THE EFFECT OF CARBON ARC RADIATIONS ON CERTAIN COMPONENTS OF THE BLOOD IN CHILDREN.

by

JAMES L. CHISHOLM, M.B., Ch.B.

Thesis for the Degree of M.D.

October 1928.

INDEX.

THE EFFECT OF CARBON ARC RADIATIONS ON CERTAIN COMPONENTS OF THE BLOOD IN CHILDREN.

I. INTRODUCTION.

While acting as a resident Medical Officer in the Royal Hospital for Sick Children, Edinburgh, the writer was very much impressed by the general improvement he saw in certain cases attending the Artificial Heliotherapy Department of the hospital.

These cases were sent to the department, not suffering from any definite disease, but labelled "General Debility", "Anaemia", "Post-operative debility", "Debility from chronic sepsis", etc.

The beneficial effects of Heliotherapy in Rickets, Surgical Tuberculosis and other definite diseases are well known and have been most thoroughly investigated by hosts of observers. However it occurred to the writer to investigate a series of such children and find out whether the beneficial effects of the Heliotherapy could be accounted for, by any changes in certain components of their blood.

The chief available sources of Ultra-violet radiation are the sun, the Hg Arc in Quartz, and the Carbon Arc - burning solid or cored carbons filled with mixtures of rare earths.

In this country owing to its low altitudes and its climatic conditions, the use of natural helio-therapy/

heliotherapy is greatly restricted and we have to fall back on one or other of the artificial means of producing radiations. The common belief that the radiations of such sources is mainly active because of the ultra-violet fraction may be so, but it has been demonstrated in only a very few instances, such as the cure and prevention of rickets and the formation of melanin in the skin. On the other hand there is much evidence that the effects observed are due to the entire spectrum. In some cases the evidence points to the visible portion of the spectrum as being particularly active. In others the action of certain wave lengths in the ultra-violet region has been shewn to be increased by simultaneous action of the visible and infra-red. The application of this is demonstrated by the placing of a cluster of incandescent lamps around the hood of the Quartz Hg vapour lamp.

Sonne[1] decides that the evidence at hand does not permit us to say that the beneficial action of irradiation is to be found exclusively in the ultra-violet region. He believes the heating by the luminous portion of the heat spectrum of the subcutaneous tissues and the blood therein to temperatures greater than these experienced in fever, but without raising the general body temperature owing to the heat regulating mechanism of the body, to be the main/

main feature of the curative action of radiant energy and it is for this reason he favours the Carbon arc lamp over the Hg Vapour, which emits far less luminous rays than either the sun or the C. Arc.

Humphris[2] thinks that the Hg vapour lamps are more suited to the treatment of superficial conditions, the Carbon arc to more deeply seated conditions, a view based on the greater penetration of the visible and infra-red rays of the Carbon Arc. For a general body bath he prefers the Carbon arc to the Quartz Hg vapour lamp, because the rays from the former are more like the solar radiation than those obtained from any other source.

Relying on Humphris' experience the cases investigated were all exposed to Carbon arc radiations.

The selected children were all of a type so very common in any large medical out-patient department of a city hospital. The type of child represented is well known to all pediatricians. It is the child of the poorer hospital class, probably living in one of the worst quarters of the city, inefficiently clothed, under nourished but yet not showing any of the clinical manifestations of rickets. There is usually a long history of chronic ill-health. The child is said to sleep badly, eat little, is easily tired, looks pale and is under average weight and height. When examined no definite disease is found but what usually strikes one/

one is the very bad posture of these children probably from an undernourished muscular system. The child is usually labelled general debility or some such term and given a tonic. Previous to artificial helio-therapy, there usually was little improvement with this treatment unless the children were sent to the country or seaside (natural heliotherapy).

Now, however, these children make up a large percentage of the children attending the Heliotherapy Dept. as out-patients and their improvement is most encouraging to all those interested in the use of artificial heliotherapy. The investigation aimed at finding out if any changes in certain components of the blood in these children could account for their improvement.

The components investigated were the Red Blood Corpuscles, the White Blood Corpuscles, the Haemo-globin content and the Platelets. The Calcium and phosphorus concentrations in the blood were also estimated at intervals in case any change in these important inorganic constituents of the blood could cause the effect noted.

All of these children showed such a marked improvement in colour along with the other manifesta-tions, that the writer was hopeful some important changes could be demonstrated in the blood components investigated, to account for the great change in the/

the child's health. It was with this idea that the investigation was carried out, and though the results obtained are not as convincing as was hoped, yet they are so uniform that in the writer's mind, it is certain that Actinotherapy has a very definite therapeutic action on a blood of poor qualities, the latter being due more to the nourishment of the individual than to any definite organic disease.

May not most of these children be suffering from an insufficiency of some vitamin, either A, D or some other not yet isolated, and that sunlight has the same effect here as in Vitamin D insufficiency?

----

2. HISTORICAL.

In studying the history of Heliotherapy, one finds that it is by no means a new cult, but one practised as far back as any method of treatment in use at the present day.

The great strides made in the use of Heliotherapy, and especially of its much more recent ally, Actino-therapy, during the present century, are apt to make one believe that this method of treatment is one of Medicine's newest. But it is well known, that bathing in the sun's rays was practised by the ancient Egyptians, the Greeks and the Romans. The solaria to be found in most of the dwellings of the more wealthy Romans, as described by Cicero, are indications of the extent to which the beneficent rays of the sun were appreciated in those times.

The most remote writings which describe the therapeutic effects of the sun, were set down in 431 B.C. These writings were made by one of the name of Herodutus. It is interesting to note his indications and contra-indications, as quoted by a Greek physician in Rome. He says:

"Exposure to the sun is especially indispensable to people requiring restoration and increase of musculature, although one should guard against such rays as have passed through clouds, and one should avoid/

avoid also in wind-protected parts such rays as may there collect. Furthermore, one should take care that in winter, spring and autumn the sun should have a direct access to the sick person: in summer and in the case of feeble individuals this method is to be avoided: the head is to be covered during the cure."

It will be therefore seen that though the furthest back one can date Heliotherapy is to the time of Herodutus, one would have to reach very much further back - probably right into pre-historic times - in order to find the first beginnings of this cult. The sun has been worshipped from the most ancient of times, who can tell but that it will be worshipped more fervently in the future.

Since these far-off days sun-bathing was practised fairly widely up till the advent and conquest of Christianity throughout the then civilised world. No trace of this method of treatment is to be found in the writings of the Dark Ages, and it was not until the end of the second half of the 18th Century that Heliotherapy again had a sway. This is ascribed to the results of Christianity, which discouraged any practices allied to "Sun worship".

Rollier gives an interesting account of the early uses of sunlight in his book "Heliotherapy". He mentions that in 1774, Faure published his work on "L'usage de la chaleur actuelle dans le traitement des ulcères"; (Memoires de l'Academie royale de Chirurgie, Paris,/

Paris, 1774 Tone V). In the same year Le Peyre and Le Courte used lenses to focus the rays of the sun on to open wounds with such good results that they even cured cases of cancer! In 1779 Bertrand published his essays on the Influence of Light on Living Organisms.

But it was in 1815 that Heliotherapy was given more respect by the works of Loebel, published in the Journal of Practical Treatment Vol. II, Pt VI, 1815. He advised general rather than local insolation. Loebel gave a full list of indications and contra-indications. Some of his contra-indications could be well remembered by many of the medical profession of this generation. Amongst them are the following - acute inflammatory conditions, lung trouble associated with inflammation, haemoptysis, haemorrhage of all kinds, congestions and gastric disturbances.

The merit of having enlarged the range of indications for Heliotherapy belongs to the French, and especially to the school of Lyons. This school extended the use of Heliotherapy to the tubercular forms of arthritis.

Towards the end of last century and up to the present day a large amount of work has been done in the scientific aspect of the problem; and the name that stands out preeminent, in that respect, is that of Finsen, who studied the special properties of the various/

various rays of the sun's spectrum. As well, of course, he will be ever remembered for his practical work in the treatment of small-pox by means of red light, and in the treatment of lupus by "Finsen light".

Following Finsen, numerous workers carried out scientific laboratory investigations, in an attempt to explain the mode of action of the sun's rays. The most prominent of these are Roux, Arloing, Koch, Marceuse, Strebel, Weinzierl and V. Schrötter. Most of the work done was on the penetration of the rays in the body, and their effect on micro-organisms.

In 1903 A. Rollier opened his Clinic in Leysin amidst the Alps at a height of 1300 metres. This was the first Clinic devoted exclusively to the systematic treatment of external Tuberculosis. Rollier's principle, in the use of Heliotherapy for the treatment of Tuberculosis, is to strengthen the individual power of resistance to such an extent, that a quicker cure of the local focus is brought about by treating the whole organism. His results certainly have been exceptionally impressive.

The discovery of the electric arc made artificial Heliotherapy possible and Finsen was the first to practise Actinotherapy; and in 1893 published his results of the treatment of lupus by the rays emitted from the carbon-arc lamp - the now famous "Finsen Light".

Following/

Following Finsen's discovery a great deal of work was done on the clinical side of the problem. To begin with Actinotherapy, in the form of Carbon arc radiation, was used solely for local lesions. The beneficial action of the solar radiations on sores was known from early times, and Actinotherapy was tried on these lesions with beneficial results. As time advanced, it became more widely recognised that radiant energy had more than a local action, and what was at first thought to be due to the direct bactericidal action of the rays was later proved to be due to its general action, as the penetration of the bactericidal rays is so slight as to be practically negligible. The application of Actinotherapy to the treatment of the deficiency disease, especially Rickets, brought this form of treatment into the front line, and since that time great strides have been made in the use and mode of application.

It is a curious fact that though the cure of Rickets by sunlight was expounded by T.A. Palm in 1890, it was not till 1918 that sunlight - natural or artificial - was recognised generally as almost a specific therapeutic agent for this malady.

The invention of the Quartz Hg-vapour lamp, and the improvements in the Carbon arc lamp have now made the practice of Actinotherapy as large as - if not larger than, natural Heliotherapy, and there are few/

few institutions of any size in this country that do not boast of at least one source of "Ultra_Violet Rays".

In England splendid work has been done by Sir Henry Gauvain at Alton and Hayling Island. As natural Heliotherapy the whole year round is an impossibility in this country, Sir Henry relies on artificial means of production of the ultra_violet rays when he is unable to obtain bright sunshine.

Every hospital with the means of producing radiant energy is doing splendid work in the preven_tion and cure of disease, with this therapeutic agent, but it is to be hoped more supervision is to be brought into force to prevent the exploiting of it for monetary gain by people unqualified in its use, as is being practised all over this and other countries at the present time.

III. TECHNIQUE AND GENERAL EFFECTS.

The artificial sources of ultra-violet rays of any practical importance are the Hg vapour arc, the Tungsten arc, the Iron arc, and the Carbon arc, using either solid Carbons or Carbons filled with mixtures of rare earths or metals.

The chief source of production therefore depends on the electric arc, discovered by Finsen in 1893, but ultra-violet rays may also be generated by the spark discharges of Leyden jars or spark coils, but not in sufficient volume for therapeutic uses. An arc is formed by an electric current passing between two terminals, the result of which is to produce an intense illumination. This illumination is composed of ultra-violet rays, together with certain visible rays according to the type of lamp and the electrodes used.

Arc lamps may be divided into two main groups, open and closed arcs.

Open arc lamps usually have their electrodes of carbon or tungsten, pure or modified but other metals may be used - namely, iron, cadinium, aluminium, silicon etc.

Closed arc lamps comprise quartz Hg vapour lamps, which may be air-cooled or water-cooled.

In this investigation, Carbon-arc lamps only were/

were used. The type used is one manufactured by John Bell & Croyden Ltd., and called the "Alpine Sun Lamp". It is one of the new type of Carbon-arc lamps, having four arcs in series. This avoids the waste which occurs with single arcs working off a voltage of 200 volts or over as supplied by most Corporations, as in the latter the surplus voltage has to be dissipated in heat by a large resistance. The lamp is supposed to work on a current of 25 amperes, but when burning only consumes a current of 15 amperes. The arrangement of the electrodes in each arc of this lamp is important. An upper positive electrode alternates with an upper negative electrode, so that the craters formed in the positive electrodes (whence the most powerful radiations are emitted) are pointing upwards in the two lower positive electrodes and downwards in the two upper positive electrodes, thus producing a uniform flow of radiation in the horizontal, at a distance of 2 feet. Sieman's iron impregnated carbons were used throughout - the positive electrodes being 18 mm. thick and the negative 13 cc.m.

The children were all irradiated with this type of lamp, and were all quite nude at time of exposure. Goggles were worn to protect the eyes. No untoward effects were experienced in any of the cases.

The patients were always kept at a uniform distance of two feet from the lamp and sometimes received the/

the radiations in the recumbent position, and at other times while sitting on wooden forms. The lengths and frequencies of exposures did not differ materially from those usually given to children being irradiated generally, in this clinic, except in so far as individual reaction interfered.

The children were exposed every day, except Saturdays and Sundays or when they absented themselves. On the first day an initial exposure of five minutes was given to the whole back. If no idiosyncrasy to light manifested itself when the child reported the following day, this dose was doubled, and increased to fifteen minutes on the third day. On the fourth day the totally uncovered front was exposed for the first time and received a dose lasting five minutes - the back being also irradiated for fifteen minutes; this dose was not usually increased the next two days. On the seventh day, an extra five minutes was given to the back and the same increase to the front on the next day. On the eighth and succeeding days, therefore, the children received a total exposure lasting half-an-hour, twenty minutes to the back and ten minutes to the front. This was never exceeded.

Most children show no untoward reactions when irradiated along the lines outlined above, but should a child show a rather intense erythema, or any other sign of an over-susceptible response to the rays, the treatment/

treatment is either temporarily stopped or curtailed.

An erythema was usually produced after the second or third exposure, desquamation soon followed, and pigmentation was usually apparent from one week to ten days after the initial exposure, being sooner in dark coloured and later in fair coloured children.

With the doses given pigmentation was never as marked as the pigmentation produced by many authorities, such as Gauvain, Finsen and Rollier, but yet it was always quite apparent.

The children that pigmented easily appeared, in the writer's opinion, to be those that were responding most satisfactorily.

GENERAL EFFECTS.

The physiological effect of radiation is probably entirely due to the photo-chemical reactions which result when light is absorbed. It is known that most of the constituents of living cells are colourless, as they do not absorb visible rays, but that the great majority of them absorb ultra-violet rays strongly, so that irradiation has a marked effect on living cells.

THE SKIN.

As the skin is the means through which radiant energy acts on the organism, the changes taking place in it during, and after irradiation deserve some consideration.

PENETRATION.

Its penetration has been studied though not very accurately. The reflection and penetration of the skin is very different for different parts of the spectrum as well as for different parts of the body, and pigment, hair and blood are all important elements in determining the relative amount of energy absorbed and distributed. We know that the luminous rays particularly the red, are capable of passing through several centimetres of the human body, as is shewn by holding up the hand between the eye and a source of bright/

bright illumination, or in trans-illumination; but as we come down the scale to the shorter rays the penetration correspondingly decreases, till rays shorter than 3000 A° (A° or an Ångström unit being equal to one ten-millionth part of a millimetre) are all absorbed by a layer of epidermis 0.1 mm. in thickness.

Macht, Bell and Elvers[3] claim that the penetration through the skin of rabbits, cats and dogs of ultra-violet rays from modern Hg-vapour lamps is much greater than generally supposed.

ERYTHEMA AND PIGMENTATION.

The almost immediate reddening of the skin after irradiation is due to radiant heat (infra red and luminous rays). This "tissue response", as it is sometimes called, is usually mottled and not restricted to the irradiated parts of the skin. It soon disappears after irradiation and is followed in a few hours by an erythema. This latent period is variable. A few patients begin to react almost immediately, but usually it follows some four to eight hours after irradiation. This real erythema is due to the action of the ultra-violet rays on the cutaneous capillaries. It is always strictly confined to the irradiated area and according to the intensity of the radiation, may be combined with blistering and haemorrhage.
After repeated doses this erythema is followed by pigmentation,/

pigmentation, which is due to the deposition of the pigment melanin as granules round the nuclei of the basal cells of the epidermis. These granules thus form a protective screen round the nuclei protecting the latter from overdosage, within a restricted sense. In therapeutics the appearance of pigmentation necessitates the administration of longer exposures.

The rays of the shortest wave-lengths in the solar spectrum are the most potent pigment producers. These are the rays between 2900 Å and 3300 Å. Rays shorter than 3300 Å are absorbed by glass, and it is a well known fact that pigmentation does not occur if sunlight is first passed through glass. Again rays shorter than 2900 Å produce a violent erythema which is not followed by any marked pigmentation. The screen formed by the pigmentation is thought to convert light into heat and thus protect the organism. A well pigmented body does not feel the difference between heat and cold like an unpigmented one. Pigmentation also insures the maximum amount of absorption of ultra-violet rays and therefore an increased therapeutic action (Rollier).

It is a well known fact that a pigmented skin is very resistant to infection; and it has been noted that it is almost impossible to vaccinate a pigmented skin unless the scarification actually cuts well down into the true skin.

Nevertheless/

Nevertheless there is no unanimity of opinion as to the therapeutic value of pigmentation. Many regard it, owing to its absorption of rays, as unfavourable for light action and therefore attempt to prevent its formation. In this group are the following authorities Finsen, Hasselbalch, Reyn, and Peacock. Others ascribe to it a very important value - Rollier, Gauvain, Bernhard, Jesionek - and believe that the degree of pigmentation is a favourable diagnostic sign. The writer has followed rather the view of the latter authorities, and all the cases irradiated, after a few weeks showed definite pigmentation, but the intense pigmentations produced by some of these authorities were not attempted.

EFFECTS ON THE CIRCULATORY SYSTEM.

Excluding the effects on the blood, which will be dealt with separately in the next section, the effect of irradiation on the circulation is slight. True many observers have experienced a depressant effect on the blood pressure - accounted for by Rothman and Callenberg[7] as a hypo-adrenalaemia, but this effect is never constant nor maintained.
Many have reported beneficial results in treating cases of hyperpiesis with irradiation, and it may be taken, with some exceptions, that irradiation produces a greater or less drop in the blood pressure. Indirectly an embarrassed heart is relieved, the general/

general health improved, headache alleviated and the heavy feeling of weight in the limbs disappears.

EFFECTS ON OTHER SYSTEMS.

The Eye. The eye naturally is subject to the effect of light. Only light from 7600 Å to 3800 Å i.e. the visible rays can penetrate the lens. Light from 3800 Å to 2950 Å is absorbed by the lens which seems to act as a protection to the retina. Light of wave length less than 2950 Å is absorbed by the cornea and conjunctiva, which results in conjunctivitis, cloudiness of the cornea with desquamation of the epithelium together with iritis. There is an interval before this occurs as there is in the skin reaction. On two separate occasions the writer suffered from a fairly severe conjunctivitis produced by accidental exposure. On both occasions there was some redness and smarting some three hours after, but it was not until about 8 hours after exposure that the really very painful conjunctivitis was experienced. No treatment was given, and it was not until about one hour later that the symptoms gradually subsided. Some redness and soreness were experienced for a day or two following.

The effect on the Alimentary system is probably secondary to the general improvement caused by the rays to the other systems. The giving of Vitamin D as/

as cod liver oil or by irradiation has been shown to alter the intestinal pH from the abnormal alkaline state found in rickety children to the normal acid side of neutrality.[24] Certainly the chronic diarrhoea met with in rickety children is very quickly improved by exposure. This is said to be due to decreasing the microbic infection of the bowel, or more directly due to the altered state of the intestinal pH. Similarly the respiratory and nervous systems are improved. The bronchitis of the rickety child rapidly responds to irradiation; and the feeling of well-being and cheerfulness that comes to those undergoing treatment points to the therapeutic effect on the nervous system, be it psychic or otherwise.

EFFECTS ON BACTERIA.

It is well known that ultra-violet rays are strongly bactericidal. In 1890 Koch showed that tubercle bacilli were killed by sunlight.

Recently experiments by numerous observers have shewn the rays from artificial sources to be more powerful.

The rays with wave lengths of 2960 Å to 2100 Å have been shewn to possess the strongest bactericidal effect, and as these rays are not capable of penetrating $\frac{1}{10}$ mm. thickness of skin, it follows that the therapeutic/

therapeutic effects of ultra-violet rays in superficial microbic infections cannot be due to their direct action but to their influence on the soil in which the bacteria are breeding.

Water is transparent to ultra-violet rays and it is interesting to realise that irradiation therefore has the power of rendering it sterile.

EFFECTS ON METABOLISM.

Although there is a general belief that sunlight is beneficial, observation has suggested the possibility that men and animals can live in darkness for a relatively long period of time, without serious functional disturbance.

J.H. Oltramare[5] found that many animals (rabbits, guinea-pigs, chickens, pigeons, tortoises, frogs, salamanders and fish) could live in darkness as long as three months without showing any apparent ill-effects. He considers that two phenomena take place - an augmentation of reserves and a diminution in exchange. The animals in darkness increase in weight more rapidly than those in light, although receiving the same amount of food and there is also a correspondingly greater increase in the glycogen reserve.

Mayerson, Gunther and Laurens[6] studied the effect of irradiation of dogs with the C. arc. They wished to/

to decide whether radiation, being such a powerful stimulus to pathological and deficient metabolism would have any effect on an already "normal" metabolism. They found that irradiation of normal adult dogs with moderate intensities increases endogenous N. metabolism, stimulates the absorption of Ca. and P. from the intestine and usually decreases the amount of blood sugar. The changes persist and in some cases are most apparent in the post-irradiation period. They found that serum P. was markedly increased in some cases.

S. Rothman believes that irradiation produces a decrease in sympathetic tone (hypo-adrenalaemia). He, with J. Callenberg[7], investigated the question as to whether this was bound up with a shift in K. and Ca. concentration between the skin and the blood. He found a single general irradiation producing a marked skin inflammation increased the serum Ca very considerably the day after the irradiation, e.g. from 9.2 to 13.2 mgs. per cent. Five days later the serum Ca. had fallen to 9.8 mgs. per cent, the inflammation having disappeared and practically all the pigment. If a single massive irradiation results in pigmentation the serum Ca remains above the original level. For example before irradiation the serum Ca was 9.75 mgs. per cent, the day after a twenty minutes exposure it was 11.4 mgs. with marked inflammation and/

and rose-red skin. Seven days later the serum Ca was 10.3 mgs. per cent. and the skin a brownish-red colour. If the exposure is repeated resulting in a second dermatitis, the Ca. again rises, but if pigmentation is marked, then a repeated irradiation does not further increase the serum Ca. He maintains therefore that the rise and fall of the Ca. during the development and disappearance of the inflammation reflects the degree of sympathetic tone. This decreases during inflammation, increases gradually with incipient pigmentation and continued to do so as pigmentation increases. Serum Ca, he shows, remains high during continued irradiation even though the treatment is continued some weeks, and the lasting increase in Ca corresponds to the lasting sympathetic hypotonia, which is present when pigmentation is complete. As will be seen further on, the writer was unable to produce any increase in the serum Ca or P above the normal readings, in the series of cases investigated; and in that respect they differ from those obtained by these investigators, but, of course, massive doses as given by Rothman and Callenberg were not used.

According to Fries[8] the improved appetite and weight of malnourished children, following Quartz Hg-vapour lamp irradiation is not due to any concomitant rise in the basal metabolism, since the basal metabolism/

metabolism of children during months of treatment and non-treatment shows no appreciable differences.

The way in which radiant energy affects metabolism has therefore as yet to be explained, but exposure to it has now been proved to result in general acceleration of metabolism. This is surely indicated by the increase in the amount of carbon dioxide expired, and the increase of growth in daylight as compared with darkness. The increased temperature of the blood possibly influences the rate of metabolism, as biochemical reactions may be greatly accelerated by even slight rises in temperature. Possibly this may explain the failure of Fries to find any change in the basal metabolism of his cases, as he used the cold rays of the Hg-vapour lamp only. Ultra-violet rays, as well, have the effect of activating vitamines in the body.

ACTIVATION OF INERT SUBSTANCES.

Some mention must be made of this, the latest use of irradiation. The activation of inert substances has been the pioneer work of such workers as Hess in 1924 and Steenbock and Black in the same year. This use of ultra-violet rays has, as yet, been chiefly confined to activating inert substances into powerful antirachitic agents. The fact that skin, liver, lung and muscle as well as eggs, milk and faeces acquire calcifying/

calcifying and growth-promoting properties, is a matter of scientific and clinical importance. That an animal when irradiated has constituents in its body so activated, has far reaching implications in connection with our ideas as to the mode of action of irradiation, as has the fact that diets which are deficient in certain respects may be made complete by irradiation, or by the addition of irradiated substances such as ergostrol.

INDICATIONS AND CONTRA-INDICATIONS.

From what has been written and quoted above, it is to be seen that the general effects of irradiation are considerably more important than any local effect or any action confined to one system. It is a therapeutic agent which has diverse and far-reaching results, and affects the whole organism. Is it therefore to be wondered that such brilliant results are obtained on the one hand, and such hopeless ones on the other? The all important point to be remembered in using this powerful agent is that we must not forget the state of the whole organism that is being treated. We should not allow ourselves to be confused by a multitude of disease names. We should remember that the symptoms of disease are in a large measure due to the circulation of toxins; and that although toxins differ among themselves, yet the means which/

which the body has of dealing with them, and with the bacteria themselves, are always fundamentally the same. If we can discover an agent which is effective in activating, at least in some degree, all the defensive mechanisms of the body, then the diseases in which it is of value will obviously be numerous.

Radiant energy is an agent which comes up very favourably to such a standard.

Such an agent however must be used with caution, and experience has taught us that harm may be done instead of good in some cases.

The diseases which may and may not be treated by irradiation are well summarised by E.P. Cumberbatch[9] in a short article in the British Medical Journal. He divides the diseases into four groups. In the first group he places diseases in which irradiation always effects a cure. These diseases are rickets (in which radiation acts as a specific) tetany and laryngismus stridulus in rickety children. The second category contains cases in which treatment will generally effect a cure, either alone or along with some other form of treatment. Such cases include:-

I. Infants who are unable to assimilate their food and who consequently waste.

II. Post-febrile debility in children. Here the nasal and bronchial catarrh disappears and aural discharge loses its offensive character or may disappear, a fact frequently observed by the writer.

III. Adults after influenza.

IV. Tuberculosis - especially surgical cases and lupus vulgaris.

V. Many skin conditions such as impetigo and acne, which respond well. Patients liable to boils are greatly benefited. Some cases of seborrhoea also do well. He finds no success in true psoriasis, contrary to the experience of some other workers. Many cases of pruritis ani and vulvae can be freed from the itching. Erysipelas has been much improved by some workers. Alopecia areata can generally be cured after prolonged treatment.

In the third group he places a large number of diseases or cases, mostly common and obstinate for which treatment is now being tried. Insufficiency of experience renders it difficult to say whether the rays are of real use. Included among this group are the rheumatic cases, chronic fibrositis and myositis. Results so far have been disappointing with that class of trouble. Sciatica and neuritis have not responded well. In hyperpiesis, chronic bronchitis, bronchial asthma, hay fever, Raynaud's disease, acro-cyanosis success has been claimed by some writers.

The fourth group contains those cases in which harmful results may be expected. Such cases are those/

those of hyperpyrexia, acute local infection, cases of pus formation without free drainage. Pulmonary tuberculosis should not be treated, unless under the supervision of an expert, as general phthisis has been activated by improper irradiation. Persons with failing hearts and very old people should not be irradiated. Harmful results are sure to be experienced if cases of Bright's disease are treated in this way.

Finally irradiation should be stopped during menstruation.

From a study of the above facts, it is apparent that there are comparatively few diseases in which irradiation is contraindicated. Even though a definite cure of a certain malady may not be hoped for by means of irradiation alone, yet surely the beneficial effects of the rays on the general well-being of the patient are sufficient to make this form of treatment a really useful addition to the great field of therapeutics.

IV. EFFECT OF HELIOTHERAPY ON BLOOD.

Numerous observers have published works on the effects of irradiation on the blood, some on the effects during irradiation, some on the effects following and others on the effects in vitro. The observations have been made under the most varied conditions, at high altitudes, in the tropics, at sea-level, inland, on the shore, with the sun, the Hg-vapour lamp, the Carbon arc, on the well, the sick, on children and on adults. It is therefore not surprising that the most diverse results have been obtained.

The popular belief that the pale appearance, seen in those working and living in poorly lighted rooms, is due to an anaemic state of the blood is refuted by Jesionek[10], who states in his book, that it is not the Hb. content or the absolute number of red cells which is decreased by the lack of light, but the volume of blood going to the periphery. Light, within physiological limits, he maintains dilates the cutaneous vessels and thereby allows more blood to go to the skin. It is therefore possible that during a lasting deprivation of light, the skin vessels may become constricted and the skin thus assume a bloodless appearance, as such anaemic-looking people often have a surprisingly high Hb. content.

Blood studies made during the long polar nights show/

show, that in spite of the pale yellow green appearance of the men, there is no change in the blood. Gyllenkrentz[11] found no diminution in the Hb. content in the members of the Spitzbergen expedition; and Blessing[11] reports that the members of the Nansen expedition showed no blood changes, provided the food was sufficient.

Bernhard[12] on the other hand is convinced of the harmful effects of the lack of light, as exemplified in the anaemic condition of those who live on the shady side of the deep valleys, as compared with those who get the sun's rays. He believes that the reason why Blessing found no change in the blood of the members of the Nansen expedition is the fact that the winter was spent in an illuminated ship.

Miles and Laurens[13] studied the physiological characters of dogs kept for varying lengths of time in total darkness, and then returned to ordinary room light. The factors they most particularly studied were the red cells, Hb. content, leucocytes and platelets. The features found by them in dogs kept for a relatively short period in darkness (15-28 days) are:- (1) initial decrease in R.B.C. cells with return to normal during the dark period, on readmission of light continuation of normal readings with in certain cases, fluctuating values below and above the normal, before a steady level is maintained;

(II)/

(II) initial decrease in Hb. content with gradual return to normal during period of darkness, on re-admission of light no immediate change but a subsequent slight decrease; (III) a transient rise of W.B.C. cells disappearing usually before the end of the dark period, on readmission of light small fluctuations before attaining usual level; (IV) differential counts show slight changes varying with individual dogs, some showing an increase, others a decrease in polymorphs; (V) the platelets behave similarly to the R.B.C., the return to light causing a temporary increase. Total solids are low, indicating a blood dilution, coagulation time is slightly increased, and a slight rise in the H-ion concentration of the blood is found.

Laurens further kept two dogs in darkness for nine months. He found that after the usual initial decrease there was a steady increase in the R.B.C. for about three months with lowered counts at the end of eight months. On readmission of light at this time the R.B.C. were further decreased before returning to normal. He thinks this indicates a slightly increased fragility of the R.B.C. The Hb. after an initial decrease rose with the R.B.C. At the end of eight months it was lowered, and a continued decrease, as with the R.B.C., occurred at the beginning of the light period. The W.B.C. subsequent to the rise occurring/

occurring at first shewed steadily decreasing values until the time, when acute illness, apparently caused by the darkness, was accompanied by a marked increase. The number of polymorphs increased in one dog; and the platelets were definitely lowered by darkness.
Miles and Laurens[14] later studied the influence of known amounts of Carbon-arc radiations on dogs. In moderate doses they found an initial increase in the R.B.C. followed by a decrease; with double this dose there was an immediate decrease. Following the irradiation there was an increase in the R.B.C. of one and a half million above the normal figures. They take this to be an indication of a stimulation of the blood forming organs, obscured at first by increased blood volume. Differential counts showed lymphoblasts and myelocytes and an increasing lymphocytic and large mononuclear percentage. With the moderate dosage the platelets were increased, but with the double dose, they decreased to begin with, but were in the post-irradiation period definitely increased above normal.

Mayerson[15] has recently confirmed these results. Levy[16] found that in mice made anaemic by injecting pyrodin, the R.B.C. regenerated much more rapidly in animals irradiated with a Quartz-Hg vapour lamp, than in non-irradiated controls.

Burchardi/

Burchardi[17] compared the blood of twelve patients irradiated almost daily for 2 to 3 months with a Carbon-arc lamp, with the blood of 83 patients not irradiated. The increase he found in Hb and R.B.C. was very small - 79.5% to 83.4% and 5,343,000 to 5,978,000 respectively - being more rapid at the beginning and becoming less so as pigmentation proceeded and finally ceasing after pigmentation had become pronounced. A decrease in leucocytes, total and differential goes along with the increase in R.B.C. and Hb., the decrease being due to a loss of neutrophils at the expense of the mononuclears and eosinophils.

It is interesting to note that Sooy and Moise[18] found definite beneficial results following the treatment of idiopathic purpura haemorrhagica by exposure to Quartz Hg vapour lamp. The platelets and the R.B.C. increased and bleeding time and retraction time decreased.

Gunn[19] irradiated 6 young rabbits with a Quartz Hg vapour lamp. He found the platelets increased quite definitely, the highest figures being reached between the 3rd and 6th days, from which time they dropped back rapidly to normal. The R.B.C. decreased during the first few days of irradiation, but rapidly rose thereafter and in three animals counts of over a million higher than the original were obtained after two weeks, and continued for some time after the last irradiation. /

irradiation. He found no difference in the leucocytes.

Aschenheim and Meyer[20] exposed sixteen children to solar and Quartz Hg-vapour lamp irradiations. The ages of the children varied from 8 months to 13 years and the children were affected with Tuberculosis, Rickets, Anaemia and Myocarditis or were entirely well. They report that a single intensive exposure had about the same effect as continued irradiation. All the children showed changes, more marked in some than in others, in the blood components. They found that sunlight and Quartz Hg-vapour lamp radiations were practically equally effective. The outstanding change in most of their cases was an increase in the large mononuclears at the expense of the polymorphs. The total white blood count did not always run parallel with the rise and fall of the lymphocytes and leucocytes. The Hb. content and the R.B.C. increased markedly in nearly all their cases and remained high particularly if the value had previously been low. All these changes continued for some time after the exposures had been discontinued.

Koopman[21] irradiated five well and three sick persons - the latter suffering from pulmonary tuberculosis, chronic nephritis and diabetes respectively. He found the number of R.B.C. remained unchanged; the W.B.C. increased during the first hour and then decreased, remaining low for six hours. The polymorphs increased/

increased during the first three hours, after which they decreased. The lymphocytes steadily increased, while the Hb., viscosity and coagulation time of the blood remained unchanged. The fragility of the R.B.C. did not vary.

LoGrasso and Balderry[22] in an investigation on the effect of irradiation on cases of pulmonary tuberculosis found a very definite increase of the Hb. In 42 out of 49 cases there was an average increase of 10% and only 4 cases remained unaffected. In nearly all the cases there was an initial polymorph leucocytosis, but later there was a relative increase in the lymphocytes.

Balderry and Ewald[23] report the results of treating 15 cases of tuberculosis for more than 3 months with Carbon-arc radiations. They found marked improvement in the Hb., and R.B.C. In their series of cases the Hb. content was increased by 67% and the R.B.C. by 50%: as well they found an increase of 50% in the lymphocytes and 17% in the leucocytes.

The chief observed effects, therefore, of irradiation on the blood are a definite and lasting increase in the red blood corpuscles, the haemoglobin, and the platelets. The effect on the leucocytes is not so simple, and different observers have obtained various results. The majority however have found that there is usually a slight increase in the number of/

of leucocytes, the increase being due to lymphocytes at the expense of the polymorphs. Some[17] have observed an increase in the eosinophils as well as the mononuclear cells.

Irradiation has been shown beyond all doubt, to increase the calcium and phosphorus content of the blood, if these constituents are below normal levels. The action seems to be due to the stimulation of the function of absorption. Recent work[24] has shown that the absorption of calcium seems to be governed by two main factors. One of these is undoubtedly vitamin D, though it may be doubted whether its sole effect is that suggested by Bergeim[25]. Since its administration to rachitic subjects has been shown to alter the intestinal pH. from the alkaline to the acid side of neutrality, it may be - a matter on which experimentation is desirable - that the vitamin stimulates the secretion of hydrochloric acid in the stomach or inhibits the flow of alkali into the intestine. As will be shown later from the works of Kramer, Kramer, Shelling, Shear and Wilkins[33 34] this action need not be a local one, for the same effect is produced by subcutaneous and intramuscular injections of cod liver oil ether concentrates - the action therefore being a local demonstration of the general influence of the vitamin exerted through the blood stream. In this way vitamin D would act by/

by bringing into play the second controlling factor of calcium absorption namely the intestinal pH.

This surely points to the manner in which irradia-tion can so constantly cause an increase in an already low calcium metabolism. The same effect is produced in the phosphorus metabolism - both these elements being absorbed normally in an intestine with a pH on the acid side of neutrality. At this stage it would be useful to summarise the physiology of the different blood components.

The sources of the blood cells, as given by Gulland and Goodall[26] are the lymphoid tissues through-out the body and the bone-marrow. The former supply only lymphocytes, and even this function is shared largely by the bone-marrow.

THE R.B.C.

The primitive red blood-cells are nucleated and called megaloblasts. They are first produced by a modification of mesoblast cells in the vascular area surrounding the early embryo. The erythroblasts are the direct progeny of the megaloblasts. From both the erythroblast and the megaloblasts are derived the normo-blasts and these cells after absorption of the nuclears enter the blood stream as the erythrocytes. In post-natal life the source of the red blood corpuscles is the bone-marrow only. The function of the red blood corpuscle with its haemoglobin is to oxygenate the tissues.

THE LEUCOCYTE.

Similarly from the primitive mesenchyme cells we get the primitive leucocyte or large lymphoid cell. From the latter develop the small lymphocytes on the one hand and the myeloblast on the other. As a further stage of the development of the small lymphocyte we get the large lymphocyte, the large mononuclear, and the transitional type of cell. From the myeloblast develop the polymorphonuclear series - the basophil, the eosinophil and the neutrophil, the latter being the common "polymorph". The leucocytes - especially the polymorphs and the large lymphocytes - are active phagocytes and therefore play an important part in the protection of the body from micro-organisms. The eosinophils seem to have a special relation to the toxins of parasites such as filaria, and possibly also to metabolic poisons such as those concerned in the production of asthma and some skin affections. The lymphocytes also increase in number in the peripheral circulation in response to invasion by a very limited number of special toxins, such as those of whooping cough and syphilis. Another function of the leucocytes is supposed to be that of the absorption, transport and assimilation of protein, fat, carbohydrate and iron. As well the leucocytes give rise to proteolytic and diastatic ferments, to oxydase, to prothrombin and thrombokinase.

The/

THE PLATELETS.

The origin of the platelets is still not clear. The chief views regarding them are as follows:-

(1) That they are broken pieces of white cells or their nuclei.

(II) That they are nuclear remains derived from the erythrocytes by extrusion.

(III) That they are nucleated cells which constitute a third type of the formed element of the blood.

(IV) That they form an independent but non-nucleated element of the blood.

(V) That they are precipitates from the plasma.

(VI) That they are detached portions of the cytoplasm of the giant cells of the spleen and bone-marrow.

The modern tendency in this country is to regard them as a third element of the blood derived from the giant-cells of the bone marrow. Some observers state that they have a nucleolus, and the writer has many times seen a central body in a platelet, which may be a nucleolus.

They are diminished in infectious diseases during the febrile stage, in infections with animal parasites, in haemophilia, idiopathic purpura haemorrhagica, and leucocythaemia; in pernicious anaemia when they are often greatly increased in size. They are also said to be diminished in number in cachexia, malnutrition, and some cases of cancer. The writer has noticed that counts/

counts made in rachitic children are always much lower than normal; and Cramer, Drew, and Mottram[27] have shown the constant occurrence of a thrombopaenia in Vitamin A (old classification) deficiency in rats.

They are said to be increased in number after even slight haemorrhages, chlorosis, secondary anaemias, in most inflammatory and septic conditions, after injection of anti-sera, and after splenectomy.

The writer always found very low platelet counts in cases of purpura haemorrhagica, counts usually varying between 15,000 and 36,000 during the acute stages. In one case of Banti's disease in which splenectomy had been performed, he found that one month after the operation the platelet count was over half a million, though counts made before the operation ranged about 250,000.

Numerous counts were made on children, who were not apparently suffering from any disease, and in the writer's hands the average count for a healthy child between five and twelve years was from 250,000 to 350,000. He believes a count lower than 200,000 constitutes a thrombopaenia and a count over 400,000 a thrombocytosis. With the technique yet to be described, he found that he could get fairly constant counts in each case, a difference of over 40,000 between counts being the exception.

The/

The function of the platelets is still an obscure matter. That they have an undoubted action in the clotting of blood is well known, for blood, from which the platelets are experimentally removed, remains fluid indefinitely unless tissue extract or platelets are added.[28] Hardy (1892) found explosive corpuscles in the blood of crustacea and Tait (1910) showed that fibrin formation begins when each of these corpuscles bursts. Recently Burke and Tait (1926) have observed the same process taking place in rabbits and human blood, under the dark field microscope. When each platelet bursts, globules of protoplasm are projected radially in all directions. Along the course of these particles, threads of fibrin are laid down. Two separate processes may act to assist haemorrhage. There is the actual mechanical plugging of the vascular defect by platelets. This is entirely distinct from coagulation. The second process is gelation of the blood and involves not only the platelets but the plasma and the erythrocytes. The substance that initiates the process (thrombokinase) may be derived either from cytolized platelets or tissue juices at the point of rupture, or from both. The end result is the formation of fibrin and clotting. The retractibility of the clot is also due to the platelets, as is exemplified in the poor or non-retraction of the clot in cases of purpura haemorrhagica where/

where the total number of platelets in the blood is very low. Recently work has been published by Prof. Govaerts, and quoted by Mills[28] to show that platelets play an important part in the process of inborn immunity. Prof. Govaerts gave large intravenous injections of bacteria to animals and then took cultures from the carotid artery at minute intervals. He found two entirely different results could be obtained depending on the type of bacteria utilized. If the organism is one to which the animal is susceptible the number of organisms per ccm. of blood remains constant or even rises and a septicaemia results. If the animal is not susceptible to the organisms, the number of organisms undergoes a rapid drop within 7-8 minutes almost to nil. In the latter instance the microscope shows the organisms to be adhering to the platelets which stick to each other and to other organisms, till a large clump of bacteria and platelets is formed. In the other cases, no such reaction occurs. The same thing is seen when the two different types of bacteria are injected - only clumping of the insusceptible is found. Whatever may be the mechanism, it is through the activity of the thrombocytes, or platelets, that the blood stream of the immune animal is freed from micro-organisms.

The usual methods were used for enumerating the red corpuscles. Hayem's solution was the diluting fluid/

fluid and the blood was always diluted 1 in 200 using a Thoma-Zeiss Haemocytometer. The white cells were enumerated with the same instrument and the diluting fluid was a solution of 1 c.c. glacial acetic acid in 100 c.c. distilled water to which enough methyl green had been added to colour the solution a fairly deep green. The blood was always diluted twenty times. For the differential counts a stained film was made with Jenner's stain and some 300 white cells counted.

For the estimation of the Haemoglobin, Tallqvist's Haemoglobinometer was used because of its simplicity and speed. The writer found that after much experience with this method, he could get results as accurate as with any of the other more convenient methods.

In counting the platelets several different methods were first tried out, before the observations were commenced.

Koster[29] found that widely different counts could be obtained by the same observer, using the same method, the same guinea-pig, during the same hour, the difference depending on how the blood was obtained. Exertion of pressure after puncture was uniformly productive of a count at considerable variance with that obtained when blood flows freely from the injured surface. He found the best results were obtained by incising the foot with a safety razor/

razor blade producing a good sized drop of blood. He used various staining solutions (Wright, Leak and Guy, Reese and Ecker) but finally decided that the source of error could be minimized by counting the platelets unstained, because in the process of staining, despite all caution and effort to prevent it, very frequently small particles of stain would be precipitated and these simulated platelets.
He adopted eventually the following method. Using a red blood cell pipette to suck up the blood to the 1 mark, he diluted this quantity of blood with a 3% solution of sodium citrate to the 101 mark, mixed the blood and solution thoroughly and placed a suitable sized drop on a counting chamber. Then counting 400 squares he multiplied the result by 100 to get the actual number of platelets.

The disadvantage of this method in the writer's opinion, is the fact that after puncture the blood comes in contact with the skin and tissue and then is sucked up a dry pipette to which he believes a great many of the platelets adhere and disintegrate before they become swamped in the diluting fluid.

Bedson's[30] technique is to make the puncture through a drop of the diluting fluid on the skin, thereby ensuring the blood to mix with the diluting fluid as it escapes. He uses a solution of 2% sodium citrate in saline. A loopful of this mixture is then mixed/

mixed on a slide with an equal quantity of a solution of brilliant cresyl blue, covered with a cover slip and the preparation ringed off with paraffin.
The platelets and the red cells are then counted, and the number of red cells having been estimated in the usual manner, the absolute number of platelets is readily arrived at.

Another method which was tried was that advocated by Falconer[31] in which a solution of urea, sod. citrate, and corrosive sublimate is used to lyse all the blood cells but the platelets, and thereby a direct count is made as in doing a white count. This method in the writer's hands was not found to be satisfactory, as numerous bits of debris - possibly from the nuclear remains of the leucocytes - were found in the preparation and made it a matter of great difficulty in deciding what was a platelet or not.

As well, counts were attempted on stained films, but the writer agrees with Koster that it is not possible to make anything but an approximate estimation of the number. In the end the following technique was employed. A solution of sodium metaphosphate 2% in normal saline as advocated by Pratt and given in Gulland and Goodall's "Blood" was used. To this the writer added a small quantity of methyl green, enough to colour the solution a fairly light green, so that the platelets were slightly tinged a green colour/

colour while artefacts in the preparation usually took on a much more intense colour. This often helped to decide at once an artefact from a platelet. The platelets were seen very distinctly and their structure was so apparent that the small central "nucleolus", as reported by some observers, was quite distinct in many cases.

After the lobe of the ear had been cleaned with ether, a drop of the diluting fluid was placed on the skin and a puncture made through it. A "Jenner Vaccinostyle" was always used, the puncture ensuring a quick flow of a good sized drop of blood.
The mixture of blood thus obtained was sucked up into a red blood cell pipette which was already three-quarters filled with diluting fluid. A little experience soon taught the necessary amount of this mixture required to be sucked into the pipette, so that the dilution of the cells is enough to make the count practicable. After thoroughly shaking the pipette, a drop of the mixture was placed in the Thoma-Zeis counting chamber and a thin cover slip applied. The preparation was allowed to stand on the stage of the microscope for 10-15 minutes, before counting with the oil-immersion lens. With careful adjusting of the condenser and diaphragm, the platelets were always seen without the least difficulty. At least thirty to forty platelets were counted, which involved counting some/

some 450 to 500 red blood corpuscles as well. It was early noticed by the writer that even after allowing fifteen minutes for the cells to settle, a certain number of platelets invariably adhered to the lower surface of the cover slip; and unless this depth of the film was brought into focus in each field, after counting the cells which had settled, many platelets would escape enumeration. Differences of 50,000 to 80,000 were found to occur in the writer's hands unless this precaution were taken into account.

The advantage, in the writer's mind, of using a pipette over Bedson's method lies in the fact that if it be found that the dilution of blood is not great enough (he never attempts to count the cells in a field of more than 50-60 R.B.C.) more diluting fluid can be sucked up into the chamber and thus dilute still further the blood already withdrawn. This he feels is an advantage, especially for those who are not yet experienced enough to judge the necessary dilution required. He also found that puncturing through the diluting fluid, as done by Bedson, made a very appreciable difference to the counts. In some cases when he tried both methods, all counts made after puncturing through the fluid were from 40,000 to 100,000 greater than those not.

The estimation of the calcium and phosphorus contents of the serum were carried out by the laboratory of the Royal College of Physicians, Edinburgh, to the governing body of which I am greatly indebted.

The method used for Calcium estimation in this laboratory is that first described by Tisdall and Kramer. It consists in precipitating the calcium directly from 2 c.c. of serum by means of a saturated solution of ammonium oxalate, collecting and washing the precipitate by centrifuging, and finally titrating in the presence of sulphuric acid, with potassium permanganate. Kramer and Tisdall allow only 30 minutes for the precipitation of the calcium oxalate, and this is the time used in the laboratory. Recent work[24] has shewn that more accurate results are obtained only after 24 hours precipitation, when one can be certain that the whole of the Calcium in the serum has been precipitated. However, the maximum error possible with only 30 minutes standing is about 5%, hence the figures given in this work may be taken as being fairly accurate.

The estimation of the phosphorus - or more properly the inorganic phosphates of the serum - was performed by the usual colorimetric method, which gives fairly accurate readings in the hands of the experienced.

As far as possible all these estimations were done fortnightly in each child, except in the case of the calcium and phosphorus which in the later cases were only done monthly. The blood was withdrawn always a short time after exposure.

As/

As will be demonstrated in the notes of each case to follow, very definite effects in certain of the blood components were elicited.

THE RED BLOOD CORPUSCLES.

In every case there was a very definite rise in the number of the red cells. This was usually apparent by the end of the first fortnight, and did not cease when pigmentation became quite visible, as stated by some observers. However in most cases there was a greater rise before pigmentation became pronounced.

The average increase in the number of red blood corpuscles over the twenty cases was about 600,000. If only cases with initial counts of under 4,000,000 are considered, the increase is greater, namely, round about 800,000. In three cases, where the initial counts were only about 3,500,000 the increase averaged over 1,000,000. Figures like these surely are definite enough to show that there must be some stimulating effect of radiant energy on the blood forming organs.

The initial increase of blood volume thus masking the increase in the red blood cells (as described by several observers) may account for those cases with a drop in the red blood cell count at the end of the first fortnight.

THE HAEMOGLOBIN.

The effect on the haemoglobin content of the blood was similarly as marked. There was an increased percentage in every case. All over there was an increase in the percentage of 11, while if cases with an initial percentage of under 70, are only considered, there is an increase of 15%. It was always experienced that the lower the initial percentage, the more rapid was the increase. In most of the cases it was striking what a rapid effect there was on the haemoglobin, nearly maximum levels being attained before pigmentation became marked.

THE WHITE BLOOD CELLS.

Here the effects at first did not seem so constant as in the previous two blood components. On the whole there was a tendency to higher total counts as irradiation proceeded, but the more striking effect was the increase of the lymphocytes at the expense of the polymorphs. In each case a differential count was performed before treatment, some 3-4 weeks later, and when treatment was stopped.
The second counts invariably showed an increase of 5% - 10% of lymphocytes above the initial counts.
The terminal count however usually revealed that the percentages were approximating the normal, though in most cases there was yet a slight lymphocytosis.
The/

The increase in the eosinophils reported by some observers was not experienced. Only one case showed any increase and this case, it later transpired, was one infected with oxyuris.

THE BLOOD PLATELETS.

Here again appreciable differences were encountered. Most of the cases showed an increase over the initial counts. The lower the initial count the greater was the increase. Most cases which showed a thrombopaenia (i.e. below 200,000 in the writer's opinion) were very quickly stimulated and the counts soon were within normal limits. Initial counts of average numbers were not materially affected, and a thrombocytosis was never produced.

BLOOD CALCIUM AND PHOSPHORUS.

As the figures given in the case reports show, there were rather inconstant effects produced in these constituents. It is difficult to explain why the amounts of these elements varied from time to time, since it has been shewn that they usually are present in very constant quantities. However it should be borne in mind that several different processes are functioning to keep the blood level constant and that irradiation may have an effect on each or all. One of these is the rate of absorption, another/

another the rate of excretion by the bowel, and a third the rate of deposition of calcium phosphate in growing bone. All these patients were growing children. It has been suggested that they may have been suffering from some vitamin deficiency; it may be that one of the deficient vitamins was vitamin D - though not insufficient enough to produce definite rickets, the children being beyond that age. The action of radiant energy is to stimulate absorption and thereby bone formation. Might not one of these processes during irradiation be more active at one time than another and thereby give rise to the variable levels experienced. There is also the possibility of the readings showing a small margin of error on the low side, due to the fact that precipitation was only given some 30 minutes instead of the 24 hours required as has recently been shown. No increase above normal readings was experienced in any of the cases.

It is evident that while we are in possession of an enormous amount of information concerning the results of irradiation in man and animals, normal and abnormal, it has yet to be explained how the effects of irradiation are produced.

Hinrichs [32] in an article has briefly reviewed the various views as to the action of ultra-violet rays. It is stated, he says, that irradiation produces primarily a surface effect; it inhibits the action/

action of hormones and enzymes; it kills protoplasm by coagulation and not by the inhibition of enzyme action; its effect is due to sensitization to heat; its action interferes with the time relation in a system of interdependent progressive processes; its effect is due to the precipitation of the proteins of the protoplasm following electron emission; certain constituents of protoplasm as tyrosin and phenylalanin act as optical sensitizers rendering living cells susceptible to the toxic action of the ultra-violet rays.

More recent work in connection with the activation of skin ergosterol has shown that an efficient agent can be absorbed otherwise than through the intestinal mucous membrane.

Kramer, Kramer, Shelling and Shear[33], have shown that when cholesterol-free cod liver oil concentrate suspended in ether is injected subcutaneously, it cures rickets, the anti-rachitic factor (i.e. Vitamin D.) being as potent, provided a suitable vehicle is used, as when given orally. Similarly Wilkins and Kramer[34] report that the intramuscular injection of an ether concentrate of cod liver oil is followed by the same changes in two children with active rickets, as usually observed following the oral administration of cod-liver oil. The increased absorption of Ca and P. from the intestine is thus but a local demonstration of/

of a general influence of the vitamin exerted through the circulation.

These experiments surely seem to show that the effects of radiant energy on deep seated organs can easily be accounted for by the action of some substance, probably of the nature of a vitamin and surely vitamin D in the case of rickets, activated by photochemical action of the rays on its precursor in the skin. The most recent work on the activation of foodstuffs as well as of animal tissues and products, as described in an earliėr part of this work, points to ergostrol as the precursor in the skin of vitamin D. How this substance (or substances) once it is activated, exerts its influence on the organs of the body is a question that has yet to be explained.

Before going on to the actual case reports, it must be reported what a great influence irradiation produces on the general well-being of the patients. No one is more sincere in stating this than the mothers of the children. After a week or two of exposure, in most cases the mothers state they can notice the beneficent effects of the rays because of the change in the child's demeanour. From being a cross, sleepless and easily tired child he changes to a much brighter and better behaved one. He sleeps better, eats better and plays about more. His weight steadily increases, the muscles improve in tone and the/

the very bad posture of many of these children is greatly improved. Should he have chronic nasal and aural discharges, these very often dry up. Finally there is a great change in the mental aptitude of the child, from being dull and apathetic he becomes bright and apparently more intelligent.

V. CLINICAL.

Following these few remarks will be found the actual findings in each case.

The first two cases are children who are congenital dwarfs, the father being also a dwarf. They were not rickety. Their health had not given any reason for anxiety, until a month or two prior to treatment, when the mother noticed that they were not in their usual active spirits. It is interesting to record that they each grew fully three-quarters of an inch during treatment.

The third case was rather unsatisfactory as regards investigation, the child being very nervous and terrified by the sight of a syringe. Hence it was only possible to withdraw blood on two occasions. It will be noticed that most of the children showed pigmentation quite early. The darker the complexion of the child the more marked was the pigmentation. None of the children showed the almost black skins that are aimed at by some workers.

Aural discharges present in one or two of the children when they first commenced treatment soon cleared up and never recurred while the child was observed.

It will be noticed that every child gained weight, though many of them were said to have been losing weight/

weight before treatment was commenced. Some showed greater increases than others; and it was observed that the poorly nourished child from the poorer home was the one whose weight responded more rapidly. For instance Case 9 was perhaps the child of this series who came from the poorest home; within nine days this child had put on over two and a half pounds in weight, and gained in all over three pounds.

It must be added that several more cases were investigated, but that these soon ceased attending from one cause or another and as only one or two readings were recorded they are not included.

Case I. G. Thomson: 11 years: Height 46".

<u>History</u>: Child a congenital dwarf. In good health till 2-3 months prior to treatment when became easily tired, slept badly and lost appetite. Began to lose colour and weight and sweated rather freely at nights.

After a few weeks exposure the mother stated that she noticed a great improvement. He was not nearly so tired and slept better; his appetite had greatly improved and he was now running about again like a normal child. He had ceased sweating at nights and his colour and appearance now looked healthy.

(Note for a child of 11 years he is 8" below average height and 30 lbs below average weight.)

Showed sharp erythema on second day. Desquamation on 4th day, pigmentation appreciable ninth day.
Was well pigmented in a fortnight.

<u>Exposures</u>.

1st week	(6 days)	75 mins.)	
2nd "	(4 ")	80 ")	
3rd "	(4 ")	80 ")	Total exposure
4th "	(4 ")	80 ")	$17\frac{1}{3}$ hours.
5th "	(4 ")	80 ")	
6th "	(5 ")	100 ")	
7th "	(5 ")	100 ")	
8th "	(5 ")	145 ")	47 days attendance.
9th "	(5 ")	150 ")	
10th "	(5 ")	150 ")	

Date	Wt.	R.B.C.	W.B.C.	Hb.	CI.	Plate-lets.	Blood Ca. per 100 cc. serum	Blood P. per 100 cc. serum.
12.12.27	45-4	4,260,000	9600	70%	.8	220,000	10 mgs.	5.2 mgs.
19.12.27	47-0	4,300,000	10,800	75%	.89	205,000		
27.12.27	46-14	4,080,200	8600	75%	.92	204,000	10 mgs.	-
5.1.28	47-10	4,030,000	7800	75%	.92	230,000		
18.1.28	47-12							
2.2.28	47-12	4,430,000	8200	75%	.85	288,000	10 mgs.	4 mgs.
16.2.28	47-14	4,540,000	7400	75%	.83	302,000	10 mgs.	5 mgs.

Weight	increase	=	2 lbs. 10 oz.
R.B.C.	"	=	280,000
Hb.	"	=	5%
Platelets	"	=	8200.

Differential Counts.

Date	12.12.27	5.1.28	16.2.28.
Polymorphs	65%	60%	60%
Small Lymph.	24%	30%	28%
Large Lymph.	10%	9%	10%
Eosinoph.	1%	1%	2%

Case 2. Euphemia Thomson. $9 \frac{7}{12}$ yrs. Height $42\frac{1}{2}$".

History: Congenital dwarf. For past two months had been listless and not inclined to play. Appetite and sleep poor. Easily tired. On examination there was no sign of disease in any of the organs.

After 1 month's irradiation, mother noticed very marked improvement. Sleeping and eating very much better; colour and appearance much healthier. (Note $8\frac{1}{2}$" below average height).

Showed a normal erythema on the second day. Desquamation commenced about fourth day and pigmentation appreciable at end of first week. Was well pigmented at end of fortnight.

Exposures.

1st week	(6 days)	90 mins.	)
2nd "	(4 ")	80 "	)
3rd "	(3 ")	60 "	) Total Exposures
4th "	(4 ")	80 "	)
5th "	(5 ")	100 "	) 17 hours 35 mins.
6th "	(6 ")	100 "	)
7th "	(5 ")	100 "	)
8th "	(5 ")	145 "	) 47 days attendance.
9th "	(5 ")	150 "	)
10th "	(5 ")	150 "	)

TABLE./

Date	Wt.	R.B.C.	W.B.C.	Hb.	CI.	Platelets.	Blood Ca. per 100 cc. serum	Blood P. per 100 cc. serum.
12.12.27	32-12	4,000,000	9,400	70%	.8	230,000	9 mgs.	5 mgs.
19.12.27	33-2	4,240,000	9,600	75%	.89	210,000		
27.12.27	33-3	4,100,000	8,600	75%	.8	205,000	9.5 mgs.	-
5.1.28	33-8	4,280,000	8,800	75%	.88	262,000		
25.1.28	33-0							
2.2.28	33-8	4,510,000	8,400	75%	.83	260,000	10 mgs.	3.8 mgs.
16.2.28	34-2	4,400,000	9,200	75%	.85	275,000	10 mgs.	4.8 mgs.

Weight increase = 1 lb. 6 oz.

R.B.C. increase = 400,000

Hb. increase = 5%

Platelet increase = 45,000

Differential Counts.

Date 12.12.27.		5.1.28	16.2.28.
Polymorphs	60%	50%	58%
Small Lymph.	30%	35%	32%
Large Lymph.	5%	10%	8%
Eosinoph.	5%	5%	2%

Case 3. Margaret Stevenson. $6 \frac{2}{12}$ yrs. Height $43\frac{1}{2}$".

History. Has been in poor health for many months, easily "colded". Tonsils blamed and tonsillectomy performed fortnight before treatment commenced. Had had a left otorrhoea for 2 months. Appetite poor, very nervous and easily tired.

On examination muscular tissue small but tonicity good. No glands palpable. Mouth and throat healthy. No physical signs in chest or abdomen. No evidence of old rickets.

After irradiation general health very much improved, sleeping and eating better. Was easily tired after each irradiation but after 2 months treatment this improved; and at same time otorrhoea had dried up. Colour and appearance justified mother's statement that child looked a different creature.

Very blonde child, did not pigment very markedly. Small exposures required to begin with as an intense erythema was easily produced.

Exposures. /

Exposures.

1st week	(4 days)	50 mins.	Total Exposure
2nd "	(4 ")	135 "	
3rd "	(4 ")	100 "	
4th "	(5 ")	120 "	19 hours 15 mins.
5th "	(5 ")	150 "	
6th "	(5 ")	150 "	
7th "	(5 ")	150 "	42 days attendance.
8th "	(5 ")	150 "	
9th "	(5 ")	150 "	

Date	Weight	R.B.C.	W.B.C.	Hb.	CI.	Platelets.	Blood Ca. per 100 cc. serum	Blood P. per 100 cc. serum
19.12.27	36.7	3,880,000	7000	60%	.82	194,000	9 mgs.	3.7 mgs.
30.12.27	36.8	3,730,000	8200	60%	.84	198,000		
4.1.28	36.8	4,020,000	8600	60%	.81	223,000		
1.2.28	38.6	3,670,000	9200	70%	.9	189,000		
17.2.28	39.0	3,840,000	7800	70%	.9	240,000	9.5 mgs	3.8 mgs.

Weight	increase	2 lbs. 9 oz.
R.B.C.	decrease	40,000
Hb.	increase	10%
Platelet	increase	46,000

Differential Count.

	19.12.27	25.1.28	17.2.28.
Polymorphs	70%	60%	65%
Small Lymph.	20%	30%	28%
Large Lymph.	9%	10%	6%
Eosinoph.	1%	1%	1%

Case 4. James Bell. 10 yrs. Height 53".

This child had been in poor health for some months. Losing colour, very nervous, sleeping badly and sweating at night.

Child pale, skin poor texture and covered with papular rash. Mouth and teeth good. No glands palpable. No physical signs in thorax or abdomen. Sent to department labelled "General Debility".

After a fortnight's exposure definitely improved. About 6 weeks after first exposure began to lose weight and became nervous again. Thread worms discovered. After cure of worms, weight and general condition improved very much. Marked improvement in condition of skin. It is to be noticed there was an increase in the eosinophils about a fortnight before worms were discovered.

This child pigmented rapidly and was one of the best pigmented in the series.

Exposures.

1st week	(4 days)	60 minutes)	
2nd "	(5 ")	125 ")	
3rd "	(5 ")	145 ")	Total
4th "	(4 ")	120 ")	Exposure.
5th "	(5 ")	150 ")	
6th "	(5 ")	150 ")	35 hours
7th "	(5 ")	150 ")	50 mins.
8th "	(5 ")	150 ")	
9th "	(4 ")	120 ")	58 days
10th "	(4 ")	120 ")	attendance.
11th "	(4 ")	120 ")	
12th "	(thread worms)	)	
13th "	(4 ")	120 ")	
14th "	(4 ")	120 ")	

Date	Weight	R.B.C.	W.B.C.	Hb.	CI.	Platelets.	Blood Ca. per 100 cc. serum	Blood P. per 100 cc. serum.
3.1.28	60-8	4,610,000	7800	70%	.76	276,000	9.5 mgs.	5 mgs.
18.1.28	62-0	4,600,000	8400	70%	.76	284,000		
2.2.28	63-8	4,400,000	7600	70%	.79	280,000	9	3.6
16.2.28	63-12	4,540,000	7200	75%	.83	292,000	10	5
1.3.28	63-6	4,620,000	8400	75%	.8	320,000	9	4.8
14.3.28	61-6	4,200,000	7800	80%	.9	384,000		
Thread Worms discovered; and treated with Santonin.								
28.3.28	65.0	4,820,000	6800	80%	.8	284,000	10	4.8

Weight	increase	4½ lbs.
R.B.C.	increase	210,000
Hb.	increase	10%
Platelet	increase	8,000

Differential Count.

	3.1.28.	1.3.28	28.3.28.
Polymorphs	68%	60%	65%
Small Lymph.	20%	25%	22%
Large Lymph.	10%	7%	10%
Eosinoph.	2%	8%	3%

Case 5. Thomas Forsyth. 10 $\frac{5}{12}$ yrs. Ht. 56½".

History. Old Cervical Adenitis, left side operated on 5 months before coming to sunlight. No glands now palpable, but has not been in good health since. Easily tired, sleeps badly, night terrors; poor appetite, poor colour, not inclined to play with the children.

No sign of disease in thorax, abdomen, throat or mouth. Poor musculature. Posture bad.

At end of one month's treatment there was marked general improvement, even though absent over a week with "influenza". Sleeping and eating better and "more life in him" to use mother's expression.

At end of 10 weeks treatment, when discharged, had kept up improvement and looked and acted a much healthier child. Pigmented little, fair complexioned child.

Exposures.

1st week	(5 days)	75 mins.	)
2nd "	(3 "	60 mins.	)
3rd "	"influenza"		)
4th "	(3 days)	45 "	) Total Exposure
5th "	(5 ")	140 "	)
6th "	(5 ")	150 "	) 18 hours 10 mins.
7th "	(5 ")	140 "	)
8th "	(4 ")	120 "	) 42 days attendance.
9th "	(4 ")	120 "	)
10th "	(4 ")	120 "	)
11th "	(4 ")	120 "	)

Date	Weight	R.B.C.	W.B.C.	Hb.	CI.	Plate-lets.	Blood Ca. per 100 cc. serum	Blood P. per 100 cc. serum.
9.1.28	75-8	4,430,000	8600	70%	.8	243,000	9.5 mgs.	4.1 mgs.
18th-25	"Influenza"							
1.2.28	74-14	3,850,000	7600	70%	.9	261,000	10	3.6
14.2.28	75-10	4,200,000	8200	70%	.8	212,000	9	5
29.2.28	76-0	4,820,000	7600	75%	.8	284,000	10	5
16.3.28	76-2	4,880,000	7400	80%	.8	316,000		

Weight increase = 10 oz.

R.B.C. increase = 450,000

Hb. increase = 10%

Platelet " = 73,000

Differential Count.

	9.1.28	14.2.28.	16.3.28.
Polymorph	70%	65%	65%
Small Lymph	25%	25%	28%
Large Lymph	4%	9%	5%
Eosinoph.	1%	1%	2%

Case 6. Rose Jack. $6\frac{11}{12}$. Ht. $49\frac{1}{2}$".

<u>History</u>. Brought to hospital with history of being nervous and "jumpy". Bad sleeper. Sometimes complained of pains in the legs. Poor appetite and easily tired. Poor colour. Regarded as "pre_rheumatic" and sent to sunlight department labelled so.

No evidence of rheumatism, heart tolerance normal. Rather pale and easily excitable. Nil in chest and abdomen. Mouth and teeth good. Posture however very bad, soft flabby muscles.

After 14 days exposure general improvement marked enough as to be commented on by mother. Sleeping, eating and looking better. Not so excitable and bad_tempered.

After course of treatment there was maintained improvement. Colour very much better. Has not complained of the pain in legs for several weeks. Posture much improved, muscle tone healthier. Pigmentation well marked.

<u>Exposures</u>.

1st week	(5 days)	70 mins.	
2nd "	(5 ")	130 "	
3rd "	(4 ")	120 "	Total Exposure
4th "	(3 ")	90 "	
5th "	(4 ")	120 "	24 hours 20 mins.
6th "	(5 ")	150 "	
7th "	(4 ")	120 "	52 days attendance.
8th "	(5 ")	150 "	
9th "	(3 ")	90 "	
10th "	(4 ")	120 "	
11th "	(5 ")	150 "	
12th "	(5 ")	150 "	

Date	Weight	R.B.C.	W.B.C.	Hb.	CI.	Plate-lets.	Blood Ca. per 100 cc. serum	Blood P. per 100 cc.serum.
19.1.28	53-2	4,050,000	7800	75%	.93	201,000	10 mgs.	5 mgs.
8.2.28	54-6	4,110,000	8200	75%	.9	274,000	9	5
22.2.28	55-12	4,400,000	7200	78%	.8	268,000	10	5
2.3.28	55-8	4,320,000	7600	80%	.9	284,000	9	-
16.3.28	56-0	4,890,000	8400	80%	.8	223,000		

Weight increase	=	2 lbs 14 oz.
R.B.C. increase	=	840,000
Hb. increase	=	5%
Platelet "	=	22,000

Differential Count.

	9.1.28	8.2.28	16.3.28
Polymorph	65%	60%	60%
Small Lymph.	20%	22%	25%
Large Lymph	14%	16%	12%
Eosinophil	1%	2%	3%

Case 7. George Howieson. $6\frac{9}{12}$ yrs. Ht. 50".

<u>History</u>. For past few months "run-down". Taking colds and sore throats frequently. Restless at night. Very easily tired. Had tuberculous glands removed from neck 9 months before.

Pale child, development however good. Flat chest with poor movement. No physical signs in chest or abdomen. A few small glands still palpable in neck. Teeth not good - several carious. Posture bad, muscles soft and flabby.

After getting over the "cold" he took soon after commencing treatment, his general condition was much improved. Mother chiefly noticed how much better he slept and how more inclined he was to play outside with other children. Appetite and colour were also much improved. The glands which were palpable before treatment were appreciably smaller after.

Pigmented little, but had a good erythema and desquamation. Blonde type.

<u>Exposures</u>.

1st week	(3 days)	90 mins.	Total Exposure
2nd "	(2 days) "cold"	35 "	
3rd "	(5 days)	95 "	
4th "	(4 ")	105 "	18 hrs 35 mins.
5th "	(5 ")	150 "	
6th "	(4 ")	120 "	42 days attendance.
7th "	(5 ")	150 "	
8th "	(5 ")	150 "	
9th "	quarantine - brother with measles.		
10th "			
11th "	(5 days)	100 mins.	
12th "	(4 days)	120 mins.	

Date	Weight	R.B.C.	W.B.C.	Hb.	CI.	Plate-lets.	Blood Ca. per 100 cc.serum	Blood P. per 100 cc. serum.
1.2.28	54-6	4,100,000	7200	70%	.8	201,000	10 mgs.	3.5 mgs.
	4th-8th off with "cold"							
14.2.28	53-4	4,340,000	8200	75%	.8	222,000	9.5	5
1.3.28	54-4	4,420,000	8600	78%	.9	236,000	9	-
16.3.28	54-8	4,380,000	9200	80%	.9	300,000		
30.3.28	55-12	4,410,000	8800	80%	.9	243,000		
13.4.28	56-12	4,500,000	7800	80%	.9	250,000	10	5

Weight	increase	=	2 lbs 6 oz.
R.B.C.	increase	=	400,000
Hb.	increase	=	10%
Platelet	increase	=	40,000

Differential Counts.

	1.2.28	1.3.28	13.4.28
Polymorphs	70%	70%	65%
Small Lymph.	20%	23%	25%
Large Lymph.	8%	5%	8%
Eosinoph.	2%	2%	2%

Case 8. Margaret Paterson. 9 $\frac{2}{12}$ yrs. Ht. 50½".

History: Chronic ill-health for many months, complicated by chronic otitis media - radical mastoid 8 months previously. Still some otorrhoea. Poor appetite, bad sleeper, losing weight and colour.

Very poorly nourished child. Pale sallow skin. No physical signs in chest or abdomen. No glands palpable. Mouth and throat healthy.

Very marked improvement under treatment. Otorrhoea completely dried up. Colour greatly improved and mother was very impressed with the change in the child.

Erythema as usual after second exposure, desquamation a few days later and pigmented more darkly than the average.

Exposures.

1st week	(5 days)	45 mins.	)
2nd "	5 "	75 "	)
3rd "	5 "	95 "	) Total Exposure
4th "	4 "	115 "	)
5th "	5 "	150 "	) 20 hours.
6th "	5 "	150 "	)
7th "	5 "	150 "	) 48 days attendance.
8th "	5 "	150 "	)
9th "	4 "	120 "	)
10th "	5 "	150 "	)

TABLE/

Date	Weight	R.B.C.	W.B.C.	Hb.	CI.	Plate-lets.	Blood Ca. per 100 cc. serum	Blood P. per 100 cc. serum.
30.1.28	51-0	4,150,000	6200	60%	.7	173,000	9.5 mgs	4 mgs.
15.2.28	50-12	4,220,000	6800	65%	.7	194,000	10	5
5.3.28	51-14	4,480,000	7600	70%	.8	214,000	10	4.8
21.3.27	51-14	4,280,000	8400	75%	.9	204,000		
4.4.28	52-6	4,880,000	9200	80%	.8	282,000	9	4.6

Weight	increase	=	1 lb. 6 oz.
R.B.C.	"	=	730,000
Hb.	"	=	20%
Platelet	"	=	109,000

Differential Counts.

	30.1.28	5.3.28	4.4.28
Polymorphs	68%	60%	65%
Small Lymph.	20%	35%	30%
Large Lymph	10%	4%	4%
Eosinophil	2%	1%	1%

Case 9. Ellen Campbell. 6 $\frac{5}{12}$ yrs. Ht. 45$\frac{3}{4}$"

History. Cerv. adenitis (T.B.): glands removed 8 months before. Had always been delicate and no better since operation. Poor appetite - bad home. Easily tired, losing weight and sleeping badly.

Very poor development and poorly nourished. Pigeon breasted, posture very bad, muscles thin and flabby. Skin dry and scaly and numerous papules over it. No signs of disease in chest or abdomen. No glands palpable.

After 13 weeks attendance, there was a marked improvement, none more striking than in the condition of the skin. Appetite and sleep very much better. Child from being dull and listless became one of the cheeriest and noisiest attending. Marked increase in weight. Improvement maintained throughout. Erythema, desquamation and pigmentation at usual times.

Exposures.

1st week	(5 days)	75 minutes	)
2nd "	5 "	150 "	)
3rd "	5 "	140 "	) Total Exposure
4th "	4 "	105 "	)
5th "	5 "	150 "	) 22$\frac{1}{3}$ hours.
6th "	5 "	150 "	)
7th "	5 "	150 "	) 48 days attend-
8th "	5 "	150 "	)
9th "	5 "	150 "	) ance.
10th "	4 "	120 "	)

Date	Weight	R.B.C.	W.B.C.	Hb.	CI.	Platelets.	Blood Ca. per 100 cc. serum	Blood P. per 100 cc. serum.
30.1.28	35-5	3,640,000	7800	70%	.9	202,000	9 mgs.	3.6 mgs.
15.2.28	38-1	3,680,000	8400	70%	.9	245,000	10	5
29.2.28	37-14	4,100,000	9200	75%	.9	288,000	9.5	5.1
14.3.28	37-14	4,080,000	7200	75%	.9	208,000		
5.4.28	38-8	4,420,000	7400	80%	.9	282,000	10	5

Weight increase = 3 lbs 3 oz.

R.B.C. increase = 780,000

Hb. increase = 10%

Platelet increase = 80,000

Differential Counts.

	30.1.28	29.2.28	5.4.28
Polymorphs	68%	65%	60%
Large Lymph.	25%	28%	30%
Small Lymph.	5%	6%	8%
Eosinophil.	2%	1%	2%

Case 10. Margaret Izett. $7\frac{1}{12}$ yrs. Height 49".

History: This child was sent to department labelled "General Debility". Complaints were: easily tired, poor eater, anaemic-looking and losing weight. No cough, or "growing-pains". Had been "delicate" for some years.

On examination child was a good height, but thin, and poor muscular tone. Posture bad. Nil in chest or abdomen and mouth and throat healthy.

Improved rapidly with treatment and after five weeks, treatment stopped for a month. Improvement was maintained the month at home. Another four weeks treatment given and there was a slight further improvement in general health, though little change in the blood.

Erythema, desquamation and pigmentation average.

Exposures.

1st week	(5 days)	60 mins.	
2nd "	5 "	100 "	
3rd "	5 "	100 "	
4th "	4 "	105 "	
5th "	5 "	150 "	Total Exposure.
Period of intermission.			
6th "	2 days	30 mins.	15 hours 50 mins.
7th "	5 "	105 "	
8th "	5 "	150 "	41 days attendance.
9th "	5 "	150 "	

TABLE./

Date	Weight	R.B.C.	W.B.C.	Hb.	CI.	Plate-lets.	Blood Ca. per 100 cc.serum	Blood P. per 100 cc.serum.
30.1.28	49-2	3,910,000	8200	70%	.8	200,000	10 mgs.	3.8 mgs.
14.2.28	50-0	4,240,000	7600	70%	.8	210,000	10	4.8
29.2.28	49-8	4,420,000	8600	75%	.8	260,000	10.5	5
	Radiation stopped 1 month.							
29.3.28	50-8	4,510,000	7800	75%	.8	201,000	10	4.6
18.4.28	51-12	4,480,000	7200	75%	.8	282,000	10	4.6

Weight	increase	2 lbs 10 oz.
R.B.C.	"	570,000
Hb.	"	5%
Platelet	"	82,000

Differential Counts.

	30.1.28	29.2.28	29.3.28	18.4.28.
Polymorphs	70%	60%	68%	70%
Small lymph.	20%	28%	25%	20%
Large lymph.	8%	10%	6%	9%
Eosinoph.	2%	2%	2%	1%

Case 11. William Maxwell. $6\frac{6}{12}$ yrs. Ht. 42".

History. Bad health for a long time. Tonsils blamed and removed some 4 months before. Did not improve after operation. Colour poor, easily tired, did not want to play; poor appetite.

Examination.

Poorly nourished, pale; muscles soft and flabby, posture bad. Throat and mouth healthy. No glands palpable. Chest and abdomen showed no physical signs.

Improved steadily under treatment. Appetite and spirits improved. Not so easily tired. Great improvement in colour.

Showed slight erythema, good desquamation and pigmentation.

Exposures.

1st week	(5 days)	75 mins.)		
2nd "	5 "	150 "	)	
3rd "	5 "	150 "	)	Total Exposures.
4th "	4 "	120 "	)	
5th "	5 "	150 "	)	21 hrs. 35 mins.
6th "	5 "	150 "	)	
7th "	4 "	120 "	)	48 days attendance.
8th "	5 "	150 "	)	
9th "	5 "	150 "	)	
10th "	5 "	150 "	)	

TABLE./

Date	Weight	R.B.C.	W.B.C.	Hb.	CI.	Platelets.	Blood Ca. per 100 cc. serum	Blood P. per 100 cc. serum.
30.1.28	40-0	3,540,000	7200	65%	.9	177,000	10 mgs.	4.1 mgs.
15.2.28	40-14	3,860,000	8400	70%	.9	227,000	10	4.5
7.3.28	40-12	3,980,000	8600	75%	.9	289,000	9.5	5
21.3.28	41-0	4,160,000	8800	75%	.9	284,000		
4.4.28	42-0	4,630,000	8200	80%	.8	240,000	10	4.8

Weight increase = 2 lbs.

R.B.C. " = 1,090,000

Hb. " = 15%

Platelet " = 63,000

Differential Counts.

	30.1.28	29.2.28.	4.4.28
Polymorphs	62%	65%	65%
Small lymph.	28%	30%	28%
Large lymph.	8%	4%	6%
Eosinoph.	2%	1%	1%

Case 12. William Thayne. Aet. 7. Height 47¼".

<u>History</u>. Brought to outpatient dept., because had been easily tired, listless, losing appetite and weight. After some medical treatment, decided to have tonsils removed and tonsillectomy was performed a month prior to irradiation. No improvement was noticed following tonsillectomy.

After a few weeks treatment, this child's condition was very markedly improved. Gained weight steadily, general appearance, appetite and sleep much better. On discharge the change in the child was very marked. Good erythema and desquamation produced; pigmentation marked in three weeks.

<u>Exposures</u>.

1st	week	(5 days)	55 mins.	)
2nd	"	5 "	100 "	)
3rd	"	5 "	95 "	)
4th	"	4 "	95 "	) Total Exposure
5th	"	5 "	150 "	)
6th	"	5 "	150 "	) 18 hours 15 mins.
7th	"	5 "	150 "	)
8th	"	5 "	150 "	) 44 days attendance.
9th	"	5 "	150 "	

TABLE./

Date	Weight	R.B.C.	W.B.C.	Hb.	CI.	Plate-lets.	Blood Ca. per 100 cc. serum	Blood P. per 100 cc. serum
30.1.28	50-0	3,600,000	7800	70%	.9	160,000	10 mgs.	3.5 mgs
15.2.28	50-2	3,880,000	7600	70%	.9	181,000	9.5	5.5
29.2.28	52-0	4,100,000	8400	75%	.9	210,000	10	5
14.3.28	52-10	4,320,000	8800	75%	.9	212,000		
28.3.28	53-2	4,410,000	8600	80%	.9	243,000	9	5

Weight increase = 3 lbs 2 oz.
R.B.C. " = 750,000
Hb. " = 10%
Platelet " = 83,000

Differential Counts.

	30.1.28	29.2.28	28.3.28
Polymorphs	65%	60%	60%
Small lymph.	25%	25%	28%
Large lymph.	8%	14%	10%
Eosinoph.	2%	1%	2%

Case 13. Robert Pilmer. Aet 8 $\frac{6}{12}$. Wt. 51".

<u>History</u>. Child had been ailing for some months back. Losing weight, poor appetite, sleeping badly and easily tired.

On examination abdomen rather protuberant and sent to department as ? T.B. Abdomen. But there were no glands or masses palpable, and child's posture was very bad,with very soft flabby muscles, the probable cause of the protuberant abdomen.

This child was very definitely improved. The weight increased markedly from the beginning. Erythema marked on second and third days. Desquamation soon followed, and pigmentation was well marked after a fortnight.

<u>Exposures</u>.

1st week	(5 days)	70 mins.	Total Exposure
2nd "	4 "	95 "	21 hrs. 45 mins.
3rd "	5 "	150 "	47 days Attendance.
4th "	5 "	150 "	
5th "	3 "	90 "	
6th "	5 "	150 "	
7th "	5 "	150 "	
8th "	5 "	150 "	
9th "	5 "	150 "	
10th "	5 "	150 "	

TABLE./

Date	Weight	R.B.C.	W.B.C.	Hb.	CI.	Plate-lets.	Blood Ca. per 100 cc.serum	Blood P. per 100 cc serum.
13.2.28	52-0	3,770,000	8200	70%	.9	188,000	10 mgs.	5 mgs.
5.3.28	54-7	3,980,000	7800	80%	.9	197,000	9.5	4.6
19.3.28	54-4	3,860,000	6800	80%	.9	212,000		
28.3.28	54-10	4,420,000	7200	80%	.9	214,000	10	4.8
16.4.28	55-0	4,440,000	7800	80%	.9	202,000	10	5

Weight	increase	=	3 lbs.
R.B.C.	"	=	670,000
Hb.	"	=	10%
Platelet	"	=	14,000

Differential Counts.

Date	13.2.28	19.3.28	16.4.28
Polymorphs	68%	60%	65%
Small Lymph.	25%	30%	28%
Large Lymph.	6%	8%	5%
Eosinophils	1%	2%	2%

Case 14. Jessie Arthur. Aet. 11 $\frac{5}{12}$. Ht. 52$\frac{3}{4}$".

<u>History.</u> For the past few months in failing health. Losing weight and colour. Appetite poor and easily tired. Rather breathless. Sent to department as "Anaemia and Debility". Slight cough at nights. No sweating. No physical signs in chest or abdomen. Heart shows no murmurs. No glands palpable, mouth and throat healthy. Very pale with bad posture and poorly nourished musculature.

Improvement most pronounced. Cough ceased to trouble. Eating and sleeping very much better and colour greatly improved.

Erythema marked 3rd day. Desquamation on succeeding days and well pigmented by 14th day.

<u>Exposure.</u>

1st week	(5 days)	50 mins.)	Total Exposure
2nd "	4 "	105 ")	
3rd "	5 "	110 ")	11 hrs. 50 mins.
4th "	5 "	145 ")	
5th "	5 "	150 ")	29 days attendance.
6th "	5 "	150 ")	

Date	Weight	R.B.C.	W.B.C	Hb.	CI.	Plate-lets.	Blood Ca. per 100 cc. serum	Blood P. per 100 cc. serum.
13.2.28	49-2	3,650,000	6400	60%	.8	182,000	10 mgs.	4.6 mgs.
22.2.28	50-10							
29.2.28	50-10	3,820,000	7200	60%	.8	176,000	10	4.8
7.2.28	50-12							
14.3.28	51-0	4,250,000	7800	75%	.9	202,000		
21.3.28	51-0	4,420,000	8200	75%	.8	234,000	10	5

Weight	Increase	=	1 lb. 14 oz.
R.B.C.	"	=	670,000
Hb.	"	=	15%
Platelet	"	=	52,000

Differential Counts.

Date.	13.2.28	14.3.28	21.3.28.
Polymorphs	58%	60%	60%
Small Lymph.	28%	30%	25%
Large Lymph.	10%	8%	12%
Eosinophil	4%	2%	3%

Case 15. Gertrude Alexander. Aet $7\frac{4}{12}$. Ht. 48".

History. For the past 3 months has been in poor health. Had to stay from school 2 months prior to irradiation because of cough. Easily tired, losing weight. Sent to department as "Debility".

Examination. Nil to be made out in chest or abdomen. No glands palpable. Throat and mouth healthy.

Improved rapidly. After 10 weeks no cough left. Colour very much improved. Appetite improved and not so easily tired. Posture, which was poor, greatly improved.

Exposures.

1st week	(5 days)	50 mins.	Total Exposure
2nd "	3 "	75 "	17 hours 35 mins.
3rd "	3 "	90 "	39 days' attendance.
4th "	3 "	90 "	
5th "	3 "	90 "	
6th "	5 "	150 "	
7th "	5 "	150 "	
8th "	4 "	120 "	
9th "	4 "	120 "	
10th "	4 '	120 "	

	Weight	R.B.C.	W.B.C.	Hb.	CI.	Plate-lets.	Blood Ca. per 100 cc. serum	Blood P. per 100 cc. serum.
30.2.28	50-6	3,970,000	8000	70%	.9	234,000	9.5 mgs.	5 mgs.
27.2.28	51-0	4,200,000	7800	70%	.8	248,000	9	5
14.3.28	51-8	4,380,000	7200	72%	.8	260,000		
28.3.28	51-8	4,220,000	6800	80%	.9	276,000		
5.4.28	50-14	4,560,000	8200	80%	.9	304,000	9.5	4.8
19.4.28	50-12	4,680,000	7800	85%	.9	275,000		

Weight	increase	=	1 lb. 6 oz.
R.B.C.	"	=	710,000
Hb.	"	=	15%
Platelet	"	=	41,000

Differential Count.

Date.	13.2.28.	14.3.28	19.4.28
Polymorph	75%	65%	70%
Small Lymph.	18%	25%	25%
Large Lymph.	4%	8%	4%
Eosinoph.	2%	2%	1%

Case 16. Alex. Borthwick. Aet 7 $\frac{3}{12}$. Ht. 47¾".

History. Chronic Otitis Media for nearly a year, but discharge had stopped some weeks before irradiation. Child's health poor. "Anaemic", poor eater; nervous and very irritable: did not play with other children.

On examination. No physical signs of disease in chest or abdomen. Colour poor. Muscles soft and flabby. Throat and mouth good.

After a few weeks treatment, definitely improved. Mother noticed this chiefly as increase of appetite and improvement in temper. Colour and spirits also benefited.

Sharp erythema on second day. Desquamation apparent on fourth day. Pigmentation well developed by tenth day. (Dark-complexion).

Exposures.

1st week	(5 days)	65 mins.)	
2nd "	5 "	145 ")	
3rd "	5 "	150 ")	Total Exposure
4th "	5 "	150 ")	
5th "	5 "	150 ")	21 hours.
6th "	5 "	150 ")	
7th "	5 "	150 ")	45 days' attend-
8th "	5 "	150 ")	
9th "	5 "	150 ")	ance.

Date	Weight	R.B.C.	W.B.C.	Hb.	C.I.	Platelet.	Blood Ca. per 100 cc. serum	Blood P. per 100 cc. serum.
27.2.28	48-12	4,070,000	10,600	70%	.87	240,000	9 mgs.	4-9 mgs.
12.3.28	48-0	4,080,000	8,800	78%	.9	266,000	9	5
26.3.28	48-10	4,390,000	7,600	80%	.9	283,000		
11.4.22	49-0	4,450,000	7,800	80%	.9	279,000		
23.4.28	49-0	4,580,000	8,200	80%	.89	232,000	10.5	5

Weight Increase = ¼ lb.

R.B.C. " = 510,000

Hb. " = 10%

Platelet decrease 8000

Differential Counts.

Date	27.2.28	26.3.28	23.4.28
Polymorph.	65%	65%	68%
Small Lymph.	20%	25%	22%
Large Lymph.	12%	8%	8%
Eosinoph.	3%	2%	2%

Case 17. Joan Callaghan. $8 \frac{9}{12}$. Ht. $51\frac{1}{2}$".

History. This child had been in ill-health for many months, latterly losing weight and colour. Complaining of pain in the legs and thighs and treated as a "pre-rheumatic subject". Heart tolerance normal, but subject to fainting turns. Had one a day or two after irradiation commenced.

Nutrition poor (poor home): muscles flabby, posture very bad; narrow chested. No glands palpable and nothing abnormal found in chest or abdomen.

Posture was improved with exercises and general condition improved slowly. Some two months elapsed before any very appreciable improvement took place. Thereafter however improvement was rapid. No more fainting attacks occurred. Stopped complaining of pains in the legs. Colour very much improved. Looked a healthy child after irradiation. Had no salicylate treatment during course of irradiation, though had a course before commencing.

EXPOSURES./

Exposures.

1st week	(5 days)	50 mins.	)	
2nd "	3 "	50 "	)	
3rd "	4 "	100 "	)	
4th "	5 "	150 "	)	Total Exposure
5th "	5 "	150 "	)	
6th "	4 "	120 "	)	31 hrs. 20 mins.
7th "	5 "	150 "	)	
8th "	5 "	150 "	)	68 days Attendance.
9th "	5 "	150 "	)	
10th "	5 "	150 "	)	
11th "	3 "	90 "	)	
12th "	4 "	120 "	)	
13th "	5 "	150 "	)	
14th "	5 "	150 "	)	
15th "	5 "	150 "	)	

Date	Weight	R.B.C.	W.B.C.	Hb.	CI.	Plate-let.	Blood Ca. per 100 cc.serum	Blood P. per 100 cc.serum.
5.3.28	53-14	3,990,000	6400	65%	.8	250,000	10 mgs.	4.5 mgs.
19.3.28	53-9	3,860,000	7800	70%	.9	224,000		
1.4.28	53-1	4,280,000	7200	70%	.8	212,000	9	5
15.4.28	54-3	4,310,000	7200	75%	.8	260,000		
30.4.28	54-8	4,300,000	7600	75%	.89	284,000		
16.5.28	54-1	4,400,000	8200	75%	.8	276,000	9.5	5
30.5.28	55-14	4,480,000	8600	78%	.8	298,000		
13.6.28	56-0	4,450,000	8400	80%	.9	284,000	10	5

Weight	increase	=	2 lbs. 2 oz.
R.B.C.	"	=	460,000
Hb.	"	=	10%
Platelet	"	=	34,000

Differential Count.

Date.	5.3.28	8.4.28	13.6.28
Polymorph	60%	65%	65%
Small Lymph.	28%	30%	30%
Large Lymph.	10%	4%	3%
Eosinoph.	2%	1%	2%

Case 18. Lottie Porteous. $7\frac{6}{12}$. Height 46".

History. Poor health last 4-5 months. Though well nourished was easily tired, listless and had a poor appetite. Weight stationary.

Examination revealed no sign of disease in chest or abdomen. No glands palpable and throat and mouth healthy. Muscles rather flabby and posture poor. Labelled "General Debility".

Did not show much improvement first few weeks, but reason apparent when developed measles. After return to irradiation there was a marked improvement in her condition both in appearance and symptoms. Interesting to note that though in very close daily contact, no other case of Measles developed in the clinic following this case, though many of the children had not had Measles.

Exposures.

1st week	(5 days)	55 mins.	Total Exposure
2nd "	5 "	75 "	13 hours 25 mins.
3rd "	5 "	75 "	40 days' attendance.
4th "	4 "	65 "	
5.4.28-15.5.28 Measles.			
5th week	(2 days)	30 "	
6th "	4 "	60 "	
7th "	5 "	145 "	
8th "	5 "	150 "	
9th "	5 "	150 "	

Date	Weight	R.B.C.	W.B.C.	Hb.	CI.	Platelets.	Blood Ca. per 100 cc. serum	Blood P. per 100 cc. serum.
12.3.28	50-2	3,849,000	9600	75%	.9	274,000	10 mgs.	5 mgs.
28.3.28	50-2	3,540,000	12,000	70%	.9	210,000		
	5.4.28. Developed Measles.							
15.5.28	51-0	3,790,000	8,600	70%	.9	212,000	9	4.5
30.5.28	51-4	4,690,000	8,400	80%	.87	312,000		
13.6.28	52-5	4,840,000	9,200	85%	.89	364,000	10	4.8

Weight increase = 2 lb. 3 oz.

R.B.C. " = 1,000,000

Hb. " = 10% (15% from lowest)

Platelet " = 90,000

Differential Counts.

Date	12.3.28	15.5.28	13.6.28
Polymorph	70%	75%	65%
Small Lymph.	25%	20%	30%
Large Lymph.	3%	2%	4%
Eosinoph.	2%	3%	1%.

Case 19. Charlotte Archer. $7\frac{2}{12}$. Weight $46\frac{1}{2}$".

History. 5 months before had had Measles and has never been in good health since. According to mother was afterwards threatened with Chorea. Has been attending outpatient dept. last 3 months, but there has been little improvement with medical treatment.

Poor colour: restless and excitable, but easily tired. Clever at school. Subject to fainting attacks.

On examination. No signs of disease found in chest or abdomen. Heart tolerance normal. No glands palpable. Development and nutrition quite good. Muscles however flabby and posture not good.

Improvement in appearance good. Still however restless and easily tired. Has still had fainting attacks. None witnessed in department. Even though the child's health was not benefited as much as in other cases, the effect on the blood was as marked.

Exposures.

1st week	(5 days)	70 mins.	) Total Exposure 18 hrs. 35 mins. 52 days attendance.
2nd "	5 "	100 "	)
3rd "	4 "	80 "	)
4th "	5 "	100 "	)
5th "	5 "	100 "	)
6th "	5 "	100 "	)
7th "	4 "	80 "	)
8th "	5 "	100 "	)
9th "	4 "	85 "	)
10th "	5 "	150 "	)
11th "	5 "	150 "	)

Date	Weight	R.B.C.	W.B.C.	Hb.	CI.	Plate-lets.	Blood Ca. per 100 cc.serum	Blood P. per 100 cc.serum.
2.4.28	42-8	4,030,000	8200	70%	.8	285,000	10 mgs.	5 mgs.
16.4.28	42-12	4,250,000	9800	75%	.8	283,000		
30.4.28	43-0	4,340,000	8600	75%	.8	264,000		
16.5.28	43-12	4,370,000	8400	80%	.9	312,000	10	5
1.6.28	45-3	4,380,000	8800	80%	.9	364,000		
15.6.28	44-8	4,730,000	9200	85%	.9	320,000	10	4.5

Weight increase = 2 lbs.

R.B.C. " = 700,000

Hb. " = 15%

Platelet " = + 35,000

Differential Counts.

Date	2.4.28	16.5.28	15.6.28
Polymorph	68%	65%	70%
Small Lymph.	20%	25%	20%
Large Lymph.	10%	8%	5%
Eosinoph.	2%	2%	5%

Case 20. George Tilson. Aet 8 $\frac{4}{12}$. Height 46".

History. In hospital with pneumonia 2 years before, very seriously ill and has "never been the same since". Poor eater, poor colour, under weight and height. Takes colds easily. Quite bright and intelligent and sleeps well. No illnesses since the pneumonia.

Examination. Small pale child. Muscles small but good tone. Chest and abdomen sound. Mouth and throat good.

There was very marked improvement in this child - one of the most marked encountered in this series. The whole general condition of the child was greatly improved, and in the mother's words "Would hardly believe there could be such a change".

Exposures.

1st week	(5 days)	90 mins.	Total Exposure
2nd "	5 "	120 "	
3rd "	5 "	150 "	
4th "	5 "	150 "	18 hours 30 mins.
5th "	5 "	150 "	
6th "	5 "	150 "	
7th "	5 "	150 "	40 days' attendance.
8th "	5 "	150 "	

Date	Weight	R.B.C.	W.B.C.	Hb.	CI.	Plate-lets.	Blood Ca. per 100 cc.serum	Blood P. per 100 cc.serum
18.4.28	45-0	3,530,000	6800	65%	.9	184,000	9.5 mgs	5 mgs.
2.5.28	45-8	3,840,000	7200	68%	.9	202,000		
16.5.28	44-10	4,650,000	8600	80%	.9	310,000	9	4.8
1.6.28	45-12	4,730,000	9800	85%	.9	295,000		
15.6.28	46-7	4,810,000	9600	85%	.89	287,000	9	5

Weight increase = 1 lb. 7 oz.

R.B.C. " = 1,280,000

Hb. " = 20%

Platelet " = 103,000

Differential Count.

Date	18.4.28	16.5.28	15.6.28
Polymorph	60%	65%	65%
Small Lymph	28%	30%	25%
Large Lymph.	10%	4%	8%
Eosinoph.	2%	1%	2%

SUMMARY OF CASES.

Case	R.B.C.	Lympho-cytosis.	Hb.	C.I.	Platelets.	Weight. lbs.
1	+ 280,000	+	+ 5%	+ 0.03	+ 82,000	+ 2 - 10
2	+ 400,000	+	+ 5%	+ 0.05	+ 45,000	+ 1 - 6
3	- 40,000	+ +	+ 10%	+ 0.08	+ 46,000	+ 2 - 9
4	+ 210,000	+	+ 10%	+ 0.04	+ 8,000	+ 4 - 8
5	+ 450,000	Nil	+ 10%	Stationary.	+ 73,000	+ 0 - 10
6	+ 840,000	+	+ 5%	- 0.13	+ 22,000	+ 2 - 14
7	+ 400,000	+	+ 10%	+ 0.1	+ 40,000	+ 2 - 6
8	+ 730,000	+ + +	+ 20%	+ 0.1	+ 109,000	+ 1 - 6
9	+ 780,000	+	+ 10%	Stationary.	+ 80,000	+ 3 - 3
10	+ 570,000	+ +	+ 5%	"	+ 82,000	+ 2 - 10
11	+ 1,090,000	+	+ 15%	- 0.10	+ 63,000	+ 2 - 0
12	+ 750,000	+	+ 10%	Stationary.	+ 83,000	+ 3 - 2
13	+ 670,000	+	+ 10%	"	+ 14,000	+ 3 - 0
14	+ 670,000	+	+ 15%	"	+ 52,000	+ 1 - 14
15	+ 710,000	+	+ 15%	"	+ 41,000	+ 1 - 6
16	+ 510,000	+	+ 10%	"	+ 8,000	+ 0 - 4
17	+ 460,000	+	+ 10%	+ 0.10	+ 34,000	+ 2 - 2
18	+ 1,000,000	+	+ 15%	+ 0.01	+ 90,000	+ 2 - 3
19	+ 700,000	+	+ 15%	+ 0.90	+ 35,000	+ 2 - 0
20	+ 1,280,000	+	+ 20%	Stationary.	+ 103,000	+ 1 - 7
Aver.	+ 627,000	+	11%	+	+ 55,000	+ 2 - 3 approx.

NOTE: Results of the Ca. & P. concentrations could not be tabulated because of their inconstancy.

VI. SUMMARY AND CONCLUSIONS.

The beneficial effects of sunlight in its natural form were recognised many centuries ago, but it is only in recent years that Heliotherapy has been practised to any extent.

The invention of the electric arc and its various modifications, has greatly increased the practice of Radiation, and has proved a great boon to these countries where the climatic conditions are against natural Heliotherapy.

Recent work has shown that Actinotherapy has a very useful action, though natural Heliotherapy, with its attendant environment still has many advantages.

The effects of sunlight on the body can readily be demonstrated, but it has yet to be explained how these effects are produced. The most recent work tends to show that these effects are probably due to the action of substances activated in the skin by photo-chemical action. That these substances can have an effect on the deep-seated organs is beyond dispute in the case of vitamin D deficiency.
The nature of these substances is still in doubt, but the effect of sunlight in producing vitamin D from its precursor in the skin - ergosterol - seems to favour the most recent view that they belong to the/

the vitamin series.

Very definite changes are always encountered in the various blood components after irradiation. These changes all point to a stimulation of the blood forming organs. The anaemias of malnutrition respond so rapidly that, in the writer's opinion, some stimulating hormone must be formed in the skin, which exerts its influence either directly or indirectly on the bone-marrow. It is not a want of iron that is at fault, for in most of the cases the amount of haemoglobin in each cell is not very much increased, but the absence of some substance - probably a vitamin - which is necessary for the proper formation of the blood cells.

All the cases in this series showed a stimulation of the activity of the bone marrow - more marked when the function was below normal activity. The red blood corpuscles, with one exception, were increased in all the cases.

Interesting and very constant effects were produced in the leucocytes, a definite lymphocytosis of the small mononuclears being experienced in nearly all the cases. The writer has been unable to explain the significance of this finding. The percentage of Haemoglobin rose along with the increase in the number of the red blood corpuscles, though the actual concentration per corpuscle was not always increased.

Some original modifications have been described in the technique of counting the blood platelets: and it has been shown that irradiation increases the number of these cells if it is initially low. An increase above the average number was never produced.

Other workers have shown various results of the effect of irradiation on the Ca. and P. concentrations in the blood serum. Most of them have produced an increase - some very high concentrations have been produced by one authority. In the series of cases here investigated an estimation above normal levels was never experienced. The variable results obtained in the concentrations of these substances have been explained by arguing that irradiation may at different times have a more pronounced effect on one or other of the various processes at work to maintain the usual fairly constant level of these constituents in the blood serum.

Finally it has been attempted to show the marked general effect on the nutrition and mental aptitude of the child. All children gained weight under treatment, though some had definitely been losing prior to irradiation.

CONCLUSIONS./

CONCLUSIONS.

1. Irradiation with Carbon-arc lamps produces a definite stimulating effect on the activity of the blood forming organs.

2. A lymphocytosis of the small cell series, sometimes at the expense of polymorph leucocyte, is nearly always experienced. An eosinophilia is not produced.

3. The percentage of Haemoglobin increases along with the increase of red blood corpuscles, but the concentration per cell does not always increase unless initially low.

4. The number of blood platelets is always increased when it is below normal levels. An increase above normal is not produced.

5. Variable effects are produced in the concentration of Ca. and P. in the blood stream.

6. A general beneficial action is produced on the whole organism more pronounced than can be shown by any laboratory methods.

In conclusion I wish to express my very great gratitude to Dr Lewis Thatcher for his help and interest while carrying out this investigation and for/

for his permission to make use of the cases attending the "Sunlight Department" of the Sick Children's Hospital, Edinburgh; also to Sister Robinson for her help and patience in collecting and preparing the cases for me.

VII. B I B L I O G R A P H Y.

1. Sonne, C. 1926, Verhandl D. Klimatolog. Tagung. in Davos, 1925. 382.

2. Humphris, F.H. 1926, Artificial Sunlight and its Therapeutic Uses.

3. Macht, D.I., F.K. Bell, C.F. Elvers, 1925, Proc. Soc. Exper. Biol. Med. XXIII, 210.

4. Rollier, A., 1927. Heliotherapy.

5. Oltramare, J.H. 1919, Compt. rend. Soc. de Biol., LXXXII, 190.

6. Mayerson, H.S., L. Gunther, H. Laurens, 1926, Amer. Journ. Physiol., LXXV, 399, 421.

7. Rothman, S., J. Callenberg, 1923, Klin. Wochenschr., II, 1751.

8. Fries, M.E., 1925, Proc. Soc. Exper. Biol. Med., XXII, 431.

9. Cumberbatch, B.M., 1928, Brit. Med. Journ., II, 43.

10. Jesionek, A., 1912, Lichtbiologie und Lichtpathologie.

11. Quoted from Laurens, H., 1928, Physiol. Rev., VIII.

12. Bernhard, O., 1917, Sonnenlichtbehandlung in der Chirurgie.

13. Miles, A.L., H. Laurens, 1926, Amer. Journ. Physiol., LXXV, 443.

14. Miles, A.L., H. Laurens, 1926, Amer. Jour. Physiol., LXXV, 462.

15. Mayerson, H.S., 1927, Proc. Soc. Exper. Biol. Med., XXIV, 882.

16. Levy, M., 1924, Strahlentherapie, XVIII, 681.

17. Burchardi, K., 1921, Strahlentherapie, XII, 808.

18. Sooy, J.W., T.S. Moise, 1926, Journ. Amer. Med. Assoc., LXXXVII, 94.

19. Gunn, F., 1926, Proc. Soc. Exper. Biol. Med., XXIV, 120.

20. Aschenheim, E., S. Meyer, 1921, Zeitschr. Exper. Path. u. Therap., XXII, 22.

21. Koopman, J., 1924, Deutschr. Med. Wochenschr., I, 277.

22. LoGrasso, H., F.C. Balderry, 1924-25, Amer. Rev. Tuber., X, 117.

23. Balderry, F.C., E. Ewald 1924, Amer. Rev. Tuber., VIII, 501.

24. Quoted from Stewart, C.P., G.H. Percival 1928, Physiol. Rev. VIII, 283.

25. Bergeim 1926, Journ. Biol. Chem., LXX, 51.

26. Gulland, G.L., A. Goodall, Blood.

27. Cramer, Drew, Mottram 1923, Brit. Journ. Exp. Path., IV, 42.

28. Mills, 1926, Canad. Med. Assoc. Journ., XVI, 818.

29. Koster, Journ. Exp. Med. XLIV, 75.

30. Bedson, 1922, Journ. Path. & Bact., XXV, 94.

31. Falconer, E.H., 1926, Amer. Journ. Physiol., LXXVI, 145.

32. Hinrichs, M.A., 1925, Journ. Morphol. & Physiol., XLI, 239.

33. Kramer, B., S.D. Kramer., D.H. Shelling and M.J. Shear, 1927, Journ. Biol. Chem. LXXI, 699.

34. Wilkins, L., and B. Kramer, 1927, Bull. Johns Hopkins Hosp., XL, 52.
