SOME ARMY EXPERIENCES IN THE TREATMENT OF TUBERCULOSIS BY HELIOTHERAPY*

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THE FIRST COMPLETE RECORD of any experiment in heliotherapy in tuberculosis was made in the beautiful Alpine country of Switzerland. Dr. Rollier, a pupil of Kocher, started the first clinic in 1903 at Leysin, a small village high up in the mountains overlooking the Rhone valley, and surrounded by snow-capped peaks. The results of Dr. Rollier's clinic were brilliant and the importance of his work won such wide recognition that from this clinic sprang many others, and Leysin became a Mecca for heliotherapy, visited by physicians from all the world.

In 1919, Colonel H. Bruns, chief surgeon of the United States Army of Occupation in Germany, visited Dr. Rollier's clinic to study and observe the technique and results of heliotherapy. After several months in Switzerland with Rollier he returned to the United States, and in 1921 founded and established a clinic for heliotherapy at the Fitzsimons Hospital, Denver, Colorado.

It is from Colonel Bruns' writings and from many of his observations, together with my own accomplished during my stay at Fitzsimons, that most of this paper is composed. I am also indebted to Lieut. Colonel (then Captain) William C. Pollock, Medical Corps, and Lieut. Colonel Clarke Blance, Medical Corps, U. S. Army, for some of their observations.

Heliotherapy has come to be looked upon not only as a valuable therapeutic aid to many forms of tuberculosis, but also as a hygienic procedure for the building up of body nutrition and resistance, and prevention of disease.

The development of undernourished children and the reconditioning of middle-aged adults come within the sphere of its utilization. In various surgical conditions, such as open wounds, suppurating sinuses, infectious arthritis, phlebitis, chronic leg ulcers, burns, carbuncles, and in many general medical cases it is of value. In rickets, its usefulness has been well established, also in certain skin diseases, both acute and chronic, and likewise during the recovery from various surgical conditions, and to assist in recovery from general debility.

* Received for publication January 13, 1938. Read before the School of Tropical Medicine, San Juan, P.R.

Rollier demonstrated that the sun healed by direct action and by improving the general metabolism of the body. Animal experiments indicate that radiation enhances the bactericidal powers of the blood by improved function of the leucocytes. With sun baths, there is an increase in leucocytes, first polys and then lymphocytes, and also in red cells and hemoglobin. Tuberculosis, therefore, must be treated, not only by curing its local manifestations, but also by building up general resistance and nutrition. Heliotherapy gives good results in most forms of chronic tuberculosis, but the extrapulmonary types seem to respond better, and surgical intervention in bone, joint, gland and genito-urinary tuberculosis, which leaves in its wake many cripples, may be curtailed by its use. Rollier proved that by using heliotherapy combined with rest and hygiene, movable joints and useful limbs could be obtained.

Heliotherapy has much in common with treatment by means of all artificial therapeutic rays, such as infra-red light, ultra-violet rays, X-rays and rays of radio-active substances. Of the invisible rays, the infra-red have the greatest warmth, length and penetration; exposure to them produces sweating, dilatation of skin capillaries, hyperaemia, erythema and blistering; they are said to have bactericidal properties. The ultra-violet rays are the shortest, but have the greatest chemical effect; they produce an erythema which becomes manifest after a latent period of three to six hours, and cause pigmentation on the second and third days; they have strong bactericidal powers, are easily absorbed, reflected and bent by impurities in the air, such as smoke, gas, dust, humidity, etc. The penetration of ultra-violet rays is very slight and does not go beyond the superficial layers of the skin.

The beneficial effect of heliotherapy in tuberculosis is probably due to the following factors:

1. Bactericidal effect (ultra-violet rays are bactericidal to a depth of 1½ mm and produce a deteriorative effect on bacteria to a depth of 4 mm).
2. Increased exudation and proliferation in the neighborhood of the tuberculous focus.
3. Destruction of tuberculous granulation tissue.
4. Stimulation of the fibroblastic tissue of the tubercle.
5. Increased phagocytosis and absorption of bacilli and necrotic material.
6. Connective tissue healing of the tuberculous focus.
7. Analgesic effect.

Climate, location, topography and such-like features are factors to be considered in choosing an ideal location for the application of heliotherapy. Abundance of sunshine, rarified pure air which is found in higher altitudes, temperate climate and sheltered mountain sides are

most favorable for therapeutic results. However, Rollier was of the opinion that heliotherapy could be applied in any part of the world—in the lowlands, or at the sea shore, as well as in the mountains. Sun baths can be supplemented by artificial light from carbon arc and mercury vapor lamps, thereby extending heliotherapy to any hour or season, although nothing can take the place of natural, unobstructed sunlight. Rosselet found the ultra-violet rays six times stronger in winter and two times stronger in summer in the mountains than in the lowlands, with less difference in the summer. Next to the mountains, the sea coast is probably best for the sun cure. Snow, ice, water and sand enhance the powers of the ultra-violet rays by reflection. Ultra-violet rays come from the sky as a whole as well as directly from the sun, and on cloudy days a modified effect of these rays can be obtained by air baths.

To initiate heliotherapy at Fitzsimons and to consolidate it under his personal direction, Colonel Bruns had a ward built where surgical tuberculosis patients were collected and kept out of doors continuously on open, wind-sheltered porches. Later on, in all convalescence pulmonary wards, various types of sun porches and heliotherapy platforms were built, enclosed by walls for privacy, but open to the sun. Patients were never sunned through wire or glass screens.

It takes 45 minutes to produce erythema by means of sunlight filtered through glass as compared to 15 minutes by means of open sunlight. The transmission power of special makes of glass decreases with use, and, naturally, cleanliness is important, for it requires but little dust and dirt to reduce the potency of the ultra-violet rays by 40 to 50 per cent.

On cloudy days, mercury vapor or carbon arc lamps were used for general radiation, and were distributed through the hospital near bed-ridden patients, thus obviating the fatigue of transportation to the lamp. The clinical results from artificial light, however, are not comparable to those obtained by the sun's rays. An effort has been made to construct therapeutic lamps which will give the same rays as those from the sun, but so far, without success.

In observing the reaction of the effects of general heliotherapy, we accustomed ourselves to look for focal reaction, similar to tuberculin reaction, produced in any diseased tuberculous tissue at some distance from the part exposed. Because of this reaction, sun baths were at first used only in extrapulmonary cases with results so uniformly good, that authorities were soon convinced of the healing value of the sun in such cases. The skin, unhampered by clothing, was by daily degrees and ac-

cording to schedule, exposed to the open air and sun, and all its functions—stimulation, elimination and absorption—were improved. A pale and dry skin was replaced by one of a deeply bronzed colour, healthy in appearance, soft, pliable and velvety to the touch; white patients became as brown as Malays after several weeks of sun. The skin is said to be a great anti-body factory, and increased immunity results from a healthy and active condition.

Metabolism seemed to be increased, and it was remarkable how patients undergoing this treatment improved in general nutrition and increase of musculature, although they had been confined to bed for many months. Spinal cases have also been observed who, after being bedridden for long periods, rapidly improved.

Regardless of the location of the tuberculosis, except pulmonary tuberculosis, general insolation was given, and the time of exposure and the amount of body surface uncovered was graduated. It was considered advisable to start with the feet, front and back, then the legs, thighs, hips and abdomen, and finally, chest and arms. Some advocate uncovering the whole body for a brief period at the very beginning, but as a patient at first is very apt to over-expose, it is far better to run the lesser risk of over-exposing small areas and less vital parts. Rollier's chart was followed in applying heliotherapy, but it was found necessary in most cases to individualize the treatment according to the robustness, symptoms, location of the lesion, and the idiosyncrasies of the patient. The neck and face could be exposed, but the head and eyes were always protected.

The maximum length of exposure was usually two hours in summer and three in winter. Very often in summer the air baths were continued throughout the day. Even in winter, with snow on the ground, if the patient had good pigmentation and was protected from the wind and in direct sunlight, heliotherapy and air baths could be taken in comfort, or frequently patients could lie out of doors, lightly clothed and lightly covered.

At times one found some patients more sensitive to sun baths than others. They complained of nervousness, insomnia, rapid pulse, vertigo, fever and headache, as a result of exposure. Such patients were not taken off sun therapy entirely, but their tolerance ascertained, and the time of exposure more slowly and cautiously increased. In summer it was found better to give heliotherapy fairly early in the morning in order to avoid the intense midday sun, but in winter the patient was exposed to the greatest power of the sun. On account of the depressing effect of the heat in summer, even at a high altitude, it was necessary

to have the air circulating freely about the patient. In winter, however, the bed might be curtained on three sides to protect against currents of cold air.

HELIOTHERAPY IN PULMONARY TUBERCULOSIS. Results of heliotherapy in the treatment of pulmonary tuberculosis were not as striking as in extrapulmonary disease, and there is much divergence of opinion in the profession at large as to the value of sun treatment in such cases. It is well to note that about one-third of extrapulmonary cases have also pulmonary trouble. Rollier obtained good results in pulmonary tuberculosis complicated with surgical forms of tuberculosis, and pulmonary cases were accepted only when they came to him as a complication of the extrapulmonary types of the disease. In the latter forms, brilliant results were obtained, especially in those institutions limited largely to the tuberculosis of children. Heliotherapists do not recommend it in active pulmonary cases with fever, and it was the consensus of opinion at Fitzsimons that only fibrous or nodose cases having little perifocal reaction should be sunned. The reason for the poor results obtained at times in pulmonary cases is probably due to several factors, namely: 1. Pulmonary tuberculosis is less amenable to other forms of treatment than most cases of surgical tuberculosis; 2. The diseased parts of the lungs are not so easily immobilized and often cannot be put at rest; 3. The lungs possibly are less resistant to the ravages of tuberculosis; 4. When ulceration occurs and lesions become open, mixed infection results, and we have a similar condition to tuberculosis elsewhere with mixed infection sinuses; 5. The lesions in pulmonary tuberculosis are deep seated, at unequal distances from the surface and vary in character, so that sufficient exposure for one part may mean over or under exposure for another. Moreover, in insolating the chest in pulmonary tuberculosis, the rays must pass through the very sensitive pleura, which may be acutely involved; 6. The lungs, by virtue of their peculiar anatomical structure, offer every facility for the spread of tubercle bacilli and their products. A perifocal reaction or the breaking down of a focus which might be harmless or even beneficial in another part, is more apt to be injurious in the lungs. We know that heliotherapy favors the formation of cold abscesses. In a bone or joint, these can be treated and often the elimination of active tuberculous foci can be secured. In the lungs, such a process may cause extension of the tuberculous lesions and leave behind cavities which render the prognosis doubtful.

In order to prevent perifocal reactions, the chest should be covered at first, and the patient never permitted to exceed his tolerance. After

the body is well pigmented, in cases showing fibrosis, the chest may be exposed for very brief periods only, gradually increasing the time. By this method, in properly selected cases, satisfactory results can be obtained.

Some Army physicians have stated that all patients in whom fibrosis is beginning or established, whether the disease is active or inactive, and whether pulmonary cavities exist or not, can receive heliotherapy with benefit if it be given in proper doses. But at Fitzsimons it was the consensus of opinion that where there are caseous lesions showing no fibrosis, heliotherapy is contraindicated, and that before it can be administered without danger the patient must be well on the way to recovery, as ascertained both by physical signs and symptoms and by X-ray examination. Such convalescent cases run little risk of harm, and in many, heliotherapy may be looked upon as a means of increasing and measuring fibrosis and a hardening-up process and finishing touch to the cure.

HELIOTHERAPY IN BONE AND JOINT TUBERCULOSIS. It is in the treatment of bone and joint tuberculosis that the most excellent results are obtained in heliotherapy. The bone clears, recalcification takes place, sequestra are expelled, cold abscesses absorb, sinuses heal, effusion disappears, and even in late cases with fibrous ankylosis, Rollier was able to secure moveable joints. Tuberculosis of the ankle joint, knee, and Pott's disease respond exceptionally well to heliotherapy. During my stay at Fitzsimons, cold abscesses, if superficial, were sometimes aspirated and injected with a 10 per cent iodoform emulsion, and it seemed that even spinal cases with psoas abscesses which were aspirated and whether injected or not with iodoform emulsion, did well with heliotherapy. Cold abscesses over superficial joints were usually incised under surgical precautions to avoid the danger of mixed infection, and healed readily under heliotherapy. It must be borne in mind, however, that deep seated bone and joint diseases, as those of the hips, where the abscess is deep and has burrowed extensively before rupturing, heliotherapy is usually of secondary importance, and an effort must be made by means of surgery to obtain direct and dependent drainage over all the areas, together with such other surgical procedures and treatment as may, in the judgment of the physician, be indicated. Cases of bone and joint tuberculosis were sunned with the chest protected until the pulmonary involvement became quiescent, and then the chest was exposed gradually. Heliotherapy gave better results in the bone and joint tuberculosis of children than it did in adult patients; in growing bones,

deformities can be corrected and as a rule, moveable joints are obtained. It is to be remembered, however, in all these cases that heliotherapy is but an adjunct, and plaster casts or boats, immobilization splints and fixation operations are all necessary, as indicated.

The treatment of tuberculous spondylitis was copied from Rollier's method, though it was not assumed in any way that heliotherapy was a panacea and the only means that should be employed in treating this condition, and it was the policy to use one of the fixation operations (the Albee or Hibbs operation) as an adjunct to heliotherapy, keeping the patient in bed for nine months or a year after the operation. This operation does not, in itself heal cold abscesses, and this complication must be watched for and properly treated just as if no grafts had been applied.

Even at the best, any treatment of tuberculous spondylitis requires, as a rule, two or three years, and during this time bed rest is necessary. The patients with tuberculous spondylitis, when told this were frequently resentful until they realized that with time and care their disease was curable, and that there was only one alternative, namely inadequate treatment with relapses, grave deformities and death; then they almost invariably acquiesced, and splendid results were obtained.

Certain special equipment was found to be necessary in treating bone and joint tuberculosis. A bed similar to the one devised by Rollier was used, the main features of which were rubber wheel castors, absence of springs and a firm mattress with smooth pine boards underneath to prevent sagging. A rather high, narrow bed facilitated working over a patient, and attachments for curtains, weight extensions and sun shades were the usual accessories. Canvas curtains were used to protect the patient from wind; all immobilization splints were open so that the extremities could be exposed fully to the sun; plaster-of-Paris dressings were never used except in the form of troughs and open splints.

The patient was kept absolutely flat on his back, with a single, or no pillow under the head. Cold abscesses were successfully aspirated and given such surgical treatment as necessary and judged best by the attending surgeon, i.e. any splinting bone operations, such as the Albee bone transplant, considered advisable were done. The sun baths were applied gradually, beginning with the feet and increasing the time of exposure and part exposed daily until the whole body was sunned, according to the toleration of the individual patient, and the average maximum time of exposure was built up to two hours in summer and three in winter.

Bruns stated the opinion which was generally accepted at Fitzsimons

General Hospital in the treatment of tuberculous spondylitis, as follows:

1. The conservative hygienic, postural, and heliotherapy method gives excellent results.

2. An ankylosing operation is to be considered only as an incident in the treatment, and in no way modifies the conservative policy.

3. Psoas abscesses do not necessarily impair the prognosis unless permitted to rupture and become infected.

4. Cases with psoas abscesses which are aspirated under aseptic conditions seem to do surprisingly well.

5. Cases of Pott's disease, not correctly treated, usually develop deformities and multiple mixed-infection fistulas, with a grave prognosis, while those placed under a proper regimen, i.e. heliotherapy, do not have these complications, and almost invariably recover.

6. Aside from its pronounced therapeutic effects, heliotherapy more than any other one procedure gains co-operation of the patient, and carries him successfully through a long and tedious treatment back to health.

HELIOTHERAPY IN TUBERCULOSIS OF THE GENITO-URINARY SYSTEM. This type of tuberculosis, no doubt, more commonly than supposed, often exists unrecognized and heals spontaneously, but it is usually advanced when discovered, and inoperable. A unilateral tuberculosis of the kidney calls for nephrectomy. Heliotherapy should be begun as soon as possible after the condition is diagnosed and continued after nephrectomy, when the remaining kidney hypertrophies and, even though it contains parenchymal lesions, may heal. Other than nephrectomy, no surgery was considered for lesions in other parts of the genito-urinary tract. Very frequently tuberculous nephritis was not discovered until a bilateral pyelonephrosis existed, too late for surgery. Although it is difficult to explain why, such cases frequently improved markedly under heliotherapy, and life was undoubtedly prolonged.

Raycroft, the genito-urinary surgeon during my stay at Fitzsimons, observed that concomitant with skin pigmentation there sometimes developed a parallel pigment deposit in the bladder mucous membrane.

HELIOTHERAPY IN GLANDULAR TUBERCULOSIS. Superficial glands disappeared readily when sunned, and even in tuberculosis of the tracheobronchial glands, heliotherapy was highly recommended, particularly in children. At the beginning of the treatment, glands frequently softened and broke down; then they were aspirated and injected with iodoform emulsion. Abscesses might absorb spontaneously, but when they did rupture, they usually emptied their contents and healed without persistent sinus formation. X-ray and tuberculin were of assistance in the treatment of glandular cases.

HELIOTHERAPY IN TUBERCULOSIS OF THE INTESTINES AND PERITONEUM. Symptomatic improvement was often noted after heliotherapy in those cases not too far advanced. As intestinal tuberculosis may be associated with advanced and active pulmonary tuberculosis, heliotherapy was often limited to exposure of the abdomen or local artificial light treatment together with calcium chloride injections and some form of collapse therapy, if possible, for the lungs when involved.

In tuberculous peritonitis, particularly where it was uncomplicated by any pulmonary involvement, results were remarkable.

HELIOTHERAPY IN SKIN TUBERCULOSIS. Skin tuberculosis was certainly benefitted by heliotherapy, but for lupus the Finsen light or the Kromayer lamp seemed to give better results.

HELIOTHERAPY IN TUBERCULOSIS OF THE LARYNX AND MIDDLE EAR. From observations made at Fitzsimons, special attention should be called to the value of sunlight projected by mirrors in tuberculosis of the larynx and middle ear. Here each case was under the constant supervision of the doctor and the appearance of the larynx frequently observed to prevent over-exposure. Most careful individualization is necessary according to the nature of the involvement. In treating the middle ear, all pus was wiped away, and the ear irrigated with a gentian violet, methylene blue, or eosin solution before the light was projected. If the lesions were superficial and accessible to the light in the larynx or middle ear due to a destroyed tympanum, good results were obtained by both the direct and general action of the rays.

HELIOTHERAPY IN FISTULA-IN-ANO. Fistulas-in-ano were invariably treated with heliotherapy before operative procedures were attempted. After the preliminary graduated exposures, the patient was placed in the knee-chest position, the buttocks held apart by the patient himself, and the anal region was exposed to the sun. The fistulas-in-ano which required incision were sunned and carefully packed with iodoform gauze, lest they prematurely heal and close. Ischiorectal abscesses were incised promptly, injected with iodoform emulsion, and sunned.

HELIOTHERAPY IN EFFUSIONS INTO THE PLEURAL CAVITY. The absorption of effusions in the pleural cavity under light therapy was hastened, but better results were obtained in tuberculous peritonitis than in tuberculous pleurisy.

TREATMENT SCHEDULE. The following is the schedule which was used at Fitzsimons and is a modification of Rollier's system. Lieut. Colonel

(then Captain) William C. Pollock, Medical Corps, United States Army, put it in pamphlet form, with additional hints, and each patient received a copy.

Zones for Administration of Heliotherapy

Zone 1 .....Ankles
Zone 2 .....Knees
Zone 3 .....Crotch
Zone 4 .....Navel
Zone 5 .....Nipple
Zone 6 .....Chin

Day	*Zones*	*Exposure*
1st	1	5 min. front and back
2nd	1	5 min. front and back
2nd	1 & 2	5 min. front and back
3rd	1	5 min. front and back
3rd	1 & 2	5 min. front and back
3rd	1, 2 & 3	5 min. front and back
4th	1	5 min. front and back
4th	1 & 2	5 min. front and back
4th	1, 2 & 3	5 min. front and back
4th	1, 2, 3 & 4	5 min. front and back
5th	1 & 2	5 min. front and back
5th	1, 2 & 3	5 min. front and back
5th	1, 2, 3 & 4	10 min. front and back
6th	1, 2 & 3	5 min. front and back
6th	1, 2, 3 & 4	15 min. front and back
7th	1, 2, 3 & 4	20 min. front and back
8th	1, 2, 3 & 4	20 min. front and back
8th	1, 2, 3, 4 & 5	5 min. front and back
9th	1, 2, 3 & 4	20 min. front and back
9th	1, 2, 3, 4 & 5	10 min. front and back
10th	1, 2, 3 & 4	15 min. front and back
10th	1, 2, 3, 4 & 5	15 min. front and back
11th	1, 2, 3 & 4	10 min. front and back
11th	1, 2, 3, 4 & 5	20 min. front and back
12th	1, 2, 3 & 4	5 min. front and back
12th	1, 2, 3, 4 & 5	25 min. front and back
13th	1, 2, 3, 4 & 5	30 min. front and back
14th	1, 2, 3, 4 & 5	30 min. front and back
14th	1, 2, 3, 4, 5 & 6	5 min. front and back
15th	1, 2, 3, 4 & 5	25 min. front and back
15th	1, 2, 3, 4, 5 & 6	10 min. front and back
16th	1, 2, 3, 4 & 5	20 min. front and back
16th	1, 2, 3, 4, 5 & 6	15 min. front and back
17th	1, 2, 3, 4 & 5	15 min. front and back
17th	1, 2, 3, 4, 5 & 6	20 min. front and back
18th	1, 2, 3, 4 & 5	10 min. front and back
18th	1, 2, 3, 4, 5 & 6	25 min. front and back
19th	1, 2, 3, 4 & 5	5 min. front and back
19th	1, 2, 3, 4, 5 & 6	30 min. front and back

Day	*Zones*	*Exposure*
20th	1, 2, 3, 4, 5 & 6	35 min. front and back
21st	1, 2, 3, 4, 5 & 6	35 min. front and back
22nd	1, 2, 3, 4, 5 & 6	40 min. front and back
23rd	1, 2, 3, 4, 5 & 6	40 min. front and back
24th	1, 2, 3, 4, 5 & 6	45 min. front and back
25th	1, 2, 3, 4, 5 & 6	45 min. front and back
26th	1, 2, 3, 4, 5 & 6	50 min. front and back
27th	1, 2, 3, 4, 5 & 6	50 min. front and back
28th	1, 2, 3, 4, 5 & 6	55 min. front and back
29th	1, 2, 3, 4, 5 & 6	55 min. front and back
30th	1, 2, 3, 4, 5 & 6	60 min. front and back

At the end of thirty days of continuous treatment, one reached the maximum exposure. From this period on, the treatments were not increased. Exposure from this date consisted of one hour of sun to the front surface, and one hour of sun to the back surface of the six zones.

Heliotherapy was started in such time that it was completed at least 30 minutes before meal time, and was not resumed until at least one hour after meals. If there were a period of several days without sunshine, the patient did not resume his heliotherapy at the point of the schedule at which he left off, but dropped back on the schedule one day for each day of sun missed. And, even when there was no sunshine and the weather permitted, the patient was exposed for the same period of time as if the sun were shining. Exposure under these conditions was only for the number of minutes called for in the schedule.

Rollier considered that patients developing good pigmentation generally fared better than those who did not become so brown. At Fitzsimons this was not invariably the case. Anemic and acutely ill patients did not pigment so readily, and it was only with the abatement of constitutional symptoms and an improvement in the general condition that tanning and bronzing appeared.

A word of warning should again be spoken against the careless and promiscuous use of heliotherapy especially in pulmonary tuberculosis. It should not be employed without the supervision of a physician who has had experience in its use, and it must be applied with the greatest caution and with individual supervision.