Operation.

When a nerve is divided it is imperative to operate, even if only sensation results. If I decided to operate upon the median or ulnar (the post-interosseous is rarely involved) I should correct as much of the deformity as possible first of all. I have had so little experience of either the shortening of bones or tenoplasty in this condition that I shall be very interested to hear experiences to-day. I have only operated on one case by tenoplasty, shortly after Littlewood recommended it, and the result was not very encouraging. It was an extremely difficult case, and the tendons were very adherent. In a case where I removed a piece of radius and ulna I was unfortunate enough not to obtain union.

A comparatively simple method of overcoming the contraction of tendons was referred to by Max Page and performed with success by Platt. It consisted of detaching the origins of the flexor groups from the region of the internal epicondyle and upper ends of the radius and ulna. I have not had any experience of this operation, but it appeals to me as being sound in conception. It is best performed where, after a period of graduated stretching, a residual contraction remains. In the case I referred to, where a Volkmann's contraction followed an old dislocated elbow, I made a free excision of the joint, and the contraction of the fingers was very much improved. This should only be done if the flexors of the elbow are working.

In cases of tenoplasty the after-care is very important, and the patient should be under constant observation. The arm should be elevated, the splint being applied to the dorsal aspect of the limb. Voluntary movement should be encouraged about the tenth day.

Resection of portions of the radius and ulna was advocated by Garré in 1895, and has been practised by several surgeons. Results are not very encouraging. Tenoplasty and bone resection in combination have been reported. It is well to warn surgeons who have had no experience of tendon work that conjoint operations of this kind in Volkmann contraction are very difficult, and require great neatness and patience; in the case of children they may be prolonged, and for that reason may be accompanied by considerable shock.

Myotomy and tenotomy are not to be recommended, in spite of reports which have been published. The most that can be said in their favour is that they may shorten the time necessary to correct flexion. I would emphasize that the success or failure of any treatment depends on the condition of the muscle fibres and the nerve involvement. If the muscles have been transformed into fibrous tissue no functional result is possible, and the most that can be expected is an improvement in appearance. All statements to the contrary should be doubted.

Where contraction of tendons and fixation of the forearm in pronation, together with very limited flexion, is found, I think a free excision of the elbow-joint, to which I have already alluded, may be indicated. If, in addition to this, the flexor muscle attachments to radius and ulna are detached improvement might be hopefully expected. Before any operation on bone is performed the treatment would be facilitated by obtaining as much correction as possible by gradual stretching.

It is perhaps encouraging to know that I have seen several old cases—some of which have been well treated and others badly—years after all treatment has ended, and the patients have told me that their fingers are more pliable and their hands much more useful than they were. The circulation always improves as the months and years pass, and, unless the destruction of the muscles, or the paralysis, is complete, time is always a favourable factor.

My advice to young surgeons and practitioners who meet with fractures about the elbow is that they must insist upon obtaining an x-ray photograph. If the parents refuse, the refusal should be made in writing. The parents should be told that two serious conditions are apt to follow injuries to the elbow. One is the condition we are now discussing, and which often comes in the first few hours, and the other is myositis ossificans, which is not likely to follow in less than three or four weeks. My further advice is that they should join the Medical Defence Union, for the law may be invoked whatever we may do.

ULTRA-VIOLET RAYS AND THE GENERAL PUBLIC.*

BY

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THE NATURE OF RADIATION.

ALL matter of the material universe is built of atoms. The atoms are composed of electric units, positive and negative; the various chemical atoms differ from one another only in the number and arrangement of these electric particles. But matter is always associated with a third thing—namely, radiation. Radiation is described as consisting of waves in an all-pervading medium, the ether, which is responsible for gravitation, electric attraction, and cohesion; it is the connecting link between matter and ether, and is the process by which energy is propagated through space.

Radiation is due to sudden changes or rearrangements in the movements of the constituent electric units of the atom. Any vigorous treatment of an atom may cause new radiations. If electric particles are thrown on to a surface in a vacuum tube radiation occurs, and the so-called x rays are produced. The nature of the ultimate constitution of matter has been determined entirely by a study of these radiations, which are emitted by all substances above absolute zero.

There is another kind of radiation which is emitted by radio-active substances. Radium salts emit not only ether radiations, but electrical particles also. These particles (alpha rays) are expelled at a velocity of 10,000 miles per second, and possess so much energy that when they strike a zinc sulphide crystal a flash is seen.

The different radiations can be separated in several ways. A very few of them are appreciated by the retina; and small differences in wave-length or frequency of vibration are responsible for the appreciation of colour.

When radiations pass through a partly transparent object such as a glass prism, the direction of their movement is changed; they become bent in different degrees, according to the various wave-lengths, and can thus be sorted. This is termed a spectrum. All these waves affect one or other chemical substance and can therefore be photographed. If all kinds of rays are present, as in sunshine, the spectrum is continuous; if some are missing the spectrum shows bright lines, and if a continuous spectrum is passed through a substance which absorbs certain rays the ultimate spectrum will exhibit dark lines (absorption spectrum). Other methods may be used to separate out certain waves, as by means of screens.

Animal life has developed and adapted itself to existing conditions—to the plant life which preceded it and on which it was dependent for food, to the atmosphere, and to the radiations around. Its food was composed of whatever constituents were available from plants—such as sugars, proteins, fats, and vitamins; and its radiations by those furnished by the sun and temperature of the environment. Being developed according to these environmental conditions, the conditions became essential for individual well-being.

The later phases of science have enabled us to analyse these conditions and to modify the foods and radiations which normally obtain. It may be that all this is to the good, that as man congregated in herds, he changed the conditions under which he had developed—as, for example, if he lived in confined areas and ate preserved foods which had lost some of their fundamental properties. This may not be unconnected with the modern craze for vitamins and radiations. Moreover, there is evidence to suggest that these modifications of foods, and unnatural radiation confined to a very limited wave-length, may exert an unfavourable action in certain cases.

The range of electro-magnetic waves extends, so far as they have been mapped, through sixty-two octaves. Visible sun rays occupy only one octave, and all move at a uniform

* A paper read in opening a discussion in the Section of Radiology and Physio-therapeutics of the Annual Meeting of the British Medical Association, Cardiff, 1928.

velocity of 30,000 million centimetres per second. Beyond the violet rays of visible light are five octaves of ultra-violet rays becoming progressively shorter in wave-length; solar radiation contains a few of these, something less than an octave. On the other side of the solar spectrum are the infra-red waves, about seven octaves, of which solar radiation contains three or four.

Sun rays have been used in the treatment of disease for long ages, but during the last thirty years precise observations have been made of their action in disease. The proof is complete that they exert a curative effect in cases of surgical tuberculosis, rickets, and in some cases of nerve disease, anaemia, and skin disease. Atmospheric conditions alter the action of sunshine to some extent. Thus the presence of water vapour acts in much the same way as a fire screen, which lets us see the fire, but cuts out the heat. The atmosphere tends to absorb the short wave ultra-violet rays, so that these are likely to be more plentiful in mountainous districts than at sea-level. The morning and evening sunlight are not so useful as that at midday, since the rays have to travel through a greater thickness of atmosphere. Nevertheless, light treatment may be practised almost anywhere. Swiss doctors assert that mountainous districts give the best results on account of the atmosphere being clean and dry and the rays more intense in chemical properties and ultra-violet. On the other hand, doctors in the lowlands claim beneficial results almost, if not quite, as good as those in the Alpine institutions—for example, in the neighbourhood of Berlin. It is still a matter of dispute which rays are responsible for the beneficial action and how they act.

CURATIVE RAYS.

It is generally believed that it is the violet and longer ultra-violet rays that are most important, because these are especially prevalent in the sunshine of mountainous districts and near the sea, where they become refracted and reflected by the sand and water. If the short ultra-violet rays were the most important, then the mercury vapour lamp, in which they are very rich, ought to be the most effective treatment. Rollier, the pioneer of sunshine treatment, regards the light waves as the most important, and abundant pigmentation as a sign that the patient is deriving benefit. Others hold the view that the value of heliotherapy is the direct effect of the power of the rays to produce redness of the skin.

All skin contains a substance called ergosterol; when this is acted on by ultra-violet rays it is changed chemically, and the changed substance acts as a preventive to, and cure for, rickets. So that in this particular instance ultra-violet is all-important. Regarding general benefit, however, all we know for certain is that sunshine exerts a curative action in certain diseases, and that this is not due to the action on the diseased part directly, but to an action on the skin, and only indirectly on the disease. When ultra-violet rays are employed in treatment wave-lengths are used some of which are foreign to sunshine. Sunshine contains some of the longer ultra-violet rays, but the shorter and physiologically more active are lacking.

Ultra-violet rays are generated by special plants designed for the purpose. These substitutes for the sun are the mercury arc in quartz and the carbon arc burning carbons with mixtures of rare earths. The radiations from these sources produce good effects in certain diseases, and these are generally ascribed to the ultra-violet rays, though this has only been proved in a few instances like rickets. The spectral distribution of these lamps varies greatly. Sunlight at sea-level contains less than 2 per cent. ultra-violet rays, but in a water-cooled mercury vapour lamp the ultra-violet rays may rise to nearly 50 per cent. Moreover, the spectral quality of this ultra-violet light is different from that of the sun, in that it contains a large proportion of the very short waves.

The carbon arc, the iron arc, the tungsten arc, and the mercury vapour lamp all radiate an appreciable amount of chemically active light. But the carbon arc is the only source which produces a continuous spectrum like sunshine and irradiates all kinds of light from infra-red to ultra-violet. The others show a discontinuous spectrum, only a selection of waves being emitted. The carbon arc light

is not only the best substitute for sunshine on technical grounds, but it gives the best results in the treatment of patients.

PHYSIOLOGICAL ACTION OF LIGHT.

The skin acts as a partial screen to the different wave-lengths of light. Luminous rays can pass through several centimetres of the body, but ultra-violet rays penetrate much less, and all but the very longest are absorbed by the epidermis. The infra-red waves also have little power of penetration. Within this area of the spectrum penetration varies with the wave-length, being greatest with the red waves of light and least with the short ultra-violet rays. Ultra-violet light, therefore, cannot have a direct action on deeper tissues.

Sunlight, ultra-violet rays, and infra-red rays all cause the skin to turn red at first, and, if the dose is repeated or prolonged, to become pigmented later. If the skin of a man is exposed to a powerful carbon arc the irritant effect, as shown by redness, can be largely screened off by ordinary glass; light passes through glass, but ultra-violet rays are held back. On the other hand, a plate of quartz glass through which ultra-violet rays pass has no influence in limiting the inflammatory reaction, which may remain for several days and be followed by peeling and pigmentation. Ultra-violet rays are largely responsible for the inflammatory reaction, although sunshine is more effective in influencing the extent and duration of pigmentation. Pigmentation from lamps is more superficial and transient than that produced by sunshine; it is a natural protection against the treatment, and we do not yet know whether its production is an advantage or a disadvantage to the patient.

Apart from its action on the skin, ultra-violet radiation gives a feeling of well-being and vigour. Many other effects on metabolism have been ascribed to ultra-violet rays. I believe that most of these are not specific, and can be obtained just as well with, say, a mustard plaster.

SENSITIVENESS.

The skins of patients differ in their reactions towards light as well as to certain skin poisons like the mustard gas of chemical warfare; some skins react excessively to a trifling dose, and others are uninfluenced by large doses. The skin may be compared with a photographic plate. Normally only the visible blue waves affect the gelatin silver. If the plate is treated with a dye stuff such as rose bengal it is sensitized, and the green waves also act upon the plate; and if it is treated with diethyl methyl isocyanide the plate becomes sensitive to the whole visible spectrum.

Ergosterol in the skin is activated by ultra-violet rays and acquires an anti-rickets property. Ergosterol in food is activated only by the ultra-violet rays and not by sunshine; but by adding sensitizers to the food the same thing happens as with the photographic plate, and ordinary sunshine will now activate the ergosterol.

The variations in the response of the skin to light are probably due to the presence of a sensitizer, and in some people with a supersensitive skin we even know its nature. But quite apart from this natural sensitiveness, the condition can be acquired. The application of powerful ultra-violet rays alters the proteins of the skin; these abnormal proteins are absorbed, and an allergic condition arises in which the skin becomes intolerant to light. The condition is strictly analogous to the worker with mustard gas: sooner or later all these people become allergic, so that a trace of the gas in the atmosphere causes skin inflammation. The importance of a correct dose cannot be over-exaggerated, since burns may lead to light allergy.

INJURIOUS EFFECTS.

It is sometimes thought that ultra-violet radiations are beneficial for almost any condition and that they can do no harm. Much of the literature in the advertisements on lamps leaves the impression that they are a panacea for all disease. In reality very many patients are not benefited by this treatment, and some may suffer injury. Take one example: it has been shown that no comparative diminution in the incidence of respiratory infections was noted in a series of infants treated during the winter for

a period of three months by the radiation of the carbon arc light. Growth during the first six weeks was greater in the irradiated than in the non-irradiated group of infants; but during the second six weeks the growth was less among the irradiated infants. Similar results were obtained using the mercury vapour lamp.

Injurious effects of sunshine are uncommon except perhaps when it is reflected from snow or water; here it may cause inflammatory burns or even blindness. The radiations from ultra-violet lamps, which emit rays of shorter wave-length than those found in the solar spectrum, when applied to the skin are so foreign to the body as to be comparable with the administration of a poisonous drug; either may be beneficial in a suitable subject, but harmful in an unsuitable.

A common effect of slight overdosing is sleeplessness, restlessness, lassitude, loss of weight, and nausea. Resistance to bacterial infection is said to be lowered by treating too large a surface. The most obvious ill effects are in the nature of burns; the skin becomes hot, red, swollen, and inflamed. In the sensitive these may extend beyond the region exposed. After more intensive radiation purulent exudation may occur. Repeated applications have resulted in chronic lesions, a pre-cancerous form of dermatitis. It should be understood that there is no difference between a sunburn, an ultra-violet burn, and a scald. The skin effects are often associated with severe pains in the eyes and headaches, sometimes lasting for weeks.

The eye is readily affected by strong radiations from arc lamps, molten glass, or light reflected from snow or ice; inflammation of the conjunctiva and cornea result, and the lens, and even the retina, may be affected. Ultra-violet rays coagulate protein, and cataract is a coagulation of the proteins of the lens; improper irradiation may certainly induce this condition. In a recent letter in the *British Medical Journal* a doctor writes that as a result of an unqualified person's light treatment on a patient of his, who had a slowly maturing cataract, the patient's vision was reduced in both eyes to perception and projection of light only. Some authorities regard ultra-violet light as the principal factor in the cause of senile cataract; glass-blower's cataract is the result of continuous illumination in which the whole of the spectrum is probably concerned. These effects on the eye can, of course, be obviated by wearing goggles, though this preventive is sometimes neglected, as is shown by a report in the *South Wales News* for June 14th last of a case in the Cardiff County Court, in which a woman was awarded £50 damages in an undefended case against the Cardiff Sunray Clinic. The plaintiff said that she had to face strong rays of light from a lamp and that no goggles were given to her until she had faced the light for two and a half to three minutes.

Physicians are generally agreed that radiation by ultra-violet light is contraindicated in highly nervous and neurotic people; they suffer what is called a grave "psychic reaction," and the treatment does harm. Great caution is necessary in all forms of pulmonary consumption and in other quiescent inflammatory conditions, such as appendicitis. In old people with rigid arteries, in all forms of kidney disease, and in some forms of heart disease the patient is made worse. Eczemas and some other skin diseases are often aggravated by the treatment. It may be that contraindications appear only after the first treatment. The daily press reported recently an inquest on a woman of 47 who died after ultra-violet ray treatment. She had severe burns on her back and legs, and duodenal ulcer followed. The doctor said that he had come to the conclusion that death was due to ulceration consequent upon burns set up by a sun-ray apparatus.

Careful examination is therefore necessary prior to treatment if we wish to be sure that ill effects will not follow. I believe that the expert can determine the necessary dosage for his patient without the risk of harmful general or local effects.

Most of the leading authorities on radiology have pointed out the dangers which may follow the improper use of ultra-violet lamps. Many of the lamps emit rays to which man has never before been exposed. The evidence of the

harm they may do is overwhelming. Few of us would dare to have a prescription containing poisons dispensed by an untrained person, but the dispensers of rays are uncontrolled, unregistered, and may be unqualified.

It is obviously right that the public should be given such information as will enable them to distinguish between those who have been properly educated to dispense rays and others. At the present time all kinds of rays are used by charlatans in Europe and America to impose on the public. Barbers employ them, especially for their lady clients. Beauty institutions have set up baths of blue rays, which are generally harmless frauds, though ultra-violet light has been used. Sun-ray institutes are becoming the fashion, and the public is buying machines and indulging in self-treatment.

Some countries have already taken action. The superior Council of Public Hygiene of France, consulted by the Minister of Works and Hygiene, has declared as follows: "That given the serious accidents which may result from the use of ultra-violet irradiations handled by incompetent persons, it is necessary, in the interest of public health, to confine the use of these procedures to hospital services and to authorize their application only by specialist physicians." In the United States the Council of Physical Therapy has reported on the dangers to the public of self-treatment by the sale of generators of ultra-violet energy. It points out that those not familiar with the possibilities of such apparatus place undue confidence in the advertising literature; unsuitable cases are treated or cases not amenable to treatment. The council regards such sales to the public as detrimental to the public welfare and an encouragement for the sale of worthless generators, since the public has no means of determining the quality of radiant energy.

I have endeavoured to show that treatment by radiation may be either beneficial or harmful; that its employment by unskilled people may cause serious ill effects to the patient, and I suggest that the time has come when some sort of protection must be extended to the public.

ULTRA-VIOLET LIGHT AND THE PUBLIC.*

BY

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PROFESSOR DIXON has put before you, with the clarity that has helped to make him one of the most popular lecturers in Cambridge, the position of ultra-violet light treatment as it is to-day. It was the extraordinary value of this form of treatment when properly employed, and the potent dangers associated with ignorant use, that led the British Medical Association to form a special subcommittee. This subcommittee was charged with the duty of considering how best the uses might be safeguarded and the abuses abolished.

The report of this subcommittee was considered in turn by the Science Committee and by the Council of the Association, who formulated a recommendation for presentation to the Representative Body. The final form of this recommendation as passed by the Representative Body is as follows:

"That in view of the risks to the public involved in the use of electricity and radiation as methods of treatment by untrained and unqualified persons it is to be desired (1) that suitable courses of training should be organized under medical direction for persons who wish to administer this form of treatment; (2) that persons who have satisfactorily followed such a course should be entitled to have their names entered on an approved Roll; (3) that one of the conditions attached to admission to, and maintenance on, the approved Roll should be abstinence from the treatment of any patient except on the responsibility and under the general supervision of a registered medical practitioner; and (4) that patients who require electrical or radiation treatment should be referred only to those persons whose names are on the approved Roll."

* Read in a discussion in the Section of Radiology and Physio-therapeutics of the Annual Meeting of the British Medical Association, Cardiff, 1928.