HELIOTHERAPY IN SURGICAL TUBERCULOSIS

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IN THE FIELD of surgery, light finds its greatest usefulness in the treatment of tuberculosis, particularly those special forms known as surgical tuberculosis existing in bones and joints. Tuberculosis was the first disease for which light was used as a form of treatment. With the exception of rickets, it has provided us with nearly all of our present knowledge of the value of light as a therapeutic agent. It has been deemed wise, therefore, to devote this paper to a presentation of our knowledge of the use of light in this disease; also to limit the discussion to one form of light, namely sunshine. The information we have obtained from experience with sunlight in the treatment of tuberculosis summarizes practically all of our knowledge in this field, and will serve to indicate how important is its use.

For an adequate conception of the magnitude of the problem we must begin at the beginning with a brief résumé of the nature of the particular form of tuberculosis in which sunshine has proved to be such an effective therapeutic agent. Tuberculosis arises as the result of the invasion of the body by tubercle bacilli. The pathway of invasion is the mouth, to which the organisms are carried on contaminated objects and on dust, but chiefly in droplets coughed out by patients with active pulmonary lesions. From the mouth they may, and most frequently do, pass with the inspired air to the lung. There they are deposited in the alveoli, and set up a primary focus of tuberculosis. Less frequently, they are deposited on the mucous membrance of the nasopharynx, or on the tonsils, where they also set up a primary focus of tuberculosis. Finally they may be swallowed, pass through the stomach to the intestinal tract, and produce primary foci there. While there are thus three main paths of infection—tonsillar, intestinal and pulmonary—it is the pulmonary path which is generally followed. The fate of all such primary foci is similar.

THE COURSE OF A PRIMARY PULMONARY LESION

It will serve our purpose to follow the course of a primary pulmonary lesion, the commonest type. If the number of tubercle bacilli deposited in the lung is small, and if the resistance of the patient is high, the primary tubercle formed by their invasion is quickly overcome by phagocytosis of the tubercle bacilli and repair of the damaged part by fibrosis. This abortive form of tuberculosis limited to the area first invaded, is the form from which the majority of us have suffered, usually entirely unconsciously. After a varying length of time the infection is entirely stamped out, leaving us with a lung more or less scarred, but with a considerable resistance against future exposure to tuberculosis.

In less favorable cases the defensive forces of the patient may fall just short of complete cure. They do succeed in walling up the infection in the area first attacked, but the causative tubercle bacilli lie latent, their fate dependent upon subsequent circumstances. If the patient is placed in good surroundings, and is freed from further infection by tubercle bacilli, he will in time succeed in stamping out his disease. On the other hand, if he is

subjected to bad hygienic surroundings during the period of latent infection, or passes through an exhausting illness, such as influenza, or undertakes a new and fatiguing occupation, the lowering of the resistance which thus results may permit the latent infection to flare up and spread both locally and systemically.

Finally, in a third group of patients, the dose of tubercle bacilli may have been so massive, or the resistance so feeble, that neither cure nor walling off is obtained, and the disease becomes established and spreads.

In the last group (active tuberculosis) organisms in the primary focus sooner or later escape from it and pass by way of the lymphatics to the nearest lymph gland, where they set up a fresh focus of tuberculosis. From this gland, in a similar fashion, the disease spreads to the next gland in the chain, until by a series of such steps the whole of the lymphatic chain draining the area of the primary focus becomes the seat of a tuberculous adenitis—mediastinal adenitis in the case of pulmonary tuberculosis, cervical adenitis in the case of tonsillar infection, and mesenteric adenitis in the case of intestinal invasion.

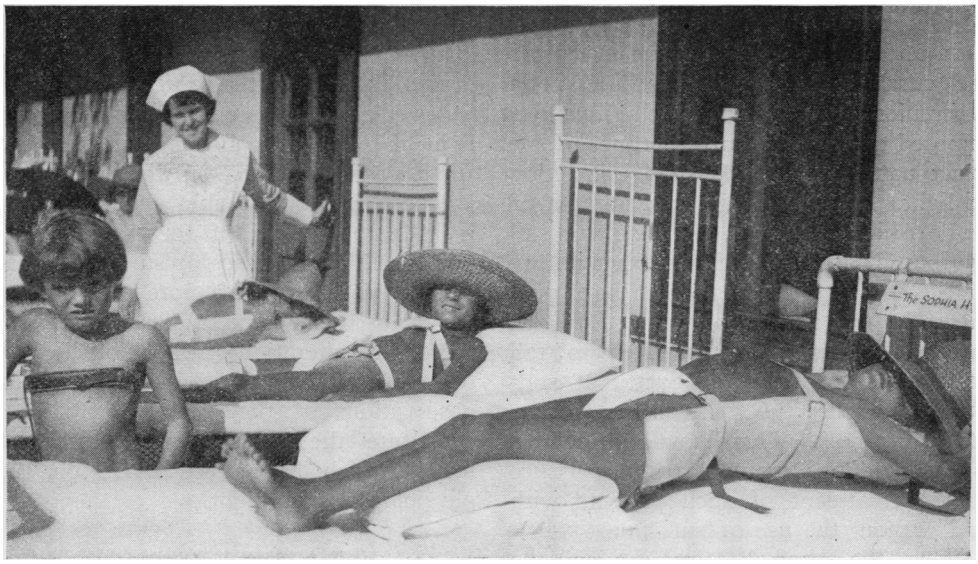
At any time during this process, the resistance of the patient may become sufficiently great to overcome the disease. On the other hand, the infection, if not overcome, may ultimately result in the invasion of the blood stream by tubercle bacilli, either by way of the lymphatics or by direct erosion of a caseous focus into a vessel. When this occurs, tubercle bacilli in great or small numbers are carried to all parts of the body. Many of them are quickly destroyed by phagocytosis, but others manage to obtain a foothold, and succeed in establishing fresh foci of tuberculosis in parts far distant from the primary focus. In many cases such distant foci are established in bones and joints, their location being determined in part by minor injuries. It is in such a fashion that tuberculosis of bones and joints arises.

SECONDARY LESIONS

The importance of this form of tuberculosis is therefore evident. We are dealing, not with a simple, primary invasion, but with a secondary lesion, which must be accompanied by at least one other lesion from which it arose. These lesions which arise from tubercle bacilli distributed by the blood stream, are usually multiple, and a blood stream loaded with tubercle bacilli will not deposit them in one place, but in many places at the same time. A patient with a tubercular lesion in bone or joint usually has other lesions which have arisen in a similar fashion, and which can be found if they are searched for. Hematogenous lesions are usually multiple, and their seriousness is proportionately increased. We are here dealing with systemic tuberculosis, rather than local tuberculosis.

In the treatment of tuberculosis we unfortunately lack any powerful and rapidly acting therapeutic agent. We have no vaccine to protect us against its onset, as we have for smallpox. We have no antitoxin to neutralize its effects, as we have for diphtheria, and we have no insulin to tide us through the period of illness, as we have for diabetes. We are forced to rely for cure upon the patient's own mechanism of defense.

In bygone years, patients suffering from this disease were regarded as hopeless. They drifted from doctor to doctor, none of whom was able to help them, because in those days the nature of the disease was not understood. Even the existence of the tubercle bacillus was unknown. Their joints were destroyed. Huge abscesses formed, which ultimately perforated the skin. Secondary infection occurred, leading ultimately to the patient's death from amyloid disease. Long years of experience have taught us, however, that we can enhance the patient's resistance, and thus aid him to overcome his infection by certain measures, of which the two most important are rest and sunshine. Of rest, little need be said here. It has been the basis of all treat-



CHILDREN WITH SURGICAL TUBERCULOSIS UNDERGOING HELIOTHERAPY

ment of bone and joint tuberculosis since John Hilton in 1863 first emphasized its importance. In the modified form of pneumothorax, phrenicotomy or thoracoplasty it is used in pulmonary tuberculosis. Its importance and value are great.

SUNSHINE A CURE OF THE ANCIENTS

Of sunshine there is much to be said. Its use goes back to the dawn of history. The same instinct which led ancient people to worship the sun as a god, led them also to a belief in the therapeutic value of sunlight. Sun baths for the cure of disease were recommended by Hippocrates, the father of medicine, by Galen, by Celsus and by Herodotus. The temples of Aesculapias were, in fact, solaria, and it may not be unjust to claim that part of the benefit their votaries obtained was due to the beneficent action of sunshine. However, the blind use to which sunshine was put by the ancients produced no certain effect upon medicine. It was not until the Nineteenth Century that any systematic attempt was made to utilize the sun as a curative agent, and for this credit must be given to the French school of medicine. In 1845 Bonnet of Lyons, in a "Treatise on Diseases of Joints," stated that white swelling of the knee (a disease we now know to be tuberculous) was greatly benefited by exposure to the sun. Bonnet's work was continued by the school of Lyons, by Ollier, and by Poncet, and the advantages of heliotherapy in the treatment of tuberculosis were the subjects of theses by baccalaureates of that university.

The basis of our present knowledge of light as a therapeutic agent dates from Finsen's work published in 1893. His classic treatise upon the action of light upon the diseases of the skin has scarcely been improved upon since his day. Of outstanding importance was his observation that the ultra-violet rays, both visible and invisible, were most active in the cure of the skin lesions, in which he was interested. Since Finsen's time a host of writers have contributed to our knowledge of the action of light. From the surgical point of view the next most important landmark was the establishment, in 1903 at Leysin in Switzerland, of Rollier's Institution for the treatment of surgical tuberculosis by means of sunshine. His work has served as the basis of all modern treatment by this method.

PHYSIOLOGICAL ACTION OF LIGHT

In attempting to discuss the nature of the curative power of sunshine upon tuberculosis, we are faced with difficulties imposed upon us by our ignorance of the exact nature of the physiological action of light. In spite of the vast amount of work which has been done, we are still profoundly ignorant of the exact nature of the complex changes which light produces in the human organism. In the last analysis we are compelled to fall back upon the empirical fact that sunshine *does* cure tuberculosis (as well as other diseases). Our knowledge of this is the result of many years' experience in the treatment of such patients with and without the use of sunshine.

From the surgical point of view, the essential facts of our knowledge of the physiological action of light may be briefly summarized. Most accurately known are its effects upon the skin. Three distinct types of dermal reaction are produced, viz., erythemia, pigmentation and vasodilatation. The erythemia is an early phenomenon occurring within 6 hours of exposure. It is of the nature of an inflammatory reaction, caused by the rays of short wave length. It may be of any degree of severity, from the faintest reddening to the most extensive vesication. Under the name of sunburn it is, of course, familiar to us all. Its degree is dependent upon the intensity of the sunlight, its richness in ultra-violet rays, the duration of the exposure, and the amount of pigment present in the skin. Pigmentation results from repeated exposures to sunlight or to any light rich in ultra-violet rays. It forms the familiar tan one brings home from a summer holiday. It is apparently a protective mechanism, which guards the organism against the powerful active rays. Its intensity varies greatly with the individual. Blonde patients tan slowly and poorly, while brunettes tan rapidly and deeply. Finally, prolonged exposure to sunshine results in a very persistent reddening of the skin due to dilatation of the capillaries. This is best observed in patients who after long exposure to the sun have been withdrawn from that treatment. As the tan fades, the skin is seen to be persistently reddened, and this phenomenon may last for a very long time—up to a year.

Apart from these skin changes, there is little to be said of the physiological action of light in cases of surgical tuberculosis based upon accurate observation. As far as we have been able to ascertain, there is no alteration in the blood chemistry, such as is produced in rickets. The observations of the workers in rickets constitute the most accurate measurements which have been made on the physiology of sunlight.

HOW A CURE IS EFFECTED

How can these somewhat vague effects result in the cure of such a persistent disease as tuberculosis? At one time there existed the feeling that the tubercle bacilli were actually destroyed by the action of sunlight upon them. It is a well known fact that sunlight is a powerful bactericidal agent, killing very rapidly most forms of bacteria which are exposed to its direct action. But most of the tuberculous foci with which we are dealing are deeply situated, and even very thin layers of tissue obstruct the rays of sunlight, particularly the active rays of short wave length. So, except for the occasional superficial lesion of tuberculosis, such as that which occurs in the skin, there is no possibility of tubercle bacilli being killed by the direct action of light. Its curative activity is more complex. In some poorly understood fashion, it alters the metabolism of the patient, and this altered metabolism enables him better to overcome the tuberculous infection. The production of tuberculous antibodies is increased, and the activity of cells which destroy tubercle bacilli is enhanced. In some way this enhanced metabolism is associated with the changes which are produced in the skin. It has been a common observation that the cure of a tuberculous patient

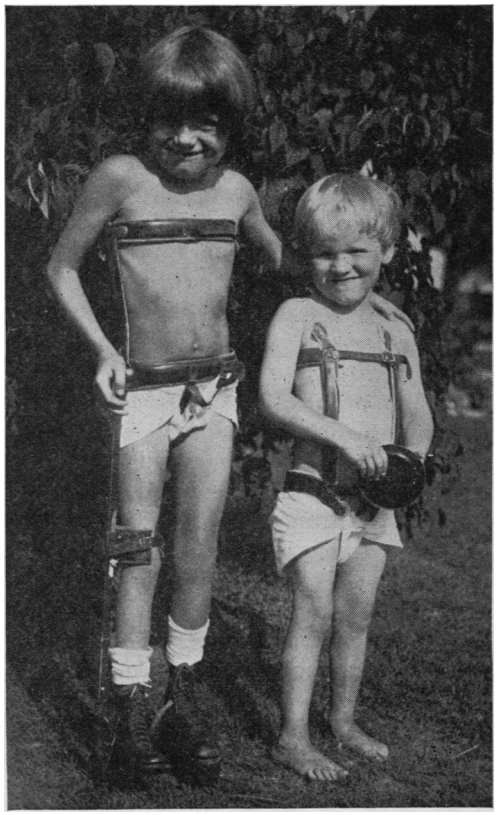
parallels roughly the degree of pigmentation. The greater the pigmentation, the more rapid the cure.

While we are entirely ignorant of the exact nature of such changes, it is fascinating to speculate upon what may be going on. Human beings derive most of their energy from food. Plants derive their energy directly from the sun, and their ability to utilize sun energy is dependent upon the presence of the pigment chlorophyle. The pigment in our skin, melanin, is not so greatly different from chlorophyle, and it may very well be that the presence of this pigment enables us to utilize directly the energy which is in the sun's rays, and to put it to new uses.

There are many parallelisms between the action of sun upon plants and patients. Plants deprived of sunlight grow up pale, weak and spindly; so do children. Plants grown in sunlight become deeply colored, sturdy and strong. The sturdiness and strength of such plant is due to an increase in the skeletal tissues of the plant. A homely illustration of this is the method by which celery is grown for the table. In order to make it white and crisp, it is banked with earth, *i.e.,* deprived of sunlight. If grown without banking it becomes green and tough, *i.e.,* it contains more pigment and more skeletal tissue. In children the same analogy holds. Sunlight makes them brown and prevents or cures rickets, a disease of skeletal tissues. It may well be that this action of sun upon skeletal tissues explains its almost specific effect upon tuberculosis of bones and joints.

HELIOTHERAPY ADMINISTRATION

In actual practice heliotherapy is administered as follows: The patients are first exposed to the sun for short intervals, in order to avoid the danger of sunburn and to build up an adequate degree of tan. There are many ways in which this can be done. The simplest is probably the best. Our practice is to unclothe the patient and expose him for a short period on the first day, usually about 20 minutes. On the second day the exposure is increased to 40 minutes, and on the third day to 60 minutes. Increasing exposures are continued until he is well



CONVALESCENT CASES CONTINUING TREATMENT

tanned, and this usually takes 10 days to 2 weeks. The complexion of the patient must be borne in mind. The exposure of brunette patients can be more rapidly increased than can that of blondes. In the latter a tan is more difficult to build up, and is more quickly lost. Since the beneficial action of the sun is produced through its action upon the skin, the greatest effect will be produced by the exposure of the greatest amount of skin. Hence it is important to expose the whole of the patient's body, both front and back. In the heat of summer it is wise to protect their heads from direct exposure to the sun; otherwise headache or other evidences of minor heat stroke may occur.

A straw hat or a sunshade serves effectively for this purpose.

Much has been written on the advantages of sunlight at high altitudes. Rollier, the first and chief exponent of heliotherapy for surgical tuberculosis, insists that the greatest benefit can only be obtained in the high clear atmosphere of mountainous regions. There is probably much truth in this. It is certain, at any rate, that in such situations there is a greater abundance of ultra-violet radiation than at sea level, and it is apparently these rays which are most active in the production of the phenomena which we associate with the cure of the disease; but treatment in such localities is out of the question for many patients. It is of great importance to know that heliotherapy can be carried out with great benefit in any place in which there is a reasonable amount of sunlight. For instance, in Toronto, in an industrial and therefore smoky section of the city, we have applied heliotherapy to our patients, with the greatest benefit on the roof of what was once a factory. The average number of hours of exposure during a summer is 550. Treatment can be commenced in May and continued until October. In exceptional seasons it can be started in March. It is found more important to the community at large to accept the use of heliotherapy in its own locality, even though it may not be quite ideal, than it is to feel that no heliotherapy is of value except that administered on mountain tops.

The results obtained by the use of heliotherapy are eminently satisfactory. As you will understand from the outline of the disease presented here, it is a serious condition. Recovery is prone to be delayed by many serious complications. Yet by means of sunshine, a very high percentage of cures can be obtained. One series of such cases has been our particular interest during the past 6 years. There have been in all 100 cases. Of these 89 are cured and have returned to civil life in occupations in which they are more or less self-sustaining; 11 have either died or are not improved under treatment. There can be no doubt in the minds of those who are associated with these patients that to heliotherapy is to be attributed a large measure of the success which has been obtained.

Valuable as sunlight has proved, there are certain grave limitations to its use. The sun does not shine every day, and in these northern climates there are many winter months in which no extensive heliotherapy can be carried out. The cloudiness of low altitudes and the smokiness of cities also place limitations upon its use. While our results are good, there is reason to believe they would be better could we utilize sunshine more extensively. In an effort to overcome this, artificial lights have been used; lights which give out large quantities of ultra-violet radiation. For the most part these are mercury arcs enclosed in quartz cells. Unfortunately, the results obtained from these are not encouraging. They will produce tanning of the skin, though not to so intense a degree as will sunlight, but their effect upon the disease is much inferior to that of heliotherapy. Our knowledge of the action of sunshine in this disease is too vague to enable us to say wherein the defect lies. It is sufficient to say that in the present state of our knowledge, sunshine, in spite of all its shortcomings resulting from cloudy days and cold weather, is still the best method for the cure of tuberculosis. In addition it has the great merit that it is available to everyone, and costs nothing.

What are the public health lessons to be learned from our experience with heliotherapy in the treatment of surgical tuberculosis? In my opinion there are two, one in relation to tuberculosis, and one in respect to heliotherapy.

SUNLIGHT A POWERFUL STIMULANT TO RESISTANCE

First in regard to tuberculosis: Our experience with sunshine in the treatment of this disease leads us to believe that it

exerts an almost specific curative effect upon it. Recall that the patients we are dealing with are widely infested with the tubercle bacillus; they have it in their lungs as well as in their bones, and usually in many other parts of the body. Recall also the fact that 95 per cent of us at some time during our life pass through a tuberculous infection, and that our successful overthrow of the disease is dependent upon the amount of resistance we can muster against it. Sunlight is a powerful stimulant to the production of this resistance.

If we can cure patients with far advanced and widely disseminated lesions of the disease by means of sunshine, how much easier will it be to cure them if we can supply this powerful agent at the first inception of their infection? Unquestionably, could we protect such patients by means of adequate heliotherapy, their chances of recovery would be very greatly improved. The greatest field of promise in the problem of tuberculosis seems to lie in finding some means which will adequately protect us against these organisms. It is impossible to isolate the community completely from exposures to the disease. It is so insidious in its manifestations and so widespread, that sooner or later we all come into contact with the germs and become infected by them. Our hope lies in enhancing the immunity we already have, and which fortunately is considerable. At the present moment the most active stimulant of this resistance of which we know is sunshine. We should as a matter of course see that our children have an adequate amount of sunshine, just as we see that they have adequate food. We should see that we ourselves have a sufficient amount of its rays.

THE WIDER APPLICATION OF HELIOTHERAPY

Secondly, in respect to the problem of the application of heliotherapy to a wider field than tuberculosis and rickets. Our knowledge of the action of sunshine is greatest in these two diseases. In one we can actually measure by chemical means the effect it produces. In the other we cannot measure its action so accurately, but by following many cases we are convinced that it does produce a beneficial action, even though we cannot follow it in all the devious and obscure channels through which it operates. We are groping blindly, handicapped by our lack of knowledge of the finer physical and chemical processes of the body. But our ignorance of the nature of its action is no reason why we should discard it or limit its application.

Many great benefits to humanity were discovered and have been used purely upon empirical grounds. Witherington discovered digitalis among the dozens of ingredients of a country woman's herbal remedy for dropsy, and digitalis is still our most potent remedy for cardiac failure. Vaccination for smallpox was discovered and proved to be of value long years before we knew anything about the nature of organisms and disease. Indeed, we still are entirely ignorant of the nature of the organism which produces smallpox and of the relationship of cowpox to smallpox which enables it to develop immunity towards the latter. Quinine has been used successfully in the treatment of malaria since the Sixteenth Century, and we still are ignorant of the exact nature of its action.

HELIOTHERAPY ACCEPTED ON EMPIRICAL GROUNDS

We must accept the evidence for the beneficial action of sunshine in the same way. Sunlight is just as necessary for our well-being as it is for that of plants. Indeed the analogy between human beings and plants is not far-fetched. After all we are animal organisms, and our physical bodies are best adapted to an outdoor environment, not to be shut up in houses and offices most of the day. No one who has seen a group of pale, sickly children released from the wards of a city hospital after a winter's confinement, to the sun and open air of a summer home and has

seen them literally blossom forth in good health, with ruddy complexions and plump bodies, can fail to be struck with the resemblance they bear to flowers in a springtime garden.

We have need for sunshine, and we are benefited by it. The facts we have observed so definitely in rickets and tuberculosis are but indices of many other beneficial effects of sunshine. A hundred obscure and elusive evidences of its action upon other diseases and upon normal metabolism await investigation. Let us seize the evidence we have and preach the gospel of the outdoor life and sunshine in every community.

SUNLIGHT AND HEALTH

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A STUDY of the importance of sunlight as a factor in the health of the community until recently has been sadly neglected. This neglect has not been due to any fault of the public health organizations, but rather to a lack of scientific investigation by the medical profession. Although from the time of Hippocrates physicians have observed in a vague manner the importance of light and fresh air in the treatment of disease, until 4 years ago no scientific proof had been noted of a definite effect of light on the metabolism of the body. Since then extensive investigations have been undertaken in this country, in Canada and elsewhere which have yielded results of the greatest importance. It is now not only the duty but the privilege of our public health organizations to disseminate and apply this knowledge in a practical manner for the benefit of the people at large.

Before speaking of the importance of light in the growth, development and general metabolism of the body, we must first consider exactly what we mean by the term "light" or "light rays." Light is still generally regarded as a form of ether-wave energy the character of which is dependent on the length of the wave. Sunlight, or, to use the correct term, solar radiation, is composed of invisible heat rays which have wave lengths longer than 760 millimicrons (a millimicron is one-millionth of a millimeter in length), visible light which varies in length from 760 to 380 millimicrons, and invisible ultra-violet rays which range from 380 to 290 millimicrons in length. Although strictly speaking the term light should be restricted to the visible rays, the term light or sunlight is here used as meaning the total solar radiation.

It was first shown some 50 years ago that sunlight retarded the growth of bacteria. Later it was observed that this action was not due to the heat of sunlight or in other words to the infra-red rays, nor to the visible rays with the exception of some of the shorter ones, but almost entirely to the ultra-violet rays. It was also observed that the shorter the ultra-violet ray the greater was this lethal effect on bacteria. It is obvious on account of this action of sunlight that it is of inestimable value to mankind from the hygienic standpoint. This is one effect of sunlight to which I wish to draw your attention.

Our knowledge of the effect of light on the growth, development and metabolism of the body has been gained largely through the study of one disease, namely, rickets. It is therefore necessary for us to consider this disease in some detail, not only on account of the importance of the