ARTIFICIAL LIGHT THERAPY IN INFANCY.

A COMPARISON OF 66 CASES TREATED WITH THE MERCURY VAPOUR QUARTZ LAMP AND 137 CONTROL CASES.

BY

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Among the many varied and sometimes conflicting claims advanced for the beneficial effects of artificial light therapy, there appear to be only a limited number supported by objective evidence. Critics are now asking what proof exists of improvement in health arising out of the establishment of light clinics for children up and down the country, apart from those effects, such as the prevention of rickets, which may be obtained more simply by the use of cod liver oil. It seems, therefore, worth while to set forth the results of a controlled investigation of the effect of light therapy on infants under conditions similar to those existing at many light treatment clinics for young children.

The present investigation was undertaken in the hope of obtaining objective evidence of the value to the general health of city infants of the working classes of treatment with the mercury vapour quartz lamp; evidence, for example, of better gain in weight, better hæmoglobin content of the blood, better resistance to infections, or better physical or mental progress.

Rickets and its associated respiratory infections, together with spasmodophilia, were as far as possible eliminated from the control group as well as from the light-treatment group by the administration of cod liver oil during the winter. This was done for the reasons that the prophylactic and curative effect of ultra-violet light as regards rickets is fully established, and no further information on this question could be expected from the present investigation. It is obvious that for those effects which light and cod liver oil therapy have in common, cod liver oil (or possibly some other source of vitamin D), will be generally preferred as more economical in time and money. Moreover, the prevention of rickets by cod liver oil administration was indicated in the interests of the infants in the control group.

Statistical Presentation of Results (see Appendix). The whole of the statistical study of the weight curves has been carried out by Miss E. M. Newbolt, M.Sc., and other members of the staff of the Statistical Committee of the Medical Research Council who have also examined statistically the writer's findings concerning the effects of treatment upon the hæmoglobin percentage of the blood.

Clinical Material. All the cases in the series were out-patients attending the Queen's Hospital for Children or a light treatment centre in Bethnal Green, both situated in a poor and overcrowded district in the East End of London. The children belonged for the most part to working-class families. The economic status of out-patients of the Queen's Hospital is indicated by the following figures, very kindly supplied by the Almoner, Miss Grace Strangeways:—

Of 111 consecutive cases seen by her at the end of June, 1927, only 34 per cent. had a family income of over £3 a week, and 20 per cent. were in receipt of Poor Law relief or free milk grants, which may be taken as indicating that in these families the income was below a satisfactory subsistence level.

Of 276 cases in the series, 198 have records extending over periods of 1 to 13 months (13 months being the total period of the investigation). Of these, however, not all can be included in the comparison, as some received a small amount of light treatment such as rendered them ineligible for inclusion in either light treatment or control groups. The total considered here is 177 cases, but of these 26 are included for one period in the control group and for another period in the light treatment group, giving a total of 66 in the light treatment group and 137 in the control group. Of the controls a certain proportion attended irregularly, but the number eligible for inclusion in each set of comparisons is given under the different headings.

All children when first included in the series were under 18 months of age and were either entirely or largely fed artificially. When first seen, nearly all were under normal weight as judged, for example, by Griffith's standard weight curve for healthy breast fed infants (*see* Appendix). The majority were cases in which feeding had been unsuitable in quantity or quality; a number attended with various minor complaints, such as constipation, intestinal disturbance, or slight bronchitis; and a few were cases convalescent from some more severe illness, for example, pneumonia, or from an operation for pyloric stenosis. No cases of acute illness were included, but children developing such illnesses after inclusion were, so far as possible, followed up. Complete artificial feeding began at ages varying from one day to ten months, and 92 per cent. were entirely artificially-fed before six months of age. The type of artificial feeding advised was the same for both groups. It consisted in nearly all cases of dried milk, sugar and water, with orange juice, until the age of eight months, and thereafter mixed feeding. Cod liver oil was ordered for all cases during the winter. General advice as regards hygiene and management was the same for both groups.

From the purely scientific point of view the best contrast between "light" cases and controls would be obtained by minimising as much as possible outdoor life with its consequent exposure to sunlight. This was obviously not practicable in the interests of the children, and all mothers were urged to give the infants as much outdoor life as they possibly could, and it is probable that in consequence these children received rather more of it than the average among London children of this class.

Some of the infants in the series received iron. These cases are omitted when dealing with the effect of light therapy upon the hæmoglobin percentage of the blood, but are included in other sections of the work. Since they were distributed in both light group and control group this should not interfere with the validity of the findings.

Clinical Records. All mothers were asked to bring their babies for examination and advice at intervals varying from two to three days, (*e.g.*, during a period of food adjustment), to one, two or four weeks when the child was

progressing well. At each attendance the child was stripped, weighed and examined. All clinical notes were made by the writer, and included notes on the child's general condition and development, his colour, nutrition, appearance of health or otherwise, intercurrent illnesses, age of eruption of teeth and of standing, whether holding to a support or alone. Every child had the percentage of hæmoglobin in the blood estimated by Haldane's hæmoglobino-meter, at, as far as possible, monthly intervals. Every estimation was made by the same observer, Miss Lorel Goodfellow, from blood drawn from a prick in the heel, precautions being taken to warm the foot if necessary.

Records of light treatment were entered from the Light Treatment day book on the child's weight chart by the Sister or nurse in charge.

Cases given Light Treatment. In the selection of cases for light treatment every effort was made to keep the two groups as evenly matched as possible. Comparison of the weights and of the ages of the children of the two groups at the outset shows that in these respects the groups were fairly evenly balanced (see Charts I and II and Tables E and C).*

One respect in which there was a great difference was in the frequency of attendance. The children in the light treatment group were asked to attend three times weekly (though only weighed and medically examined at longer intervals), those in the control group usually weekly, fortnightly or monthly, depending on such factors as the child's age and general progress and the length of the journey to hospital. Only mothers willing to go to much trouble for the sake of the child, and those not having a large family of young children, were willing to come up three days weekly, so that what advantage there might be as regards better maternal care probably lay with the "light" group.

As already mentioned, the advice concerning feeding and general management was the same for the children of the two groups.

Technique of Light Treatment. At the Queen's Hospital for Children (where all but 18 of the "light" cases were treated), the lamp used was a mercury vapour quartz lamp of the vacuum type, made by the Hewittic Company, on a direct supply current of 210 volts. All children treated at the Queen's Hospital had the skin sensitivity tested before light treatment was begun. Four small areas of skin on the abdomen were exposed for three, six, nine and twelve minutes, respectively, at one yard from the light, and the minimum erythema dose was recorded. The results for each month are shown in Table A. This table was compiled not from the infants of this series alone, but from children of ages up to 13 years. It will be seen that the average minimum erythema dose varied from 4.3 to 8.7 minutes exposure, and that approximately three-quarters of the cases showed erythema with three or six minutes' exposure. No doubt some cases would have shown erythema with less than three minutes' exposure, but this was not tested.

Treatment was ordered three times weekly, beginning with a length of exposure just under the minimum erythema dose, but the exposure was divided, half to the anterior and half to the posterior surface, the child being entirely naked. For example, if reddening of the abdominal skin was obtained by six minutes' exposure, the child was given five minutes' total exposure, $2\frac{1}{2}$ minutes

* For Tables C.—G. and Charts I and II, see Appendix.

to the back and $2\frac{1}{2}$ minutes to the front. The exposure was increased by $2\frac{1}{2}$ minutes each time ($1\frac{1}{4}$ minutes to each surface) to a total of 30 minutes, the aim being to avoid producing erythema. A few instances of reddening of the skin occurred, and, on a single occasion, after the fitting of a new burner, two or three cases were very slightly blistered.

At the light treatment clinic it did not prove practicable to determine the minimum erythema dose for each case. As the Hanovia lamp in use (vacuum type of mercury vapour quartz lamp, on alternating current of 240 volts.) was, at the beginning of the period, more powerful than the burner in use at the Queen's Hospital, the children were started with $2\frac{1}{2}$ minutes exposure, increasing at alternate treatments by $2\frac{1}{2}$ minutes to a maximum of 30 minutes.

The above-mentioned dosage, was, of course, entirely empirical, since dosage is at present unstandardised. Other workers use both more intensive and less intensive treatment.

TABLE A.

VARIATIONS IN THE MINIMUM ERYTHEMA DOSE IN 194 CASES TESTED AT THE QUEEN'S HOSPITAL
(Mercury Vapour Quartz Lamp.)

<i>Month.</i>	<i>No. of Cases.</i>	<i>Smallest M.E.D.</i>	<i>Largest M.E.D.</i>	<i>Average M.E.D.</i>
1925.		Mins.	Mins.	Mins.
Oct.	29	3	12	8.0
Nov.	19	3	9	6.8
Dec.	25	3	12	7.4
1926.				
Jan.*	15	3	9	5.2
Feb.	14	3	6	4.3
March	18	3	9	5.3
April	16	3	12	6.0
May	15	3	6	5.8
June	11	3	12	6.8
July	12	3	9	5.5
August	5	3	12	8.2
Sept.	11	6	12	8.7
Oct.	4	3	12	6.7

* New burner, middle January.

<i>Minimum Erythema Dose.</i>	<i>No. of Cases.</i>	<i>Per cent. of total.</i>
3 Mins.	39	20%
6 "	102	53%
9 "	32	16%
12 "	21	11%

THE EFFECT OF LIGHT TREATMENT UPON INCREASE IN BODY WEIGHT.

Rate of gain in weight is usually accepted as a useful criterion of an infant's state of health. It can never be the sole criterion, but in dealing with a group of infants under normal weight one might reasonably hope to see reflected in the weight curve any marked improvement, whether in general health or in resistance to infections. However, since happily the majority of such infants tend to improve in weight when obvious defects in their management are remedied, no deductions concerning the beneficial effects of one particular therapeutic agent are permissible without adequate control. Controls may be furnished either (1) by the rate of gain of the individual infants up to the time of getting the treatment in question (provided other factors in diet and management remain unchanged), or (2) by the rate of gain of a similar group of infants without this treatment. In infants the rate of gain tends to slacken fairly steadily with age, and moreover such factors as better adjustment of calorie needs might cause a rapid gain in weight after the first attendance, so that slight effects could easily be missed if the first method only were employed. A study of the form of weight curve in a limited number of cases revealed no obvious acceleration of growth from light therapy, and consequently the second form of control was the one selected.

The total number of cases in our series whose weights have been tabulated is 177; of these 26 have been included for some part of the time in the control group and for another period in the light treatment group, giving a total of 66 light treatment cases and 137 control cases.

There exists no satisfactory evidence whether the effect of light on the weight curve, if any, would be apparent within a few days or only after some weeks; nor for how long it would be maintained; nor on the amount of exposure necessary to produce an effect: consequently, some arbitrary standards had to be laid down before any comparison could be made.

(A) For the first comparison *all cases up to 2 years old and under observation for one month and upwards* were included, provided that *light treatment cases* (Group I) had had at least five exposures in every 28 days and a proportionate number for fractions of that time over 28 days; and that *control cases* (Group II) had never failed to attend for a period of over 35 days. Many cases had more than one period of observation on this basis, *e.g.*, a child which lapsed, through failure to attend for six weeks, might subsequently be included for a second period. By setting the standard for inclusion somewhat low, cases having intercurrent illnesses, and therefore temporarily omitting their light treatment, or failing to attend on the day asked, were not excluded, and the total number of cases available for comparison was made as large as possible. It was hoped in this way to obtain an indication of improved growth from light treatment, even if only one in two or three of the children showed it, *e.g.*, only those getting less outdoor life than the average, or only those with a total dosage less or greater than the average.

There were 66 light cases, with 76 periods of observation, and 137 control cases, with 166 periods of observation. Table B shows that the periods under

observation averaged for light cases 14.6 to 16.2 weeks and for controls 13.7 to 13.8 weeks.

Light cases and controls were fairly evenly matched at the outset as regards the following factors :—distribution by age (*see* Charts I and II), sex (*see* Charts I and II and Table E), average age (*see* Table C), average deviation in lbs. from the normal weight (*see* Table G), average percentage deviation from normal weight (*see* Table E). It will be seen that both light cases and controls, when they first came under observation, averaged approximately 2.8 to 3.9 lbs., or about 18 to 23½ per cent. under normal weight (as judged by Griffith's standard weight curve for breast fed infants), that girls were lighter than boys, and that light cases were ¾ to 2¾ per cent. lighter than controls.

That the children both of the light group and the control group nearly all improved while under observation was obvious clinically, and is shown in the fact that they were, on the whole, nearer the normal weight for their age at the end of the period of observation than at the beginning (*see* Charts I and II). Light cases, however, did not have a definitely better average weight increase than controls. Table E shows this in figures : both light cases and controls were, on an average, about 6½ to 8½ per cent. nearer normal weight at the end of the period of observation, but among girls the light cases with lower initial weights showed approximately 2 per cent. more gain than the controls. The girl controls showed the same percentage gain as the boys of both the control and light groups. All these differences, including the 2 per cent. advantage over the controls of the light cases among the girls, are statistically " insignificant ;" that is, they are no greater than differences that might easily arise by chance (*see* Table F).

(B) For the second comparison only *light cases which had had more intensive treatment* (Group III), were selected, *i.e.*, cases with nine exposures or more per 28 days for six weeks or longer. By so doing, all children who had at the time any but the slightest intercurrent illnesses were excluded, as all such cases temporarily missed their light treatments. There were 39 cases with 57 periods of observation. All these cases were at the end of treatment under 18 months of age, and thus in this respect also had an advantage over the control group, since the rate of growth would normally be slower in the older children. Nevertheless, they show approximately the same increase in their percentage of normal weight as the whole control series : actually, it was very slightly less, but the difference amounts only to about ¼ per cent. to 1 per cent. of the normal weight and is, therefore, not significant (*see* Table E).

A *more strict control series* (Group IV) has also been taken for comparison, *i.e.*, cases which had not had any artificial light treatment at any previous date. Of these there were 115, with 137 periods of observation. As before, the gain, expressed as the average difference in the percentage of the normal weight at the beginning and at the end of the period of observation, is about the same, the controls having a slight advantage (*see* Tables E and F).

Certain advantages might have acted in favour of the light cases, *e.g.*, better maternal care, and, in the group with the more intensive treatment, the

automatic exclusion of cases with an intercurrent illness of any but the mildest type, together with the greater likelihood on account of the frequent attendances at hospital of early advice being obtained concerning any condition needing treatment. In spite of this, however, the average rate of gain in the light cases was almost exactly the same as in the control cases. This is true whether the group is taken as a whole, or whether only a more limited group receiving fairly intensive treatment over a period of six weeks and upwards is considered.

We may, therefore, conclude that the data obtained give no consistent evidence of any effect on weight, beneficial or adverse, produced by light treatment as here given to out-patient infants, (*see* Appendix by Miss Newbold below).

THE EFFECT OF LIGHT TREATMENT UPON THE INCIDENCE OF INTERCURRENT ILLNESSES.

The treatment of young children in light clinics might influence the incidence of infectious illnesses either by improving the resistance to infection or by increasing the degree of exposure to infection.

In the cases under consideration, every effort was made to prevent the spread of infection from one case to another, but such a possibility cannot be set aside when young children are brought up by omnibuses and trams and collected into groups indoors. It is consequently possible that improved resistance might be masked by increased exposure to infection.

There was from week to week of the work no obvious difference in immunity between the two groups; coughs and colds were numerous in both, gastrointestinal disturbances not uncommon, and neither were immune to the infectious fevers. A satisfactory statistical comparison of the amount of illness among light cases and controls cannot be made for reasons indicated later, but, for what it is worth, a statistical comparison was attempted. Winter and summer results are given separately, since there would be more likelihood of obtaining evidence of the beneficial effect of light treatment in winter when exposure to sunlight is at a minimum. Only illnesses causing a definite flattening in the weight curve or loss in weight were counted, with the exception of otorrhœa or the specific fevers, since, for the latter, weights were not available as the child did not attend for a varying length of time thereafter. Many criticisms can be brought against this attempt at comparison, *e.g.*, that cases having much intercurrent illness would drop out of the light group, that cases examined and weighed once weekly cannot fairly be considered with those examined and weighed monthly, and that a count of intercurrent illnesses is subjective and arbitrary. Nevertheless, bearing these facts in mind, the comparison seems worth making, if only to show that intercurrent illnesses were common in both these groups of sub-normal children. The light group included cases having five or more light treatments in each 28 days and attending for one month or more. No case was included in the control group which attended for less than one month, or failed to attend for over five weeks.

Table B shows the result of the comparison, but the writer would emphasise that whatever its value as a comparison, no significance can be attached to individual figures, owing to the subjective nature of such an estimate. Two points are worth noting :— (1) In winter the incidence of intercurrent illness is not unlike in the two groups ; (2) In summer the light cases show roughly double as many infections of the respiratory type, the figures otherwise showing no significant difference. The explanation of the different incidence of respiratory disease in summer is not clear, possibly it is the result of chance or of the difficulty of making a fair comparison. More probably, in the writer's view, it indicates the effects of greater exposure to infection among the light cases at a time of year when the control cases were spending the corresponding time out of doors.

TABLE B.
INTERCURRENT ILLNESSES.

	WINTER : OCTOBER—APRIL.				SUMMER : MAY—SEPTEMBER.			
	<i>Non-Light Cases.</i>		<i>Light Cases.</i>		<i>Non-Light Cases.</i>		<i>Light Cases.</i>	
Number of infants	70		48		78		32	
Total period in months for all infants ...	196		137½		218½		83½	
Average period of observation in months per infant	2·8		2·87		2·83		2·61	
	<i>No. of attacks</i>	<i>No. of attacks per 100 cases per month.</i>	<i>No. of attacks</i>	<i>No. of attacks per 100 cases per month.</i>	<i>No. of attacks</i>	<i>No. of attacks per 100 cases per month.</i>	<i>No. of attacks</i>	<i>No. of attacks per 100 cases per month.</i>
RESPIRATORY DISEASES, ETC.—								
Sore throat ...	4	2·0	4	2·9	3	1·4	4	4·8
Cold in head ...	11	5·6	8	5·7	5	2·3	7	8·4
Bronchitis ...	24	12·2	23	16·7	11	5·0	5	6·0
Pneumonia ...	1	0·5	1	0·7	—	0·0	—	—
Otorrhœa ...	5	2·5	2	1·4	2	0·9	2	2·4
GASTRO-INTESTINAL, ETC.								
Diarrhœa and vomiting ...	12	6·1	14	10·1	25	11·4	7	8·4
Stomatitis ...	4	2·0	—	—	2	0·9	1	1·2
SPECIFIC FEVERS.								
Measles ...	10	5·1	6	4·3	1	0·5	—	—
Diphtheria ...	—	—	1	0·7	—	—	—	—
Scarlet Fever ...	—	—	—	—	1	0·5	—	—
Whooping Cough ...	—	—	—	—	1	0·5	—	—
PYREXIA (? cause)	5	2·5	2	1·4	3	1·4	—	—
ABSCCESS ...	1	0·5	—	—	1	0·5	1	1·2
ADENITIS ...	1	0·5	—	—	—	—	—	—

TABLE B.—Except in the case of the infectious fevers and otorrhœa, only illnesses known to have caused a loss in weight or definite flattening of the weight curve have been included in this table.

This comparison, therefore, gives no evidence that light treatment as here given increased resistance to infection.

The probable incidence of intercurrent illness in the light and control groups respectively, had cod liver oil medication been omitted throughout, is of interest, and some facts bearing on the point are available. The writer made a similar comparison some few years ago of the amount of illness in two groups of infants, one group getting cod liver oil, the other on a diet which failed to protect from rickets.⁽⁴⁾ The children were all artificially fed and were in-patients living in an institution in Vienna. The results showed that in winter (when the children were out of doors very little), respiratory diseases were much more common in the group unprotected from rickets; but that in summer (when the children were usually out all day and consequently rickets as diagnosed radiographically was prevented or cured), there was but little difference between the two groups. It may be taken as certain that rickets would have occurred in our present control group if these children had not been protected by cod liver oil, since among 169 new out-patients under two years old at the Queen's Hospital in April, 1924⁽²⁾, 15 or 9 per cent. (8 per cent. if two cases sent up for rickets are excluded), showed radiographic evidence of rickets in spite of the fact that many of them had been protected by the administration of cod liver oil given at welfare centres. We may, therefore, presume that had the present control group, all artificially fed from an early age, received no specific anti-rachitic treatment, a considerable number would have shown a diminished resistance to respiratory infections as compared with the light group.

THE EFFECT OF LIGHT TREATMENT UPON THE HÆMOGLOBIN CONTENT OF THE BLOOD.

The percentage of hæmoglobin in the blood of the infants in both groups, together with its variations and the data upon which the following statements are based, will be more fully considered in a separate paper, as results of considerable interest were obtained.

At present only the general results will be indicated :—(a) Individual cases of anæmia did not show an improved percentage of hæmoglobin in the blood as the result of light treatment.

(b) Light treatment, as here given, did not prevent the development of anæmia.

(c) No significant difference was found between the average hæmoglobin content of the blood in light cases and controls.

The figures obtained, therefore, show no evidence that light treatment with the mercury vapour quartz lamp, as here given, influenced in any way the percentage of hæmoglobin in the blood.

THE EFFECT OF LIGHT TREATMENT UPON THE GENERAL CLINICAL CONDITION OF THE CHILDREN.

Any consideration of the effect of light treatment upon the general clinical condition of the children is necessarily upon much less certain ground than

the comparisons so far made, as it is for the most part based on entirely subjective impressions. Like most other clinicians who have used artificial light therapy, the writer's impression was that, at any rate during the winter, it was of benefit to a considerable proportion of hospital children in sub-normal health. Mothers frequently state that an infant, or toddler, having light therapy is happier, brighter, cries less, eats and sleeps better than before, though in a few cases wakefulness at night appears to follow too large a dose, even in the absence of any obvious skin effect. However, there is no doubt that nowadays suggestion plays a great part in the effects obtained by light therapy, and although to the mothers peaceful nights may be objective facts, the physician told of the improvement in sleep must rate the evidence as subjective.

The contrast, if any, between light cases and controls should be most apparent during the late winter and spring months. An attempt was made to compare the clinical appearance of children getting light treatment with that of the control cases in winter by means of the author's notes made on each child at the time. This comparison includes 31 control cases and 36 light cases.

Nutrition and Colour. Judging from the notes on nutrition and colour made at the beginning of treatment, those cases given light treatment were definitely inferior to the controls in health. Nearly twice as many were marked "nutrition poor," and one and a half times as many "colour poor" or "colour fair." Reference to Table E will show that the weights of the children of the whole control and light groups will bear this out to some extent. Light cases were $\frac{3}{4}$ per cent. to $2\frac{3}{4}$ per cent. lower in weight than controls. Moreover in October, November and December, light cases averaged 5 to 2 per cent. lower in hæmoglobin than the controls. This initial difference in the groups was not intentional, and the author had attributed it to the fact that mothers of children who looked in poor health were more willing to expend time and trouble in bringing them up for light treatment. In the late winter months, as judged by the notes on clinical condition, the nutrition of children in the two groups was approximately the same, but the children of the light group had on the whole a better colour. The clinical notes, therefore, suggest that light cases as compared with controls were in poorer condition to start with, but probably in rather better general condition towards the end of the winter.

Age of Standing. Since, however, these findings are subjective, an attempt was made to determine whether children given light treatment were able to stand at a younger age than controls, on the supposition that the age of standing was a good objective indication of mental and physical development combined. Here again, however, the selection of cases for comparison was not easy, and the effort to include only cases in which the comparison seemed fair resulted in very small, and consequently inconclusive numbers:—23 light and 35 control cases. However, at each of the stages chosen, *i.e.*, standing holding to an object, walking holding on, standing alone and walking alone, the light cases showed slight superiority, *e.g.*, only 9 out of 24 controls, compared with 8 out of 12 light cases, could stand holding by 12 months of age.

Age of Dentition. The age of cutting teeth was also considered, but as one or two months light treatment would scarcely make any material difference to the age of dentition, and the number of cases getting a long period of treatment at the requisite ages was insufficient for comparison, no figures are given. Cases of delayed dentition were, however, found in both groups.

Speaking generally, it may be said that the subjective evidence furnished by the mothers' statements and by the writer's clinical notes of the children's appearance, suggests that light therapy did benefit the children's health to some extent.

DISCUSSION.

Artificial light therapy may be regarded in two ways : either as an attempt to make good a defective exposure to sunlight, or as producing effects other than those of an optimum exposure to sunlight. The treatment of rickets is an example of the first, the treatment of neuritis by local blistering with light is an example of the second.

Generally speaking, the idea underlying the use of artificial light therapy appears to be that of making good the body's need of light. If this be so, two chief questions confront us : (1) what are the results of inadequate exposure to light ? ; and (2) does a large proportion of our population suffer from these effects ?

Our knowledge on the first point is at present very scanty. If we confine ourselves to infants, it may be said that two inter-related diseases are known to be directly associated with want of light, namely, rickets and spasmophilia. Judging from observations on infants living entirely indoors, and by analogy with experiments on animals living in darkness, both diseases could very probably be almost prevented in children living in total darkness by the administration of the anti-rachitic vitamin by mouth. Many hold that, excluding rickets and its associated respiratory infections, the defective health (*e.g.*, lassitude, poor appetite, increased liability to infections), found in children living an indoor life in institutions, is partly due to inadequate ultra-violet light, but this view does not appear to be satisfactorily proved.

Concerning the second point, the prevalence of rickets in our cities among children unprotected by cod liver oil affords ample proof that a great many children suffer from inadequate light in the winter. Since, however, active rickets is rare in London by the early autumn, the existence in summer of widespread ill-health due to want of light only (as distinct from outdoor life) in this city is, in the writer's opinion, unproven.

In order to demonstrate the beneficial effect of light therapy, it is presumably necessary to treat children who have less than the optimum exposure to sunlight. There is little doubt that the control cases here studied fulfil that condition during the winter, since many similar cases have been shown to develop rickets at that season when unprotected by cod liver oil. In spite of this, however, a study of the weight charts, intercurrent illnesses and the percentage of hæmoglobin in the blood, supplies no objective evidence of the beneficial effect of light therapy in winter on children having cod liver oil.

Obviously a negative result such as this does not show that light treatment is without beneficial effect in such cases ; in fact the writer's notes suggest that light therapy did to some extent improve the children's health, although such improvement was not demonstrated objectively by any of the three methods here employed. Objective evidence of the value of artificial light therapy might possibly have been obtained had the exposure to sunlight been less for all cases, or by the use of a different combination of rays from another source of artificial light, or by different dosage, but as regards this no information can be offered.

No attempt will here be made to deal with the large literature on the subject of light therapy in childhood, but it is of interest to compare results obtained by two groups of observers who have carried out somewhat similar investigations, remembering that specific diseases such as rickets, tetany, tuberculosis, asthma, hay fever, or diseases of the skin are not here under consideration.

Barenberg, Friedman and Green (3) carried out an investigation similar to that here described, but on in-patient infants instead of on out-patients. Twenty-one cases were treated with the mercury vapour quartz lamp, with 19 controls. All were given cod liver oil. They found as a result of light treatment no diminution in respiratory infections, no increased resistance to an outbreak of pertussis or of varicella, no evidence of hæmoglobin increase. They consider that there is evidence of an initial stimulation to increase in weight, but as this appears to be chiefly based upon the average absolute gain in weight of a light group with a mean age of $6\frac{1}{2}$ months, compared with a control group with a mean age of 11 months, the opinion cannot be considered as substantiated. As regards muscle tone, however, the authors considered the children given light treatment as markedly superior. Their results, therefore, are very similar to those described in this article.

Pugh(4) at St. Mary's Hospital, Carshalton, where open air treatment is so extensively practised, has also studied the effect of artificial light treatment on the children's power of resistance to infection. He found no evidence of increased resistance (*e.g.*, to epidemic catarrh or chicken pox) among children given artificial light treatment. It seems possible, however, that his patients were already receiving optimum exposure to the light of the sun.

SUMMARY.

Observations extending over thirteen months were made on the effects of treatment with the mercury vapour quartz lamp on the health of infants. The infants were out-patients, were artificially fed, came for the most part from poor and overcrowded districts in the East End of London, and were sub-normal in general health and in weight when they came under observation. The series treated with light numbered 66, the controls 137. All were given cod liver oil during the winter with a view to eliminating rickets and spasmophilia as a complicating factor from the investigation.

Weight. The rate of gain in weight of the controls was approximately equal to that of the light cases, whether the light group is considered as a whole, or comparison is made only with a section of cases having more intensive

treatment. What differences there are, are under 2 per cent. of the normal weight (Griffith's standard weight curve), and are probably due to chance.

Hæmoglobin percentage in the blood. This was approximately the same in the control and the light group. Light treatment did not cure or prevent the development of anæmia. The figures will be dealt with fully elsewhere.

Resistance to infection. A satisfactory comparison is difficult, but the amount of intercurrent illness in the light group and controls appeared to be about the same in winter. In summer the figures suggest that the controls showed fewer respiratory infections.

General clinical condition. The author's notes made at the time suggest that in the late winter and spring months, the light cases, as judged by colour, general nutrition and appearance of health, *seemed* to have made greater progress than the controls. Nevertheless, no objective evidence was obtained to support this.

It should be remembered that the negative results obtained from this investigation cannot be interpreted as necessarily in opposition to any positive findings obtained by others with similar cases ; since the dosage of artificial light is entirely empirical, different results might have been obtained with another type of lamp, *e.g.*, the carbon arc, and had the exposure to daylight been less for all cases, the contrast in light exposure between the two groups would have been greater.

The results have no bearing on the effects of light treatment on specific diseases which were not here under consideration.

The fact, that no objective evidence was obtained that light treatment as here given was of benefit to the health of the infants under consideration, emphasises the need of more investigation before authoritative statements can be made on the uses and limitations of artificial light therapy.

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APPENDIX.

STATISTICAL EXAMINATION OF THE WEIGHT CURVES.

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An attempt is here made to examine statistically the question whether light treatment improves or does not improve weight. Whether or not weight is always a good criterion of improved health is a question outside our province, but even apart from this it is not easy on these data to give a definite answer to the simple question of increase or not. It is complicated by the fact that treatment began and ended with different babies at different ages over the first two years of life, when the weight changes rather rapidly, and also that the length of treatment varies, and the possibility exists that while light treatment might at first increase weight, prolonged treatment might have no further or even an unfavourable effect, so that by the end of long treatment the first increase might have been lost. It has also been found that with older children growth in weight varies with the time of year*, and the same may be true for babies, but I do not know of any data on this point.

On these comparatively small numbers sub-division by all these three variables is hardly practicable, and as *age* is probably the most important of them, we have confined ourselves to making some allowance for that.

The method adopted was to take a standard weight curve for these ages, find the deviations from the weight expected by this standard at the beginning and end of treatment separately for each baby and compare the *difference* between the deviations at the end and the deviations at the beginning, for the light and non-light groups. This has been done both for relative and absolute deviations. For the relative deviations we took the actual deviations expressed as percentages of the appropriate standard weight. The relative deviation seems the better measure to use, the only point of taking the absolute as well was the fear that the relative might be unduly influenced by the choice of standard. We have not been able to find a really appropriate standard for these data. We have used Griffith's Weight Chart (from the *New York Medical Journal*, 1899, LXIX, 295). This is a composite curve (male and female together) of healthy breast-fed babies of apparently different social classes and different nationalities, and it was chosen because it covers the whole range of the first two years of life. It is clearly much too high a standard for these babies, and might lead to very misleading conclusions if any one group—say the light group—were considered alone. As in our case we are only concerned with the difference between the light and non-light groups, of the excess deviation at the end of the treatment over that at the beginning, I do not think a fallacy is introduced as the light and non-light cases are scattered fairly equally over different ranges of age.

It would have been preferable to use a standard more appropriate to the data (the numbers are not large enough to make their own standard of the total), but I have not succeeded in finding one. The charts given (males and females separately) by K. Pearson and M. N. Karn*

* Dr. Corry Mann found both height and weight growth were more rapid in summer (1st April to 1st October) than winter in boys aged about 6—13 (Med. Res. Council, Spec. Rep. Series, No. 105). Dr. W. Camerer found his results with boys agreed with those of Malling and Hansen, for weight according to him the *maximum period* was August to mid-December, *middle period* December to end of April, *minimum period* end of April to end of July. In the latter period the loss of weight balances the increase in the middle period. The increase in the maximum period is three times as great as in the middle period. Height took a different course. *Jahrbuch der Kinderheilkunde*, Neue Folge 36-37, 1893-4, p. 975.

* "Study of the Data provided by a Baby Clinic in a large Manufacturing Town." Drapers' Company Research Memoirs. Studies in National Deterioration, X. Camb. Univ. Press 1922.

MEAN WEIGHTS OF INFANTS AT THE BEGINNING AND END OF THE PERIODS OF OBSERVATIONS.
FEMALES.

- Mean of Control cases, beginning of observation.
- + Mean of Control cases, end of observation.
- ⊙ Mean of Light cases, beginning of observation.
- Mean of Light cases, end of observation.

- Griffith's Standard Weight Curve.
- - - Pearson and Karn's Mean Weight Curve, first year.
- Arbitrary extrapolation from Pearson and Karn's first year values.

from a baby clinic in the north of England, are better suited to the data, but even they are too high, and also they only cover the first year of life. We tried producing them over the second year by reducing the Griffiths second year weights in the same proportion that the Pearson-Karn weight at twelve months bore to the Griffiths weight at twelve months (see Charts I and II), but this seems rather arbitrary. The graph for females illustrates well the different conclusions that might be reached with the two standards, if the deviations in the first year of life were compared with those in the second for any one group.

Results.—Table E shows for males and females separately the relative deviations at the beginning and end of treatment for the different light and non-light groups. This table shows that the end relative deviation is always less in absolute value than the relative deviation at the beginning, but as has been pointed out before, this difference can only be interpreted with reference to the particular standard chosen. The differences with which we are concerned are given in Table F, which compares the light with the non-light groups. If *all* light cases (Group I) are compared with *all* non-light cases (Group II) the light show a small advantage in the case of females, too small, however, to be of any significance compared to the sampling error and in the case of males there is no difference between the two groups. In the selected light (Group III) and selected non-light (Group IV) for both females and males, the advantage is with the non-light groups, but here again the difference is too small to be of any weight compared with the error of sampling. Tables G and H give the same comparisons for *absolute* instead of relative deviations. In this case a very slight advantage is shown in all groups by the light cases, but the difference is smaller than its standard error and is also only between 1 and 3 ozs., so that no importance can be attached to it. If we make quite a crude comparison and do without a standard altogether, we note that the mean ages of the light and non-light babies at the beginning and end of treatment are as given below :—

TABLE C.
MEAN AGE IN WEEKS.

	Males.		Females.	
	Beginning of treatment.	End of treatment.	Beginning of treatment.	End of treatment.
Light cases ..	34.0 weeks	48.6 weeks	35.4 weeks	51.6 weeks
Non-light cases ..	32.0 „	45.7 „	39.1 „	52.9 „

so that the mean length of treatment is roughly the same for light and non-light babies. The graphs show also that the beginning of treatment is scattered over the age range about equally for light and non-light cases. It is, therefore, not so very unjustifiable simply to compare for the light and non-light groups the mean of each child's weight at the end of treatment expressed as a percentage of his weight at the beginning of treatment. The results of this show that by this comparison what small advantage there is lies with the non-light group in the case of males and with the light group in the case of females. The more exact method given above, using a standard curve, is, however, to be preferred.

TABLE D.
OBSERVED WEIGHT AT END OF TREATMENT EXPRESSED AS A PERCENTAGE OF THE WEIGHT AT THE BEGINNING OF TREATMENT.

						Males.	Females.
Light cases ..	..	..	..	..	..	130.7%	137.7%
Non-light cases ..	..	..	..	..	..	136.5%	133.4%

All that we can say is that on the whole, these figures do not show any definite advantage in weight at the end of treatment of the light cases over the non-light cases. I think that it would not be justifiable to draw any general conclusions as to the effect of light treatment on the weight of babies in general.

TABLE E.
RELATIVE WEIGHTS AT THE BEGINNING AND END OF THE PERIODS OF OBSERVATION.

	Number of		At the beginning of the periods of observation.		At the end of the periods of observation.		Difference between the percentage deviation at the end and beginning of treatment. (B-A=X).	
Females	Obser.	Babies	Average % deviation (A)	Standard deviation.	Average % deviation. (B)	Standard deviation.	X	Standard deviation.
Group I	39	35	-23.47	14.23	-14.94	12.36	8.53	9.96
„ II	78	64	-20.70	17.00	-14.07	14.81	6.62	10.73
„ III	30	20	-17.30	13.50	-10.96	11.27	6.35	5.74
„ IV	63	54	-21.69	18.05	-14.69	16.16	7.00	11.17
Males								
Group I	37	31	-18.65	13.83	-12.11	13.42	6.54	6.35
„ II	88	73	-17.90	15.36	-11.52	13.77	6.53	9.78
„ III	27	19	-17.78	12.91	-12.33	11.41	5.45	4.27
„ IV	74	61	-18.92	15.31	-11.81	14.22	7.28	10.27

TABLE E. Shows in columns (A) and (B) the average percentage deviation from normal weight, i.e., the average for each group of cases of (observed weight—normal weight) 100

normal weight.

The standard of normal weight used was the weight for the age as shown in Griffith's weight curve. The mean percentage deviation, or the mean percentage above or below normal weight, is shown for each group of cases at the beginning and end of the periods of observation.

- Group I. *Light cases* up to 2 years old, under observation for one month and upward, who had 5 or more exposures in every 28 days.
- Group II. *Controls* up to 2 years old, under observation for one month and upwards, who never failed to attend for a period of over 35 days.
- Group III. *Selected Light Cases* from Group I, up to 18 months old, under observation for 6 weeks and upwards, who had 9 or more exposures in every 28 days.
- Group IV. *Selected Control Cases* from Group II who had had no previous period of light treatment.

NOTE.—The number of babies is less than the number of observations because some babies had more than one period of observation.

TABLE F.
DIFFERENCE BETWEEN THE PERCENTAGE INCREASE IN WEIGHT OF LIGHT CASES AND CONTROLS.

Difference between the mean % increase in weight of :		X of Light Cases minus X of Controls.	Standard deviation of Difference.
Females.			
Group I and Group II		1.91	2.00
Group III and Group IV		-0.65	1.75
Males.			
Group I and Group II		0.01	1.48
Group III and Group IV		-1.83	1.45

TABLE F. Derived from Table E. X= Mean relative deviation at end of period observation minus mean relative deviation at beginning of period of observation. (B-A=X).

TABLE G.

WEIGHT (IN LBS.) AT THE BEGINNING AND END OF THE PERIODS OF OBSERVATION.

	Number of		At the beginning of the periods of observation.		At the end of the periods of observation.		Difference between the deviation in lbs. at the end and beginning of observation. (D - C = Y).	
	Observ.	Babies	Av. dev. in lbs. (C).	Standard deviation.	Av. dev. in lbs. (D).	Standard deviation.	Y	Standard deviation.
Females								
Group I	39	35	-3.89	2.23	-2.96	2.30	0.92	1.56
„ II	78	64	-3.54	3.01	-2.82	2.91	0.71	1.60
„ III	30	20	-2.88	2.13	-2.07	2.01	0.81	0.92
„ IV	63	54	-3.57	3.24	-2.86	3.17	0.71	1.66
Males.								
Group I	37	31	-3.11	2.10	-2.32	2.47	0.79	1.11
„ II	88	73	-2.77	2.56	-2.17	2.62	0.60	1.59
„ III	27	19	-2.97	1.78	-2.31	1.91	0.66	0.71
„ IV	74	61	-2.83	2.54	-2.18	2.71	0.65	1.68

TABLE G. Shows the deviation in lbs. from normal weight. The standard of normal weight used was that shown in Griffith's weight curve.

TABLE H.

DIFFERENCE BETWEEN THE WEIGHT INCREASE IN LBS. OF LIGHT CASES AND CONTROLS.

Difference between the average increase in weight in	Y of Light Cases <i>minus</i> Y of Controls.	Standard deviation of difference.
Females.		
Group I and Group II	0.21 lbs.	0.31
Group III and Group IV	0.10 lbs.	0.27
Males.		
Group I and Group II	0.19 lbs.	0.25
Group III and Group IV	0.01 lbs.	0.24

TABLE H. Derived from Table G. Y = Mean deviation in lbs. at end of period of observation minus mean deviation in lbs. at beginning of period of observation = D - C.