossier and Potiron (1955), after a five-year study, conclude that "repeated and systematic transfusions are the only efficient method of preventing the anaemia of prematurity and are the sovereign remedy for the cure of such anaemia—early or late and from whatever cause the prematurity occurred." We consider that this new preparation which we are describing here makes the foregoing conclusion no longer justified.

The use of intramuscular iron gives all the advantages of transfusion or intravenous iron therapy without the disadvantages.

Summary

An iron-dextran complex—"imferon"—has been given intramuscularly to more than 100 anaemic infants, with marked and rapid haematological and clinical improvement. The haemoglobin levels have been maintained for several months. The preparation has also been successfully used in the prevention of the anaemia of prematurity and in surgical cases complicated by haemorrhage, and pre-operatively to supply extra iron when operative bleeding is likely to be severe.

It is easy to give, and, provided the amount calculated to be equivalent to the iron deficit is not exceeded, is free from unpleasant reactions. It can be given in the out-patient department or the home, and thereby obviate admission to hospital in many cases. It can occasionally replace transfusion. Although it should not be used instead of oral iron as a routine procedure, it is a valuable addition to the therapy available for the treatment of severely anaemic infants or those intolerant of, or resistant to, oral iron preparations.

We are indebted to Dr. F. Fletcher for his help and advice throughout the course of this study and to Messrs. Bengers for supplying the imferon. We are also indebted to Dr. H. B. Marsden, pathologist, Royal Manchester Children's Hospital, who did all the haemoglobin estimations and reported on the marrow smears from the infants at that hospital; and to

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REFERENCES

- Baird, I. M., and Podmore, D. A. (1954). *Lancet*, 2, 942.
 Beaujon, A. (1951). *Rev. Policlin. (Caracas)*, 19, 485.
 Cappell, D. F., Hutchison, H. E., Hendry, E. B., and Conway, H. (1954). *British Medical Journal*, 2, 1255.
 Dickstein, B., Wolman, I. J., Tan, C., Slaughter, B., Butson, H., and Cohen, R. (1952). *Amer. J. Dis. Child.*, 84, 52.
 Granrud, H., and Øster, J. (1950). *Nord. Med.*, 43, 468.
 Hagberg, B. (1951). *Acta paediat. (Uppsala)*, 40, 519.
 Haler, D. (1952). *British Medical Journal*, 2, 1241.
 Hanna, M., and Shehata, A. H. (1951). *Ann. paediat. (Basel)*, 176, 121.
 Jennison, R. F., and Ellis, H. R. (1954). *Lancet*, 2, 1245.
 Rossier, A., and Potiron, L. (1955). *Arch. franç. Pédiat.*, 12, 261.
 Schöner, W. (1952). *Wien. med. Wschr.*, 102, 718.
 Scott, J. M., and Govan, A. D. T. (1954). *British Medical Journal*, 2, 1257.
 Stransky, E., and Daus-Lawas, D. F. (1952). *Ann. paediat. (Basel)*, 179, 348.
 Wiesener, H. (1952). *Dtsch. med. Wschr.*, 77, 622.
 Wolman, I. J. (1953). *Quart. Rev. Pediat.*, 8, 11.

METABOLIC CHANGES AND THERAPEUTIC CONSIDERATIONS IN BILATERAL ADRENALECTOMY

BY

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The profound metabolic and circulatory changes produced by surgery and anaesthesia have been intensively studied in recent years. The metabolic aspect, in particular, has been investigated by Moore and Ball (1951), who correlated data of other workers in this field. The consensus of opinion is that hyperactivity of the adrenal cortex is responsible for the broad pattern of these changes.

The superimposition of bilateral adrenalectomy upon a surgical procedure would thus produce further problems and difficulties to the body economy worthy of study.

Clinical Material and Methods

Three consecutive patients with carcinoma of the breast and widespread metastases admitted for simultaneous bilateral adrenalectomy and oophorectomy were considered. Each had had a radical mastectomy; all had been treated with prolonged androgen therapy.

After haemoglobin, protein, and electrolyte deficiencies had been corrected, the patients were prepared for operation by the regime advocated by Hollander *et al.* (1952). The details of cortisone, deoxycortone acetate (D.C.A.), and salt administration, which were started the day before the operation, are shown in Fig. 1. Each patient was taking fluid by mouth on the first day after operation and a normal diet on the seventh day. Accurate fluid balance charts were kept throughout the patients' stay in hospital.

The investigation started two or three days before the operation and lasted until the patients were discharged three weeks later. Urine analysis included volume, specific gravity, sodium, potassium, chloride, creatinine, urea, and ammonia. Routine clinical laboratory methods were used throughout, save for creatinine, which was estimated by the method advocated by Brod and Sirota (1948). The glomerular filtration rate was calculated as 24-hour endogenous creatinine clearance. The percentage excretion of water,

sodium, and potassium was calculated according to the method of Platt (1950). The potassium/nitrogen ratio was calculated from the sum of the urea, ammonia, and creatinine nitrogen found in the 24-hour urine specimen.

Blood chemistry included haematocrit and the plasma content of sodium, potassium, chloride, CO₂ combining power, creatinine, and urea. The intracellular sodium, potassium, and chloride were calculated from the formula:

$$C_o = \frac{C_b - C_p (1 - Ht)}{Ht}$$

where C_o, C_b, and C_p are the concentrations of sodium, potassium, or chloride in the cells, whole blood, and plasma respectively in mEq/litre, and Ht is the haematocrit expressed as a fraction of whole blood. Since the completion of this paper it has been brought to our attention that a similar formula, but with an obvious printer's error, had been derived by Eliel and Pearson (1951).

Results

Our results after adrenalectomy are similar in pattern to, but different in detail from, those found in non-adrenalectomized patients after surgery and anaesthesia. The data are presented in three phases.

(1) Period of Sodium Retention

On the first day after the operation the concentration of urinary sodium was decreased in one patient and was the same as the controlled pre-operative level in two. After this the concentration of sodium in the urine decreased in the subsequent 24-hour periods, reaching its minimum value approaching zero in two patients on the fifth day, and in one patient on the third day after operation—average four days (Figs. 1 and 2). The potassium excretion in the three patients averaged 44 mEq/day for the first three days after

TABLE I.—Case 3, aged 56. Bilateral Adrenalectomy and Oophorectomy. Detailed Constituents of the Three Periods of Sodium Excretion

Day	Urine Vol. ml./24 hr.	Sp. Gr.	% Excretion Na*	% Excretion K†	% Excretion H ₂ O‡	G.F.R. Cr. ml./24 hr.	K/N Ratio
-1	1,380	1.016	1.35	23.5	2.45	39	6.2
Period of Relative Na Retention	0		Operation				
	1	500	1.030	0.60	23.6	32	6.5
	2	790	1.022	0.20	24.2	62	5.5
	3	500	1.024	0.07	21.2	42	4.0
	4	1,215	1.012	0.05	11.5	97	3.1
Period of Early Na Diuresis	5	560	1.012	0.14	17.0	39	4.2
	6	1,475	1.010	0.32	15.0	146	3.8
	7	1,255	1.012	0.56	20.8	146	4.9
	8	1,405	1.008	0.90	8.0	176	2.1
	9	1,480	1.010	1.00	12.5	154	3.0
Period of Relative Na Retention	10	1,740	1.012	1.82	15.2	224	6.5
	11	1,905	1.012	1.55	17.4	227	6.9
	12	1,865	1.012	0.95	19.0	186	4.9
	13	2,350					
	14	1,640	1.008				
Period of Late Na Diuresis	15	1,340	1.010	0.70	15.5	150	4.6
	16	1,655	1.020				
	17	1,380	1.014	0.72	21.2	140	6.1
	18	1,580	1.016				
	19	1,630	1.014				
Period of Late Na Diuresis	20	1,630	1.012	0.92	24.5	180	7.7
	21	1,330	1.012	0.91	24.2	162	7.3
	22	1,115	1.013	0.91	22.0	148	6.3
	23	2,695	1.012	2.25	23.2	286	6.2
	24	1,800	1.014	1.80	23.0	233	5.8
Period of Late Na Diuresis	25	2,500	1.008	2.33	35.0	350	6.0
	26	2,100	1.013	1.95	31.0	256	6.0
	27	2,000	1.013				
	28	2,625	1.014				
	29	1,405	1.016				
30	1,620	1.008				78	9.5

* $\frac{U.Na \times P.cr.}{P.Na \times U.cr.} \times 100$. † $\frac{U.K \times P.cr.}{P.K \times U.cr.} \times 100$. ‡ $\frac{P.cr.}{U.cr.} \times 100$.

§ The period of relative sodium retention occurred in all three patients. It may, however, be the result of random variation rather than a true period, characteristic of adrenalectomized patients (see Table III and discussion).