SOME ASPECTS OF CARDITIS*

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I shall describe in this paper certain symptoms and signs which have helped me in the management and treatment of patients, particularly children, with rheumatic heart disease. I have also some observations to make on prognosis, based on the after-history records of children over a 10-years period.

The symptom-complex of rheumatic fever does not present a uniform clinical picture. There is a monocyclic type with pyrexia, toxæmia, sweating, leucocytosis, and migrating polyarthritis; the heart may not be affected, and recovery is complete after a week or ten days of acute illness and three weeks of convalescence. In some these acute symptoms develop after a throat infection and two or three weeks of low-grade fever. There may be a second similar cycle of symptoms without cardiac involvement. Some have a persistent irregular temperature not rising above 100° or 101°, and there are rare cases with hyperpyrexia (Coburn, 1931).

Fever is the most constant of rheumatic phenomena. There may be no arthritis and no cardiac or other visceral manifestations of infection. Tachycardia, like pyrexia, is evidence of a general infection, and not necessarily due to the cardiac lesion; its relation to active carditis, except in advanced disease, may not be that of infection of heart muscle or valve, but the indirect effect of toxæmia on heart rate.

Temperature and Pulse

The temperature and pulse chart is an index of active rheumatic infection; it is not a record of the degree of cardiac damage. There are rare cases of hyperpyrexia in children, it is true, with severe carditis, and rapid heart action is common in heart failure; but high fever and a much-accelerated pulse with slight or no structural disease of the heart are not uncommonly associated. The case history of a boy of 6 illustrates this lack of parallelism between pulse rate and structural change. Three weeks after scarlet fever he developed pyrexia and a tachycardia of an unusually high rate with sinus rhythm; the heart was not enlarged, a systolic murmur audible over the mitral area was heard for the first time, and there was a profuse growth of haemolytic streptococci from septic tonsils. He was given sulphanilamide, and the temperature was normal in two days. He was discharged from hospital a week later with no abnormal heart signs. This was probably not a rheumatic infection, but will serve as an illustration of disturbed heart action of infective origin without structural disease. It is common knowledge that sino-aortic tachycardia is a reaction to infection; with a rise in temperature there is a corresponding increase in the pulse rate. When it is a reaction to heart failure there are always other signs of serious heart disease. In cardiac rheumatism active infection is more often the cause of a persistent rapid regular heart action at rest over a long period than myocardial insufficiency.

The sleeping pulse rate may be a guide to infection, but cannot be used to distinguish infection from heart failure as

a cause of tachycardia, for in both conditions the sleeping pulse rate is raised, and approaches more closely the alert rate than in patients not actively infected or in failure. The pulse rate after exercise is increased by infection and by heart failure; this exaggerated reaction of heart rate may continue after the infection is quiescent and after recovery from heart failure. There are other factors involved in the response to effort which make the pulse rate after exercise an uncertain guide to infection or cardiac reserves. In early mitral stenosis, early aortic incompetence, and effort syndrome the rise in pulse rate after exercise may be the same, and is of little value in differential diagnosis. Tachycardia may be caused by nervous influences, infection, and heart failure; as an isolated sign it is unreliable evidence.

Dyspnoea

Dyspnoea after effort may be a symptom of infection, structural disease, debility, an abnormal nervous system, or some other quite different pathological process. Active rheumatic infection is usually absent when there is a valve lesion without enlargement of the heart. Few patients with either active or quiescent rheumatism complain of breathlessness at rest unless they have signs of heart failure. When these signs are absent, and the respiratory rate is raised, a heart lesion is not the cause.

When the heart with mitral or aortic disease is much enlarged, undue breathlessness after exercise, if there is no other known cause, is of cardiac origin. There is some difficulty in assessing this symptom when the valve lesion is not associated with an increase in the size of the heart; the myocardium has suffered slight injury, and carries an extra burden from the valve defects, but its reserve force is sufficient to meet the demands imposed on it by moderate exercise. Neurogenic influences may be the cause of the breathlessness, and not infrequently exercise tolerance is normal when these have been removed. The difficulties in dissociating breathlessness from the heart are much less when the valvular signs are of an equivocal nature; the systolic murmur as an isolated sign can be placed in this category.

Precordial pain is a common complaint of the patient with an inflammatory lesion of the heart; it is felt at rest, occurs more often after effort, and closely resembles the pain of effort syndrome. It is not anginal in character or distribution, and can easily be distinguished from the pleuropericardial pain of pericarditis by the cardiac signs. The precordial ache is a symptom of minor value in the diagnosis of structural disease.

Toxaemic Signs

There are signs of toxæmia which are not peculiar to a rheumatic infection but should nevertheless be treated with the greatest respect, for they serve as indirect evidence of structural change which may not be revealed by the heart signs. Pallor may be regarded as an important sign of infection in a rheumatic subject. A secondary anaemia of slight or moderate degree with a low-grade leucocytosis is the blood picture one expects to see in the active phases of carditis. It may develop rapidly, and the percentage of haemoglobin and

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the number of red corpuscles may reach extremely low levels, with anisocytosis and poikilocytosis, and with the colour index in most cases below unity.

A girl aged 10 was admitted to hospital under my care 11 years ago in congestive failure, with moderate enlargement of the heart, aortic regurgitation, mitral stenosis, pericarditis, fever, and other signs of a rheumatic infection. The blood counts revealed a severe and progressive anaemia. The red blood cells fell to 2 millions, and the haemoglobin to 30%, with a colour index of 0.75; there were anisocytosis, poikilocytosis, and nucleated red cells. She was given liver by mouth in large quantities; she liked it and may owe her recovery to this strange taste. The red cell count rose to 5 millions and the haemoglobin to 90%. The tonsils were enucleated a year later. She now leads an active life, works in a munition factory, can walk four miles comfortably, and was married last year.

There may be rapid wasting, gradual but steady loss of weight, or failure to gain weight. This reaction of the body weight to infection will be influenced by the virulence of the infection or resistance to it, or such other factors as exercise, vomiting, diet, conditions of rest, and the age of the patient. The weight chart is a more accurate record of infection in children than in adults. The sedimentation rate is raised in active rheumatism, as in other infections, and may remain high when other signs of activity can no longer be detected. A very high rate is evidence of a severe infection. A low rate may be expected in the non-active phases of rheumatism. The rate falls with the onset of congestive failure, and is affected by the degree of anaemia; it is raised in thyrotoxicosis and in other diseases. It is a less reliable sign of infection in chorea than in other forms of rheumatism; it is comparable to the pulse rate, temperature, and weight charts in distinguishing between active and non-active carditis; it bears a close relation to the development and disappearance of nodules. Subcutaneous nodules and arthritis are characteristic phenomena of rheumatic activity, but they are also tissue reactions of rheumatoid arthritis, and cannot therefore always be accepted as unequivocal evidence of juvenile rheumatism. The absence of these signs does not exclude active infection.

Diagnosis of Active Carditis

I have so far described some important signs of rheumatic activity without reference to cardiac signs. It has been my object to show that it is possible, from a study of the reaction of the body as a whole to infection, to distinguish between the active and the quiescent phases of carditis. The correlation of these signs with those of structural disease of the heart is essential as a basis for prognosis and treatment. The diagnosis of active carditis from the cardiac signs alone is one not easily made. The disease may progress from recurring infection without any change in the quality of the endocardial murmurs. It is difficult to recognize reactivation of a chronic valve lesion from an acute infection, whether the signs are those of mitral stenosis, aortic incompetence, or mitral regurgitation. The development of a diastolic murmur not hitherto audible is an indication that inflammatory changes are taking place in the valve. The development of an apical systolic murmur has less pathological significance. It may be a sign of endocarditis, or a functional reaction to infection. The loud harsh murmur with slow heart rate is more often organic, but the soft bruit accompanying an overacting heart may be due to structural damage. The endocardial murmurs are unreliable signs of active carditis. The friction rub of pericarditis in the course of a rheumatic infection is unequivocal evidence of active structural damage to the myocardium. A wrong diagnosis of aortic incompetence is a not uncommon error, occasionally with grave consequences.

One expects to find some cardiac enlargement in acute rheumatic myocarditis: a close parallelism undoubtedly exists between acute rheumatic infection and an increase in the size of the heart. In a fair number of cases there is no enlargement, and other signs must be found before cardiac involvement can be diagnosed. Those who maintain that the heart is always enlarged when it has been attacked by rheumatism may have been misled by placing too much reliance on the uncertain palpable and percussion outline of an overacting heart. Even an x-ray examination has its limitations in determining slight changes in the shape and size of the heart.

The development of enlargement of the different chambers of the heart, of the aorta, and of the pulmonary artery can be determined by the radiological method, now regarded as part of a systematic examination of the cardiovascular system. Enlargement of the heart in the course of a rheumatic infection is a sign of myocardial injury; it is an early response to this infection, and is likely to be progressive when the rheumatic process is active. The size of the heart is related to the type of the initial infection. One expects to find the earliest increase in size, and the largest heart, among those who have had a severe attack of rheumatic fever. A mild infection may cause a valve lesion with little or no enlargement, and remain stationary in a long quiescent period of the disease. Enlargement is also a reaction to the extra load which the heart has to carry as a result of a valve defect. Changes in the shape and size of the auricles and ventricles may be a quick response to rapidly developing aortic regurgitation, or the gradual effect, from strain, of the slow sclerosing process of mitral stenosis. The degree of enlargement is a more reliable index of the virulence of the infection than is the valve deformity. Progressive enlargement is a more valuable sign of active infection than is a change in the character of the murmur.

Heart-block

Electrocardiographic studies have demonstrated that in a large proportion of patients with active carditis there is a lengthening of the auriculo-ventricular conduction time. Cohn and Swift (1924) found that 84% of their cases with rheumatic heart disease showed some increase in the P-R interval. Keith's figures are approximately the same in those with carditis, and more than 50% in cases with chorea or arthritis without other signs of carditis (Keith, 1938). He concludes from his observations on the effect of atropine on the P-R interval that the mechanism responsible for the delay in conduction in all degrees up to complete heart-block is overstimulation of the vagus, and suggests that the exciting cause is the overactivity of the vagal nerve endings in the heart. Lengthened conduction may outlast all other manifestations of active infection for months. It is difficult to assess the significance of varying grades of heart-block in these circumstances. An arrhythmia of this type may be evidence of a localized pathological process in the region of the bundle, and a sign of active carditis; or it may be the residual effect of past rheumatism, a static situation not necessarily changing, like a murmur or enlargement of the heart. Transient partial heart-block can occur in association with vasovagal syncope; it may be a vagal effect without anatomical changes in the myocardium. The following two case records will illustrate how difficult it sometimes is to distinguish between active infection and residual myocardial damage on the evidence of heart-block.

Miss H., aged 20, had tonsillitis in July, 1939, and in August had well-developed symptoms and signs of rheumatic fever. In November there were no abnormal heart signs. In December the electrocardiogram showed heart-block with dropped beats, with no delay in conduction time after an exercise test and after atropine; the leucocytes were 11,200 per c.mm. and the sedimentation rate 5 mm. an hour. A diagnosis of active carditis was made on the evidence of heart-block and the history of recent rheumatism.

The other case is that of a young man aged 22. He had fainted in the past but had no return of this symptom for three years. His complaint at the time of examination was epigastric pain before meals. There was no history of rheumatism or sore throat. The heart was not enlarged and there were no murmurs. The electrocardiograms while in hospital showed partial heart-block with dropped beats and no delay in conduction after exercise and atropine; right axis deviation was present. There was no leucocytosis, and the sedimentation rate was not raised. Was heart-block in this case an isolated sign of active infection or residual damage from past infection? I did not think he had active carditis.

The development of auricular fibrillation is of great clinical importance, for it influences the course of rheumatic heart disease in the direction of heart failure and is therefore in close relation to the cause of death. It is a late manifestation of the rheumatic process, with an incidence of more than 40% among those who die, and the duration of life after its onset is less than three years in a large proportion of cases (De Graff and Lingg, 1935). Nutritional changes in the myocardium may be

the cause of this disturbance of rhythm; the part played by active infection as a causative factor in its production has not been demonstrated. There are some who hold the view that auricular fibrillation is sometimes an effect and not the cause of heart failure (Luten, 1936).

Interrelation of Heart Failure and Rheumatism

When we consider heart failure in relation to rheumatic infection there is a general recognition that these two conditions are interlocked. Acute or subacute rheumatic activity must be regarded as the chief cause of myocardial failure in rheumatic heart disease. Progressive enlargement is a constant feature of heart failure; active infection may be responsible for progressive increase in size and failure. There are, among other contributory factors involved in these changes, a progressive valve lesion and auricular fibrillation; both impose an extra burden on the heart and are closely linked with activity of infection. The heart failure of bacterial endocarditis is good evidence in support of the view that active infection plays a more important part in heart failure than mechanical strain.

Bacterial endocarditis is not evidence of rheumatic activity; its relation to the phenomena of rheumatic disease is accidental (Coburn, 1931). It is a blood-stream infection which may present symptoms and signs easily distinguished from those of cardiac rheumatism. The temperature, pulse rate, and blood picture are not always distinguishing features of the two types of infection; embolic phenomena may be absent, the fingers not clubbed, the spleen not palpable, and the blood sterile. In children, bacterial endocarditis is extremely rare, and consequently the difficulties of differential diagnosis do not often arise.

Prognosis of Carditis

I have some observations to make about prognosis, based on the after-history records of 200 boys with carditis, average age 11 years, over a 10-year period. These children were under my care in a special convalescent home, and the basis of treatment was rest in bed when there were symptoms or signs of active infection; those without active infection were allowed to play games regulated to avoid undue breathlessness and over-fatigue. There are two consecutive groups of 100; in one group (Table I) the average stay in the home was four

TABLE I.—Results of 100 Cases under Observation for 10 Years

Disease	Cases	Living	Dead	Untraced
Mitral disease: systolic murmur	57	36 (63%)	18 (32%)	3
Mitral stenosis	23	8 (35%)	14 (61%)	1
Aortic regurgitation and mitral stenosis	14	7 (50%)	6 (43%)	1
Aortic regurgitation	4	2 (50%)	2 (50%)	0
Non-valvular	2	1 (50%)	0	1
Total	100	54%	40%	6%

TABLE II.—Results of 100 Cases under Observation for 10 Years

Disease	Cases	Living	Dead	Under Observation less than 10 Years
Mitral disease: systolic murmur	32	18 (56%)	8 (25%)	6
Mitral stenosis	34	16 (47%)	12 (35%)	6
Aortic regurgitation and mitral stenosis	24	9 (37%)	13 (54%)	2
Aortic regurgitation	6	3 (50%)	1 (17%)	2
Non-valvular	4	3 (75%)	0	1
Total	100	49%	34%	17%

TABLE III (Tables I and II combined).—Results of 200 Cases under Observation for 10 Years

Disease	Cases	Living	Dead	Untraced
Mitral disease: systolic murmur	89	54 (60%)	26 (29%)	9
Mitral stenosis	57	24 (42%)	26 (46%)	7
Aortic regurgitation and mitral stenosis	38	16 (42%)	19 (50%)	3
Aortic regurgitation	10	5 (50%)	3 (30%)	2
Non-valvular	6	4 (66%)	0	2
Total	200	103 (52%)	74 (37%)	23 (11%)

TABLE IV.—Degree of Enlargement

Disease	Living						Dead						Grand Total
	Blank	0	+	++	+++	Total	Blank	0	+	++	+++	Total	
Mitral disease: systolic murmur	5	5	9	5		24	1	2	3			8	32
Mitral stenosis	3	0	12	6	1	22	1	2	7	2		12	34
Aortic regurgitation and mitral stenosis	1	1	4	5		11	1	5	4	2		13	24
Aortic regurgitation			4	1		5			1			1	6
Non-valvular			3	1		4							4
Total	9	6	32	18	1	66	3	9	15	4		34	100
		57%						35%					

TABLE V.—Under Observation 1-5 Years and 5-10 Years

Disease	Dead in 1-5 Years						Dead in 5-10 Years						Grand Total
	Blank	0	+	++	+++	Total	Blank	0	+	++	+++	Total	
Mitral disease: systolic murmur	1		1	1		3	2	1	2			5	8
Mitral stenosis	1		2	4	2	9			3			3	12
Aortic regurgitation and mitral stenosis	1	1	4		2	8	1	1	4			6	14
Aortic regurgitation				1		1							1
Non-valvular								3	1			4	4
Total	3	1	7	6	4	21	3	5	10			18	39

and a half months, and in the other (Table II), six months. The 200 cases are also dealt with as one group (Table III) by combining Tables I and II. They are classified as valve lesions in Tables I to III; Table IV gives the degree of enlargement of cases in Table II. In Tables I to IV the numbers known to be alive or dead at the end of the tenth year are recorded.

The figures in Table I show that 54% are living, 40% dead, and 6% untraced. In Table II 49% are living, 34% dead, and 17% untraced. In Table III 52% survive, 37% died, and 11% are untraced in this 10-year period.

In Table I 63% with mitral systolic murmurs are living and 32% dead; 35% with mitral stenosis are living and 61% dead; 50% with aortic regurgitation and mitral stenosis are living and 43% dead; with aortic regurgitation alone 50% are living and 50% dead.

In Table II 56% are living and 25% dead in the systolic murmur group; 47% with mitral stenosis are living and 35% dead; with aortic regurgitation and mitral stenosis 37% are living and 54% dead; with aortic regurgitation alone 50% are living and 17% dead.

Table III shows 60% living and 29% dead with mitral systolic murmurs; 42% living and 46% dead with mitral stenosis; 42% living and 50% dead with aortic regurgitation and mitral stenosis; 50% living and 30% dead with aortic regurgitation.

In Table IV it will be seen that 57% with slight or no enlargement are living and 35% are dead at the end of 10 years.

Table V shows that 21 died within 5 years and 18 died in the second 5-year period.

Summary and Conclusions

Observations are made on the prognosis in carditis, based on the after-histories of 200 boys, average age 11 years.

Rather more than one-half of the children with carditis are alive and slightly more than one-third are dead 10 years after from 4½ to 6 months' treatment in a special convalescent home. The larger number of untraced cases in Table II (17% as against 6% in Table I) prevents one from concluding that the prognosis is more favourable when the stay in a convalescent home is increased from 4½ to 6 months.

Rather less than half of those who die within 10 years live longer than 5 years after treatment in a special convalescent home.

The death rate in children with mitral stenosis and aortic regurgitation is much higher than in those with mitral systolic murmurs, over a 10-year period.

Children with moderate or considerable enlargement of the heart are less likely to live 10 years than those with slight or no enlargement.

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REACTIONS FOLLOWING TRANSFUSIONS OF STORED BLOOD

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Two cases of blood transfusion reaction not due to incompatibility are here recorded. Though there is a lack of pathological data, they present such unusual features as to justify detailed clinical notes. The therapy employed in these cases invites criticism from many aspects. It is described rather fully, however, since the reaction to these measures involves interesting physiological considerations.

Case I

Woman aged 30. Six children. Rheumatic fever in June, 1940. Admitted for colpoperineorrhaphy. Haemoglobin 66%. Group A (II). Blood transfusion with Group O (IV) blood 4 days old, which was directly matched with the patient's serum and found to be suitable.

Nov. 19.—10.45 a.m.: Transfusion drip started. 11 a.m.: Complained of headache and vomited a little; chest felt tight. 11.30 a.m.: Felt cold and was a little shivery. At 12 noon, when 3/4 pint had been given, she complained of pain in the chest. The transfusion was stopped. Shortly afterwards colour was poor and pulse rapid and thready, 140 a minute. Resuscitation measures; omnopon gr. 1/3, heat cradle, and warm drinks were given, but vomiting became troublesome. Temperature rose to 102° at 2 p.m. and condition did not improve, the pulse remaining rapid and thready. The bed was blocked and rectal fluids were given. Coramine was administered repeatedly. Blood taken from a vein was sterile after 5 days' culture. At 10 p.m. there was still no improvement. Lips cyanosed, eyes sunken, extremities icy, tongue dry, mentality clear, exposed veins empty, pulse almost imperceptible. Heart rate 140 regular; B.P. 40 systolic. Lungs clear. At 11.30 p.m. intravenous saline was started, 2 pints being given rapidly.

Nov. 20.—After the saline the B.P. rose to 75/55 at 12.25 a.m. and pulse was countable at 126. A third pint was run in more slowly, and at 4 a.m. the B.P. had fallen to 60/45 and later to 50/35. One pint of plasma was then given rapidly (20 minutes), and at 5 a.m. the B.P. was 55/35. Further intravenous saline was given more slowly. Digoxin 0.5 mg. was injected intravenously, and D.O.C.A. 5 mg. was given. Five hours later, at 10 a.m., the patient's condition was still that of profound collapse; T. 99°, P. 120, R. 20, B.P. 50/35. She was restless, sunken-eyed, and a little cyanosed; veins empty, a few crepitations at right base, no icterus. No urine had been passed since the transfusion reaction had occurred, nearly 24 hours previously. Total intravenous fluid: 4 pints saline, 1 pint plasma. At 3.30 p.m. 0.25 c.c.m. pituitrin was given, and repeated in half an hour; the pulse, which had remained steady at 120 though poor in volume, fell to 100, but had risen to 120 by 6 p.m. Catheterization produced 7 oz. of highly coloured urine: albumin—moderate cloud; no blood, haemoglobin, or bile; pus, *B. coli*, and an occasional R.B.C. This urine may have been in the bladder since the transfusion was started. W.B.C. 23,000, R.B.C. 3,950,000, Hb 70%, blood urea 80 mg./100 c.c.m. At 12 midnight, 24 hours after the intravenous saline had been started and over 36 hours since the reaction occurred, B.P. was still 55/35. T. 100°, P. 120, R. 28; hiccup, retching, very restless, neck veins not filled above the angle of Louis, lungs clear, no oedema. Eucortone had been given without improvement.

Nov. 21.—At 2.30 a.m. 0.25 c.c.m. pituitrin was given, and repeated in half an hour as before; again the pulse fell promptly to 100. Respirations at this time had returned to 20. At 10 a.m., after a restless night, patient was slightly delirious. Hiccup persistent; P. 90, R. 30, B.P. 60/30. Slight dyspnoea, rhythm intermittent. Venous pulsation at root of neck but veins not filled above the level of the angle of Louis. Few basal rales. No oedema. Marked

rigidity of all the limbs. Two pints of saline had been given in the previous 12 hours, making 11 pints in about 36 hours since the drip was started. Intravenous drip was discontinued. Urine, 4 oz., passed spontaneously at 6 a.m. (The first urine definitely secreted since the reaction had occurred—44 hours.) It contained albumin (heavy cloud); no blood or haemoglobin; pus cells but no casts in centrifugal deposit. Ephedrine gr. 1/2 was given by injection 3 times between 10.30 a.m. and 2 p.m., and thereafter gr. 1/4 every four hours. Urine, 6 oz., was passed spontaneously at 3 p.m. At 6 p.m. there was definite clinical improvement. Pulse had remained between 88 and 100 all day; B.P. 60/35, R. 24. At 12 p.m. pulse rate rose to 120, dyspnoea increased, patient became restless and delirious; B.P. 75/40, R. 30. Neck veins were not filled above the level of the angle of Louis. No oedema. Early failure was suspected, but ephedrine gr. 1/4 was continued 4-hourly, digoxin being given, 0.5 mg. b.d.

Nov. 22.—At 12 noon, 72 hours after the transfusion, patient was restless and wandering mentally. T. 99°, P. 120, R. 30. Extensive herpes of lips, mouth sore, mucosa ulcerated, tongue dry and furred. No icterus. Urine, 14 oz., was passed during the night. Casts, blood, and haemoglobin were absent. During the day the pulse rate fell to 80 at 2 p.m. and 66 at midnight, becoming grossly irregular. B.P., however, rose from 64/40 at 12 noon to 75/45 at 3 p.m. and 90/60 at 12 midnight. Definite congestive failure was now present, with 1½ in. of venous filling in the neck. Respirations 36–40; slight oedema of ankles and sacrum. The cardiac irregularity was considered to be due to auricular fibrillation in a fully digitalized patient. Ephedrine and digoxin were stopped. Urine passed during day measured 21 oz.

Nov. 23.—Diarrhoea with incontinence of faeces now occurred. Urine was being passed freely—65 oz. in 24 hours. Slow fibrillation continued, but signs of congestion had cleared. Hiccup was persistent. There was marked bruising of the skin at the site of injections and very slight icterus was thought to be present. Van den Bergh's reaction gave a very weak indirect positive. Blood urea 180 mg./100 c.c.m. and urine urea 1.2%. R.B.C. 4,610,000, Hb 80%, W.B.C. 12,300, polys. 85%.

Nov. 25.—Diarrhoea was still persistent though fluids alone were being given by mouth. Marked dehydration was present and fibrillation at 80 a minute continued. B.P. 100/50. No icterus. At midnight dehydration was still pronounced, and patient was very reluctant to take fluids because of vomiting and ulceration of mouth and throat. I.V. saline was started.

Nov. 26 and 27.—Intravenous saline was continued, 16 pints being given in 48 hours. Urine passed during this period was 94 pints in addition to that voided during a period of faecal incontinence. No sign of congestion or oedema developed, and on the 27th the pulse was regular at 90. Thereafter the patient recovered rapidly, and on the 29th B.P. was 115/75 and blood urea 50 mg./100 c.c.m. Urine showed trace of albumin; pus cells and *B. coli* still present. No casts.

On Dec. 8 urea clearance was 70% of normal maximum clearance. Blood urea 36 mg./100 c.c.m.

Case II

Soldier aged 27. Admitted Dec. 25, 1941, with gunshot wound of left thigh. During the week after admission repeated secondary haemorrhages occurred, which were treated by packing of the wound and compression bandages. Blood pressure ranged between 110/70 and 135/80. Temperature up to 100°.

On Jan. 1, 1942, R.B.C. 2,750,000, W.B.C. 26,000, polys. 80%, Hb 50%. Group O (IV).

Jan. 2.—At 5.45 p.m. drip blood transfusion was started with Group O blood (citrate)—three days old—which had been directly matched with the patient's serum. No. 1 bottle (2/3 pint of whole blood) was given at a fast drip 60–100 a minute. At 6.10 p.m. severe rigor after about 1/3 pint. Pulse 120. Blood drip reduced to 10–15 a minute. Adrenaline 5 minims and morphine gr. 1/4 given. At 6.30 p.m. patient was shivery and complained of headache and pain in back of neck and chest. Vomited twice. No. 1 bottle was replaced by No. 2 bottle (though 1/2 pint still remained in No. 1), and this had run in by 8 p.m. without further reaction. Pulse remained at 120, but condition seemed better. The remainder of No. 1 bottle was then given at 40–60 a minute and the transfusion was completed by about 9.30 p.m. without further incident. At 10 p.m.: Temperature 105°, pulse 160 and thready. Sweating profusely, vomiting at intervals and complaining of intense thirst. Coramine was given and rectal saline started.

Jan. 3.—During the night he was restless and slept for short intervals only. He took large quantities of water by mouth and vomited repeatedly. Pulse fell to 100 at 5 a.m.; volume improved slightly. Temperature 99°. From 5 a.m. pulse rose gradually; at 9 a.m. he was pale, grey, and the pulse was imperceptible. He was again given coramine. At 10 a.m.: T. 97°, P. 104, R. 28; pale and restless; pulse volume poor; B.P. 50 systolic; no dehydration;