The following preliminary observations were designed to test these views. Fig. 4 shows the results on a subject in whom rapid haemodilution was induced by taking two pints of lager beer in the half-hour following bleeding. There was marked haemodilution—measured by a fall in red cells and haemoglobin—in the first hour, with a corresponding fall in plasma protein but no increase in cell size. Between the first and second hours there was a big diuresis, during which time all the quickly absorbed fluid appears to have been excreted, so that the haemoglobin and plasma protein rose to their original figure. Thereafter haemodilution proceeded normally. Evidence of the ability of the diluted plasma to cause swelling of the cells was sought for by exchanging cells and plasma in a haematocrit tube from samples obtained before and after bleeding and observing the effect on the haematocrit reading. Table III shows the negative effect of making these interchanges in this case, which is perhaps not surprising as no swelling of the cells was observed. But the same result was obtained in four animals more severely bled.

TABLE III

Corpuscles	Plasma	Haematocrit
Before bleeding	Before bleeding	46.5
" "	1 hour after	46.0
" "	5 hours after	46.0
1 hour after	1 hour after	44.0
1 " "	Before bleeding	43.8
5 hours after	5 hours after	44.0
5 " "	Before bleeding	43.8

It is clear from this case that considerable haemodilution with plasma protein reduction can occur without swelling of the red cells. It is clear also that in this case there was neither acidosis (Fig. 4) nor swelling. Furthermore, the observations made on animals subjected to repeated small haemorrhages, already described, show that considerable haemodilution can occur without alteration in cell size. The balance of this preliminary evidence is therefore against a simple osmotic phenomenon due to plasma protein dilution. More positive evidence from similar observations needs to be obtained from cases which exhibit definite cell swelling before the acid-base explanation can be accepted.

Summary

Minor increases in red cell size, probably of no physiological importance, occur after a single large acute haemorrhage.

Smaller increases occur after more sustained haemorrhage, but no increase at all with repeated small haemorrhages.

There is no evidence for the immobilization of swollen cells in muscle capillaries, as described by Brennan, nor of their mobilization by plasma transfusion.

The minor increases in size which do occur must be taken into account when using the haematocrit for following changes in blood volume caused by haemorrhage. The haematocrit figure should be controlled with a red cell count and haemoglobin determination.

Haemodilution is complete in about twenty-four hours in normal subjects, but may occupy three to four days after surgical operation.

Red cell swelling following haemorrhage is probably not due to mere reduction in plasma protein consequent upon haemodilution.

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TREATMENT OF RHEUMATOID ARTHRITIS IN CHILDREN

BY

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In reading through the literature on the treatment of chronic infectious arthritis and noting the host of remedies proposed—each of them having enthusiastic advocates but few having stood the test of time—one cannot be surprised at the almost universal scepticism among physicians regarding any remedy. As Keating (1938) has aptly said, "The treatment of this disease has varied from the local application of rattlesnake oil and salicylic acid to the injection of anything, from salicylates, heavy metals, and dyes, down to the removal of almost every organ in the body that isn't padlocked."

Methods of Treatment

The following therapeutic items are, in the opinion of most physicians primarily interested in rheumatism, of value in the treatment of chronic infectious arthritis: management of infected foci; vaccines or filtrates; foreign proteins; diet, vitamins, blood transfusion; gold salts; artificial jaundice; physical therapy.

Focal Removal.—The conservative removal of obviously infected foci is generally recommended (Thompson *et al.*, 1938), as good results following this procedure have occurred too often to be coincidental. Teeth, tonsils, prostate, sinuses, and cervix should be examined for the presence of infection. However, indiscriminate surgical intervention should be condemned. In dealing with infected foci it should be remembered that, while many arthritics probably benefit from the removal of such infected material (Buckley, 1938), still more seem to receive no help at all, and the number of dramatic cures is relatively very small. The general physician and not the "focal specialist" should decide what foci are to be removed (Hench *et al.*, 1940).

Vaccines, Filtrates.—Vaccine therapy is considered about as valuable as focal eradication. An editorial comment in the sixth Rheumatism Review (1940) states that "it is difficult to understand why vaccines should be expected to cure this disease of unknown origin when no infectious disease of known aetiology is cured by vaccine." However, other rheumatologists are convinced of the value of vaccines (Thompson and Wyatt, 1938; Crowe, 1937). Overholt and Mortensen (1937) consider that vaccines have a place in the treatment of this disease, but not as a specific. They recommend stock vaccines of "arthrotropic" streptococci—i.e., vaccines which when injected into rabbits will produce joint swellings (Lederle's *Streptococcus haemolyticus* vaccine)—and consider them to be preferable to autogenous vaccines of unknown tropism.

Foreign Proteins.—The value of the injection of foreign protein probably results from a general stimulation of metabolism consequent on the fever produced. This form of therapy is difficult to control and is always associated with varying degrees of discomfort and danger (Copeman and Tegner, 1937). Weekly doses of the protein which do not cause the patient's temperature to rise above 102° F. are considered most likely to yield good effects. Drastic shock therapy does not justify the results obtained.

Diet, Vitamins, Blood Transfusion.—There is no "arthritis diet," *per se*, specifically beneficial in arthritis, but on account of the general systemic effects of the disease the diet should provide for optimal nutrition and relief of

constipation, and should be rich in vitamins and minerals. Foods to which a patient may be sensitive should be avoided. Various vitamin deficiencies have been suggested to be of aetiological significance, but treatment with massive doses of the deficient vitamin has not been attended with any success (Abrams and Bauer, 1938). Occasional blood transfusions in acute cases with a low haemoglobin content are often valuable, as in the active phases of this disease the administration of iron seems to have little effect in raising the haemoglobin content.

Gold Salts.—This form of therapy seems to be of value. Many investigators condemn it, mostly on account of the dangerous toxic effects which may result; but because of its apparent success in curtailing the activity of the disease (Ellman *et al.*, 1940; van Breemen, 1938; Hartfall *et al.*, 1937) it should receive consideration in every case of active rheumatoid arthritis. The serious complications occur more often when large doses of the gold salt are given. Its use should be confined to patients in whom the disease is active as judged by a high sedimentation rate, low haemoglobin, loss of weight, joint-swelling, and pain. The total quantity of gold salt used in the treatment of an adult should rarely exceed 4 grammes. It is given by weekly injection in two or three courses each lasting two months, with intervals of six weeks' rest between. If severe toxic symptoms occur after the first course a second should not be given.

Artificial Jaundice.—For some years physicians have known that an attack of jaundice in a patient suffering from rheumatoid arthritis often results in a temporary remission of that disease. This observation was first made by Still and was rediscovered by Hench. Hench (1937) tried to reproduce this effect by the administration of bile, bile salts, synthetic bile salts, human bile by stomach tube, and transfusions of large amounts of highly jaundiced blood to a number of patients at different times. No significant results were obtained from these experiments. Later, Thompson and Wyatt (1938) noted that the administration of bile salts alone did not improve rheumatoid arthritis, nor did injections of bilirubin alone. But injections of bilirubin combined with bile salts (decholin) gave temporary amelioration, "which apparently duplicates the effects" of spontaneous jaundice. Hench was unable to confirm these results.

Physical Therapy.—The editors of the fifth Rheumatism Review (1939) state that "physicians may argue the merits of other forms of therapy, but they agree on the value of physical therapy." Osgood (1934) has asserted: "Physical therapy is one of our most effective weapons against eventual restriction of function in the atrophic type of arthritis."

The following physical agents are useful in the treatment of chronic infectious arthritis: thermal agents, massage, exercise and rest, hydrotherapy, heliotherapy, iontophoresis, low-frequency currents.

Thermal Agents

Heat to influence the local and general circulation may be applied in a number of ways.

Local.—The heat should be applied for twenty to thirty minutes. It may be given by means of infra-red generators or electric bulbs. For home use small inexpensive electric heat sources are available, but an output of less than 250 watts is considered unsatisfactory. Hot paraffin-wax is another good method of applying heat locally, and is particularly useful in houses where there is no electricity. Some persons are sensitive to the wax, which may cause skin reactions. Diathermy is good for deep-seated joints but is expensive and therefore not practicable for prolonged

use. For peripheral joints it has no advantage over the method previously mentioned.

General.—General heating of the body is accomplished by several methods. (a) Short-wave diathermy—i.e., placing an induction cable under a thin mattress on the treatment table and enclosing the patient in a very thick type of sleeping-bag. (b) Radiation cabinet: if this is used the patient should be lying down and not sitting up, as is generally advised. The heat source is numerous carbon filament electric bulbs. (c) Immersion in hot water: this type of treatment will be dealt with later. (d) The most suitable method of producing general heating is by means of a hypertherm. The patient's temperature should be raised to about 103° F., but careful watch (especially in very active cases) should be kept for intolerance—e.g., headache, vomiting, or vascular collapse.

Massage

According to Pemberton (Mock *et al.*, 1934) massage in rheumatoid arthritis tends (1) to prevent or delay atrophy of muscle tissue and to restore tissue when atrophy has taken place; (2) to improve local and general metabolism; (3) to increase the circulation of the blood in certain tissues; (4) to provide a mechanical substitute, in aiding circulation, for the loss of muscular contractions caused by inactivity. "Essentially the process consists in a light form of stroking known as effleurage, usually in the centripetal direction, from which it progresses through various stages to a heavy rubbing and kneading."

It may not be out of place here to correct a widespread impression that massage and stretching can, *per se*, free stiffened joints—only further damage results. All the good effects following massage should be looked for in a betterment of the circulation. In the acute phases massage should be applied with caution, and the edict, "Don't hurt your patient," is always pertinent.

Exercise and Rest

Exercise and rest are of much importance in preserving the eventual function of the affected joints. The exercises must, however, be carefully graduated and supervised. The rule should be that if pain is present two hours after the exercises have been finished they were overdone, and the length of time spent at them and the range of movement attempted should be less on the next occasion. The exercises should be of the active assistive variety, attempting the normal range in all directions for the particular joint. This means that the patient will actively move the limb in a particular direction until pain is experienced. At this point the technician will gently assist the movement, but not more than a few degrees. Exercises should be carried out methodically in increasing amounts for certain periods each day, and between these periods the joints should be rested in splints designed to prevent deformity. "Pumping" of the joints is particularly harmful.

The importance of rest for the affected joints has already been stressed, but general rest in bed is of equal importance when the disease is active. The prescription of rest should be on a minimum basis of ten hours at night, and two separate periods of one hour during the day. In persons in whom the spine is also affected the proper carrying out of exercises for maintaining the normal chest expansion and correct posture is very important.

If a joint is very acutely inflamed it may be advisable to immobilize the limb in a light splint. However, one must always bear in mind the danger of loss of joint function entailed in such a procedure; and it is recommended that complete immobilization of a limb should rarely last more than one week.

Hydrotherapy

Hydrotherapy is of much value. The following measures are especially useful.

Under-water Exercises in a Hubbard Tank.—The benefits resulting from this procedure are: (a) The great relaxation of muscular spasm and the relief of pain from the heat and buoyancy of the water: as a result of this the affected joints may be moved through a greater arc without pain. (b) The weakened atrophied muscles are capable of more work without fatigue. (c) General heating and exercise can be combined. (d) A favourable psychological effect is created.

Contrast Baths.—These are convenient for bringing about active hyperaemia in the hands or feet. The technique recommended is immersion of the limbs in water at 110° F. for four minutes, and in water at 50° F. for one minute—these times produce optimal adaptability in normals and arthritics (Krusen, 1937). The vascular adaptability is often deranged in severe cases of rheumatoid arthritis, especially in women, so that contrast baths should in general be avoided in their case.

Wet Pack.—This is a useful measure, especially in non-institutional treatment; the details of this procedure are well known.

Other Physical Agents

Heliotherapy.—A general course of ultra-violet light given concurrently with other treatment helps to build up the patient's general resistance.

Iontophoresis.—Iontophoresis with vasodilating drugs such as histamine or acetyl-beta-methylcholine has been shown by Kovacs to produce prolonged hyperaemia of the joints in rheumatoid arthritis, but I think it is indicated only where hyperaemia fails to result from simpler methods.

Low-frequency Currents.—Low-frequency currents, such as the surging faradic or sinusoidal, are occasionally of value by causing involuntary muscular contractions without movement in the limb; this is often required when the joints are very acutely affected and the limb has to be immobilized for longer periods than usual. They are also of value if a functional element is one of the causes of limitation of movement.

As there are so many different physiotherapeutic methods a definite scheme of treatment should be employed. The items in this scheme should vary somewhat from day to day, as the body quickly accommodates itself to a particular stimulation if applied for prolonged periods. Such variation also prevents the patient from becoming bored, as the treatment must necessarily be carried on for a long time.

Two cases of chronic infectious arthritis in children are presented: the disease in one was extremely active; in the other it seemed to be completely quiescent. It is interesting to note that they came from the same country district in Ireland and are the only two cases that Dr. Collis has had under his care at the National Children's Hospital, Dublin, during the last eight years.

Case I

A boy aged 11 developed diphtheria at the age of 4 years; some months later he complained of diffuse aching soreness in his body and limbs. This was intermittently present for three months, when both his knees became slightly swollen and tender. His ankles, wrists, elbows, and some of his finger-joints became similarly affected, in that order, during the space of two months. He walked with difficulty, and became very thin. This attack lasted five months, and when it passed off he was apparently quite all right, apart from some thickening in the various joints affected. Since then he has had two similar attacks yearly until eight months before examination. None of these attacks had

been quite so bad as the first, either in severity or in the number of joints affected. The attacks seem to be precipitated by unduly cold or hot weather. This boy is one of a family of seven, but the others are not so affected. There was nothing relevant in the family history.

Examination revealed concomitant squint, tonsils enlarged II+, no enlarged lymph nodes, chest expansion limited to three-quarters of an inch. There was scoliosis of the dorsal spine, some limitation of movement and thickening of both elbows and wrists, and some thickening of both knees and ankles, but normal range of movement in these joints. The blood sedimentation rate was 10 mm. at the end of one hour; haemoglobin, 78%; red and white cell counts, normal.

The only treatment employed was local heat, massage, and remedial exercises to try to increase the range of motion in the affected joints. No systemic effects of the disease were present, so no general therapeutic measures were deemed necessary.

The disease in this case is thought to be undergoing a remission, and, on account of the length of time that it has been present, possibly to be altogether quiescent.

Case II

This patient was a boy aged 10, one of a family of ten. His mother described him as the healthiest child in the family until two years previously, when he began to complain of pains in his knees and in the back of his head. His doctor sent him to the local hospital, where three weeks later his wrists, elbows, ankles, and feet became similarly affected. During these two years he had had four incomplete remissions. The present attack began seven months previously, and was so severe that he could not walk. Since then he had been in bed, but had received no treatment until he was admitted to this hospital.

Examination revealed a wasted boy weighing 45 lb., with very pale lips and cheeks. He was unable to sit up by himself and was utterly crippled. Tonsils enlarged I+. Marked pain in neck on movement of head, with limitation of movement in all directions. Chest expansion limited to one inch. Fusiform swelling with ulnar deviation and flexion deformity of both wrists; no movement. Elbows: flexion deformity; no movement; marked thickening of peri-articular structures. Knees: swollen, red, and tender; flexion deformity at 100 degrees, slight movement present. Ankles: swollen, red, and tender; slight limitation of movement. Metatarsal joints thickened and tender. Pulse and temperature normal. Blood sedimentation rate 70 mm. at the end of one hour; haemoglobin, 50%; red cells, 3,500,000 per c.mm.; white cells, 18,000 per c.mm. Routine urinalysis negative. Radiographs of various joints showed decalcification of the bones and slight erosion of the articular surfaces of the wrist-joints.

TREATMENT

A definite physiotherapeutic programme was followed, making use of most of the procedure already outlined. The contractions were gradually overcome by simple orthopaedic measures. As the disease was very active we considered it advisable to attempt some form of general therapy with a view to producing a remission of the general disease process.

We first tried the "artificial jaundice" method of Thompson and Wyatt. Their technique was followed closely until we were forced to change it on account of repeated venous thrombosis. Ten mg. of bilirubin per kg. of body weight was dissolved in N/10 sodium carbonate which had been previously brought to the boil. The mixture was allowed to cool and was then passed through a Seitz filter. A sterile solution of bile salts (decholin), 40 mg. per kg. of body weight, was then added to the filtrate. Three daily injections of 250 mg. of bilirubin and 1 gramme of decholin in 10 c.cm. of sodium carbonate were given. This dose was doubled in the two following injections. The conjunctiva became jaundiced after the fourth injection and bile appeared in the urine.

Thrombosis of the veins after the injections also occurred in both Thompson's and Hench's cases. We thought to overcome it by diluting the mixture by adding distilled water to the bile salts. A mixture containing 10 grammes of bile salts (sodium tauroglycocholic acid), 2.5 grammes of bilirubin, 40 c.cm. of N/10 sodium carbonate, and 1,000 c.cm. of distilled water was prepared as described above. We intended to give this mixture

by the intravenous-drip method over a period of twenty-four hours; however, thrombosis again occurred after less than 50 c.cm. had been administered. Eight thousand units of heparin were then given intramuscularly, and an hour later another cannula was inserted into a fresh vein and 8,000 units of heparin were injected through it. The bilirubin-bile-salts mixture was again administered by the intravenous-drip method, this time with success, and the amount previously stated was given without untoward effect during the next twenty-four hours.

The results were disappointing: there was some slight limbering of the wrists and elbows about the fourth day of treatment, and the sedimentation rate dropped about 15 mm. The experiment was hardly worth the trouble taken or the expense of the bilirubin.

At the time of writing we are proceeding with gold therapy carefully so as to avoid reactions: 0.01 mg. of solganal B in oil was the initial dose; this was repeated weekly for two doses, then 0.02 mg. was used for two weeks, followed by 0.05 mg. weekly. This latter dose will be given until 0.5 gramme is reached. Then after an interval of six weeks another course of gold therapy will follow if the sedimentation rate is still raised.

The sedimentation rate remains at 35 mm., but the general clinical condition of the child is altogether changed. On arrival at the hospital he was unable even to sit up or raise his head, and his arms and legs were held rigidly flexed. Now, although the disease as judged by the sedimentation rate is still active, he has so far progressed as to be able to walk unaided, and with continued therapy we may expect a return of reasonable activity, as the disease burns itself out.

The following three-day routine was carried out until the patient was able to stand:

1st Day: (a) Radiant heat to affected joints for 25 minutes. (b) Effleurage and pétrissage for 10 minutes. (c) Active assistive exercise for 5 minutes to each joint.

2nd Day: (a) General luminous heat, raising body temperature to 102° F. for 20 minutes. (b) Effleurage and pétrissage for 10 minutes. (c) Active assistive exercise of affected joints for 5 minutes.

3rd Day: (a) Raising body temperature to 102° F. in bath for 20 minutes. (b) Effleurage and pétrissage for 10 minutes. (c) Active assistive exercise for five minutes.

When he was able to stand unaided the last day of the routine was omitted, and graduated walking exercises, at first with the aid of a "walker," later without it, were incorporated after each treatment.

Discussion

The two cases bring out the fact that this form of rheumatoid arthritis tends to occur in bouts which are separated by periods of remission. In the end the disease tends "to burn itself out"; this usually occurs before the child reaches 16 years: we believe this happened in Case I. This fact is of fundamental importance when considering therapy. Clearly, every effort should be made to bring about remissions by carefully chosen specific measures (i.e., gold, fever treatment, and, possibly, artificial jaundice), and at the same time to improve the general health. But whatever specific treatment is used the correct physiotherapy is of the utmost importance. If the child is allowed to become or to remain crippled by contractions his life is ruined, for he will never be able to take his place as a normal member of society. Early, regular, and carefully controlled physiotherapy is therefore essential. Indeed, it may be said that the ultimate fate of the child in after-life depends upon whether the physician grasps this point clearly, and his subsequent conscientiousness. It is not easy to continue treatment for months, sometimes for years, but if crippling contractures are to be overcome continuous and prolonged treatment is essential.

Summary

Of the many methods of treatment used in rheumatoid arthritis the best results are most likely to follow the employment of physical therapy over a prolonged period and the injection of

gold salts. The patient should be educated in the use of simple physiotherapeutic measures so that these may be carried out in his own home. Other forms of treatment of possible value are eradication of focal infection, the use of vaccines, and high-vitamin low-carbohydrate high-calorie diet.

It is emphasized that all treatments should be carried out concurrently rather than singly.

Two cases of Still's disease (rheumatoid arthritis in children) are described. In a boy aged 11 the disease is considered to be quiescent. The other boy, aged 10, had the disease for two years and it is still very active. There was swelling and redness of the peripheral joints with limitation of movement.

Treatment along the above lines resulted in considerable improvement in the second case. Intravenous injections of bilirubin-bile-salts mixture were given in an endeavour to confirm the work of Thompson and Wyatt, who obtained remissions by the artificial production of jaundice. The result in my case was disappointing.

I wish to thank Dr. W. R. F. Collis for allowing me to work up these cases of his at the National Children's Hospital, Dublin, and the Board of the Hospital and the Hospitals Commission for their help in the matter of the bile-salts and pigments used.

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OBSERVATIONS UPON BREECH DELIVERY

BY

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For several generations the problems connected with breech delivery have aroused great interest on account of the high infant mortality rate. In 1931 the statistics of four large hospitals suggested that this should be placed as high as 28% of uncomplicated cases in primiparae and 15% in multiparae (Gibberd, 1931). In recent years there has been much improvement, and many institutions can now show a corrected mortality rate of 10% or even less; but the average rate is still too high. The series analysed below comprises 84 consecutive breech deliveries, representing all cases dealt with at the Woking Maternity Home since 1935. Admittedly, the number is small, but every effort is made, by prophylactic version, to avoid the presentation. Uncomplicated breech deliveries are really not very common, representing in our series about 2% of 3,500 deliveries. This, indeed, is an artificially high incidence, as many cases are sent in from the surrounding district because of the presentation, so that the natural incidence can scarcely be more than 1.5%, and possibly may be even less. In order to avoid confusion I have omitted all cases of twins, all very premature infants under 5 lb. in weight, and all cases complicated by toxæmia, ante-partum haemorrhage, and other foetal and maternal abnormalities. Although the results of a small series must be interpreted with caution, I have attempted to gauge the percentage incidence of some of the common difficulties met with, and particularly the