

## THE THERAPEUTIC VALUE OF IRRADIATED MILK IN THE TREATMENT OF RICKETS.

BY CHALMERS WATSON, M.D., F.R.C.P. EDIN.,  
SENIOR PHYSICIAN, ROYAL INFIRMARY, EDINBURGH;  
AND

T. Y. FINLAY, M.D., F.R.C.P. EDIN.,  
CLINICAL OFFICER, CHILD WELFARE DEPARTMENT, EDINBURGH  
CORPORATION.

*With a Radiological Report by*

J. B. KING, M.D., M.R.C.P. EDIN., D.R.,  
SENIOR ASSISTANT RADIOLOGIST, ROYAL INFIRMARY,  
EDINBURGH.

PROGRESS in our knowledge of the ætiology of rickets in the past few decades may be briefly summarised as follows. Dr. Palm in 1890 published a memoir in which, on the strength of observations made on the frequency of rickets in Edinburgh, contrasted with its incidence in sunnier climes, he suggested that rickets was due primarily to lack of sunshine. Little attention was paid to this view, the suggestion being lost sight of until quite recently. In 1919 Huldshinsky published a paper on the cure of rickets by means of the artificial alpine sun. This was followed by numerous papers at home and abroad confirming Huldshinsky's results. In 1926 Huldshinsky wrote as follows:

"The sunlight of which our children are deprived through our narrow alleys and sunless streets must be given them in the form of artificial alpine sun. The necessity is great and urgent that every child, whether manifesting symptoms of rickets or not, should undergo irradiation treatment for at least a month during its first year. The expense incurred will be amply repaid by the improvement of the whole nation."

Prof. H. Steenbock, of Wisconsin University, discovered a method of putting sunlight into cereals, milk, and other food products. Dr. Alfred Hess, of New York City, applied this clinically with milk and recorded notable results from its use in rickets. The unfavourable taste of the milk after irradiation was a deterrent to this method being employed to any extent. Within the last three years, however, important improvements have taken place in the method of irradiation, and there are now several processes which can irradiate milk successfully without injuring its flavour. Prof. K. Scheer, of the Children's Clinic, Frankfurt, using the "Scholl" system, has recorded striking results from the use of irradiated milk in the treatment of rickets. Scheer's results have been fully confirmed by numerous German writers, with the result that various municipalities in Germany have made provision for the supply of irradiated milk in their areas. Scheer pointed out that irradiated milk has the great advantage over various commercial products that there is no need for concern regarding weakening of the anti-rachitic principle with keeping since the milk is always consumed in a fresh condition. To quote Scheer's words: "The outstanding advantage over all other methods in my opinion and the reason why I have given such long and intensive consideration to this question, lies in the possibility of prophylactic treatment of rickets."

So far as we are aware, the strikingly favourable results recorded by numerous German workers from the use of irradiated milk have never been challenged, although a note of warning has often been sounded about the possible injurious results of excessive or indiscriminate use of irradiated milk and various irradiated medicinal products, more especially in children. With the exception of a few isolated and inconclusive observations, little or no attention has been directed to this subject by clinicians in this country, and in the past six months we have carried out a series of observations with the object of confirming or otherwise the results recorded by German authorities.

### *Methods of Irradiation.*

There are at least five recognised methods of irradiation, known by the name of Scholl, Scheidt, Buhtz, Wamoscher, and Vita ray lamps. In the Scholl system the milk is irradiated in an oxygen-free atmosphere, the oxygen being removed by admixture with CO<sub>2</sub> gas. The milk is irradiated in a water-cooled chamber, the ultra-violet rays being furnished by a quartz mercury-vapour lamp, the milk, in a very delicate film, flowing over a surface 3 inches from the lamp. The time of exposure to the rays is 45 seconds. The taste of the milk is slightly modified, giving the impression that a little soda-water has been added. Its physical properties seem to be also slightly modified; it appears to be somewhat thinner than the untreated milk. This is apparently due to some alteration in the fat globules of the milk. The bacteriological content of the milk was found on frequent examination to be reduced by about 70 per cent.

In Scheidt's apparatus the milk runs from the bottom to the top directly the length of a long quartz tube. For the production of the ultra-violet rays a high-tension electric current is used, which is sent through a vacuum pipe filled with argon gas. With the Scheidt process the irradiation takes place in the cold, and it is therefore spoken of as "the cold process." The flavour of the milk is unaltered.

Our experience is limited to these two forms of apparatus. Milk is successfully irradiated by both these processes. In the first series of 12 cases treated, which form the basis of the present communication, the irradiation was effected by the Scholl apparatus; in a subsequent series no less favourable results followed the use of "the cold process."

### *Clinical Observations.*

A series of 12 cases was selected, six of which were treated in the wards of the Royal Infirmary, while the remaining six were in-patients in the Victoria Children's Home, a part of the child welfare scheme of the Edinburgh Corporation. The ages of the children ranged from 2 to 5 years. Of the last six, four were selected as being specially suitable for the test, from the fact that they had been under indoor treatment for periods ranging from three to five months, and had proved unusually refractory to treatment, which had included, in various combinations, ultra-violet rays, ostelin, irradiated ergosterol, and irradiated cod-liver oil. These four cases provided a useful control, as the milk supplied to the home is high-grade milk from the tubercle-tested herd of the Corporation. While the general conditions and the condition of the joints of these four children had undergone improvement, their progress had been disappointing, the radiological appearances of one of them, after five months' treatment, being indicated in Fig. 7.

All the 12 cases were good examples of pronounced rickets; eight of them were treated de novo, the other four, as stated, having been under skilled hospital treatment for a considerable period before the administration of the irradiated milk. In these four cases all the medicinal and other special anti-rachitic measures in use were stopped, the same diet being continued, with the exception that 6 oz. of irradiated milk replaced 6 oz. daily of the unirradiated high-grade milk in previous use. The dietary in these four cases included 18 oz. of milk daily, the proportion of irradiated to unirradiated milk being 1 in 3. In the remaining eight cases milk entered more largely into the dietary, 36 oz. of milk being given daily, of which one-half was irradiated. The irradiated milk was supplied from the milk of a Certified milk dairy, the irradiation being carried out under the personal supervision of one of us. Frequent radiological examinations were made at short intervals, a standardised technique being employed to eliminate, so far as possible, all experimental error. Attention was directed mainly to the condition of the wrists, knees, and ankles.

Rapid improvement took place in the condition of the joints, occurring uniformly in all the cases treated.

Within 14 days of starting to give irradiated milk it was clear that a remarkable curative influence was at work. In cases of moderate severity radiological evidence of cure was obtained within four to six weeks, and in extreme cases within six to eight weeks. The manner in which the disorderly growth of the cells and imperfect ossification characteristic of rickets gave place to orderly growth and a normal radiographic appearance was surprising. An all-round improvement in the general condition accompanied this change, this being evident by increased muscular tone and activity, and improvement in the mental state of the children. Within seven weeks of the commencement of treatment it was possible to give a demonstration (in the Radiological Department of the Royal Infirmary) of the results of the treatment, which carried conviction to all who saw it. A general impression of the rate of progress may be gained from the series of illustrations appended. A short account of the radiographic findings is here given, after which two illustrative cases are recorded in some detail.

RADIOLOGICAL REPORT BY DR. KING.

The pathological changes occurring in the bones in rickets lend themselves very readily to demonstration by X rays, and it has long been recognised that the efficacy of any form of treatment may well be gauged by the degree of improvement as shown radiologically.

The pathological process at the growing ends of the long bones is essentially an abnormal vascularisation of the epiphyseal cartilage, with a resulting aberrant deposit of calcium throughout the so-called "osteoid" tissue. It is found that in a florid case of active rickets the clear line representing the epiphyseal cartilage is several times the normal width, and that throughout this cartilage there are numerous fine irregular striæ.

FIG. 1.



CASE 1.—Rickets in a child aged 5.

The metaphysis, instead of showing a regular line of increased density immediately adjacent to the epiphyseal cartilage, has an irregular flocculent appearance; and, as the changes are most marked towards the centre of the bone, there is frequently a degree of "cupping." This latter deformity is usually most marked at the distal end of the ulna. In cases where treatment has been delayed there may be bowing of the long bones, but this is of little interest here as being less amenable to medical treatment.

A very large number of studies have been made of the process of healing under various forms of antirachitic treatment, and it is not intended here to go into this in detail. It will suffice to point out that within 14 days of the commencement of treatment by irradiated milk there was a perfectly definite clearing of the epiphyseal cartilage, and that the metaphysis showed an increase in regularity, with early signs of the formation of the band of sclerosis already referred to as being a constant feature of healthy bones.

The illustrations given show the improvement after one month's treatment (Figs. 3-8). The diminution in the width of the epiphyseal cartilage will also be noticed.

The active and previously untreated cases are the most readily followed in their improvement. Con-

siderable difficulty arises in forming a comparison with any other form of antirachitic treatment, since it is desirable to compare only cases of similar age, severity of disease, and previous treatment. In can, however, be stated that the rate of improvement under irradiated milk is, from a radiological point of view at least, greater over any given period of time than that observed under other forms of antirachitic treatment. Moreover, as is mentioned elsewhere, there was marked radiological evidence of improvement in several cases which had been found abnormally resistant to modern antirachitic measures.

Brief mention may be made of the physical properties of the milk. Earlier observers found that after irradiation, milk and other foodstuffs not only acquired therapeutic power but also possessed a degree of photo-activity. They further found, however, that these two properties were not necessarily concomitant, for if the irradiation was done in an oxygen-free atmosphere there was no loss in the therapeutic value, but, in the case of oils at least, no photo-activity was developed. The greater part of the work on this subject has been done on the continent, and it may be pointed out that the photo-activity is more probably due to some chemical action than to the actual emission of radiation. Experiments were done with the milk here used and no evidence of photo-activity was found, this bearing out from isolated observations the previous experiences of others.



Radiogram of knee-joint in healthy child aged 5. Note clear epiphyseal line, with regular dense metaphysis.

ILLUSTRATIVE CASES.

The records of two cases may be given in some detail; these sufficiently indicate the details of dietary and other treatment.

CASE 1.—A photograph is given (Fig. 1) of one of the most severe cases—the patient being a child, aged 5, treated in the wards of one of us in the Royal Infirmary. He was unable to stand or walk; he had never walked; he had not learned to speak, and he had never been known to smile. On four different occasions he had been treated for rickets. The general condition is well revealed by the photograph, which, however, gives an inadequate idea of the severity of the curvatures of the limbs. For the first few weeks the treatment was restricted to rest in bed in the ward, and the following dietary:—

(a) For first three days: Ate little. Diet selected from 1 pint of milk, of which 1 part in 6 was irradiated. Rusks (wholemeal bread), half an egg, orange-juice, and a little porridge.

(b) Four subsequent days: 36 oz. milk of Certified standard, of which one-third was irradiated; otherwise as above.

(c) 2½ weeks: 36 oz. of milk (half of it irradiated); otherwise as above.

(d) After (c): 36 oz. of milk continued as in (c). A little meat added in form of fish, chicken, tripe, also potato, and occasionally turnip and apple.

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