

A REVIEW OF THE DEVELOPMENT OF ULTRA VIOLET  
RAY THERAPY; AND AN ACCOUNT OF ITS USES AND  
POSSIBILITIES IN GENERAL PRACTICE.

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## I N T R O D U C T O R Y .

There is, perhaps, no subject in our age of scientific discovery and achievement, which is attracting more attention, and is more deserving of study in the medical world, than the subject of Actinotherapy. Being, however, as yet, in what may be termed the empirical stage, - it is not possible to express anything like a final opinion as to the clinical possibilities of this particular method of treatment; nor is it possible, nor would it be wise, to dogmatise too strongly with regard to its mode of action or practical application.

At the present time, ultra violet radiation provides but another example, so frequently met with in the eventful history of Medicine; of how a great remedial discovery has not waited for scientific analysis, before being put to practical and general use.

Up through the Ages, Medicine and Surgery have, to a greater or less extent, been dependent upon each other, both in respect of progress and practice; and it would appear that Sunlight Treatment - a kind of "Tertium Quid" - is destined to occupy a position in/  
in/

in therapeutics, not antagonistic to either, but complementary and ancillary to both; Sunlight being essential to almost all forms of life, and to the maintenance of health.

Though still in the empirical stage, the beneficial results of Actinotherapy have, in not a few cases, been established beyond doubt; but it should at once be admitted that Sunlight treatment is not, and cannot possibly be, a "panacea" for the numerous diseases to which Humanity finds itself heir. It seems probable, that Ultra Violet Light may prove to be a specific remedy in certain diseases; and an important adjuvant in the successful treatment of others. So far, however, Ultra Violet Ray Therapy has been applied rather to Institutional Treatment, and not yet, as a remedial agent in the armamentarium of the General Practitioner. The demand, however, for this form of treatment as a recognized remedial agent is steadily increasing; and it seems not improbable, that within a comparatively short space of time, almost every General Practitioner will be expected to provide it.

The recognition of this fact, led the Writer, about a year ago, to make a special study of this subject; and at a later date, to install an ultra violet ray apparatus for the benefit of Patients.  
The/

The Health giving properties of Sunlight, have been recognised and utilised, to some extent, since the earliest times.

The Hebrideans have been termed, by a modern writer "Children of the Mist"; but, in a metaphorical sense, we, in these Northern Latitudes, are all Worshippers of the Sun. The Ancients worshipped the Sun, in the belief, that its rays had the power to drive away the demons of sickness. The Citizens of Ancient Rome, also believed in the healing power of the Sun, and had so-called "Solaria" in their homes; and in the far off days of Hippocrates, the natural agencies of air and water, and in a no less degree, sunlight, were employed in the treatment of disease.

Since those very early times, however, until comparatively recent years, but little interest was taken in the curative properties of sunlight; and little advance made in the manner of its proper application. We stand however to-day on the threshold of a New Era, - the Era of Preventive Medicine - the great prophylactic agents which it employs to prevent, or ward off, the inroads of disease from the individual life, and the life of the Community being:-first, an adequate supply of fresh air; second, a pure and abundant water supply; and last, but not least, /

least, the free ingress into the homes and haunts of men, of the germ-killing, and health-giving, light of the Sun.

The people of the ancient world, as has already been noted, were not ignorant of the health-giving properties of the Sun's rays; nor have the people of comparatively recent times; but the therapeutic use of either Solar or Artificial Light on a large scale, may be said to date from the time of Finsen, of Copenhagen; who in 1893, after a long series of experiments, reported favourably on the effects of Sunlight on affections of a Tuberculous nature; and it is to him that the credit of originating modern Light Treatment is entirely due. The encouraging results obtained by him, however, were only secured after prolonged experiment, owing to the small residuum of ultra violet rays available, due to partial <sup>to</sup> adsorption of the Sun's rays by the atmosphere. The tardiness of the process, together with the uncertainty of obtaining Sunlight at regular times, led Finsen to devise artificial means of Light production, - this he succeeded in doing by devising and constructing the lamp which bears his name. About a quarter of a century ago, the Finsen Lamp was installed in one of the London Hospitals; but since then, until very recently, /

recently, comparatively little progress was made along this particular line of research. Even in 1913, when Rollier addressed the International Medical Congress in London on this important subject; little enthusiasm was roused, and, but scant attention paid to the possibilities of Light Treatment; which he so clearly explained, and so whole-heartedly commended.

#### DEFINITION AND DESCRIPTION OF ULTRA VIOLET RAYS.

If made to pass through a glass prism, Sunlight is split up into its characteristic colour spectrum; at one end of which, are the Red Rays; and at the other, the Blue and the Violet; intermediate, being the Orange, Yellow and Green.

The Violet end of the visible spectrum merges into the Ultra Violet region, or region of Actinic Rays; so called, because of the chemical changes they produce, when allowed to act upon such sensitive media as photographic plates.

The Ultra Violet Ray may be defined, as an "Invisible Ray, whose luminous frequencies are greater than those of the visible spectrum"; and is termed 'ultra violet' because of its position in the spectrum; - which, as has already been noted, lies just/

just beyond the visible violet region. Like the X-Ray, the Ultra Violet Rays are invisible, being made up of waves of such a length and frequency, that they do not stimulate the optic nerve to produce the sensation of light: but, as will be pointed out later, these Rays have a very definite and powerful effect upon the human organism.

Beyond the ultra violet region is another, but recently explored; and following on this, is the region of the X-Rays and Radium Emanations.

#### UNITS OF MEASUREMENT.

In order to provide a definite standard for purposes of comparison, a unit of measurement has been adopted. Though a purely arbitrary standard, it serves as a useful basis, for estimating visible and invisible light wave lengths. It is known as the Angström Unit, and is usually defined as a "unit of wave length measurement, whose length is one ten millionth of a millimetre". Other units adopted, are, the millicron and the micron. The following are three terms used to designate wave lengths:-

$\overset{\circ}{A}$  is the symbol for the Angström Unit and represents one ten millionth of a millimetre;  $m\mu$  or  $\mu\mu$  are the symbols for the millimicron, and they represent one millionth of a millimetre; while the Greek/

Greek letter  $\mu$  is the symbol for the micron, which represents one ten thousandth of a millimetre.

Of the three terms mentioned, the Ångström Unit is the one most frequently used.

#### A P P A R A T U S.

What are known as Heat Rays, and Luminous Rays, are forms of Radiant Energy that are readily produced by the process of ordinary combustion; or, by the passage of an electric current through a suitable medium.

For the production of Ultra Violet Rays, however, in an intensity sufficient for therapeutic purposes, the high temperature of an electric arc is necessary. Any incandescent body of a sufficiently high temperature, however, will emit ultra violet rays; but for the sake of convenience, and comparative ease of production, an electric arc is the only method at present in use for the production of ultra violet rays for clinical purpose.

The old Finsen Light is essentially formed between two carbon electrodes - the light produced by a direct current of 80 amperes, being collected and focused/

focused by means of quartz lenses, on a small area of the affected part of the body. A quartz compressor may also be used in order to render the underlying parts anaemic; and so permit of further penetration of the rays.

The disadvantages of the old Finsen Lamp, however, are real and obvious. It is too cumbersome and expensive to use; the consumption of current too great; while, in its application, only small areas can be treated at a time; and the exposure necessary, much too prolonged.

Reyn, who was Finsen's Collaborator and Successor devised, however, a simpler type of apparatus, known as the Finsen Reyn Lamp, the rays from which were collected by means of a metal tube, inside of which were two quartz lenses - one at each end of the tube - the intervening space permitting the passage of a constant stream of cooling water, in order to eliminate the heat rays. Powerful carbon arc lamps were also devised by Reyn for use in general treatment, which were fairly successful; especially in cases in which local treatment had failed. This type of apparatus has also fallen into disuse for similar reasons; being too expensive to operate, and the necessary exposure time too long. To obviate some of the defects/

defects mentioned, Dr Leonard Hill, and Dr Edinow, recommend the use of a long flame carbon arc lamp; and maintain that, if the carbon possesses a central core of solid aluminium, the Ultra Violet Radiation is considerably augmented. The current with this type of lamp is from 25 to 30 amperes at a distance of three feet; but it is found that radiation from this source is only rich in the longer wave lengths of the ultra violet region, (referred to later). Mention should, perhaps, here be made of the Condenser Spark Lamp devised by Leslie Miller; which is constructed on the principle that condenser spark discharges are especially rich in the spectral lines of their metallic sparking points. This fact, however, does not compensate for other disadvantages; and like some of the types already mentioned, has now fallen into disuse.

At present in this country a form of carbon arc lamp is much used, especially in Light Clinics. There are, however, other types of open arc lamps, which one sees occasionally used. These are the Tungsten Arc, and the Iron Arc Lamps. The latter is very rich in ultra violet radiation; but the spectrum, although showing some very intense lines, is, on the whole, less continuous, and only extends to wave lengths of about 2250A; and for this reason is seldom/

seldom used. In the case of the Tungsten Arc Lamp, the electrodes are generally made of pure tungsten; the arc is formed in air; <sup>and</sup> is quite open; the rays being focused on the affected part by means of a polished concave copper reflector, which possesses the great advantage of not absorbing nearly so much of the radiation as would be the case with an ordinary reflector. The rays may be further localised, if desired, by means of an ordinary quartz lens. Direct current is usually employed, the average consumpt being 15 Amperes at 100 volts, and the consumpt is much less than that required for the carbon arc. In spite of the fact that its consumption of current is not great, and that a very rich ultra violet radiation is emitted, the Tungsten arc lamp has never attained very great popularity; probably because Tungsten electrodes are more expensive than carbon, and the present construction of the lamp not suited to the simultaneous treatment of several patients. The emission of dense fumes and spluttering is probably an additional reason for the unpopularity of the Tungsten electrode.

The consensus of opinion, at present, is that the Mercury and Carbon Arc Lamps give a sufficiently powerful radiation to serve the majority of purposes.

The most generally useful type of Carbon Arc Lamp is/

is that which consumes a current of 25 to 30 amperes. Pure carbon electrodes may be used with this type of lamp; or the carbon may be impregnated or coated with various metals; a coating of tungsten paste being frequently used. Other ingredients, however, such as iron, aluminium, or nickel, may also be employed in a similar way; and it has been found by spectroscopic analysis, that such a compounding or blending of elements intensifies the output of Ultra Violet Ray to a much greater degree than when carbon alone is used.

Carbon Arc Lamps should be capable of being raised, or lowered, for the sake of convenience in treatment; the positive pole being placed vertically above the negative; as the rays are evolved from the crater which forms on the positive pole. It is usual to connect two or three lamps in series so that several patients may be treated simultaneously. Old street lamps have been used by some, with fairly good results; but, it is doubtful, whether these give a sufficient and constant Intensity of Radiation. Professor Leonard advocates the use of the so-called "Long Flame" Arc Lamp, which has a space of about  $2\frac{1}{2}$  inches between the electrodes while burning; a type of lamp which requires a voltage of 90 to 100. It is said, however, that the intensity from this lamp/

lamp varies considerably, being too easily affected by draughts, when, or where, there is free ventilation. To prevent, or reduce, as far as possible, the wastage of electric current, and the wear of lamp parts, a self-regulating mechanism for the adjustment of carbons has been devised; and in some types of arc lamp there is an arrangement whereby the Positive Carbon is rotated by a motor, thus increasing Radiation.

One great disadvantage from the General Practitioner's point of view, is the high cost of "running" Arc Lamps, owing to the considerable consumption of current, and frequent renewal of electrodes. A single Arc lamp commonly requires a current of from 50 to 60 volts; and when used on a high voltage main, a large resistance is necessary; an arrangement which results in a certain loss of current; although this disadvantage has to some extent been minimised, if not entirely removed, by the inventive skill of a particular firm of lamp designers who have produced a carbon arc lamp, in which four arcs are placed side by side on a single stand, thus greatly reducing the resistance necessary. Another method of economizing current is to instal a Transformer in order to reduce the voltage - an arrangement, which, however, involves a considerable initial expenditure.

MERCURY/

MERCURY VAPOUR LAMPS.

These are either Air-cooled or Water-cooled. Of the Air-cooled there are two types:- Atmospheric and Vacuum.

The Air cooled patterns as a rule are used for systematic irradiation; or, when large areas have to be treated; while the water cooled pattern of lamp is used chiefly for focal or cavity work. The Air Cooled types yield a dominant excess of Near Ultra Violet intensity; while the Water Cooled gives a preponderance of Far Ultra Violet intensity.

Atmospheric.

This type of Mercury Vapour Lamp consists of an irregularly fused quartz tube which is sealed at one end, and closed at the other, by a "ground in" quartz stopper. The quartz contains, but is not completely filled with, mercury freed from air. The tube is suitably connected by terminals through a Resistance to the "power electrical supply"; while the arc tube is housed in a polished aluminium cowl and visor. The cowl is fixed, but the visor is made capable of partial rotation by means of an insulated hand wheel with a stopping device; so that the visor may be fixed at any desired angle. In the centre of the visor is a flanged aluminium opening, in which is fitted a Mica observation window;

a/

a device which serves to protect the eyes when the lamp is being inspected or lit. In addition, suitable localisers made of aluminium, can be fitted to this flanged opening, when the necessity for local treatment arises. The whole of the above is supported on a cast aluminium bracket, which is capable of sliding upwards, or downwards; and rotates on an upright hollow metal tube, inside of which has been placed a counter-balancing weight. The arc is formed by the breaking of the mercury column; and this operation is effected by means of a small heating coil which surrounds a limb projecting from the arc tube. When the current is switched on, the arc is started by the boiling of the mercury in a small bulb, which gradually expands down the whole length of the arc tube; the receding mercury making room for itself in the reservoir at the end of the arc tube, opposite to the boiling limb. When the arc is once established, the heating coil is automatically cut out of circuit. The advantage of this type of arc tube, is, that no tilting is required to start it, as in the case of the Vacuum Type Arc. The lamp swings quite freely in its suspension, and is entirely unaffected by any adjustment of the apparatus. The necessary Resistance can either be mounted at the base of the instrument, or can be separately fixed to the wall; this being combined with a switch-board and fuses, together with a non-reversible plug and socket.

The whole instrument is mounted on a heavy cast iron base, provided with rubber-tyred ball-bearing castors; so that it can be easily moved from place to place; and of all types of lamp the Writer thinks this installation is the most generally suitable for use by the General Practitioner. The arc tube works at atmospheric pressure, or slightly above; and is, in consequence, much more stable than the vacuum type of tube. The striking of the arc occupies a little more time than in the vacuated burner type; but this does not greatly detract from the advantage mentioned.

Further, there is no difficulty in transit with this lamp; as the quartz tube can be sent empty, and the mercury put in by the user, on arrival. When the lamp subsequently becomes dirty, the mercury can easily be removed, and the quartz tube washed out, and cleaned with nitric acid. A most important advantage is, that, should the burner become broken or damaged in any way; it is possible to effect a repair by fusing in a fresh piece of quartz. It is now claimed, that apart from serious accident, this atmospheric type of lamp is practically permanent.

#### Vacuum Type of Mercury Vapour Lamp.

The general lines of construction are much the same as in the case of the last instrument; with this notable difference, that the mercury is contained in a quartz tube which is free from air; and is therefore/

therefore known as the "Vacuum Arc Lamp". The arc is struck by tilting the quartz tube, and bringing it back to its former position; a process which occasionally, however, causes damage to the quartz tube; the mercury, when in motion, having a kind of "hammering" effect. Owing to the constant tilting of, and consequent injury to, the quartz tube, the lamp is easily put out of action. On three occasions the Writer endeavoured to take delivery of this type of lamp; but, on each, was unfortunate enough to find damage done to the quartz tube; and consequent destruction of the vacuum with escape of mercury. Even were this difficulty eliminated, the working life of this lamp would be relatively short; as the arc tube itself deteriorates with use, owing to the deposition of mercury on the inside of the quartz, thus interfering with the passage of the Ultra Violet Rays. In brief, the effective power of these rays decreases in proportion as the burner wears out; the curative results being less satisfactory in the case of burners that have been in use for a considerable time. The time of exposure, and the distance from the lamp, have to be increased in proportion to the age of the burner; and, it is recommended that all such quartz tubes should be renewed once at least in the course of a year; and even more frequently if used on/

on an average longer than three hours per day.

The increased consumption of current as the burner ages; the flickering or unsteadiness of the arc tube; and the difficulty of cleaning the tube; result in its irradiating power being seriously diminished, and necessitates the replacing of the tube, at considerable cost.

For general irradiation purposes, the air-cooled lamp is likely to prove to be the most satisfactory to the General Practitioner. At any rate it has proved to be so in the experience of the writer.

#### THE WATER COOLED MERCURY VAPOUR LAMPS.

The Water Cooled Mercury Vapour Lamp differs from the air cooled quartz lamps in this respect, that the quartz burner is enclosed in a metal cooling jacket, through which water slowly circulates; a quartz window being fitted in the wall of the jacket, through which the rays may pass. In this type of lamp, the Ultra Violet radiations are applied by means of quartz crystal transmitters or compressors, the lamp being so constructed that the parts brought into contact with the patient can easily be sterilised.

The Water Cooled Lamp is generally used for external treatment; /

treatment; but, if used in conjunction with suitable applicators, can also be used for internal treatment. It renders the treatment of most (cutaneous) affections rapid and easy; and, at the same time, permits of the light source coming almost into contact with the skin of the patient.

As has already been mentioned, particular attention must be paid to the nature of the water that is to be used for cooling purposes. The consumpt of water is approximately 4 pints per minute; and the necessary electrical energy about 500 Watts per hour.

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BIOLOGICAL EFFECTS.

The biological action of Ultra Violet Rays is, as yet, imperfectly understood. The physiological effect is in all probability due to photochemical reactions, resulting from absorption of light. Most of the constituents of living matter are not absorbent of visible rays, and are consequently colourless; but the majority, however, absorb ultra violet rays, and as a result, ultra violet radiation has a very marked effect on living cells. This effect confirms the view held by Grotthus, who many years ago maintained, that only rays which are absorbed can possibly produce chemical change. It has also been found, that the various constituents of protoplasm begin to absorb light in a marked degree, in the region of 3000 Å.U. The entire protoplasm of minute organisms is affected when exposed to ultra violet radiation, but the effect on organisms of greater dimensions is more a surface one, owing to the small penetrative power possessed by ultra violet rays. A partial diffusion, however, of the reaction throughout the organism is noticeable. Some interesting experiments have been performed on certain minute organisms, which prove very instructive. When exposed, unprotected, to ultra violet rays, the motility of these organisms was/

was at first found to be greatly increased, but under continued exposure, movement gradually slowed down and finally ceased. It was found also, that when glass was interposed between the organisms and the source of radiation, these effects were considerably delayed, showing, that glass absorbs, or cuts off, most of the ultra violet rays. Further experiments showed that if these organisms were previously immersed in a solution of a fluorescent dye, they were somewhat better protected, and less easily affected when later exposed to ultra violet radiation: proving that the fluorescent matter has the power of converting some of the ultra violet rays into visible rays, which are not absorbed and so are not usually hurtful to protoplasm.

The exact effect of ultra violet rays on protoplasm has not yet been definitely ascertained; some Observers are of opinion that its lethal effect is due to heat coagulation as a result of sensitisation to radiation. Probably the most evident biological effect on Patients, when exposed to ultra violet radiation, is the marked effect it has on the skin. Nothing untoward is noticed at first by the person under treatment, except a faint glow which might be attributed to the incandescence of the quartz, -  
after/

after a latent period, however, of from 4 to 8 hours, a definite feeling of heat may be felt in the part irradiated; which, if the part has been over-exposed may amount to actual pain. The reaction normally amounts to nothing more than a mild inflammatory reaction, the part becoming hot, red in colour, and somewhat swollen. The cause of this hyperaemia, which is one of the principal therapeutic effects of radiation, has not, as yet, been explained in theory. The theory being, that it is possible, by means of ultra violet rays to obtain a photograph of the dividing nuclei of a cell. The Chromatic substance of the cell absorbs the rays, thereby splitting up the chromatin, and at the same time possibly liberating some toxin, which stimulates an increased blood supply. The erythema gradually fades, and is followed by desquamation. After repeated exposures the skin becomes bronzed, due to the deposit of pigment in the form of melanin granules, which are supposed to be protective in their action. These melanin granules are arranged round the nuclei of the skin and basal cells, forming a sort of screen, which protects from an overdose of the rays. Therefore, the appearance of pigmentation in treatment, renders the administration of longer exposures necessary.

The formation of melanin is less marked in albino or fair-complexioned skins, and this fact probably accounts/

accounts for the greater response of this type to ultra violet radiation, and consequent greater risk of overdosage. It would appear, therefore, that Nature, by means of pigmentation, has provided an automatic defence against an overdose of light.

All Patients do not pigment alike, and it is alleged by some observers, that those who do not pigment readily, do not benefit to the same extent from ultra violet ray treatment. It is also thought that pigmentation is a reaction in some way related to endocrine balance; and besides acting as a protection to overdosage, is also a means of converting light into heat.

Rollier regards it as a transformer of light energy into another form of energy, primarily, expended in some chemical action, useful in defence.

Accompanying the erythema there is vaso-dilatation, and this probably accounts for the lessening of arterial pressure, after irradiation. It is also found that the trophic condition of the skin rapidly improves, when it is exposed to ultra violet rays - a fact which led Rollier to describe Sunlight as "the best Masseur", because, under its influence, wasted and flabby muscles soon become firm and strong; an effect often strikingly manifest in tuberculous children. Even when the limbs of such children are completely immobilised, there is no wastage of muscle or/

or loss of tone, when exposed to sunlight. Pigmentation to some extent is associated with the resistance of the skin to infection. It has been noticed that, in certain specific infections, the rash did not appear on the pigmented parts of the body; but was found to be present on the non-pigmented areas, which had been covered. It was further shown, that Recruits in the Swiss Army who were accustomed to working in the fields stripped to the waist, and therefore in some degree pigmented, did not respond to vaccination, unless the usual scarification was substituted by actual cutting of the skin. It is a notable feature of all black or coloured Races, that such skin affections as acne, or boils, are conspicuous by their absence. One is therefore forced to conclude that sunlight, or ultra violet radiation, exerts something of the nature of a bactericidal action on the skin, thus obviating the possibility of skin infection. Exposure to ultra violet rays also exerts a definite influence on metabolism, the whole metabolism of the body is quickened, and general health and vitality are greatly improved. In all probability, the rays are absorbed by the blood in the cutaneous capillaries; although as yet, little or nothing is known, as to how these are stored; or in what form they are set free in the tissues. The beneficial effect, it/

it is believed, may simply be due to chemical changes in the blood which result from exposure; one such effect being the higher calcium content found in the blood; and another, the increase of inorganic phosphorous, produced after irradiation, results which are possibly due to the greater absorption of these salts from the bowel, and which may explain why such good results are obtained in the case of rickets. Recent experiments have been made with ultra violet light on animals, and the results of these suggest a close relationship between light and diet, in the aetiology of rickets. It was found that, when a rickets-producing diet was given to rats, rickets either developed or not, according to the dosage of ultra violet light - the insufficient diet, of course, remaining constant.

Another result of irradiation is, the hyperplasia of the parenchymatous tissue of the endocrine glands. The relationship between the para-thyroid glands and calcium metabolism is well established; and this general hyperplasia of endocrine gland tissue may be responsible for some of the good effects produced.

Experiment has also shown, that with a low calcium content there is a general lowering of vitality; capacity for work is also lowered, and physical fatigue easily induced; while there is an increased liability to disease. On the other hand with a high calcium content/

content the opposite holds good, so that the effect of ultra-violet radiation producing a high calcium content in the blood, is suggestive, and all important.

A high calcium content has also the effect of increasing the coagulability of the blood, so that it seems reasonable to suppose that a course of ultra violet radiation will benefit cases in which there is a diminished coagulability. Radiation not only benefits the organism directly, but also indirectly, through the medium of irradiated food stuffs: for example, a rachitic diet, when irradiated, appears to acquire anti-rachitic properties. Foods of various kinds seem to be affected in this beneficial way, the explanation being that a substance known as Cholesterol present in the food is activated by ultra violet rays. These rays also possess the power of activating vitamins in the body; but not the power to create vitamins.

The action of the fat soluble Vitamin A, already present in the body, or which may be administered concurrently with radiation, is considerably augmented.

Observations on the cardio-vascular system show that, the pulse remains practically unchanged, but the systolic blood pressure tends to drop, sometimes very appreciably; while the percentage of haemoglobin is increased 10 to 20 per cent. There is also quite a definite increase in the number of red and white corpuscles, and in the case of the white cells, there is/

is also some variation in their relative numbers, after exposure to ultra violet rays. For example, the polymorph leucocytes are diminished in number; while the lymphocytes and eosinophils are increased; as also are the blood platelets.

The immunising and bactericidal properties of the blood are increased; why this should be is somewhat difficult to explain; when one considers the changes in the differential white cell count, especially the diminution in polymorphs.

The Alimentary System also shows changes resulting from irradiation. Pacini states that if gastric juice be removed from the stomach during or shortly after radiation, it shows a diminution in its acid content; and this, together with the blood changes, may account for the benefit seen in cases of duodenal ulcer; which have not responded well to usual medical treatment. He also attributes the relief of pain, in some of these cases, to irradiation of the cutaneous sensitive areas; caused, either by the production of a superficial hyperaemia, so relieving internal congestion; or by virtue of the analgesic property of the rays, which may relieve peripheral nerve irritation, in an area reflexly related to some internal organ - in this case the stomach.

The pain referred to deeper structures is probably relieved through this association. No matter what/

what the mechanism be, in the production of analgesia by ultra violet rays, it is an important therapeutic property, and may confidently be relied upon to allay pain in some cases. Not only do ultra violet rays increase the haemo-bactericidal power of the blood; they also possess a strong general bactericidal action; for instance, sputum bacilli when spread in a thin film and exposed to direct sunlight are killed in 10 minutes; and the effect of such radiation on ordinary septic wounds is markedly cleansing. The destructive effect on bacteria is probably due to coagulation, by affecting the protoplasm in such a way that it is possible for certain salts to combine with the protein of the protoplasm and so form insoluble compounds. Another theory is that of heat coagulation of the protoplasm, which follows sensitisation by ultra violet radiation.

The effects of Sunlight and of Ultra Violet Radiation on the Nervous System produce a physical sense of well-being, mental exhilaration, and cheerfulness; and certain intelligence tests have shown that the general mental state is improved by Ultra Violet Irradiation. The general outlook of the Patient becomes brighter; and this fact, in itself, materially aids recovery from disease.

Besides the foregoing general effects of Ultra Violet/

Violet Irradiation, there are also certain local effects; but clinically, the general effects are of much wider application than the local.

To sum up, the therapeutic changes which result from Ultra Violet Irradiation, one might conveniently use the following classification.

Objectively.

1. The so-called LATENT PERIOD,  
followed in order by -
2. HYPERAEMIA.
3. DESQUAMATION,  
and lastly
4. PIGMENTATION.

Subjectively.

1. Local ANALGESIC effect in  
painful areas.
2. Feeling of PHYSICAL WELL BEING,  
and SENSE OF BUOYANCY.

Experimentally.

1. BLOOD CHANGES, such as increase of
  - (a) CALCIUM.
  - (b) PHOSPHORUS.
  - (c) IRON.
  - (d) BLOOD PLATELETS.
  - (e) Increase in bactericidal  
properties of the Blood.
2. Increase in number of Red and  
White Corpuscles; with alterations  
in the White Cell Differential  
Count, e.g., polymorphs often dim-  
inished, while lymphocytic and  
eosinophil types of cell increased.

3. Increase in % of HAEMOGLOBIN.
4. Stimulation of the ENDOCRINE  
GLANDS.
5. Activation of VITAMINS,

Experiment has shown, however, that some of these therapeutic properties are mainly limited to conditions of growth or function which are definitely below normal; and that they have no corresponding effect on normal individuals.

It has been found that, in the Ultra Violet Region, the rays of greatest therapeutic value appear to lie in the region of 3000 Å U. In this region, both penetrating and bactericidal rays are present; although the main general effects of irradiation are probably due to the penetrating rays. Rays which are chiefly bactericidal have very little penetrative power, and are absorbed by even a thin layer of protoplasm; for example, one bacterium will protect another lying beneath it.

At the present time, there is a difference of opinion as to whether the presence of the Infra Red Rays augment or detract from the value of Ultra Violet Irradiation; and also whether the shorter luminous rays do not also play a part in the therapeutics of Ultra Violet Ray Treatment. It is known, that the Luminous Rays of the spectrum have considerable penetrating power, and the Infra Red Rays seem/

seem to have an effect very much akin to these, namely, - dilatation of cutaneous vessels, and stimulation of sweat glands. They do not have, however, any bactericidal effect. The Luminous and Heat Rays have been in use for many years, in the form of Light Baths, principally in the treatment of rheumatic and neuralgic affections; the source of Light here being the ordinary incandescent electric light lamp. Any ultra violet rays generated by the incandescence of the filaments being cut off or absorbed by the glass bulbs.

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T E C H N I Q U E .

Not a little of the success of Ultra Violet Ray Therapy is due to the choice of a suitable and reliable source of energy; but whatever the type of apparatus used, it must be kept scrupulously clean. It is also necessary that the Operator be thoroughly familiar with the proper working of his particular instrument. It has been found that lamps of the same construction, and made by the same firm of makers; may vary very considerably in their power of irradiation; and consequently, to the same extent may also vary in their results.

Further, it ought to be remembered, that patients vary very greatly in respect of susceptibility to radiation; the susceptibility being greater in blonde, or fair complexioned people; and somewhat less marked in the case of the darker-skinned types. But, whatever be the type of person under treatment, and whatever be the nature of the disease; the skin area of the affected part must be carefully, and thoroughly cleansed of all foreign matter, such as films of grease, which are likely to interfere with proper irradiation, and neutralise its effects.

Having taken this precaution, the patient to be treated should be placed in such a position, that the incidence/

incidence of the rays on the affected part will be, as nearly as possible, at right angles; because the action of the rays is more direct, and therefore more effective when the incidence is at this inclination. It follows, therefore, that the period of exposure must be proportioned to the size of the angle of incidence; as unequal results are produced by the radiation of convex surfaces; such as the shoulder, or any other rounded parts of the body. The most satisfactory results are obtained, therefore, when the rays are brought to bear on the affected part at an angle of  $90^{\circ}$ ; and, if the area to be treated is large, care should be taken to secure an equal distribution of effect; and for this purpose, the simultaneous use of a second similar type of lamp, may be used.

For the treatment of small orifices, solid quartz rods may conveniently be used; these being mounted on a holder, which can be attached to the lamp. The co-efficient of refraction of the quartz is so high that light is transmitted through it, as through a tube; a greater amount of light reaching the patient, through the quartz, than through the atmosphere at a similar distance. The Law of Light, varying inversely as the square of the distance, does not seem to apply to the transmission by quartz.

As has already been stated, special applicators  
in/

in the form of solid quartz rods may be used for the irradiation of cavities, such as the ear, nose, urethra etc.; and also for the purpose of focussing the light on the small naevi of children. The usual procedure is to place the quartz rod in the desired position, holding it between the finger and thumb of the left hand, at the same time bringing the lamp up to the rod, and then connecting the two.

In the treatment of prostates or internal piles, a rectal speculum with obturator is made use of; and on the former being introduced, the latter, i.e. the obturator, is withdrawn, and the lamp brought to the end of the speculum. In the case of external piles, special haemorrhoid applicators are employed, which are also made of quartz, and can be pressed against the prolapsed mass by means of suitable holders. Care must be taken to secure the proper fixing of the quartz in the holder; as otherwise, there is a risk of its being drawn in by the action of the sphincter muscles.

A useful applicator has been specially designed for the treatment of tonsils. The tongue having been depressed by the left hand by means of a wooden tongue depressor, the applicator is attached to an inspection lamp, and applied to the surface of the tonsil.

In/

In order to protect the skin surrounding a lesion, when protection is necessary, black or red paper may be used; or, the affected part may be smeared with some dark pigment mixed with soft soap; a composition which is easily removed after irradiation.

The eyes should be adequately protected in all cases where general irradiation is given, by the wearing of suitable glasses by the patient and also by the Operator. These glasses should be fitted with protecting side pieces, so that stray side rays may be entirely excluded. The glass mounting should be made of india-rubber, or similar material, in order that sterilisation may be carried out. Neglect of protecting the eyes during exposure may have very serious consequences. Painful conditions such as Photophobia, conjunctivitis, excessive lacrymation, severe smarting of the eyelids, with contraction of the pupil, may frequently result. Marked swelling of the eyelids may also be a symptom with the formation of corneal ulcer and perhaps iritis and retinitis.

The lamp used, should be of one or other of the types previously mentioned; and, if systemic irradiation is to be the form of treatment used, then the air cooled type of Mercury Vapour Lamp is to be preferred; and speaking or writing from personal experience, the writer of this Thesis is of the opinion that the atmospheric burner is much more convenient than that of/

of the vacuum type. The open carbon arc lamp is hardly so suitable for use in the ordinary consulting room. An ideal form of instillation would be the combination of an air-cooled and water-cooled instrument, as the inclusion of the latter type would greatly facilitate intensive treatment of small areas; the water cooling arrangement allowing of closer proximity of the source of light to the part of the body requiring treatment. The air-cooled lamp furnishes a longer wave length spectrum or near ultra violet intensity, which however has not much germicidal action, but is more penetrative; while the spectrum from the water-cooled lamp is relatively richer in the short wave lengths or far ultra violet intensity, which, however, possess marked germicidal action, though less penetrative power.

#### DOSAGE.

In ultra violet radiation, Dosage is at the moment a vexed question and the present method resolves itself into a question of reaction. It has been found by some experimenters that the measure of the Therapeutic effect is the amount of reaction induced; and that the reaction is directly proportional to the intensity of the radiation, which in turn, is partly dependent on the amperage employed.

As/

As has already been noted, there are other factors which cause variation in the intensity of a reaction; the reason being that each individual skin varies in its power of resistance to Actinic Light. Dark types, as a rule, can stand a greater dosage than people of a well-marked light type. Then there is the difference, which age always makes. Children can only stand about half the dose of an adult male of a similar type; while infants require only about half the dose of children. Sex, also, is another variant factor; the skin of a woman being more sensitive than that of an adult male. Experiment has also shown that the parts of the body which are habitually exposed, e.g. the face and hands - are much less susceptible to actinic light, than parts usually protected and in consequence require a longer exposure time.

Intensity of reaction will, of course, also depend, on the duration of the exposure; and also on the distance of the part under treatment from the source of radiation. Failure to place the patient at a proper distance from the arc is a frequent cause of overdosage.

Notwithstanding the considerable progress made in Ultra Violet Radiation, no general agreement has been reached, as to what constitutes a correct dosage;

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a difficult problem<sup>which</sup> can only be solved by "trial and result". Hence the supreme importance of standardizing lamps. At the first stage of treatment by Ultra-Violet Rays, a part only of the patient's body is exposed; but, at a later stage, the area exposed and the duration of exposure may be increased, until the whole body is irradiated for the full period.

When the maximum period of exposure is reached, usually half the time is given to irradiation of the front of the body; and half to the back; whereas, in the case of prolonged exposures, the patients usually turn round every 15 minutes or thereby. As already stated, the distance of the patient from the lamp must be very carefully gauged; in view of the fact that the intensity of radiation varies inversely with the square of the distance of the patient from the lamp.

A distance of three feet from the arc is found to be safest, and most generally effective; although in the case of the open carbon, or tungsten arcs, the patient ought not to be placed too near on account of the greater amount of heat generated by these lamps during incandescence; and also because sparks sometimes fall from the electrodes.

Not a few methods of general irradiation are now advocated; but, the "fractional irradiation" system is perhaps the safest known. In this case, the feet are/

are first exposed; the second exposure including feet and calves; the third including, feet, calves, and thighs; and so on, till the whole body has been subjected to the Rays.

The duration of exposure is usually increased by one minute at each subsequent treatment. In the case of the carbon arc lamp, the exposure given is usually 20 to 30 minutes to begin with, at the customary distance of three feet; this, however, is gradually increased up to a possible maximum of four hours three times weekly.

Clinically, the aim of radiation is, to produce what is called an "erythema dose"; which means, that there is produced a slight reaction indicated by a slight reddening of the skin, and also possibly by a slight exfoliation; a resultant condition sometimes described as "stimulative erythema". Reactions of greater severity, known as "destructive erythemata", ought if possible to be avoided. Destructive Erythemata are characterised by intense hyperaemia; which is followed by changes in the protoplasm of the cells, and also by exudation and finally blister formation.

Some Authorities consider that over-irradiation produces a deteriorating effect on the blood, and observation/

observation has shown that there is an optimum dose of ultra violet radiation so far as the haemobactericidal power of the blood is concerned; and that, if this dose be exceeded, there is a diminution in the bactericidal properties of the blood. It would appear, therefore, that there is some close relationship, between the so-called erythema dose and the haemobactericidal dose. If more were known with regard to this relationship; and if a suitable standard of dosage were found; perhaps, some of the occasional cases which at present do not respond readily to ultra violet radiation, might well be improved.

A diversity of opinion exists as to whether one should aim at the production of pigmentation or not. If the chief use of pigmentation be to protect the part from over-dosage; it would seem to be desirable to produce a reaction just short of an erythema dose; and thus retard pigmentation as much as possible. On the other hand, the appearance of pigmentation is held by some Clinicians to be a valuable index of the beneficial results of Ultra Violet irradiation. Until this difference of opinion, however, has been satisfactorily settled, it will perhaps be wiser and safer to aim at the production of an erythema dose for each individual case; the determination of which, as has been said, will not be an easy matter.

A rough estimate of the sensitiveness of any particular individual to ultra-violet radiation, may be obtained by the following simple preliminary test - sometimes referred to as the "spot test" - and which is carried out as follows:- five holes are cut in some flexible material, e.g. a piece of cloth, the holes being arranged in a straight line, half an inch apart, and half an inch in diameter. Flaps are provided, so that the holes may be covered separately. The piece of cloth is then placed on the flexor surface of the arm; all the spots being bared together. At the end of the first minute, the first spot is covered by its respective flap. Then the other holes are covered in their order, at the end of the 2nd, 3rd, 4th, and 5th minute, respectively. The patient should report himself 6 hours, or thereby, after exposure; and the strength of the reaction in each spot noted; thereby, affording a rough measure of the sensitiveness of the individual.

Before beginning the test described, it is essential that the position of the spots relative to the incidence of the rays be at, or as near to a right angle as possible. The outermost spots will, of course, be somewhat oblique to the rays; but this disadvantage will be minimised if the line of the spots is in a line with the arc tube. During the test/

test the temperature of the room should, if possible, be about 70 degrees F.

A normal dose may be defined, as, the faintest perceptible erythema which is produced on the patient's most sensitive skin surface. When a normal dosage has been ascertained by the "spot" test; one can roughly deduce the appropriate dosage for the body as a whole, or, any part of it, taken alone.

Intervals between treatment and subsequent appropriate dosage can only be determined after carefully eliciting all possible information regarding the first exposure.

Overdosage may be either local or general. A local overdose to the skin results in the production of a greater degree of erythema than was intended; possibly causing a destructive erythema, instead of a stimulative or regenerative one. Such a local overdosage usually causes a considerable amount of pain and irritation. Simple remedial measures such as olive oil, castor oil, or carron oil, may be applied to the affected part in order to lessen the discomfort and tenderness. Overdosage, resulting from general body treatment, rarely occurs, however, unless through gross overdosage during a single exposure. It is as a rule not seen within a period of less than two or three months treatment; and only then/

than, in the event of radiation having been repeated thrice or perhaps four times weekly; and each exposure lasting not less than half an hour. Symptoms resulting from overdosage, usually come on gradually, and show that the nervous system has been over-stimulated. The patient becomes irritable, and there is loss of both appetite and energy. Sleeplessness is another very troublesome symptom; the patient is unable to sleep because of abnormal mental activity; ideas flow too quickly, and thoughts so occupy the mind that the relaxation essential to natural sleep is almost impossible.

A symptom following a single exposure of excessive duration occasionally is, a feeling of tiredness; while, in some extreme cases the patient develops what seems to be a slight tendency to syncope. These, however, are symptoms which as a rule disappear when radiation ceases; and leave no permanently injurious effects. The symptoms, however, are sufficiently serious while they last; death, in some cases, being directly attributable to them. This risk of overdosage suggests that Ultra Violet Ray Therapy should at all times be carefully administered and ought never to be given unless under proper medical supervision.

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GENERAL CONSIDERATIONS IN TECHNIQUE.

It is a great advantage, indeed it may be said to be necessary, for the General Practitioner to have at least two rooms at his disposal, when giving Ultra Violet Radiation Treatment. The room or rooms in every case should be well lighted and ventilated; and should also have some convenient and adequate means of heating; as it has been found that reaction is more marked, and treatment more beneficial, when the patient is comfortably warm; in which case, more intense reactions generally follow; and better results obtained. Reference should also be made to the fact that no time is more suitable than another for irradiation; and that no danger is likely to accrue to patients, even if immediately after treatment they partake of a heavy meal; as Erythemic symptoms do not, as a rule, appear for several hours after exposure. Patients feel comfortably warm during, and after, irradiation; but are not overheated, and therefore, without risk to themselves may go out of doors immediately or soon after receiving treatment.

What is known as an Exposure Meter is a great convenience and asset in Ultra Violet Ray treatment. Clocks may be used, which can be set for any length of time, and obviates the necessity of constantly looking/

looking at one's watch during an exposure. It is also a means of economizing time; and minimises the risk of overdosage which occasionally occurs when the ordinary watch is relied on.

In the event of a particularly sharp reaction following an exposure, with consequent discomfort and irritation; simple palliative measures may be used; but it is better on the whole not to resort to these, unless found absolutely necessary; as soothing oils and similar applications tend to prevent the full penetration of the rays at subsequent exposures. It is advisable, also, not to bathe the irradiated part for 24 hours following an exposure.

With regard to the Ultra Violet Radiation of children, the first application should be given with the child in its Mother's arms; until confidence is gained, when little or no difficulty will be experienced in subsequent exposures. When, as frequently in public institutions, such as that in East Fortune, large numbers of children are simultaneously treated, it is convenient to have concentric circles of measured radii marked permanently on the floor; the lamps being placed on the outermost of these. During irradiation the children walk slowly round and round in the particular ring corresponding to the dose required at the time. This method possesses the advantage/

advantage of allowing the whole body to be equally exposed to the process of irradiation.

It is affirmed by some Authorities, that the continued exposure of the operator to ultra violet radiations may produce the same injurious effects as in the case of continued exposure to X-Rays, before the adoption of preventive measures. Little evidence, however, has been adduced in support of the allegation, and when one considers the close relationship between ultra violet radiation and natural sunlight itself, it seems unlikely that the alleged danger really exists.

In view of the fact that mercury vapour lamps vary considerably in the strength of their ultra violet ray output, a convenient method has been found of standardising the strength of any particular type of lamp. The standardizing processes can be carried out in one or other of two ways. The first method is based on the power of ultra violet rays to darken photographic paper as compared with a standard shade or by its power of bleaching a solution of acetone methylene blue; a small quantity of which being placed in a quartz tube and exposed to the rays for a certain time and at a certain distance. The resulting tint of the solution is then compared with a series/

series of standard solutions of varying shades; and the one corresponding to the tested solution, gives an indication of the strength of the rays emitted by any particular type of lamp.

In the case of deep-seated lesions, and especially in the case of lupus, it is essential that the maximum amount of rays be made to penetrate the tissues; and in order to facilitate this process a quartz compressor is generally used to render the part anaemic; thus preventing the absorption of the rays by the blood.

It is also found that when irradiating mucous surfaces a more intense and prolonged exposure is necessary, than is the case with skin irradiation. Longer exposures may be given also in the treatment of small areas, such as the knees, or an ulcer, even at the first radiation.

Experience has also shown that patients of an extremely sensitive nature, whose blood pressure is abnormally low, who suffer from heart disease, or show signs of pulmonary phthisis, must be irradiated with the utmost caution, an important matter to which reference will be made later.

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DISEASES, MORE OR LESS SUSCEPTIBLE, TO ULTRA  
VIOLET RAY TREATMENT.

In the case of diseases of the skin, ultra violet radiation has had a wide and useful field of application - many diseases of a chronic nature which resisted other methods of treatment, have yielded surprising results, both by general and local irradiation. In addition to skin diseases, there is quite a number of others which benefit either by this method alone, or, in conjunction with others. But, as is the case with the majority of new modes of treatment, the range of Ultra Violet Ray usefulness has probably been somewhat exaggerated, and claims and assumptions made which, as yet, have not been proved by clinical findings. Possibly, however, these claims may be substantiated later by fuller knowledge and wider experience.

Not a little of the success of Ultra Violet Radiation in Dermatology, is probably due to its bactericidal effect on the skin; and to its stimulating action on cell growth; indirectly also, to the strengthening of the resistance of the whole body to infection. These effects are strikingly seen in cases of septic wounds, and chronic ulcerations, which rapidly clean, granulate and finally heal.

Cases/

Cases of abscess, boils, and carbuncles are very favourably affected by radiation which has produced a third degree erythema. The usual duration of exposure is three minutes, at a distance of 12 to 18 inches; and in the case of each subsequent treatment, the duration of exposure as a rule is increased by 2 minutes. If pus has already formed in the focus of infection, the lesion should be incised before irradiation takes place. Other factors in favour of this treatment are, the marked and almost immediate relief of the patient from pain; and the less evident scarring when the incision has healed. It is believed that, wherever a normal dose of ultra violet radiation produces an excessive general reaction, the presence of sugar in the urine should be suspected, and an examination of the blood also made. Syphilitic skin eruptions and even the tertiary ulcerations and suppurating glands are all likewise favourably influenced by exposure.

X-Ray burns are encouraged to heal by the action of the rays, and cases of old standing X-Ray dermatitis are distinctly improved. Some Authorities strongly advise that old X-Ray burns, which threaten to undergo carcinomatous change, should be treated by ultra violet rays and so avoid, in some cases at least, the necessity for amputation.

Rapid/

Rapid improvement is also seen in cases of psoriasis, particularly in the chronic isolated patches, which are so often resistant to other methods of treatment. Other skin diseases that have been successfully treated are, acne, furunculosis, and eczema, especially in its chronic form.

Cases of pruritus ani, especially where no ascertainable cause can be found, also respond well to artificial sunlight. There is an almost immediate relief from the intolerable itching, due to the analgesic effect of the rays on the interepithelial nerve fibrils, and also to the powerful bactericidal action on the skin. Six to twelve exposures are usually sufficient, and associated conditions, such as perineal abscesses, fissures, or sinuses, are usually benefited, or cured, at the same time.

Before commencing treatment, it is essential that all hairs be removed, the affected part thoroughly washed with soap and water, and finally with methylated spirits. Folds in the skin may be obliterated by pulling apart the buttocks; the patient being usually placed in the knee-elbow, or, lithotomy position. It should be emphasised, however, that in most cases a permanent cure cannot be hoped for, unless the cause of the trouble be ascertained and removed.

Obstinate cases of acne, whether they occur on the face, neck, or back, and especially in the case of/

of patients who have a pale oily skin, respond readily, as a rule, to this treatment, so that general and local treatment should be combined, more especially as there is usually a general lack of tone, anaemia and constipation.

An excellent example of the analgesic effect of the ultra violet rays is shown, in the marked relief of pain in cases of Herpes, in all its forms; and providing that treatment be undertaken early, as a rule radiation will be found sufficient to arrest the development of the vesicles.

Favourable results are also obtained in cases of impetigo; care, however, must be taken to wipe, or pick off, all crusts before applying the rays. Alopecia, especially the premature alopecia of men, also responds well to treatment. In the female, there is usually a more general thinning of the hair; and as each hair casts a shadow, the light is in some degree prevented from reaching the scalp, thus rendering hyperaemia more difficult. It is customary, therefore, to have the hair parted and retained in position before treatment begins. The improvement is probably due to the erythema which causes an increased blood supply. It is necessary to give a slightly longer exposure to produce erythema of the scalp, than on other parts of the body. In almost every case, the general condition of the hair improves, its/

its rate of growth increases, and it takes on an added lustre. After the first two or three exposures it is found that the scalp loses its shiny appearance; and a growth of fine downy hairs is observed, which is followed later by a stronger growth of hair.

The streptococcal infection of the skin, as seen in erysipelas, is usually arrested owing probably to the erythema causing an increased blood supply to the part; while the relief of pain is most probably due to the analgesic effect of the rays.

The treatment of lupus, as has already been said, was first carried out by Professor Finsen, by means of the Sun's rays; and, at a later date, by the use of the carbon arc lamp. In the treatment of almost all cases of lupus, improvement is striking; the improvement being probably due to the extreme sensitiveness of the Tubercle Bacillus to ultra violet light; together with the associated leucocytosis, or, rather lymphocytosis, and the increased bactericidal power of the blood. It is said that the dry type of lupus with the characteristic yellowish nodules is the type most amenable to ultra violet treatment, but the type least suitable for treatment by X-Rays; the X-Rays being contra-indicated because of the risk of carcinomatous change supervening. The ulcerative type of lupus is, however, distinctly benefited by X-Ray Therapy. Sir Norman Walker has expressed the opinion/



opinion that Light Treatment is pre-eminently the best known form of single treatment in cases of Lupus.

Cases under the direction of Sir Norman Walker were treated by general irradiation only; there being no special local treatment of the diseased part.

Some Authorities, however, advise the use of a quartz compressor during exposure, in order to ensure the maximum action of the rays; as otherwise they are absorbed by the blood. It is usual to produce third degree erythema over the lesions at first, care being taken that the new epithelium which forms round the edges of the lesions should be adequately protected during subsequent irradiation.

Before leaving the subject of skin conditions, which are definitely amenable to ultra violet ray treatment, mention perhaps should be made of its success in cases of Naevus. With this method the cosmetic results are superior to methods hitherto in vogue. There is no subsequent scarring, so that when the reaction subsides, the skin retains its normal texture. It is necessary in these cases to produce a severe reaction, amounting even to blister formation. The Water-cooled type of Mercury Vapour Lamp is used, pressure being used against the naevus by the window of the lamp, or by a quartz compressor; the surrounding skin being protected in the usual way by means of paper or adhesive plaster.

Although/

Although natural Sun-Cure at high altitudes is now generally admitted to be the most satisfactory method of treatment in most cases of surgical or localised Tuberculosis, the climate in these latitudes does not permit of this to any great extent; but it has been proved that ultra-violet radiation is a particularly effective substitute. Cases of pulmonary tuberculosis, however, must be radiated with exceedingly greater caution; in fact this method of treatment has been contra-indicated in such cases. Opinions of Clinicians vary, however, some averring that very good results can be obtained, and any risk obviated or minimised by giving short exposures, with somewhat long intervals between. It is generally regarded as advisable that irradiation be discontinued in cases of pulmonary tuberculosis; as in these, after treatment, there is an increase of temperature, or increase in the pulse rate. The type of pulmonary tuberculosis regarded as most suitable for treatment is the type of case in which the disease is localised; and the type of case in which fever symptoms are absent. The risk is in cases with multiple foci; and in which there is a definite rise and fall in temperature; and in patients inclined to haemoptysis. It is believed by some authorities, that when the extremities are irradiated, a decongestion of the viscera takes place; and, /

and, conversely, that when the trunk is exposed to the rays, congestion of the internal organs supervenes. Although not generally held, this view, if proved, would go far to explain why, in some cases of pulmonary tuberculosis, haemoptysis is of such frequent occurrence.

It is, perhaps, in surgical cases of Tuberculosis that the most satisfactory results are obtained by Ultra Violet Radiation. A combination of X-Rays and Ultra Violet Ray therapy, produces remarkable results in cases of Glandular Tuberculosis; especially if treated before the stage of pus formation. But even after a Gland breaks down, the discharge progressively ceases; while the sinuses rapidly heal, and the final aesthetic seems to be more satisfactory than that resulting from other methods of treatment. Gratifying results are also obtained in Tuberculous Bone and Joint Lesions; and in cases of Pott's Disease; while joints with discharging sinuses begin to improve, even after years of suffering. The sinuses heal up and cease to discharge; a cessation which results in the general condition of the patient being greatly improved. Orthopaedic measures in conjunction with the radiation not only expedite healing, and result in the arrest of the disease, but in not a few cases ensure a fair range of movement in the case of affected joints; and in cases in which there/

there has been considerable absorption of bone, the osteoblasts are stimulated, resulting in recalcification and new bone formation.

The Tubercular Peritonitis of children is also found to respond well to treatment; the general condition being improved, and the free fluid in the abdomen gradually absorbed.

It should here be emphasised that treatment of tubercular affections should both be local and general, and the usual hygienic measures be rigorously carried out.

With regard to the treatment of Rickets, Ultra Violet Radiation may almost be said to be a specific remedy, and at the same time, one of the evidences of its influence on metabolism. The calcium and phosphorus content of the body is raised, as a result of radiation; while there is an increase in the energy of the fat-soluble Vitamin A. There is a similar marked improvement in cases of Osteomalacia and allied bony defects, and, even in cases in which no considerable bony defects exist there is great improvement. The flabby, hypotonic child soon loses some of his characteristics:- becomes more interested in his little World; and the fractiousness so often seen in such cases, disappears.

It has also been advocated that Ultra Violet Ray Treatment begin as soon as pregnancy is established; advice/

advice which may seem unusual and unsound to some, but expedient to others in view of the great drain upon calcium metabolism during pregnancy; and the fact, or at least the possibility of rickets originating and developing before the child is born. The Advocates of Ante-natal radiation also recommend that radiation be continued throughout the period of lactation; or, alternatively, that every child be radiated daily, or at any rate, frequently, and regularly during the first month or six weeks of its life; a measure which, if generally adopted in public clinics, and by the General Practitioner, whatever its local and particular effects, would, probably, result in a marked improvement in the General Health of the child.

The Writer has been unable to gain very much information with regard to the use of Ultra Violet Ray Therapy in cases of delayed union of fractures; but possibly good results may be obtained in these, as in other cases of bony defects, because of the resultant raising of the calcium contents of the blood; and because radiation causes a diminution of pain, its application would tend to the early introduction of movement, when this seemed advisable.

Affections of a chronic Rheumatic or Fibrositic nature are usually benefited; but a combination of radiant heat, or diathermy, with Ultra Violet Rays, is usually more effective. The results of treatment in cases of Neuritis is usually particularly marked,-  
the/

the pain being, in many cases, quickly relieved and function speedily restored.

With regard to the Circulatory System, the most beneficial effect produced is the reduction in high Blood Pressure; probably due to the depletion of the internal organs, as a result of the general surface hyperaemia; the dilatation of the cutaneous vessels greatly diminishing the work of the heart itself. In addition to this, the General Circulation is found to be greatly influenced by radiation; more blood being brought to the surface as a result of the dilatation of the capillaries. Not only is there a fall in blood pressure as a result of radiation; there is also induced a feeling of rest and refreshment, so that insomnia and headache speedily disappear.

Theoretically one would expect marked improvement in Haemophilic subjects; as in such cases the calcium content is frequently increased; as are also the blood platelets; and as Ultra Violet Radiation increases both of these, it is possible that this treatment will result in good; if only a little more were known regarding its pathology.

Improvement has also resulted in certain Respiratory Disorders, such as Whooping Cough, Chronic bronchitis, Hay Fever, Laryngismus Stridulus; and even in the case of ordinary Colds. The treatment of spasmodic asthma by this method has, however, as yet proved/

proved rather uncertain.

No doubt only temporary benefit has been derived from radiation in many Nervous Diseases. But there is sometimes real and permanent improvement in cases of true Neurasthenia. In these cases the effect of treatment will not only be mental but physical; but whether this is due to the alteration in the blood chemistry; or to endocrine balance; or to the improvement in the bactericidal power of the blood; is not definitely known. Probably, however, it is the result of all three. Perhaps the good results of radiation in Neurasthenic cases are due to the increase of the phosphorus and calcium content of the blood; and to the lessening of the chronic intestinal toxæmia from which Neurasthenics usually suffer.

Ultra Violet Radiation has also been used in certain disorders of the Genito-Urinary System; but the beneficial effect is seen best in cases of chronic degenerations of the kidney, where the superficial hyperaemia exerts a favourable influence, possibly in relieving strain. Beneficial effects of the Ultra Violet Rays on the endocrine and sexual glands have already been referred to. It is known, that in Southern Countries menstruation appears in girls at an earlier age than in more Temperate regions; and conversely, in the Arctic circle, during the Polar night, women frequently cease menstruation until the re-appearing of the Sun.

Clinically, /

Clinically, Ultra Violet Radiation produces good results in cases of disordered menstruation; cases in which there is no local pathological lesion; and, in which, the cause of the disorder is probably some alteration in the function of the endocrine glands. Some success has also followed treatment of cases of Rhino-Laryngeal Tuberculosis; while symptoms such as hoarseness, pain, and difficulty of breathing, have also been promptly relieved. Histological examinations of Sections of the Turbinal Mucosa in cases of Nasal Lupus under treatment, have shown a gradual disappearance of the tubercles.

As in other parts of the body, so in the case of the Eye; the diseases most susceptible to Ultra Violet Light treatment are the chronic-inflammatory. Nevertheless, the best time to begin Light Treatment is before the disease has become chronic; and before the lesion has been further complicated by organized deposits, or extensive tissue degeneration.

Cure, in ophthalmic cases, at least from the patient's point of view, is on a somewhat higher standard than cures effected in other parts of the body, because the end-result is judged by the patient in terms of the vision finally obtained; and not on account of the formation of a healthy cicatrix; as in the case of healed wounds in other parts of the body. In the case of the Eye, such an end-result would probably/

probably render the Eye useless, and be judged a failure. Cases of ulcer and opacities often clear up very satisfactorily under irradiation; which however in all cases, but especially in the case of the Eye, should be used with moderation; the eyelids in every case being closed during irradiation. In such cases Ultra Violet treatment has not only all the advantages of <sup>the</sup> actual cautery, but is without its destructive effect on the tissues, and its resultant scar-formation.

Experiment has also shown that Ultra Violet Radiation is particularly useful in the treatment of infectious fevers; especially after the acute febrile symptoms have disappeared, because this form of treatment rapidly increases the patient's resistance, as is evidenced by the small number of cases which develop Bronchial-Pneumonia as compared with the number, for example, which result from an attack of Measles.

During the acute stages of severe illness in general, pain is much relieved by the analgesic effect of the rays, particularly evident in cases of Mumps; cases in which there is frequently intense pain; and later, a complication in the testicle.

It should also be stated that cases classed under the heading of simple malnutrition, anaemia, general debility/

debility, and delayed convalescence, all do well when subjected to a course of Ultra Violet Ray treatment.

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ULTRA VIOLET RAY THERAPY AS A COMPLEMENT TO  
X-RAY TREATMENT.

Being as yet in what has been termed the Empirical Stage, it is not easy to state quite definitely, to what extent, and in what manner, Ultra Violet Rays are complementary to X-Rays in the treatment of Medical, or Surgical cases. In certain physical conditions, however, such as old-standing cases of Psoriasis, cases in which the lesions were definitely indurated; the more recently affected areas were found to respond readily to, and to be definitely improved by Actino-therapy. The less recent lesions however, remained intractable until the X-Ray dosage was superimposed, when they also cleared up satisfactorily.

Experiment has also shown that X-Ray burns, or dermatitis, when exposed to Ultra Violet radiation, improve in a marked degree.

When, however, as in Lupus cases, it is desired to produce an extreme dermatitis; it is found that the most satisfactory results are obtained by superimposing the X-Rays on an Ultra Violet dermatitis. In the course of the War, excellent results were obtained in the treatment of painful scars, by the Combination of Ultra Violet and X-Ray treatment; a not improbable explanation being that the X-Ray exerts a disintegrating effect on the nerve tissue, and/

and that, as this softens, the nerve fibres are relieved of their pressure.

The relationship in which these two sets of spectral rays stand to each other, has not yet been clearly defined; but clinical research tends to show that X- and Ultra-Violet radiations are complementary to each other; and that, used in combination, yield satisfactory results.

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NOTES ON CASES TREATED.

## Case 1.

Miss E. K. aet. 37 years. Single. The lady referred to suffered from Lupus from early childhood. Both sides of the face were affected, and also the lobes of the ears. At the time of first examination the condition seemed to be more active, and inclined to spread. The pre-auricular gland on one side was on the point of breaking down and was incised, the pus being thus evacuated. There were also some definitely palpable cervical glands; but no evidence at all of pulmonary infection.

The patient sought advice not on account of the original Lupus complaint; but on account of a recently developed pain in the left wrist. This pain subsequently proved to be caused by a tuberculous synovitis; X-Ray showing some involvement of the carpus.

The Writer advised the usual hygienic measures, and in addition, prescribed Ultra Violet Ray treatment; this being given both by the Air cooled Mercury Vapour Lamp, and later also by the Open Carbon Arc.

The patient gave a quick erythema response to the general irradiation; but, persistently complained of being very much exhausted after exposures. This feeling/

feeling was more marked when the patient was being submitted to Carbon Arc Lamp radiation. The time of exposure was accordingly reduced, but the Writer concluded that the feeling of lassitude was due rather to the heat of the open arc, than to any direct effect from the Ultra Violet Radiation.

In addition to general irradiation, more concentrated local exposures were given both to the face and wrist region. Some little time elapsed before any definite improvement could be discerned; but later, however, became quite evident in the condition of the face. The pain and destruction of tissue at the wrist persisted, however, for several months in spite of treatment, but, finally, the inflammation slowly subsided, while the pain and discharge gradually diminished. The wrist was constantly supported by means of a short "cock up" splint.

There is now a very marked improvement, both in the face condition and in the appearance of the wrist. Almost the whole of the affected face area has been replaced by healthy scar-tissue except in the case of a few isolated patches. The patient still continues to receive treatment and further improvement is expected. Perhaps it should be mentioned that this was the dry type of Lupus, with a few scattered nodules. It was quite noticeable on removing the splints, that there was no marked wasting of muscles, and that there was a good functional movement at the wrist-joint.

There/

There is at present only occasional discharge, and the sinus is slowly closing, as is also the sinus from the broken down Trochlear gland.

Case 2.

Mrs A. aet. 69 years. Suffered from Eczema for the past 18 years. Began in fingers and gradually extended up the arms to the flexures of the elbow joints, and finally to the arm-pits. She has had the benefit of various methods of treatment, but with only slight success.

At the time of examination there was general involvement of the flexor surfaces of both forearms, with scattered patches on the upper arms. There were moist patches in the flexures of the elbow-joints and also in both axillae. Local irradiation was given to the arms and axillae, the upper arms being abducted during irradiation. A first exposure of three minutes, at three feet, was given; subsequent exposures were given at the same distance, for a period of five minutes. After the first radiation, the severe irritation was almost completely relieved, the condition itself seemed, however, to be a little more marked, and there appeared to be a certain increase of exudation. After the third exposure there was  
a/

a quite definite improvement. There was no exudation even in the flexures of the joints; while the eczematous areas were much faded, and beginning to desquamate. Only six radiations were necessary to cause all disappearance of the disease. In the last two the scalp was irradiated.

### Case 3.

Wm. H. aet. 3 years. Male. A full-time child, but delicate, from birth. Symptoms of a more definite nature developed about a year ago. The abdomen became more protuberant, free fluid being quite discernible on physical examination. The bowels were alternately loose and constipated. The child became asthenic, and the appetite markedly impaired. An operation for acute intussusception was undergone about eighteen months ago, followed by a good recovery.

General hygienic measures were afterwards adopted and irradiation recommended. No pulmonary involvement could be made out.

Treatment began by exposing the front of the legs, at a distance of three feet, for four minutes, to the air-cooled mercury vapour lamp (atmospheric type). The second exposure included the back of the legs and back of the trunk, for the same exposure time and distance. On the third occasion, the chest and abdomen/

abdomen were irradiated for a period of three minutes, at a distance of three feet. On subsequent occasions the whole body was irradiated with short localized exposures. The first signs of improvement were noticed in the general appearance and temperament of the child. The appetite began to improve, and the child to become less fractious. After the abdomen had been irradiated locally, together with the general exposures, there was a gradual but decided diminution in the amount of free fluid in the abdomen, and the usual doughy feeling seen in such cases was replaced by an elastic resistance somewhat resembling the normal. I have now recommended fortnightly radiations through the winter months. There has been no return of diarrhoea since the disappearance of the abdominal fluid.

Case 4.

L.H. female, aet. 21 years. Always very healthy; but in the latter years of school life became somewhat debilitated and developed enlarged cervical glands on one side, probably from a local tonsillar infection. There was no evidence of pulmonary or other tuberculosis. General irradiations and local exposures were given, but these were begun/

begun rather late as pus had already formed. The abscess was not incised, but was repeatedly aspirated; great care being taken not to infect the surrounding skin. Ultra Violet treatment was continued for some months, resulting in the rapid disappearance of the discharge, and closure of the sinus. Other palpable glands, which had not broken down, rapidly disappeared; and the patient's general condition became markedly improved. The final aesthetic result is good - the resulting scar is pliant and healthy, and blends well with the environing skin; and no puckering nor retraction has taken place.

#### Case 5.

Alopecia Prematura. Mr T. aet. 34., began to lose hair about the age of 27. About a year ago he sought medical advice, a scalp lotion being prescribed which produced a very marked, and very painful irritation. No appreciable improvement followed this treatment. On first examining the patient, an almost complete absence of hair from the frontal and crown portions of the scalp was noted; the hair round the temples and occiput was also sparse and unhealthy in appearance. Local exposures with the air-cooled Mercury Vapour Lamp were given. An initial exposure of four minutes at three feet was administered; the patient/

patient being instructed to report when the reaction had subsided. It was found, however, that very little, if any, erythema resulted from this irradiation.

Three days later a second was given, lasting seven minutes, when a slight, but very definite, erythema resulted. Subsequent treatments were given at intervals of four days. Following the fourth radiation there was a general improvement in the appearance of the scalp; the "shininess" had vanished; there was a perceptible growth of fine hair which is now being replaced by hair of normal texture. This treatment is being continued with a view to increasing growth and thickness.

Case 6.

R. S. Male, aet. 34, suffered from Lumbago complicated by acute sciatica; a condition which had lasted about a month, before treatment by radiation. Other remedial measures had failed to produce much effect; but after the second exposure the pain had completely disappeared. Only local treatment was given.

Case 7.

D. McK. aet. 60 years. Acute attack of sciatica in right leg. Some degree of flat foot. Duration 3 weeks, during which time the sciatica proved resistant/

resistant to medical treatment. Three exposures to the back of the thigh and leg were given, commencing at a distance of three feet, for a period of three minutes; while three subsequent exposures were each increased by two minutes, the distance remaining the same. After the fourth irradiation, there was a complete cessation of pain; the patient being able to return to work. The erythema in this case was well marked, but of short duration; so that exposures were given every second day.

#### Case 8.

Mrs J. McL. aet. 51 years. Suffered from very intense facial and occipital neuralgia for 10 days. No definite cause could be found in the teeth or accessory sinuses, etc. Intensive medical treatment was continued during that time, with practically no resulting improvement. Wishing, if possible, to avoid strong, sedative, drugs, exposure to the Ultra Violet Rays was tried. The acute pain was definitely less acute after the first irradiation, and disappeared after three exposures. The face and upper part of the chest, both back and front, were irradiated, with the eyes carefully protected. The Erythema was fairly intense, and it was thought advisable to give the same length of exposure on each occasion.

## Case 9.

Mr T. aet. 58 years. Complained of severe headaches, noises in the ears, dizziness, with a tendency to syncope. There was also shortness of breath on slight exertion, palpitation, and a general feeling of lethargy. Urine examination was negative. Heart sounds were closed, and there was a marked accentuation of the second aortic sound. There was also an enlargement of the left ventricle. Systolic Blood Pressure was 210 m.m. of Mercury; and the Diastolic 120 m.m. Hg. Prolonged treatment only resulted in slight and temporary benefit. A marked improvement resulted from a sea-voyage, but in this case, also, the benefit was temporary.

General exposures to the Ultra Violet Rays was then resorted to twice weekly. First the legs were exposed; then the legs and thighs, and back of the trunk; and lastly the whole body. Treatment was continued for two months; the final exposure lasting for twenty minutes, at a distance of three feet. The systolic blood pressure was then found to have fallen to 195 mm. Hg.; and the diastolic to 110 mm. Hg.; while all other symptoms except occasional shortness of breath had disappeared. Treatment has been discontinued for two months and no return of symptoms has been observed.

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## Case 10.

Mrs Mgt. S. aet. 50 years. Had suffered from Varicose ulcer over left tibia for four years. The ulcer had gradually extended. It was impossible to keep the patient in bed. Local treatment had effected a certain improvement in the condition; but the ulcer never healed until Ultra Violet irradiation was resorted to. Four minutes at three feet was the duration of the initial exposure. After the first two or three irradiations the patient ceased to suffer from the intense irritation in and round the wound; the indurated edges of the ulcer became healthy; the discharge lessened and finally ceased; healthy granulations appeared which finally led to the closure of the wound. Fifteen irradiations were necessary; the maximum exposure being 20 minutes at a distance of three feet. No ointment was allowed during treatment; and green protective tissue was used to cover the wound. The general condition of the leg was also greatly improved. The patient is now wearing an elastic stocking and until now has experienced no further trouble.

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## Case 11.

Mrs L. aet. 30 years. For some months there were patches of Psoriasis on the fronts of both thighs, and no other treatment had been tried. Exposures to the Mercury Vapour Lamp were given on six occasions, the usual dosage being given on each; with the result that the patches speedily faded and completely disappeared.

## Case 12.

Betty O. aet. 6 years. She suffered from measles and subsequent broncho-pneumonia, which left the child in a very debilitated condition, with frequent recurring attacks of bronchitis, not however regarded as tuberculous. Weekly exposures were given for a period of three months, beginning with the legs, and were continued until the whole body was irradiated. The general condition of the patient improved, as did the appetite. The weight also increased. The chest cleared; expectoration gradually diminished, and finally ceased.

At present the patient reports only once per month.

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## Case 13.

Miss M.M. aet. 45 years, was operated on for meta-tarsalgia, and complained of subsequent pain in operation scar, rendering walking difficult and painful. Treatment by Ultra Violet Irradiation considerably improved the local condition; made the scar less adherent, and more pliant; and made walking less difficult, and more comfortable.

A similar scar condition appeared on the other foot, which had been previously operated on for Hallux Valgus; this also yielded to irradiation and added greatly to the comfort of the patient. Fairly prolonged exposures were given, on an average, 10 minutes at three feet; and it was only after 10 or 12 exposures that improvement became apparent.

MISCELLANEOUS.

There are numerous cases of marasmic, and apparently potentially, rickety, children who have derived benefit from Ultra Violet Irradiation.

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S U M M A R Y.  
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Medicine and Surgery have been engaged in an age-long campaign against disease and its consequent suffering; and all along the line, up through the centuries, have been wresting territory from these stubborn enemies of the race. The battle still goes on, and the enemy still being worsted, and the frontiers of the kingdom of Light and Health continue to extend.

Particularly noticeable and remarkable advances have been made by Medicine and Surgery in comparatively recent years; especially during the last quarter of a century. In his report for the year 1925, to the Ministry of Health, on the subject of Public Health in England and Wales, Sir George Newman states that there has been a remarkable reduction in, and in some cases, disappearance of, devastating epidemics, such as Cholera and Typhoid fever which, at one time, disturbed the whole nation; and that, similarly, a fall has occurred in cases of Scarlet Fever, Diphtheria, Whooping Cough, Tuberculosis, Smallpox, and Bronchitis; and that these diseases have become milder; while Infancy and Childhood are, unquestionably, healthier than they were half a century ago. The chief causes of death in order of mortality in England and Wales in/

in 1925 were:- Diseases of the heart and circulation (177 per 1000 deaths); Bronchitis, Pneumonia, and other respiratory diseases (165); Cancer (110); diseases of the nervous system (99); and all forms of Tuberculosis (85). These five physical conditions may seem to be responsible for 60 per cent of the mortality in the countries named; and it may be thought that these five diseases are the chief physical enemies with which the physicians and surgeons have to contend. That, however, is not strictly true; for, according to the report mentioned, the five diseases named are end-results of the reaction of the human body to the process of disease set up at an earlier stage. Many deaths are charged to the five major groups mentioned; that are properly chargeable to primary disease, and earlier conditions; so that our chief enemies are those earlier conditions which produce these end-results.

The measure of health enjoyed by any generation, according to the report, depends on antecedent conditions, - the conditions under which its infancy and childhood have been passed. And in the great field of Child Welfare, as in other fields, but, especially in this, Ultra Violet Radiation has rendered, and can still render, signal service.

The General Practitioner can also render invaluable aid in the field of preventive medicine, for/

for on him primarily rests the responsibility of detecting disease in its incipient stages.

Little more, perhaps, need be said with regard to the therapeutic value of Sunlight in the prevention and treatment of disease; but the hope may be expressed that the utility and value of Ultra Violet Radiation will be more generally recognized by Practitioners than it has, perhaps, been. The scope of its natural application in our Northern, insular country is unfortunately limited both in respect of its intensity and times of appearance. Our absorbent ever-varying atmosphere, consisting not only of certain gases, but also of water vapour and solid microscopic and ultra microscopic particles; has, unfortunately set a definite limit to the quality, and also to the intensity of the Ultra Violet Radiation which we receive from the Sun; so that it is necessary for us to make good this deficiency by the artificial means at our disposal, and now under review. It has been proved that the apparatus devised and available can give us the whole unfiltered range of Ultra Violet Radiation, which issues from the Sun, such as can only be experienced on the outer margin of our atmosphere.

It would, therefore, appear that Ultra Violet Radiation has already secured for itself a definite and useful place in the ever-widening field of Therapeutics/

Therapeutics; and that under proper supervision, and by that the Writer of this Thesis means, with the aid and guidance of Medicine and Surgery, Ultra Violet Ray Therapy can do much to bring us nearer to an ideal condition of Communal health; a consummation earnestly to be toiled for, by a profession which has always been strenuous; and has never ceased to be progressive.

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