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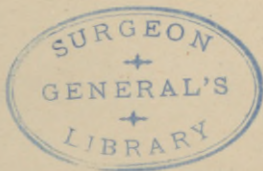




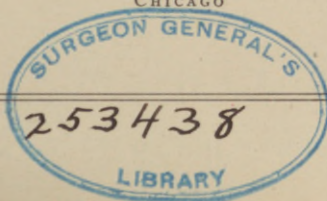
✓  
OUTLINE  
of  
ULTRA-VIOLET  
THERAPY

By ✓  
A. J. PACINI, M. D.

✓ Second Edition ✓



1923  
POOLE BROS.  
CHICAGO



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## *Introduction*



NATURAL history is everywhere replete with indisputable evidence that there exists always a mutually reciprocal relation between an organism and its environment. On the basis of these mutual relations Darwin propounded and defended the theory of evolution that has done much to reorganize the scientific attack in the study of the problems of life.

It is not unnatural to suspect that there must be an influence that accrues as a result of a constant immersion in the actinic photosphere that envelopes our planet; and if we observe the many phenomena that are in constant progression about us, we can see at once innumerable and striking examples of what Loeb has so beautifully termed "slavery to light."

With the perfection of methods for producing ultra-violet energy there has come a correspondingly great increase in the purposeful clinical application of the same; and there exists today a rather tangible science that indicates with reasonable clinical accuracy the unusual therapeutic benefit that can be derived from ultra-violet usage.

As in all scientific endeavors, there are some few individuals who stand out pre-eminently conspicuous in this field; and I may mention Professor Wm. Bayliss, Professor Robert W. Wood, J. E. Barnard, the officers identified with the office of the Surgeon General, United States Public Health Service, Dr. Janet Clark, Dr. Alfred F. Hess, Dr. P. G. Shipley, Dr. E. A. Park, Dr. G. E. Powers, Dr. Geo. M. MacKee, Dr. Geo. C. Andrews, and Dr. W. T. Bovie. To all of these I have applied

directly or indirectly for scientific assistance which I have obtained through personal communications and through the study of their scientific memoirs; and I take this opportunity of expressing to them my deep gratefulness for such of their work that is quoted *verbatim* in the accompanying pages.

It is a difficult matter to present a subject that is so vast and so little organized as ultra-violet therapy in a fashion that pretends to logical sequel; but the nearest approach has been made, it is thought, by offering a discussion of the general principles involved; the qualities of the air-cooled or biologic ultra-violet energy; the qualities of the water-cooled or bactericidal ultra-violet energy, and the various broad divisions of therapy, such as are everywhere practiced by those better skilled in the application of this radiation. Wherever it has been possible to include a statement of the principle underlying therapeutic application, this principle has been mentioned; for, if these principles are well understood, any condition not mentioned in the pages but similar to some such as are mentioned, may be attacked with ultra-violet therapy with a degree of confident expectancy that results from a knowledge of the *modus operandi*.

I would be ungrateful if I failed to mention the fact that my association with the scientific personnel of the corporation with which I am identified has done much to stimulate my efforts in the scientific pursuit of the value of ultra-violet in its biophysical application.

## CHAPTER I GENERAL PRINCIPLES



**QUARTZ LAMPS:** Quartz lamps represent, simply, a mercury arc in a vacuum contained in a quartz generator.

They are supplied for clinical use in two quite distinct forms: an air-cooled lamp and a water-cooled lamp.

Perhaps the most important part of the modern quartz lamp equipment is the tube, which in its modern form has assumed a high degree of engineering perfection. A diagrammatic representation of the modern uviarc is as follows:

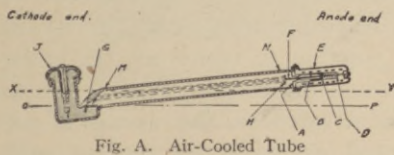


Fig. A. Air-Cooled Tube

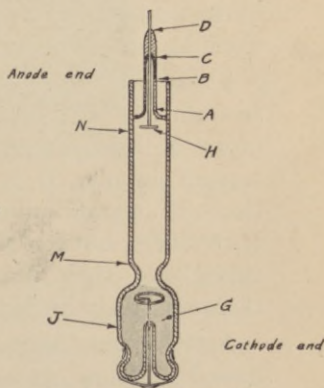


Fig. B. Water-Cooled Tube

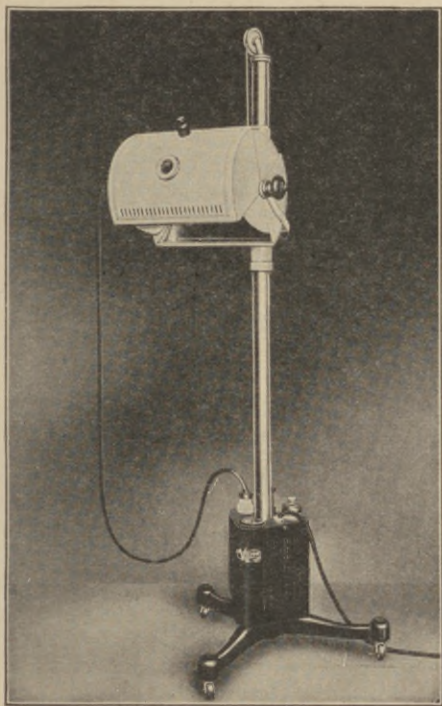
Diagrammatic Explanation of Construction of Both Types of Uviarc

- A. Quartz stem of seal structure
- B. Connection of quartz stem and seal grading
- C. Connection of seal grading and seal coating
- D. Tip of seal coating
- E. Anode seal guard (air-cooled tube)
- F. Tungsten electrode (air-cooled tube)
- G. Cathode mercury pool
- H. Anode target
- J. Cathode chamber
- M-N. Luminous portion
- O-P. Level of mercury during operation (air-cooled tube)
- X-Y. Level of mercury when cold (air-cooled tube)

These modern uviarcs represent a marked accomplishment in the construction of ultra-violet generators, and the important relation that these tubes bear to the progress of ultra-violet therapy is in every way similar to the acknowledged progress that was made possible in the field of X-ray endeavor through the advent of the Coolidge hot cathode X-ray tube.

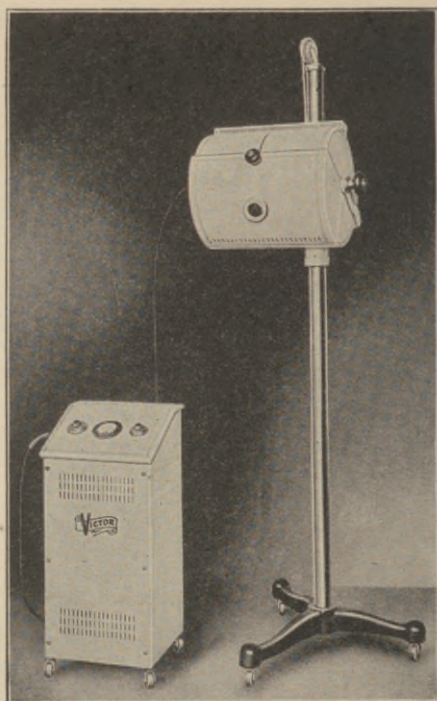
Essentially, the uviarc is a direct-current device, and must be supplemented by whatever means that will insure a direct current when operated on an alternating-current supply. It is possible to construct the uviarc that will operate on alternating current without the use of rectifiers; but for clinical purposes the expense of such tubes, and their unusual electrical limitations, make them relatively inefficient for general adaptation.

**AIR-COOLED LAMPS:** In its most recent form the air-cooled mercury vapor lamp assumes the appearance indicated in the accompanying illustrations, the first of which shows an outfit for operation with direct current, and the second, an outfit for operation with alternating current.



Rotary Casing Type, counterweighted, with RHEOSTAT control for DIRECT current

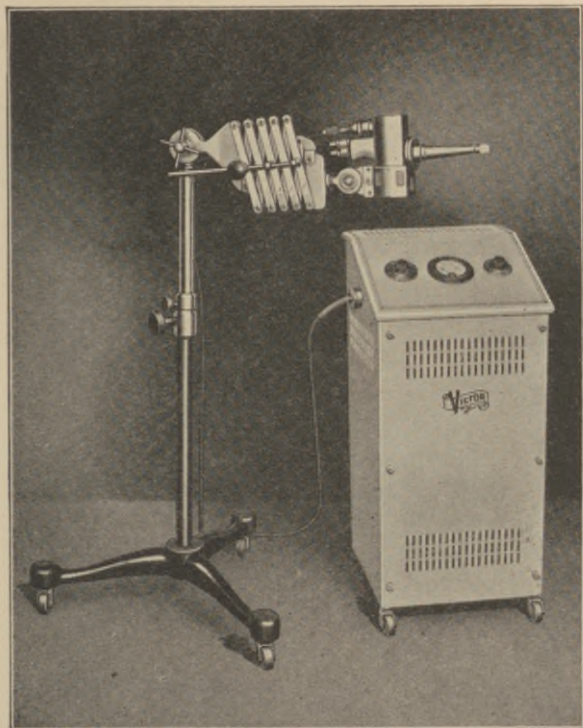
In the direct-current outfit there is supplied a ballast resistance which must always be included for its steadying effect on the light. In the alternating outfit, in addition to the ballast resistance there must be furnished a means for rectifying the alternating supply. This is accomplished through use of a tungar rectifier which, together with the ballast resistance, is included in a separate unit as indicated in the illustration.



Rotary Casing Type, counterweighted, with RECTIFIER control for ALTERNATING current.

**WATER-COOLED LAMP:** Water-cooled mercury vapor lamps are similarly built for operation on direct or alternating supplies, and are illustrated below.

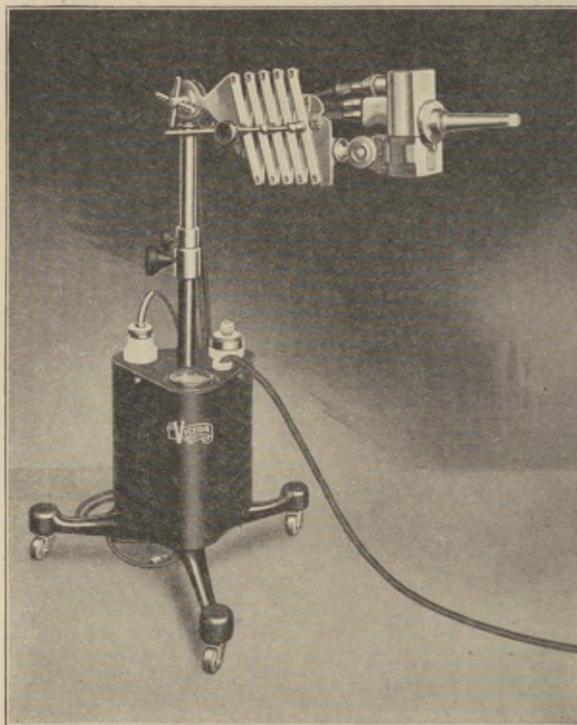
In order best to appreciate the important difference that distinguishes the qualities of radiation which issues from the air-cooled and water-cooled type of quartz lamp, it is important briefly to review some of the characteristics of lamp operation together with a statement of the inherent properties of ultra-violet.



Water-Cooled Outfit, mounted on adjustable floor stand, with extension truss. RECTIFIER control for ALTERNATING current

**ULTRA-VIOLET GENERATION:** To produce ultra-violet energy the burner is tilted so that the mercury cathode flows to the tungsten anode and thereby produces an electric contact. This initial tilting is a deliberate short circuit of the current supply, so that the supply line should be heavily fused in order to avoid troublesome experience (at least 30-ampere fuses should be used).

Immediately the arc is broken by allowing the burner to assume its original position, the electric current,



Water-Cooled Outfit, mounted on adjustable floor stand, with extension truss. RHEOSTAT control for DIRECT current

instead of flowing through the metallic mercury, continues to flow through the mercury vapor. Since the mercury vapor is at first cold, the resistance is quite high; and the light that is emitted fills the entire diameter of the generating tube and emits a low intensity of luminant. In a short time the mercury vapor becomes hotter and permits a greater voltage to be accepted by the tube. Three things are observed in this stage of



energy transformation. First, the voltmeter is seen to rise, indicating a greater voltage acceptance. Then, the luminant issuing from the tube is increasingly more brilliant. Finally the stream of illuminant in the tube shrinks away from the quartz walls of the generator, assuming the appearance of a narrow filament in the position of the central axis of the tube. These changes are collectively known as the "building-up" period, and represent certain characteristics in the effort for the entire electrophysical system to attain an equilibrium.

During the building-up period, when the voltmeter reads between 20 and 40 volts, it is sometimes possible to discern a clicking sound issuing from the tube. This click is the result of a mercury hammer, and represents the part in the building-up characteristic when the conditions are least stable. After forty volts is past the click usually subsides and the lamp promptly assumes its complete equilibrium. The final voltage assumed by the burner is dependent upon many factors; but the most important of these factors is the amount of resistance included in electrical series with the tube. The total building-up period requires from five to ten minutes; so that a lamp has not reached its equilibrium, which means its maximum clinical efficiency, until it has been lighted about ten minutes.

**CARE OF BURNER:** Mercury vapor burners are really complicated instruments of precision. They are fragile. They enclose a rather high vacuum that contains a quantity of metallic mercury which is easily shaken about in the tube. For these various reasons they demand intelligent usage, and it is fitting and proper that the prospective therapist become thoroughly familiar with the instructions issued by the manufacturer for the care and use of tubes.

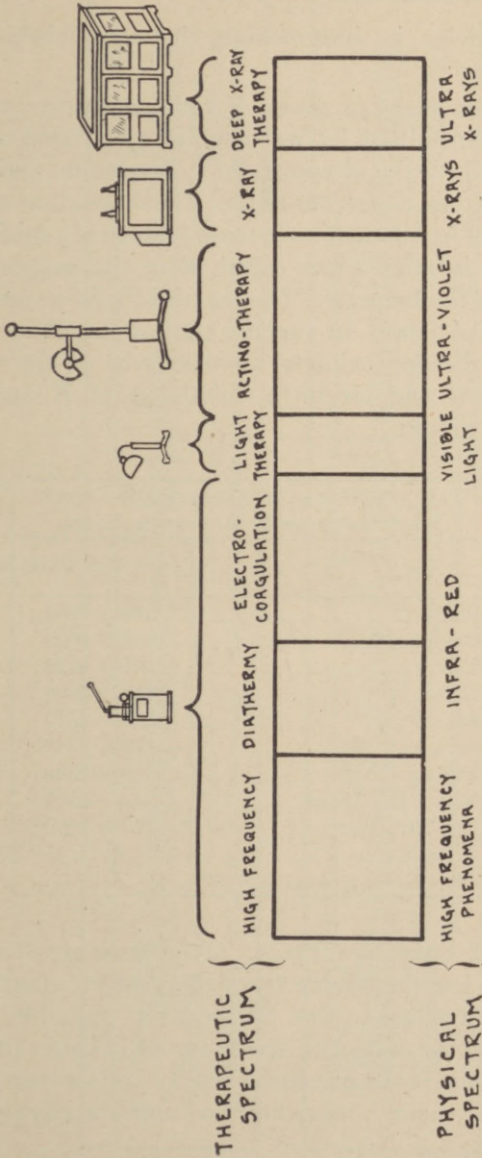
Above all, it is decidedly significant to observe that the final equilibrium of the operating lamp depends upon a neat adjustment of resistance, voltage, amperage and adequate ventilation. Failure to maintain this neat adjustment results in damage to the tube, just like failure to observe the characteristics demanded of an X-ray tube will result in unfortunate experience with its use. Follow the manufacturer's instructions to the letter.

ULTRA-VIOLET RADIATION: Under proper operating conditions the brilliant illumination emitted by the mercury arc furnishes a peculiar spectrum which may be divided into three portions, as follows:

SOURCE	INFRA-RED	LIGHT	ULTRA-VIOLET
1. Mercury Vapor.....	52%	20%	28%
2. Sunlight.....	80	13	7
3. Arc Lamps (such as carbon)....	85	10	5
4. Incandescent Lamps.....	93	6	1

From the comparison submitted, it is observed that the quartz lamp provides a distribution of energy richer in ultra-violet than sunlight, other forms of arc lamps and incandescent lamps.

THERAPEUTIC SPECTRUM: The relative position that the quartz lamp occupies in the therapeutic spectrum of the clinician is revealed in the accompanying diagram.

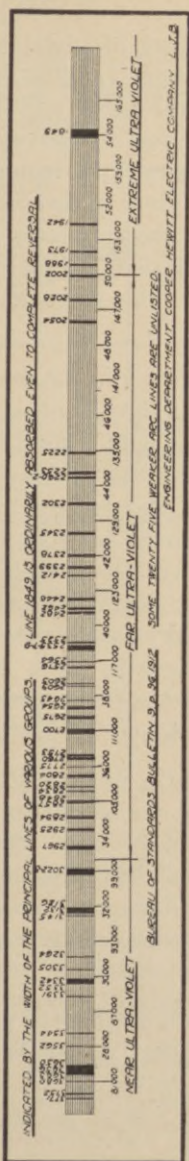
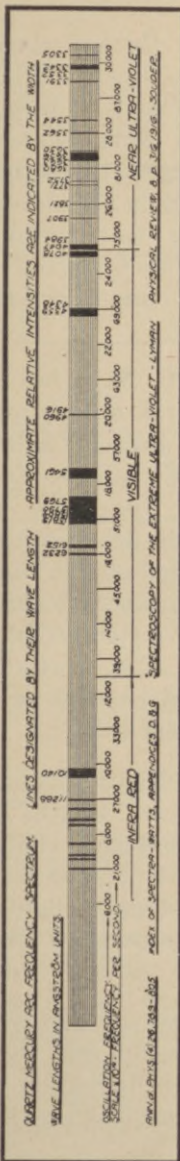


Ultra-violet is intermediate between visible light and X-rays.

It is customary to speak of radiant energy, which is energy transmitted by wave motion, in terms of units introduced by the physicist, A. J. Angström, and therefore known as Angström units. The Angström unit is a measure of length and is one ten-millionth of a millimeter; or, as it is more often called after the suggestion of Stoney, a tenthemetre. The better to gain a concept of the relative figures for energies that are familiar, a table showing the approximate wave-lengths of the various colors, near and far ultra-violet and of X and deep X-rays is given:

TABLE SHOWING APPROXIMATE RELATIVE WAVE LENGTHS IN ANGSTROM UNITS	
	ANGSTRÖM UNITS
Red. ....	6980 - 6630
Orange. ....	6600 - 6000
Yellow. ....	5830 - 5620
Green. ....	5440 - 5000
Blue. ....	5000 - 4570
Indigo. ....	4490 - 4340
Violet. ....	4280 - 3920
Near Ultra-Violet. ....	3920 - 3000
Far Ultra-Violet. ....	3000 - 2000
X-Rays. ....	6 - 2
Ultra X-Rays (deep therapy)	1 - 0.1

QUARTZ LAMP SPECTRUM: Quite accurate studies of the wave lengths issuing from the modern quartz lamp are now available. One of the most valuable charts, indicating the complete spectrum as it issues from the quartz lamp, is the one furnished by the Cooper Hewitt Electric Company, reproduced on opposite page:



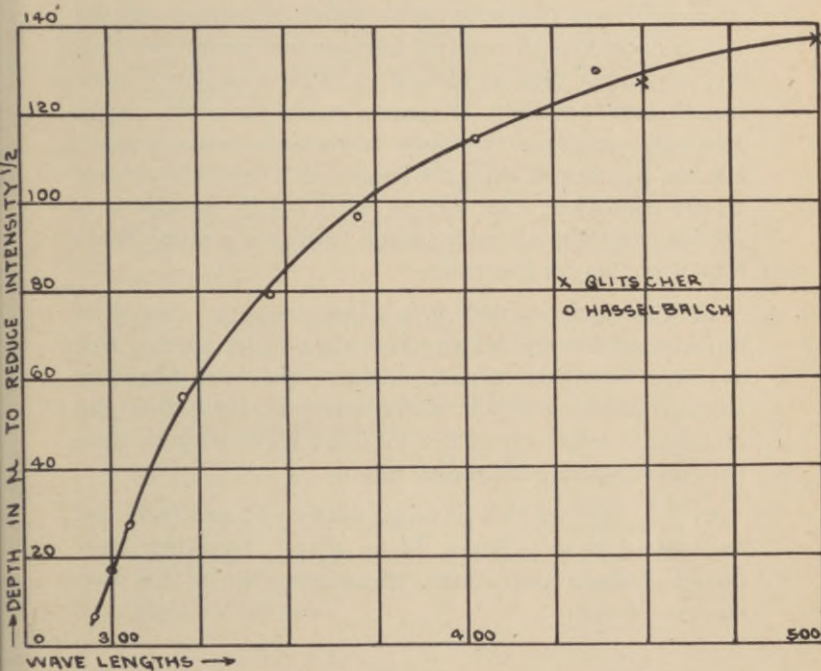
The student of ultra-violet therapy should become more and more familiar with these individual bands. Each spectral band will be found to have a clinical significance and to convey an effect different from its adjoining band. It seems definitely established that one of the great future strides in the development of ultra-violet therapy rests with the biophysical elucidation of the individual merit of each spectral ultra-violet band; or, in the language of radiotherapists, selective filtration.

**ULTRA-VIOLET ABSORPTION:** As a beam of ultra-violet energy is permitted to fall upon a quartz prism and the ultra-violet spectrum projected upon a fluorescent material, the various bands indicated in the above figure can be clearly visualized. During this visualization materials placed in front of the light before it reaches the prism will show their effect on the absorption of ultra-violet. By this means it has been definitely proved that near ultra-violet, or the region included between the wave lengths 4000 and 3000, is relatively more penetrating than far ultra-violet, which is the region between 3000 and 2000 Angström units.

Janet Clark, in her "Physiological Action of Light" shows how the decreasing wave lengths present an increasing absorption. She combined the findings of Glitscher and Hasselbalch and presents the following curve, where it is seen that as the wave length approaches 3000 Angström units, the absorption becomes less and less.

These findings may be expressed in the form of a law as follows: that materials transmit less ultra-violet in proportion as the wave length diminishes. From the findings of Clark, Glitscher, Hasselbalch and others, and

on the basis of the law propounded, near ultra-violet may be designated as relatively penetrating; and far ultra-violet as superficial in its effect.



**DISTINCTION BETWEEN AIR AND WATER-COOLED LAMPS:** It has been generally taught that the air-cooled type is used for systemic irradiation, and the water-cooled type for focal or cavity work.

A brief consideration of the fundamental physical principles involved will serve to make apparent a distinct differentiation between the two.

When the electrical energy passes through the mercury vapor there is created a central stream of luminescence from which ultra-violet energy is emitted. This trans-

formation of energy, like many transformations, is accompanied with the evolution of much heat. The heat volatilizes the liquid mercury in the cathode reservoir and gives rise to a dense cloud of mercury vapor which envelopes the central luminescent beam; so that the rays must first be filtered through a mercury vapor mantle before passing the quartz in the air-cooled lamp. Remembering that the short ultra-violet wave lengths are less penetrable than the longer ones (just the reverse to the conditions that obtain with X-ray energy) it is obvious that the air-cooled lamp furnishes a dominantly long wave length spectrum.

In the water-cooled type, the mercury mantle is quickly condensed, leaving the ultra-violet energy free to issue from the quartz without previous filtration through mercury vapor; so the spectrum from this type of lamp is relatively richer in short wave lengths than the corresponding air-cooled lamp.

On the basis of this physical difference, and from the findings of Ward, Sidney Russ, Ritter, Herschel, Becquerel, Draper and others, the comparison of the two energies shows:

#### ULTRA-VIOLET ENERGY

(Mercury Arc)

AIR-COOLED LAMP	WATER-COOLED LAMP
1. Near ultra-violet intensity	Far ultra-violet intensity
2. Biologic (dominantly)	Abiotic *(dominantly)
3. Chemically oxidizing	Chemically reducing
4. Relatively penetrating	Relatively superficial
5. Metabolic synergist	Metabolic depressor

\*Abiotic-bactericidal.



*References*

1. Luckiesh, physicist of the Nela Research Laboratory, conveniently divides the visible spectrum into near and far ultra-violet regions. The air-cooled equipment furnishes a dominant excess of near ultra-violet intensity; the water-cooled equipment furnishes a relative preponderance of far ultra-violet intensity.
- 2 and 4. Browning and Russ reported in the "Proceedings of the Royal Society of London" that near ultra-violet intensity has no marked germicidal action but penetrates much skin (biologic effect) and far ultra-violet intensity has marked germicidal action but is much less penetrable.
3. Ritter, Herschel and Becquerel propounded a law that has been accepted since 1872, that long wave lengths (near ultra-violet intensity) exert an oxidizing action as opposed to the reducing action of short wave lengths (far ultra-violet intensity).
5. Rideal and Taylor in their "Catalysis in Theory and Practice" show that reactions by radiant energy may be either accelerated or retarded. Near ultra-violet intensity is an accelerator and acts as a metabolic synergist. Far ultra-violet intensity is a retarder or metabolic depressor.

With this newer and biophysically established concept of the qualities of the ultra-violet regions, it is at once apparent that the empirically introduced standard of systemic and focal lamps for the air-cooled and water-cooled types has made for profound confusion and possibly injudicious application in the clinic. More properly, the lamps are biologic and bactericidal, and each one should be used systematically or focally, depending upon the pristine pathology of the lesion treated.

ULTRA-VIOLET THERAPY: Ultra-violet therapy implies the application of air-cooled and water-cooled equipment for the derivation of certain clinical manifestations. Knowing the fundamental qualities that are a property of the wave lengths dominantly emitted by each lamp, and reviewing the great bulk of literature that has accumulated in this country and abroad on the clinical use of ultra-violet, it is possible to present certain outlines of procedure that are accepted as efficient in accomplishing clinical success.

## CHAPTER II

### AIR-COOLED LAMP



**PROPERTIES:** It has been pointed out that the air-cooled lamp furnishes an energy characterized as:

1. Near ultra-violet
2. Dominantly biologic
3. Chemically oxidizing
4. Relatively penetrating
5. Metabolic synergist

These are its general effects obtained, presumably, by the action of the long ultra-violet rays that attack:

- (a) The surface cells, particularly their nucleus
- (b) The capillary blood
- (c) The capillary lymph
- (d) The nerve filaments distributed in the region

When the energy is played upon a skin surface, it affects the structures just enumerated. As a result, two objective phenomena are observed:

1. A hyperemia
2. An erythema

That a profound alteration of the capillary network is established promptly is determined as follows:

Stroke the skin of the area treated as if eliciting the so-called "adrenal" reflex (Sargent's white line). It will be noted that the skin blanches more or less promptly; then the streak appears red, and sometimes raised (dermographia). Expose the same surface to the air-cooled lamp, and while the exposure is in progress, re-elicite the adrenal reflex (so called). At first, one finds that the reaction time between the initial blanching (vasoconstriction) and ultimate reddening is markedly

lessened. This is the period of vasodilatation. But as the exposure is continued, it will be seen that the reddening quickly disappears and is again succeeded by a blanching. This is the second reaction, or period of vasoconstriction.

That is to say, short, mild exposures under the air-cooled quartz lamp are vasodilatory. Longer and more severe reactions are vasoconstricting. How purposefully to utilize these effects clinically will be discussed in the section on cardiovascular diseases.

In addition to the changes in the capillary blood supply, which appear immediately, there occur also certain objective changes in the skin. When the exposure is brief and subintensive, a faint reddening appears; when longer and more intense, a scarlet reddening; and when prolonged exposure and accentuated intensity is supplied, a reddening accompanied by blisters and desquamation. These changes are accompanied by a certain amount of skin tenseness due to edema. It has been found that the degrees of reaction produced, called erythema, correspond to definite histological changes in the skin; so that the reactions are classed as:

REACTION	DESIGNATION
1. Mild reddening 2. Scarlet reddening 3. Blistering	Stimulative erythema Regenerative erythema Desquamative erythema

These objective changes, the hyperemia and the erythema, are guides in the clinical application of the energy, and all therapeutic procedures orient themselves around these fundamental reactions.

However, in addition to the objective findings, certain subjective findings are likewise present, and these differ according to whether the erythemic reactions are produced:

- (a) Quickly
- (b) Slowly

When the erythema is produced too *quickly*, the subjective findings are *few*. When the erythema is produced *slowly*, the subjective findings are *many*. In clinical work there are occasions when it is desirable to minimize the subjective findings and rely entirely upon the erythemic reaction for the result. This is so especially in the *focal* treatment of skin lesions. Here, the effect desired is focused upon the superficial lesion. Since in this type of treatment one aims to produce given histological changes in the cellular pathology of the skin lesion, this is best obtained by the use of a focal technic which we have elsewhere described as *intensive*. The characteristics of this form of treatment are:

1. High intensity of ultra-violet
2. Short tube-skin distance
3. Short exposure time

There are several ways in which this may be accomplished. One method is to use:

Volts.....90

Uviarc-skin distance. .10 inches

Time.....depending upon reaction sought,  
and reactivity of individual

The determination of the individual's reactivity is difficult. Many factors affect it; but particularly, they are:

1. Endocrine type (light or dark)
2. Sex
3. Age
4. Part rayed

Speaking generally, light people respond more promptly than dark; females more than males; the young sooner than the old; and the regions usually protected from the light and of high nervous sensibility, quicker than other parts. But these factors are so variable as to preclude any definite statement of exposure time. From a large experience, it is found that the reactivity to the rays increases in the following order for the parts named:

PART	RELATIVE SENSITIVITY
Chest.....	1
Abdomen.....	1
Back.....	1+
Groin.....	1+
Anterior arm.....	1½
Posterior arm.....	1¾
Posterior leg.....	1¾
Anterior leg.....	2
Dorsum of hands.....	5
Palms of hands.....	15
Sole of feet.....	25

To the right is given a figure expressing a rough estimate of the relative sensitivity of the part. For example, an exposure that will produce in one minute a stimulative erythema upon the chest, will require, on the soles of the feet, 25 minutes. On the basis of this study, and similar ones, a very approximate exposure guide, for intensive technic would be:

## INTENSIVE IRRADIATION

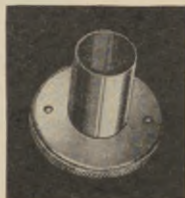
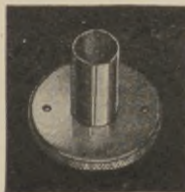
Air-cooled lamp: Volts, 90; tube-skin distance, 10 inches; central ray strikes surface at right angles; average approximate exposure values, in *seconds*.

## ERYTHEMA

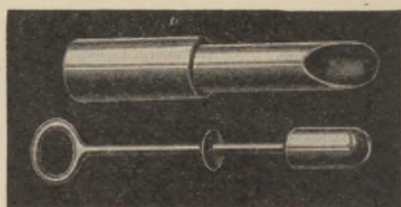
	STIMULATIVE		REGENERATIVE		DESQUAMATIVE	
	LIGHT	DARK	LIGHT	DARK	LIGHT	DARK
Infants. . . . .	5	8	10	12	15	20
Children. . . . .	8	10	15	20	25	30
Female adults. . .	15	20	20	30	40	60
Male adults. . . .	20	25	30	40	60	75

These values are for surfaces whose sensitivity is designated "I" in the chart showing relative sensitivity of anatomic regions. For regions less sensitive, multiply the above figures by the relative sensitivity factor. For example: dark type, female adult requires 30 seconds' exposure for regenerative erythema over chest, abdomen, back and groin. For dorsum of hand, this would be 5 times 30, or 150 seconds.

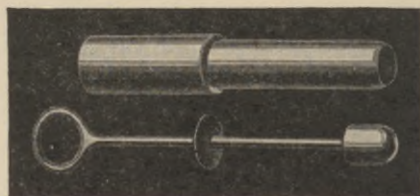
It is often desirable to focalize the rays even more circumscribed than the area obtained by chamois screening. When this is desired, certain adapters and localizers, which should form part of the equipment, are used. The more common air-cooled lamp accessories, and their uses, include the following:



These metal localizing tubes present various diameters. They attach directly to the casing of the air-cooled lamp. The central ray issues from the localizing tube in the direction of the long axis. They may be used completely to cover smaller superficial lesions such as naevi and keloids; or in the treatment of orifices that have been dilated, using a speculum with the localizing tube introduced into the speculum.



These obturated specula are designed usually for orificial insertion. It will be observed that the angle of one is obtuse, so that the light issuing from this instrument strikes the surface at 45 degrees. As compared to the speculum with the round end instead of the oval end,



because of the acute angulation (cosine law) the exposure time must be increased by  $\frac{1}{3}$ . That is, what will be produced in two minutes with the round-end speculum will require three minutes' exposure with the oval-end speculum.



From the discussion presented, it is seen that intensive focal air-cooled lamp technic is useful especially in superficial skin lesions, other than superficial infections. It must be said, however, that when superficial destructive action is wanted, though the air-cooled lamp will suffice, the very abiotic or coagulative qualities (upon which the bactericidal property of the water-cooled lamp depends) of the water-cooled lamp are more efficiently used. The water-cooled lamp is always operated at from 50 to 60 volts; and since, in skin work, it is used for its abiotic or destructive effect, the exposure time can be about five or more minutes, depending upon the part. So that we may use in dermatologic practice:

For stimulative erythema—air-cooled lamp

For regenerative erythema—air-cooled lamp

For destructive erythema—water-cooled lamp

In addition to the intensive technic, the air-cooled lamp (and the water-cooled lamp) is used for systemic effect. By systemic effect is meant the purposeful production of desired subjective changes useful in correcting the effects of certain forms of pathologic invasions.

Systemic raying may be:

1. Regional
2. Fractional
3. General

Regional systemic raying means the irradiation of a given anatomic section of the body for the purpose of inducing remote or derived effects in viscera correlated to the skin surface by nervous and blood relations.

By fractional raying is meant the irradiation of the body in fractions, usually fifths, divided as follows:

*First day:* The front and back of the feet, below the ankles

*Second day:* The front and back of the legs, from the knees down

*Third day:* The front and back of the legs, from the iliac crests down

*Fourth day:* The front and back from a point on the level with the ensiform cartilage down

*Fifth day:* The front and back from the neck down

Levy and Gassul seem to have proved that intensive irradiation over the entire body at one sitting may lead to such reflex engorgement in all the viscera as to bring on hemorrhage if pathology coexists (as in pulmonary tuberculosis). Rollier appears to have realized this; and in America, LoGrasso at Perrysburg insists, with reason, that fractional heliotherapy is imperative in the successful control of tuberculopathies.

By general irradiation is meant the exposure of the entire anterior and posterior surfaces of the body.

In all these forms of systemic treatment—regional, fractional and general—the effect sought is not confined to the skin. It is the biologic uplift that is induced by the rays. So that erythemic reactions are to be minimized. A low intensity treatment is obviously desired, and may be had by using:

1. Low voltage
2. Long tube-surface distance
3. Long exposure time

An excellent routine for this type of raying is to use:

Volts . . . . . 70  
 Tube-skin . . . . . 40 inches  
 Time . . . . . Depending upon individual

Of course, the same rules of individual reactivity hold fast. But a good summary is:

GENERAL OR SYSTEMIC IRRADIATION

Air-cooled lamp; volts, 70; tube-skin distance, 40 inches; central ray strikes at right angles; average approximate exposure values, in *seconds*.

ERYTHEMA

	STIMULATIVE		REGENERATIVE	
	LIGHT	DARK	LIGHT	DARK
Infants.....	15	20	30	40
Children.....	20	30	40	60
Female adults.....	50	60	90	120
Male adults.....	60	90	120	150

It is important to know that the rays must strike the surface at right angles. If less than a right angle is used, an increase in time must be allowed, according to a basic law, which says that the incident intensity varies as the cosine of the incident energy (for ultra-violet). When other than a right angle is used, the following table is used to compensate for the loss of intensity due to angular incidence of the energy:

ANGLE OF INCIDENT RAY	FRACTIONAL INCREASE OF TIME REQUIRED
90	0
75	1/10
60	1/5
50	1/4
45	2/5
30	1/2

*Example.* A light-type child requires a stimulative erythema (systemic treatment). At right angles the time would be 20 seconds. At 45 degrees incidence, the time is  $20 + \frac{2}{5}$  of 20, or 28 seconds.

As the exposures are applied, the tolerance of the patient increases; so that each subsequent exposure must

be increased in time to compensate for the tolerance established. Rule: The tables furnished give the initial exposure time. Each subsequent exposure is increased by an amount equal to the original exposure time. In mathematical expression, exposure time is increased arithmetically.

*Example.* First exposure, intensive focal treatment in a light-type, male adult is a regenerative erythema requiring 40 seconds. Second exposure will require 80; third, 120; fourth, 160, etc.

There are certain fundamental requisites that must be observed in the treatment of any given individual.

1. Study the pathology of the case under consideration.
2. Determine the type of lamp required to meet the issue best. (Air-cooled biologic, or water-cooled abiotic.\*)
3. Having determined the necessary lamp to be used, conceive the effect sought.
4. If focal, set the lamp for the given characteristics:
 

Volts.....	90
Tube-skin distance.....	10 inches
5. If general or systemic, determine if the raying is to be:

Regional  
Fractional  
General

and set the lamp at

Volts.....	70
Tube-skin distance.....	40 inches

6. Study the time required, which may be roughly approximated by weighing:

---

\*Bactericidal.

- (a) Type of individual (light or dark)
- (b) Part rayed
- (c) Sex
- (d) Age

and may be gathered from the tables furnished.

7. Build up the lamp to the required characteristics by:

- 1. Tilting
- 2. Adjusting rheostat control or rectifier control until proper voltage is reached

8. Expose for the necessary time using an interval timer.

The eyes of the patient and operator should be protected against the rays by the use of goggles. No clothing must be worn on the part treated.

Immediately following the treatment, explain to the patient that a reddening should appear. The time required for the erythema to develop depends upon the reactivity of the patient, *as does also the time that it persists*. So long as the reddening is developing, additional ultra-violet treatment is not necessary. But at the moment it begins to disappear, its physiological action is spent. That is the time for the second treatment. Therefore, have the patient carefully observe the development of the required degree of erythema and when he observes it to disappear, have him report for the second treatment. The rule is, initiate a reaction; then maintain it. By this means, the patient's sensitivity becomes its own guide for treatment frequency. In general, with ultra-violet therapy, small doses often repeated are infinitely more effective than large doses applied at long intervals.

### CHAPTER III WATER-COOLED LAMP



#### PROPERTIES:

1. Far ultra-violet
2. Dominantly abiotic (bactericidal)
3. Chemically reducing
4. Relatively superficial
5. Metabolic depressor

The radiation issuing from this type of lamp is relatively more intense in short wave lengths than is the air-cooled lamp. This holds true only providing that the lamp is operated at a proper voltage—best 50, never more than 65. Free and continuous circulation of clear water is imperative; continuous circulation to insure adequate cooling for the complete condensation of the mercury vapor mantle that filters out the *short* wave lengths; and clear water, because the stream passes in front of the uviarc so that any contained impurities will act as filters. When these precautions are observed, namely:

1. Low voltage (50-65)
2. Constant circulation of water
3. Clear water (and clean lenses on the lamp)

The lamp then furnishes an intense, far ultra-violet spectrum rich in abiotic wave lengths. Otherwise not.

Of course, the best known property of far ultra-violet, or water-cooled lamp energy, is its bactericidal capacity. When operated under the conditions named, organisms

exposed at a distance of 200 millimeters from the lamp are killed in the following time intervals:

<i>Diplococci</i>	SECONDS REQUIRED TO KILL
Gonococci.....	6
Meningococci.....	6
<i>Staphylococci</i>	
Pyogenes albus.....	10
Pyogenes aureus.....	12
<i>Streptococci</i>	
Viridans.....	14
Hemolyticus.....	18
Mucosus.....	25
<i>Pneumococci</i>	
Group I.....	25
Group II.....	20
Group III.....	25
Group IV.....	15
<i>Bacillus</i>	
Influenzae.....	18
Diphtheria.....	10
Tubercle.....	12
Leprae.....	15
Colon.....	18
Typhoid.....	18
Dysentery types.....	20

(For colonies grown from clinically obtained materials. The organisms were suspended in clear, sterile water.)

There is an interesting fact in connection with the treatment of water with ultra-violet rays, as follows: If to a sample of water that has been sterilized with the rays, fresh live bacteria are added, within an hour's

time practically 90 per cent of the organisms are killed. The action is called "residual effect." It has found important clinical usage and is a unique finding that merits study and research.

In living tissues and when the organisms are imbedded, the effect of the rays in destroying bacteria is indirect; but when the organisms are superficial, the effect is direct.

The indirect destruction of bacteria is an action involving certain immunity changes which affect:

1. The serum
2. The white cell count
3. Focal inflammatory defenses

That is, the serum (much like water irradiated with ultra-violet) acquires a higher germicidal capacity which it retains for some time following the exposure. The white cell count is affected, according to Janet Clark, depending upon the wave lengths of the energy, about as follows:

WAVE LENGTH	LEUCOCYTIC RESPONSE
4000-3000 (near ultra-violet)	Leucopenia
3000-2000 (far ultra-violet)	Lymphocytosis

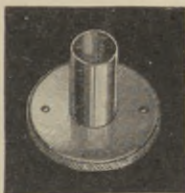
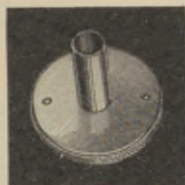
The inflammatory changes induced focally by far ultra-violet are the classic ones—rubor, tumor, calor. A large amount of blood is conveyed to the irradiated focus so as to produce a solar inflammation. It must be remembered that far ultra-violet is a protein coagulant; so that if an infected mucosal membrane is too strongly irradiated, an incrustation of coagulated protein is formed which serves to retain any purulent products underneath. Therefore, in raying mucosal surfaces for bactericidal effect, use only the shortest effective exposures that will insure bacterial destruction, but not tissue coagulation. This applies to the membranes of the nose, sinuses,



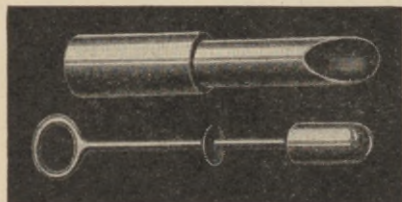
genital tract and rectum. In treating infections that are superficially situated, it is, therefore, infinitely best to rely implicitly on the adage, "small doses often repeated." On this basis, and using the actinic death points given for the various organisms, it is obvious that at distances of 200 millimeters, or less, the maximum exposure time necessary to kill the most resistant organism listed (pneumococcus) is about 30 seconds. This time varies with the applicator used, and the amount of variation has been calculated from studies elsewhere presented (Hirsch's "Urology"). It depends upon the applicator, and is about as follows:

#### APPLICATOR

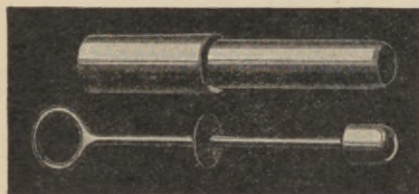
##### Use and Exposure Time for Bactericidal Effect



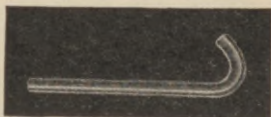
Tubular localizers confining the radiation to a circumscribed area equivalent to the diameter of the localizer,  $\frac{1}{2}$  inch,  $\frac{3}{4}$  inch and 1 inch. In connection with specula these localizers are used also for introduction into orifices. In this connection they find a field of utility in the treatment of cervical uterine infections and suppurative discharges. The  $\frac{1}{2}$ -inch tube has been recommended by some for gingival irradiation in checking the purulent discharge of infected dental structures, and in pyorrhea. Coefficient, 30 seconds.



This obturated speculum represents a convenient design for use in connection with the treatment of prostatic inflammation when introduced rectally. Owing to the angular orifice of the instrument, 90 seconds are required as a maximum exposure for bactericidal effect.



Used, like the above speculum, for rectal and vaginal irradiation. The light is emitted at right angle and therefore requires only 60 seconds for bactericidal effect.



A 45-degree tipped quartz rod. Coefficient, 60 seconds.



120-degree curved. Coefficient, 30 seconds.



Curved and flattened for an oval dispersion of energy in post pharyngeal irradiation. Coefficient, 30 seconds.



A short, blunt, pointed rod of high light intensity transmission used in connection with rhinitis, hypertrophied turbinates, ozena and allied pathologies. Coefficient, 20 seconds.



An ovilary tip quartz rod for urethral application. Coefficient, 60 seconds.



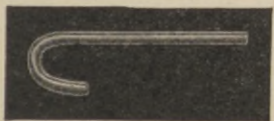
An ovilary tip, fine focus pencil applicator useful especially in focal pathologies of the eye, including ulcers, pannus, etc: Coefficient, 60 seconds.



A spatulate flattened quartz applicator for distributing the light laterally over mucous membranes of the turbinates. Coefficient, 30 seconds.



A tonsil applicator, used also in pharyngeal irradiation for acute infections and for infection carriers. Coefficient, 90 seconds.



A full-curved applicator used by some for attacking dental pathology from the buccal aspect. Coefficient, 60 seconds.



A laryngeal and pharyngeal applicator. Coefficient, 60 seconds.

When the water-cooled lamp is used for direct bactericidal effect, it is imperative that the energy reach the surface. It must make what has been properly called optical contact. Several expedients may be used to insure a maximum optical contact. An excellent expedient is to coat the mucous surface by spraying with a photosensitive material, such as:

Gentian violet  
Methyl violet  
Fuchsine  
Methyl blue  
Methyl green

The dyes may be dissolved in water or in glycerin; both solvents have a high ultra-violet transmission. About one part of dye in 1000 of solvent is ample. For a discussion of photo-sensitization, see "Principles of General Physiology," by Bayliss.

Nascent halogens (chlorine, bromine and iodine) and oxygen are quite powerful disinfectants. These acidic ions are readily set free from their basic association by the action of far ultra-violet.

*Experiment:* Procure a quartz flask. Half fill it with hydrogen peroxide. Set the flask and its peroxide in front of the water-cooled lamp window and ray the solution. Free or nascent oxygen is liberated which collects as bubbles on the walls of the flask. It is a wise practice to utilize this conjoint action in sterilizing a mucosal surface. For this, use:

1. Far ultra-violet energy
2. Hydrogen peroxide
3. Nascent oxygen given off by the peroxide under the action of the lamp

Each of these agents is in itself highly bactericidal. Together, they offer a most cogent attack against any infection.

In addition to the bactericidal action of the water-cooled lamp there is, also, a metabolic action contrary to that exerted by the air-cooled lamp. This has been discussed\* under the title of Ultra-Violet Energy as a Metabolic Pacemaker, as follows:

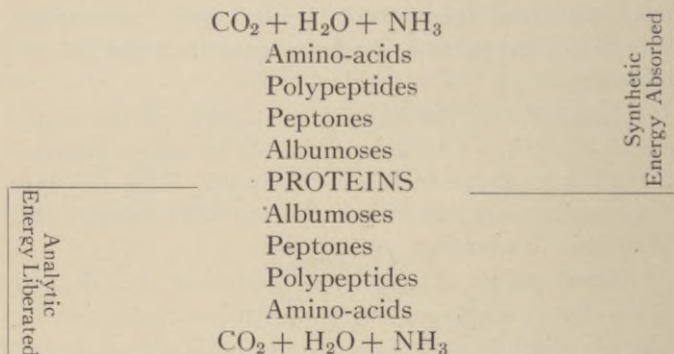
"When we come to the discussion of exactly how ultra-violet energy governs the chemical mechanisms of animal physiology, it is quite certain that at present the only scientific course is to admit that we do not know. But, considering the chemical action of the living machine in its broadest aspect, there seems to be no doubt that we may regard it as divided into two opposed processes. First, a group of synthetic reactions by means of which the products assimilated by the economy are converted into extremely complex carbohydrates and proteins; and, secondly, the decompositions and changes which convert the carbohydrates and proteins into simpler substances. It has been customary to speak of the first group of reactions under the generic physiologic term 'anabolism;' and, similarly, the second group as 'katabolism.' Both together, anabolism and katabolism give us 'metabolism.'"

This building up and breaking down that takes place in the body is subject to certain fundamental principles of energetics; from the study of which we may conclude

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\*Victor Service Suggestions for July, 1922.

that the synthetic reactions involve the absorption, and the analytic reaction, the liberation of energy. Expressed diagrammatically, in the case of protein "metabolism," we have:



Now, under usual conditions of laboratory experiment, a chemical reaction such as is represented above involves the liberation of much heat; and it is a dominant characteristic of "living" chemical reactions that they are not accompanied by much heat. This restraint in the liberation of heat is designated "chemical resistance;" and when the chemical resistance of the economy is lessened (as in disease) the chemical reactions furnish heat expressed objectively as pyrexia.

So that chemical resistance determines the velocity of chemical reactions in the body. And the mechanism operating the reactions, for want of a better definition, may be called chemical force.

Metabolism may in this manner be reduced to a chemical mathematical expression involving:

1. Chemical force, or Fc
2. Chemical resistance, or Rc
3. Chemical velocity of reaction, or Vc

In which we understand chemical force to represent the energy that builds up and breaks down; the resistance is the tissue tolerance that averts too hasty consummation of the reaction, and the velocity is the speed of change representing the sum of the metabolic processes. They bear to each other the following relation:

$$\text{from which } \begin{cases} V_c = \frac{F_c}{R_c} \dots\dots\dots (1) \\ F_c = V_c \times R_c \dots\dots\dots (2) \end{cases}$$

And it is this equation in which the actinotherapist is fundamentally interested; that chemical force is the product of chemical velocity times chemical resistance.

Such terms as constructive energy, chemical energy, used synonymously with ultra-violet energy, show an empiric attempt to describe the peculiar property of ultra-violet radiation; that of influencing chemical activity. For the therapist, it is highly scientific to regard ultra-violet energy as chemical force. And it is interesting to see how an increase in the value of chemical force influences the remaining factors of equation (2).

Suppose values are assigned to the terms in the equation, as follows:

$$\begin{aligned} F_c &= V_c \times R_c \\ 8 &= 4 \times 2 \end{aligned}$$

Let this represent, arbitrarily, a clinical metabolic state; a velocity of four units acting against a resistance of two units. Increase the chemical force to twice the amount, say by adding ultra-violet energy (systemic irradiation). If the chemical force under these conditions becomes doubled, then one or all of three things may happen:

1. The value for the velocity may increase
2. The value for the resistance may increase
3. Both values may increase. In figures, if

$$F_c = V_c \times R_c$$

$$16 \left\{ \begin{array}{l} = 8 \times 2 \\ = 2 \times 8 \\ = 4 \times 4 \end{array} \right.$$

It is not at all strange that this purely mathematical derivation should find clinical proof in the application of ultra-violet energy. Wherever metabolism is at fault, which means a perversion of the velocity (hypermetabolic) or resistance (hypometabolic) of the chemical reactions of the body, the chemical force can be purposefully modulated so as normally to rearrange the distribution of energy in the economy; or in clinical language, to correct metabolism.

In general, the long ultra-violet wave lengths (as derived from the air-cooled lamp) have to do with the acceleration of chemical velocity; the shorter wave lengths (as derived from the water-cooled lamp) increase chemical resistance. Hence the classification elsewhere propounded\*; that the energy of the air-cooled lamp is a metabolic synergist, and that of the water-cooled lamp, a metabolic depressor.

From this basic premise the chemical pathologist at once visualizes the great applicability of this strange energy in the clinical service of the internist. When the metabolic transformation of any given class of foodstuff (such as fat, mineral salt, carbohydrate, protein) fails properly to complete its synthetic and analytic cycle, there is present, clinically, a metabolic disease: obesity, diabetes mellitus, amino-acid diatheses, rickets. This

\*Service Suggestions, *Ultra-Violet Energy*. Vol. XXII, No. 6, June, 1922.



cyclic failure may arise from a number of pristine causes, all leading to a perverted balance of reaction velocity and resistance. And by correcting the balance through the intelligent selection of the proper quality of chemical force (ultra-violet energy), the cycle is in each instance brought to a satisfactory conclusion, which physiologically expels the disease.

Great is the truth of Sheppard's eternal aphorism: "We are only at the beginning of the conscious utilization of the powers of light as distinct from the unconscious enjoyment of them." A new era of therapeutic accomplishment lies sealed in the secrets of biophotochemistry.

Short ultra-violet wave lengths are quickly absorbed by whatever material. Even air, in thick layers, hinders their transmission. So that when the water-cooled lamp is used for its systemic action, the raying, to profit from the short wave lengths, must be at close range. *Rule:* Water-cooled lamp systemic raying must be at distances less than seven inches from the window of the lamp.

As for the air-cooled, so for the water-cooled lamp, the dosage is governed by the erythema produced. We have established the bactericidal dose at 30 seconds. The systemic dose would be about as follows:

Water-cooled lamp; volts, 50-65; tube-skin distance, 7 inches; each area covered by the distribution of illuminant at this distance receives the following time:

## ERYTHEMA

	STIMULATIVE		REGENERATIVE		DESQUAMATIVE	
	LIGHT	DARK	LIGHT	DARK	LIGHT	DARK
Infants.....	3	4	6	8	10	15
Children.....	5	6	8	10	15	20
Female adults...	10	15	20	25	30	40
Male adults.....	20	25	30	40	50	60

Finsen observed that the relative exsanguination of a part made for increased tolerance to actinic radiation. Blood quickly absorbs ultra-violet and makes for a prompt erythemic reaction. There are two general methods of relieving the part of blood; by the use of adrenalin (useful in mucosal surfaces) and by the use of quartz lenses, such as are shown in the illustrations.



When the lens is used, it is pressed firmly against the tissue so that obvious blanching is produced. The method is generally designated as "compression."

By a method of gently sweeping a lens over the surface of a part, a technic known as "ironing" has been introduced. It is not so good. Rays do not act accumulatively; so that the effect produced by keeping a lens in steady contact for 30 seconds is not the same as the effect produced by sweeping or ironing the part for the same length of time.

There is another practice, in connection with water-cooled lamps, that demands critical comment: the use of special cobalt filters. Filters cut off short wave lengths, so that when the blue glass is used, the direct bactericidal quality of the rays from the water-cooled lamp is lost. Only the deeper penetrating wave lengths (or biologic fraction) come through the filter, which had, therefore, better be used with the air-cooled outfit.

## CHAPTER IV

### REGIONAL ACTINOTHERAPY

**B**Y REGIONAL ACTINOTHERAPY is meant the irradiation of a definite body region of the skin, which, through vascular and nervous channels, is in intimate relation with a given viscus. Regional actinotherapy is, obviously, indicated in the pathology of pain, and plays a tremendously important clinical role.

According to its origin, pain may be subjective or objective. Subjective pains have no discernible physical cause. They arise as a product of mental action from changes affecting the co-ordinating centers of the sensorium. A variety of conditions disclose subjective pain; emotional states, hysteria, depressions, compulsions and allied psychic and psychoneurotic disorders. Subjective pain is an indication for systemic actinotherapy, and will therefore be discussed under that section.

Objective pain is the result of a demonstrable pathology and may be produced:

1. In the centers, as in the brain or cord
2. In the nerves, as the trunk or its terminations

There are on the body surface certain well-defined zones which are related to visceral diseases; they were described first by Head, who, while working in the London Hospital, observed that in different diseases of the viscera, zones of cutaneous hyperalgesia occur that coincide closely with the areas of distribution of herpes. Head had already shown that herpes was due to a disease of the posterior root ganglion. He therefore concluded that in the ganglion certain stimuli must be transmitted from the visceral fibres to those going to the

somatic areas, and produce an irritation of these fibres, so that even very light stimuli give rise to pain. With only slight modifications, these areas are acknowledged as correct today.

To localize the viscus causing the hyperalgesic zone, the following analysis is pursued:

1. Determine if in connection with the viscus suspected of disease there is an associated hyperalgesia (by drawing a sharp point lightly over the skin and observing if hypersensitiveness is manifested).
2. Outline the limits of the hyperalgesic zone and orient it with a cord segment.
3. Ascertain what organs are supplied by this cord segment.
4. Examine the organ (or organs) for disease (X-ray, physical diagnosis).
5. See if pain is intensified by manipulation of the organ.

TABLE OF CORD SEGMENTAL REPRESENTATION OF MOTILITY, SENSIBILITY AND REFLEXES  
(From L. F. Barker)

SEGMENT OF SPINAL CORD: SPINAL NERVE ROOTS	MUSCLES*	MOVEMENTS	CUTANEOUS SENSIBILITY**	REFLEXES
C <sub>1</sub>	Small muscles of the neck.	Rotation and extension of the head.		
C <sub>2</sub> and C <sub>3</sub>	1. Muscles of the neck; M. sternocleidomastoideus. 2. M. trapezius.	1. Flexion and rotation of the head. 2. Elevation of the shoulders.	C <sub>2</sub> Occiput; narrow strip along lower jaw; part of external ear. C <sub>3</sub> "Sternomastoid zone."	
C <sub>4</sub>	1. Mm. scaleni; diaphragm (N. phrenicus). 2. M. levator anguli scapulae.	1. Costal and abdominal breathing. 2. Elevation of scapula.	(Head's sternonuchal zone.) 1. Dorsal part, quadrangular area of regionuchae. 2. Ventral part, lateral region of neck; infraclavicular region, upper part of deltoid region, and part of suprascapular region.	Dilatation of the pupil on pinching the skin of the neck (C <sub>4</sub> - <sub>5</sub> ).
C <sub>5</sub>	1. M. supraspinatus; M. infraspinatus; M. teres minor; Mm. rhomboidei. 2. M. deltoideus. 3. M. biceps; M. coracobrachialis; M. brachialis internus; M. brachioradialis. 4. M. supinator.	1. Lateral rotation of upper arms. 2. Lifting upper arms. 3. Flexion of forearm. 4. Supination of forearm.	Small triangular area near the lower cervical spine; lateral surface of upper arm.	1. Dilatation of pupil (C <sub>4</sub> -7). 2. Scapular reflex (C <sub>5</sub> -Th <sub>1</sub> ).

\*For plurisegmental innervation of muscles, see preceding table; here only the dominant segment is given.  
\*\*The names of the zones in quotation marks are those used by Head.

TABLE OF CORD SEGMENTAL REPRESENTATION OF MOTILITY, SENSIBILITY AND REFLEXES  
(From L. F. Barker)

SEGMENT OF SPINAL CORD: SPINAL NERVE ROOTS	MUSCLES*	MOVEMENTS	CUTANEOUS SENSIBILITY**	REFLEXES
C <sub>6</sub>	1. Mm. pectoralis major and minor; M. latissimus dorsi. 2. M. teres major; M. subscapularis. 3. M. serratus anticus major. 4. M. pronator teres. 5. M. triceps. 6. Thenar muscles.	1. Abduction and depression of upper arms. 2. Medial rotation of upper arm. 3. Fixation and rotation of scapula. 4. Pronation of forearm. 5. Extension of forearm.	Small triangular area near lower cervical spine; radial surface of forearm and hand, including digits I-III.	1. Dilatation of pupil (C <sub>4-7</sub> ). 2. Scapular reflex (C <sub>5</sub> -Th <sub>1</sub> ). 3. Triceps reflex (C <sub>6-7</sub> ).
C <sub>7</sub>	Extensors of hand and fingers. Flexors of wrist. Thenar muscles.	Flexion and extension of the wrist.	Small triangular area near lower cervical spine. Radial side of forearm and thumb; a small strip on the flexor surface of the forearm, and a longer strip on the dorsal surface lateral from the axial line.	1. Dilatation of pupil (C <sub>4-7</sub> ). 2. Scapular reflex (C <sub>5</sub> -Th <sub>1</sub> ). 3. Triceps reflex (C <sub>6-7</sub> ). 4. Periosteal-radial reflex.
C <sub>8</sub>	1. Long extensors and long flexors of the fingers. 2. M. pronator quadratus. 3. Hypothenar muscles.	Extension and flexion of the fingers.	Most of the hand and fingers (except the thumb on the volar surface, and the ulnar side of the little finger on the dorsal surface); small strips on front and back of wrist and forearm.	1. Scapular reflex C <sub>5</sub> -Th <sub>1</sub> . 2. Palmar reflex C <sub>7</sub> -Th <sub>1</sub> . 3. Cilio-spinal reflex (efferent fibers) (C <sub>8</sub> -Th <sub>1</sub> ).

\*For plurisegmental innervation of muscles, see preceding table; here only the dominant segment is given.

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TABLE OF CORD SEGMENTAL REPRESENTATION OF MOTILITY, SENSIBILITY AND REFLEXES  
(From L. F. Barker)

SEGMENT OF SPINAL CORD: SPINAL NERVE ROOTS	MUSCLES*	MOVEMENTS	CUTANEOUS SENSIBILITY**	REFLEXES
Th <sub>1</sub>	<ol style="list-style-type: none"> <li>1. Hypothenar muscles.</li> <li>2. Mm. interossei.</li> <li>3. Mm. lumbricales.</li> </ol>	<p>(C<sub>8</sub> and Th<sub>1</sub>). Movements of the thumb and fingers.</p>	<p>Medial surface of upper arm and ulnar edge of forearm and hand; part of little finger, the ring finger, and ulnar margin of middle finger. "Dorso-ulnar zone."</p>	<ol style="list-style-type: none"> <li>1. Scapula reflex (C<sub>6</sub>-Th<sub>1</sub>).</li> <li>2. Palmar reflex (C<sub>1</sub>-Th<sub>1</sub>).</li> <li>3. Cilio-spinal reflex (efferent fibers) (C<sub>8</sub>-Th<sub>1</sub>).</li> </ol>
Th <sub>2</sub> -Th <sub>3</sub>	<ol style="list-style-type: none"> <li>1. Muscles of the back.</li> <li>2. Intercostal muscles (Th<sub>3</sub>-Th<sub>11</sub>).</li> <li>3. Muscles of abdominal wall (Th<sub>5</sub>-L<sub>1</sub>).</li> </ol>	<ol style="list-style-type: none"> <li>1. Movements of spine extension and rotation.</li> <li>2. Respiration.</li> <li>3. Prelum abdominis; rising from recumbent position.</li> </ol>	<p>Th<sub>2</sub>. Skin over thorax below the cervico-thoracic limiting line (between second and third rib) lateralward to include the upper medial part of the arm; behind, to seventh cervical spine. "Dorsobrachial zone."</p>	
			<p>Th<sub>3</sub>. In front between third and fourth rib; behind, below the spina scapulae. To a slight extent in the axilla and upper medial arm(?). "Scapulobrachial zone."</p>	
			<p>Th<sub>4</sub>. In front, region of nipples above the intermamillary line; behind, as low as fifth thoracic spine. "Dorso-axillary zone."</p>	

\*For plurisegmental innervation of muscles see preceding table; here only the dominant segment is given.

\*\*The names of the zones in quotation marks are those used by Head.

TABLE OF CORD SEGMENTAL REPRESENTATION OF MOTILITY, SENSIBILITY AND REFLEXES

(From L. F. Barker)

SEGMENT OF SPINAL CORD: SPINAL NERVE ROOTS	MUSCLES*	MOVEMENTS	CUTANEOUS SENSIBILITY**	REFLEXES
			<p>Th<sub>6</sub>. Area just below the nipples.  "Scapulo-axillary zone."  Th<sub>6</sub>. In front, crosses xiphoid; behind, a little above eighth thoracic spine.  "Subscapulo-inframammary zone."  Th<sub>7</sub>. In front, tip of xiphoid.  "Sucscapulo-ensiform zone."</p>	
			<p>Th<sub>8</sub>. In front about midway between nipple and navel.  "Mid-epigastric zone."  Th<sub>9</sub>. In front above the navel; behind, just above first lumbar spine.  "Supra-umbilical zone."</p>	Upper abdominal reflex (Th <sub>8-9</sub> ).

\*For plurisegmental innervation of muscles, see preceding table; here only the dominant segment is given.

\*\*The names of the zones in quotation marks are those used by Head.





TABLE OF CORD SEGMENTAL REPRESENTATION OF MOTILITY, SENSIBILITY AND REFLEXES

(From L. F. Barker)

SEGMENT OF SPINAL CORD SPINAL NERVE ROOTS	MUSCLES*	MOVEMENTS	CUTANEOUS SENSIBILITY**	REFLEXES
L <sub>3</sub>	1. M. ileopsoas. 2. Adductors of the thigh (L <sub>2-4</sub> ). 3. M. quadriceps (L <sub>2-4</sub> ).	1. Flexion of the thigh. 2. Adduction of the thigh. 3. Extension of leg on thigh.	Region of the knee.	Knee-jerk (L <sub>2-4</sub> ).
L <sub>4</sub>	1. M. quadriceps (L <sub>2-4</sub> ). 2. Lateral rotators of thigh. 3. M. tibialis anticus.	1. Extension of leg on thigh. 2. Lateral rotation of thigh. 3. Dorsal flexion of foot; elevation of medial margin.	Medial surface of leg.	1. Knee-jerk (L <sub>3-4</sub> ). 2. Gluteal reflex (L <sub>4-5</sub> ).
L <sub>5</sub>	1. Mm. gluteus med. and min. (L <sub>4-S</sub> ). 2. M. semimembranosus; M. semitendinosus; M. biceps femoris.	1. Adduction and medial rotation of thigh. 2. Flexion of leg.	1. Narrow triangular area in front of ankle, extending to dorsum of foot. 2. Narrow triangular area over tendo-Achilles and heel, extending to planta pedis. "Fibulodorsal zone."	1. Gluteal reflex (L <sub>4-5</sub> ). 2. Achilles-jerk (L <sub>5-S</sub> ).
S <sub>1</sub>	1. Mm. gluteus maximus (L <sub>4-S</sub> ) <sub>2</sub> .	1. Fixation of pelvis on thigh; extension of thigh.	1. Narrow zone extending from the dorsum pedis up behind the fibula, on the lateral surface of the foot and leg.	1. Achilles-jerk (L <sub>5-S</sub> ).

\*For plurisegmental innervation of muscles, see preceding table; here only the dominant segment is given.

\*\*The names of the zones in quotation marks are those used by Head.

TABLE OF CORD SEGMENTAL REPRESENTATION OF MOTILITY, SENSIBILITY AND REFLEXES  
 (From L. F. Barker)

SEGMENT OF SPINAL CORD: SPINAL NERVE ROOTS	MUSCLES*	MOVEMENTS	CUTANEOUS SENSIBILITY**	REFLEXES
	2. M. pyriformis; M. obturator internus; M. gemelli; M. quadratus femoris.	2. Lateral rotation of thigh. 3. Dorsal flexion of the foot and toes.	2. Narrow zone extending upward from behind the lateral malleolus; it extends in a spiral direction over the calf to reach the medial condyle of the femur. "Soleal zone."	2. Plantar reflex (S <sub>1-2</sub> ).
	3. M. tibialis anticus. Mm. peronei; Mm. extensor digitor longus and brevis.			1. Achilles-jerk (L <sub>5</sub> -S <sub>2</sub> ).
S <sub>2</sub>	1. M. gastrocnemius; M. soleus.	1. Plantar flexion of foot.	Lateral part of buttock, and most of posterior surface of thigh and upper lateral calf (anesthesia has riding breeches shape). Lateral surface of leg; lateral margin of foot; sensibility of bladder and rectum. "Sciatic zone."	2. Plantar reflex (S <sub>1-2</sub> ). 3. Ejaculation center (S <sub>2-3</sub> ).
	2. M. flexor digiti comm.; M. flexor hallucis. 3. M. tibialis posterior.	2. Flexion of the toes. 3. Adduction of foot, with elevation of its medial margin.		

\*For plurisegmental innervation of muscles, see preceding table; here only the dominant segment is given.

\*\*The names of the zones in quotation marks are those used by Head.

TABLE OF CORD SEGMENTAL REPRESENTATION OF MOTILITY, SENSIBILITY AND REFLEXES  
(From L. F. Barker)

SEGMENT OF SPINAL CORD; SPINAL NERVE ROOTS	MUSCLES*	MOVEMENTS	CUTANEOUS SENSIBILITY**	REFLEXES
$S_3^*$	4. Small muscles of foot. 1. Perineal muscles.	4. Flexion, adduction and abduction of toes. Voluntary starting and stopping of urination and defecation; erection; second phase of ejaculation.	1. Most of gluteal region.	1. Ejaculation center ( $S_{2-3}$ ).
	2. Voluntary muscle of genito-urinary organs and rectum.		2. Perineum, scrotum, penis. 3. Uppermost part of medial surface of thigh.	2. Erection center ( $S_3$ ). 3. Bladder center ( $S_{3-4}$ ). 4. Rectal center ( $S_{3-4}$ ).
$S_{4-5}$ + coccyg.	1. M. levator ani ( $S_{3-4}$ ). 2. M. sphincter ani externus ( $S_{3-4}$ ). 3. M. coccygeus ( $S_3$ -coccyg.).	Voluntary starting and stopping of urination and defecation.	1. Anal and perineal regions. 2. Medial sacral and coccygeal regions.	1. Bladder centers ( $S_{3-4}$ ). 2. Rectal centers ( $S_{3-4}$ ). 3. Anal reflex ( $S_6$ + coccyg.).

\*For plurisegmental innervation of muscles, see preceding table; here only the dominant segment is given.

\*\*The names of the zones in quotation marks are those used by Head.

Just as the irritation produced in the viscus as the result of visceral pathology causes a pain to be referred to certain areas, so does stimulation of these areas also refer back reflex changes that affect the viscera. This is the basis of regional actinotherapy; and though used in *painful* diseases of the viscera, it is to be noted especially that regional actinotherapy may be used for the correction, at least in part, of visceral disease that fails to produce pain.

### DISORDERS OF THE STOMACH

The more common lesions of the stomach causing pain, and for which regional actinotherapy is useful, are:

1. Gastralgia (?)
2. Hyperchlorhydria
3. Cardiac or pyloric spasm
4. Acute dilatation
5. Acute gastritis
6. Chronic gastritis
7. Gastric ulcers
8. New growths
9. Perigastric adhesions

Pains induced by these lesions involve:

- (a) The epigastrium
- (b) The back between the posterior borders of both scapulae
- (c) The hyperalgesic areas include the sixth (when the esophagus is involved), the seventh, eighth and sometimes ninth dorsal (study table and see cut).

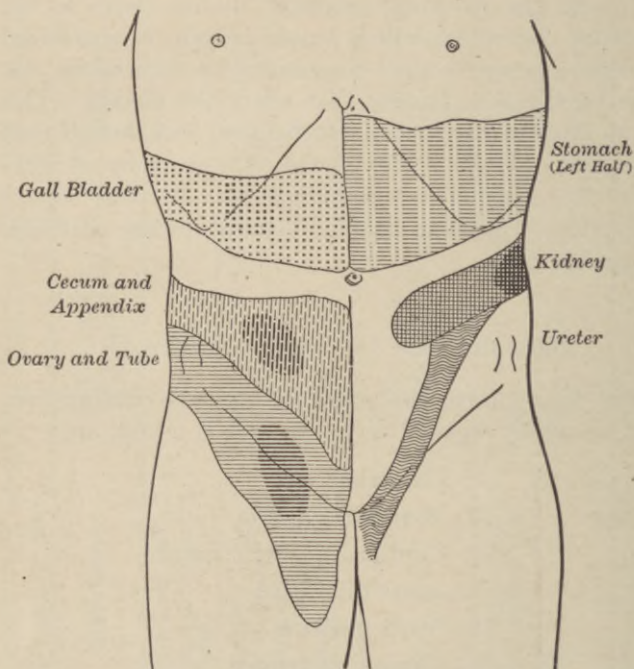


FIG. 1—The general location and outline of the zones of cutaneous hyperalgesia for some of the abdominal viscera. Anterior view. The maxima are deeply shaded. Only the left half of the gastric zone is given. The ureteral zone consists of a series of maxima (diagrammatic).

### GASTRALGIA

A sensory neurosis of the stomach that induces, reflexly, a pressure-pain sense in the epigastrium.

*Regional Actinotherapy:* The individual rests on a table. Draw a bed-sheet, or equivalent covering, over the face and upper part of the chest so as to cover all above a line that connects both nipples. Draw a second sheet over the legs and pelvic region to a level with the

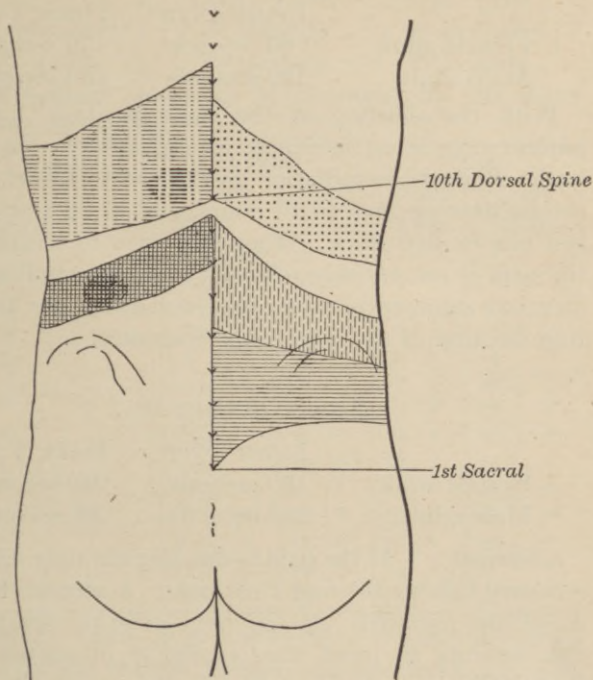


FIG. 2—The general location and outline of the posterior parts of the zones (diagrammatic).

umbilicus. This leaves an area in front exposing the hyperalgesic regions.

Adjust the lamp over the patient so that the uviarc is directly over the median line of the individual, and in the same direction as the median line. Open the casing sufficiently wide entirely to cover the exposed area. The lamp must show an operating voltage (voltage across the tube) of 70. Apply a regenerative erythema, as follows:

	LIGHT TYPE	DARK TYPE
Female adult	90 seconds	120 seconds
Male adult	120 seconds	150 seconds

With the sheeting in the same position, have the patient turn so as to expose an equivalent area on the back. Repeat the radiation on the back. The erythema should develop in 6 to 10 hours, and in its acute form, last one or two days. When it begins to disappear, if the pain is not entirely relieved, a second application in identical manner is used, but increasing the exposure time because of the established tolerance.

#### SECOND EXPOSURE

	LIGHT TYPE	DARK TYPE
Female adult	180 seconds	240 seconds
Male adult	240 seconds	300 seconds

*Comment:* If the pain is due to gastralgia, excellent recovery follows the first treatment. A second exposure is seldom required. If the pain persists, restudy the case bearing in mind the possibility of gastric ulcer. Practically immediate amenability to actinotherapy is a distinguishing diagnostic symptom of gastralgia.

#### HYPERCHLORHYDRIA

A secretory neurosis of the stomach that produces pain (as distinguished from all other secretory neuroses).

*Regional Actinotherapy:* Since, in hyperchlorhydria, the pain is diffuse, and extends over the entire abdomen, the region treated is the whole back and front above the waistline, two exposures to a treatment (back and front). Frequently repeated doses of stimulative erythema are better, it appears, than fewer doses of regenerative erythema. Initial exposure:



	LIGHT TYPE	DARK TYPE
Female adult	50 seconds	60 seconds
Male adult	60 seconds	90 seconds

Each subsequent exposure is increased by the same amount as the original, viz.:

	FEMALE		MALE	
	LIGHT	DARK	LIGHT	DARK
1st exposure. . . . .	50 sec.	1 min.	1 min.	1½ min.
2d " . . . . .	1⅓ min.	2 "	2 "	3 "
3d " . . . . .	2½ "	3 "	3 "	4½ "
4th " . . . . .	3⅓ "	4 "	4 "	6 "
5th " . . . . .	4⅓ "	5 "	5 "	7½ "
6th " . . . . .	5 "	6 "	6 "	9 "
7th " . . . . .	5⅝ "	7 "	7 "	10½ "
8th " . . . . .	6⅔ "	8 "	8 "	12 "
9th " . . . . .	7½ "	9 "	9 "	13½ "
10th " . . . . .	8⅓ "	10 "	10 "	15 "
11th " . . . . .	9⅓ "	11 "	11 "	16½ "
12th " . . . . .	10 "	12 "	12 "	18 "
13th " . . . . .	10⅝ "	13 "	13 "	19½ "
14th " . . . . .	11⅔ "	14 "	14 "	21 "
15th " . . . . .	12½ "	15 "	15 "	22½ "

*Comment:* Since hyperchlorhydria is generally associated with (1) mental fatigue and overwork, (2) gastrointestinal atony with chronic constipation, or (3) indiscretions in food, coffee or tobacco, these must be attended to promptly. One must be cautioned not to overlook the possibility of gastric or duodenal ulcer, or reflex causes of hyperacidity such as cholelithiasis, chronic appendicitis or ileal stasis. Hyperchlorhydria, of whatever origin, yields under a course (six to fifteen treatments, every second day) of ultra-violet therapy; but when due to other than secretory neurosis, the surgical possibilities should not be neglected.

CARDIAC OR PYLORIC SPASM

Like other hollow abdominal viscera, the stomach is subject to colic; but the parts of the stomach chiefly

affected are the pylorus and cardia. The pain and hyperalgesia is epigastric.

• *Regional Actinotherapy:* The mechanism here is to excite, by stimulation, the nerve filaments that are in the epigastric skin region. This, by reflex, relieves the spastic reaction of the pyloric or cardiac sphincters. Minimum exposures to the epigastrium are sufficient. Overexposure is contraindicated because of the hyperemic temperature created; and, as Schmidt has shown, cold is borne better than heat.

Direct the rays to the epigastrium. The back need not be exposed. Use a broken stimulative dose, about as follows:

	FEMALE ADULT		MALE ADULT	
	LIGHT	DARK	LIGHT	DARK
Initial dose.....	10 sec.	12 sec.	12 sec.	18 sec.
15 minutes later.....	10 "	12 "	12 "	18 "
30 minutes later.....	10 "	12 "	12 "	18 "
45 minutes later.....	10 "	12 "	12 "	18 "
1 hour later.....	10 "	12 "	12 "	18 "
Total.....	50 "	60 "	60 "	90 "

*Comment:* A stimulative dose, broken in five fractions, gives a splendid nervous reaction that usually diverts the sphincteral spasm. Each fraction follows the preceding exposure after a 15-minute interval. The sum of the fractions, at the end of one hour, equals the stimulative dose time. Excellent results in pure spasms of the stomach.

#### ACUTE DILATATION

Usually a post-operative sequelum when there has been much handling of the viscera. A relaxation of muscle tone. The discomfort-pain is epigastric, which should be rayed heavily, *during or after immediate gastric lavage.* Actinotherapy does not relieve the stomach of its contents. It increases, by reflex, the muscular tone.

*Regional Actinotherapy:* Regenerative erythema over the epigastrium.

	FEMALE ADULT		MALE ADULT	
	LIGHT	DARK	LIGHT	DARK
Regenerative erythema	90 sec.	120 sec.	120 sec.	150 sec.

*Comment:* When not the result of operative handling, it is generally a less severe situation. If exposed viscera are irradiated during operation, many think that acute dilatation is completely aborted. This is an interesting speculation worthy of investigation. In post-operative dilatation, depend upon immediate and complete lavage for relief; and upon actinotherapy, to maintain the gastric tone for precluding possible repetition.

#### ACUTE GASTRITIS

A painful reaction of the stomach occasioned by inflammatory pathology. When the inflammation involves the walls of the stomach, the immediately adjacent lymphatics become affected. The distribution of pain and hyperalgesia is the same as for gastralgia; but the pain seems to run right through to the back, so that pain between the shoulders is also felt. Morphine must sometimes be used.

*Regional Actinotherapy:* Regenerative erythema from the nipple line to the umbilicus level, over front and back. Prepare with sheets as for gastralgia. Exposure, over each region (back and front):

	FEMALE ADULT		MALE ADULT	
	LIGHT	DARK	LIGHT	DARK
Initial exposure. . . . .	1½ min.	2 min.	2 min.	2½ min.
2d " . . . . .	3 "	4 "	4 "	5 "
3d " . . . . .	4½ "	6 "	6 "	7½ "
4th " . . . . .	5 "	8 "	8 "	10 "
5th " . . . . .	6½ "	10 "	10 "	12½ "
6th " . . . . .	8 "	12 "	12 "	15 "

*Comment:* The radiation should relieve the tension of the recti muscles, which, particularly on the right side, are generally contracted. In proportion as this tension is reduced, the pain of the gastritis yields.

### CHRONIC GASTRITIS

Usually not painful. Only a feeling of discomfort.

*Regional Actinotherapy:* Stimulative erythema in a course of exposures. Useful particularly in the atrophic forms where pains resembling the gastric crises of tabes are occasionally present. Actinotherapy is a most useful auxiliary measure. Exposure course:

EXPOSURE	FEMALE		MALE	
	LIGHT	DARK	LIGHT	DARK
Initial.....	50 sec.	1 min.	1 min.	1½ min.
2d.....	1⅓ min.	2 "	2 "	3 "
3d.....	2½ "	3 "	3 "	4½ "
4th.....	3⅓ "	4 "	4 "	6 "
5th.....	4⅓ "	5 "	5 "	7½ "
6th.....	5 "	6 "	6 "	9 "
7th.....	5⅓ "	7 "	7 "	10½ "
8th.....	6⅓ "	8 "	8 "	12 "
9th.....	7½ "	9 "	9 "	13½ "
10th.....	8⅓ "	10 "	10 "	15 "
11th.....	9⅓ "	11 "	11 "	16½ "
12th.....	10 "	12 "	12 "	18 "
13th.....	10⅓ "	13 "	13 "	19½ "
14th.....	11⅓ "	14 "	14 "	21 "
15th.....	12½ "	15 "	15 "	22½ "
16th.....	13⅓ "	16 "	16 "	24 "
17th.....	14⅓ "	17 "	17 "	25½ "
18th.....	15 "	18 "	18 "	27 "
19th.....	15⅓ "	19 "	19 "	28½ "
20th.....	16⅓ "	20 "	20 "	30 "

*Comment:* Primary forms of chronic gastritis, resulting from dietetic errors, hasty eating, faulty mastication,

lack of exercise, are benefited much; more especially is the mental depression, usually a prominent feature of the condition, dispelled.

Secondary forms, where the chronic gastritis accompanies various organic diseases, such as cancer, severe anemia, tuberculosis, renal disease, arterial sclerosis, cardiac insufficiency or portal obstruction, yield less readily unless, obviously, the major pathology is at the same time attacked.

### GASTRIC ULCERS

It appears that the mechanism of pain production in gastric ulcer is much similar to that obtaining in gastritis; excepting that the circumscription of the ulcer more definitely focalizes the pain area on the skin. Increased acidity of the gastric juice is usually present, though its absence by no means rules out gastric ulcer. There is some question as to whether the increased acidity induces the pain attack.

*Regional Actinotherapy:* Irradiate the epigastrium, using a regenerative erythema, as follows:

	FEMALE		MALE	
	Light	DARK	LIGHT	DARK
Initial. . . . .	1½ min.	2 min.	2 min.	2½ min.
2d. . . . .	3 "	4 "	4 "	5 "
3d. . . . .	4½ "	6 "	6 "	7½ "
4th. . . . .	6 "	8 "	8 "	10 "
5th. . . . .	7½ "	10 "	10 "	12½ "
6th. . . . .	9 "	12 "	12 "	15 "
7th. . . . .	10½ "	14 "	14 "	17½ "
8th. . . . .	12 "	16 "	16 "	20 "
9th. . . . .	13½ "	18 "	18 "	22½ "
10th. . . . .	15 "	20 "	20 "	25 "

The interval between each treatment should be about two days. After the tenth treatment, stop the ultra-violet therapy. Wait an interval of two weeks without treatment. Then begin again the course above outlined.

*Comment:* The treatment is long, but commendable. Hematemesis is soon checked, as can be determined by the silk thread test. Complications are aborted. Pain is dispelled. Under X-ray, the gastric spasm usually elicited is found to disappear. Hyperchlorhydria is diminished, the acidity of the gastric juice reaching a normal value.

Clinically, at least in so-called "medicinal" ulcers of the stomach (so small as to contraindicate surgical intervention) most encouraging control follows actinotherapy. Be certain to distinguish from (1) carcinoma (especially *ulcus carcinomatosum*), (2) from duodenal ulcer (right-sided hunger pain, especially at 2-4 a.m.; vomiting less common; periodicity of symptoms more marked; X-rays); (3) from gallstones and cholecystitis (absence of occult blood and of hypomotility; occasionally, urobiligenuria; character of pain; sometimes icterus; X-rays); (4) from appendicitis in a high appendix; (5) from nervous epigastrials (absence of occult blood, and of a definite relation of pain to the ingestion of food; introduction of 100 c. c. N/10 HCl through a tube may cause no pain); (6) from gastric crises of tabes (pupils; knee jerks); and (7) from epigastric hernia (relation of pain to exercise rather than to food; palpation). It is wise to rule out, in addition, (8) renal stone, (9) intestinal parasites, and, in women, (10) pelvic disease.

## CHAPTER V

### REGIONAL ACTINOTHERAPY



FROM the viewpoint of gynecology, referred pains are important in connection with the treatment of certain disorders of the female genitalia, particularly the uterus, the tubes and the ovaries. The area of distribution of cord segments involved in uterine, ovarian and tubal diseases includes:

1. For the uterus; tenth, eleventh and twelfth dorsal
2. For the cervix; third and fourth lumbar, sometimes also the first and second sacral segments
3. For the ovaries; the tenth dorsal
4. For the tubes; eleventh and twelfth dorsal, and first lumbar segments

So that the region involved in pelvic visceral disorders is from the level of the free borders of the ribs to halfway between the hip and the knee in front, and the corresponding area in back. It must be recalled that involvements of the female genitalia are capable of producing local, referred, reflected, transferred and sympathetic pains; and that this multiple effect taxes the diagnostic acumen of the surgeon.

#### DYSMENORRHEA

Painful menstruation presents certain clinical varieties, such as:

1. Neuralgic
2. Congestive
3. Mechanic
4. Membranous
5. Ovarian

For the neuralgic type, in which the pain is usually most severe just before the onset or during the early hours of the flow, regional actinotherapy is useful, particularly when combined with the supportive treatment demanded by the case (colchicum or salicylates in the gouty; iron, arsenic and strychnine intramuscularly administered in the anemic).

The actinic erythema required over the region of hyperalgesia depends upon the severity of the pain when

Mild or Moderate	}	Stimulative erythema
Intense		
	}	Regenerative erythema

Exposure factors are:

	STIMULATIVE		REGENERATIVE	
	LIGHT	DARK	LIGHT	DARK
Initial.....	50 sec.	60 sec.	90 sec.	120 sec.
2d. ....	1 $\frac{2}{3}$ min.	2 min.	3 min.	4 min.
3d. ....	2 $\frac{1}{2}$ "	3 "	4 $\frac{1}{2}$ "	6 "
4th. ....	3 $\frac{1}{5}$ "	4 "	6 "	8 "
5th. ....	4 $\frac{1}{6}$ "	5 "	7 $\frac{1}{2}$ "	10 "
6th. ....	5 "	6 "	9 "	12 "
7th. ....	5 $\frac{5}{6}$ "	7 "	10 $\frac{1}{2}$ "	14 "
8th. ....	6 $\frac{2}{3}$ "	8 "	12 "	16 "

This generally relieves the pain during the acuity of the attack. In the course of the intramenstrual period, a complete survey of the pelvic organs should be made and the underlying pathogenesis of the dysmenorrhea corrected.

Congestive dysmenorrhea is treated with a regenerative erythemic reaction over the pelvic area as outlined previously.



## SCHEME

	LIGHT TYPE	DARK TYPE
Initial.....	1½ min.	2 min.
2d.....	3 “	4 “
3d.....	4½ “	6 “
4th.....	6 “	8 “
5th.....	7½ “	10 “
6th.....	9 “	12 “
7th.....	10½ “	14 “
8th.....	12 “	16 “
9th.....	13¼ “	18 “
10th.....	15 “	20 “

By stimulating the capillary requirement of blood, which the erythema accomplishes, the related internal viscera are correspondingly “decongested.” If there is some leucorrhœa between periods, suspect a tumor or uterine displacement. Saline cathartics should always precede decongestive actinotherapy.

Ovarian dysmenorrhœa is similarly treated, using regenerative erythemic applications as for congestive dysmenorrhœa. Avoid alcoholic stimulants and morphine.

## MENORRHAGIA AND METRORRHAGIA

One, menorrhagia, is an increased menstrual discharge; the other, metrorrhagia, is a discharge occurring at times other than the normal period.

These conditions may arise as primary affections of the uterus, such as:

- (a) Endometritis (especially granular form)
- (b) Interstitial or submucous fibroid tumors
- (c) Para, or peri, metritis
- (d) Secundines, retained
- (e) Subinvolution
- (f) Malignant disease
- (g) Chronic inversion

or they may arise from conditions which secondarily affect the uterus, such as:

- (a) Diseases of the tubes and ovaries
- (b) Renal, hepatic, or cardiac diseases; tuberculosis, continued fevers, etc.
- (c) Fecal impaction
- (d) Hemophilia
- (e) Ectopic gestation

Pain is relieved by actinotherapy, when pain is a distinguishing symptom. Beyond this, the pristine cause must be sought and corrected. For the pain, a stimulative erythema is ample, repeating frequently, say daily or at most every second day. This same exposure reflexly influences the tone of the uterine musculature, and is therefore a splendid measure.

#### FALLOPIAN TUBES

Pain due to disease of the Fallopian tubes may result from:

- 1. Distension of the tubes
- 2. Inflammation
- 3. Adhesions

These are collectively realized as forms of salpingitis, which may be acute or chronic. Pozzi gives an anatomical and clinical classification which is quite serviceable, as follows:

- |              |   |                             |
|--------------|---|-----------------------------|
| 1. Noncystic | } | (a) Acute catarrhal         |
| salpingitis  |   | (b) Acute purulent          |
|              |   | (c) Chronic parenchymatoses |
|              |   | (d) Pachysalpingitis        |
| 2. Cystic    | } | (a) Hydrosalpinx            |
| salpingitis  |   | (b) Pyosalpinx              |
|              |   | (c) Hematosalpinx           |

Salpingitis is usually secondary to a gonorrhoeal or puerperal septic endometritis. Taking cold during the menstrual period, excessive exercise, tuberculosis, syphilis or eruptive fevers are also causal.

Throbbing pains are usually due to hyperemia; when there should be given a regenerative erythema over the pelvic region. Dull aching pains are due to chronic inflammation, generally, and yield best to stimulative erythema over the pelvic region of hyperalgesia.

When the indications are not such as to indicate operation, there being only slight pain and moderate menorrhagia, regional actinotherapy furnishes an excellent palliative treatment. Rest in bed and saline purgatives should be prescribed.

## EXPOSURES

	STIMULATIVE		REGENERATIVE	
	LIGHT	DARK	LIGHT	DARK
Initial.....	50 sec.	60 sec.	90 sec.	120 sec.
2d. ....	1 $\frac{2}{3}$ min.	2 min.	3 min.	4 min.
3d. ....	2 $\frac{1}{2}$ "	3 "	4 $\frac{1}{2}$ "	6 "
4th. ....	3 $\frac{1}{3}$ "	4 "	6 "	8 "
5th. ....	4 $\frac{1}{6}$ "	5 "	7 $\frac{1}{2}$ "	10 "
6th. ....	5 "	6 "	9 "	12 "
7th. ....	5 $\frac{5}{6}$ "	7 "	10 $\frac{1}{2}$ "	14 "
8th. ....	6 $\frac{2}{3}$ "	8 "	12 "	16 "

## PELVIC INFLAMMATION

Pelvic inflammation is a clinical concept that includes pelvic peritonitis and pelvic cellulitis. It would appear, at first hand, that the two conditions might readily be separated; but the difficulties of differential diagnosis are sometimes so great as to preclude any absolute distinction until after an exploratory operation.

## PELVIC PERITONITIS

*Definition:* An inflammation of the pelvic peritoneum.

*Etiology:* Most usually pelvic peritonitis arises as a result of an extension to the peritoneum of inflammations involving the uterus, ovaries or tubes; and in the great majority of the cases, inflammation of the tubes. First, there may be an endometritis; then a salpingitis; and then a peritonitis. When the course of infection takes the avenues described, the pristine disorder may be traced to infection of the genital tract, such as that incident to:

(a) Gonorrhoea

(b) Introduction into the genital tract  
anywhere of septic materials, as from

instrumentation. Or the infection may extend by way of veins and vessels from the uterus into the broad ligament, omitting the intervening tubes.

*Pathology:* At first the peritoneum becomes hypermic, its luster is lost and exudation forms and accumulates. According to the quantity and character of exudate, pelvic peritonitis may be:

1. *Adhesive:* In which there is scarcely any serum exuded; the inflamed area being coated with fibrin and adhesions form which bind together the pelvic organs and intestines.
2. *Serous:* In which the exudate consists mainly of serum and lies either free in the peritoneal cavity or is encapsulated by adhesions.
3. *Purulent:* In which there is a severe exudate, and when especially septic, the exudate is almost wholly purulent.

## PELVIC CELLULITIS

*Definition:* An accumulation of serous exudate with or without fibrin and white cells, involving principally the cellular structures of the peritoneum.

*Etiology:* Pelvic cellulitis arises as the result of two causes, summed up by Cragin in the words traumatism and sepsis. Traumatism may come from labor, abortion or cervical operations; or from impaired physiological integrity of the individual cells of the pelvic structure (physiologic trauma).

At one time, pelvic cellulitis was considered common; but the experience gained through exploratory laparotomies teaches that masses and thickenings are most frequently found to be salpingitis and peritonitis. So that although pelvic cellulitis exists, its occurrence is fairly infrequent.

*Pathology:* Serum, fibrin, and white cells accumulate. This exudate may resolve; it may form new connective tissue; or it may suppurate, and often does. When it suppurates the pus may point above the tubes, or it may rupture into any of the adjacent structures, as the vagina, bladder, rectum or uterus.

## SECONDARY PATHOGENESIS

In cellulitis, as in peritonitis, two distinguishing pathologic phenomena are resident. The first is the presence of a pathogenic organism; the second is a lowered threshold of physiologic integrity on the part of the individual cells in the region invaded by the organisms. Too little attention is paid to the topic of cellular contribution in the process of infection. It is generally summarily dismissed by referring to it as "immunity" or "resistance." The accumulation of exudate is a significant index pointing to an impaired metabolism, and therefore alters the

exchange existing between blood supply and cellular activity. It seems that we could include pelvic cellulitis and peritonitis under the general term of pelvic inflammation; both being clinically related and being different manifestations of the same pathologic process. They differ only in the virulence of the attacking organism and in the anatomical orientation that the infection assumes. So that we may refer to the infectious character of these effects as the pristine pathogenesis of pelvic inflammation, and to the inhibited cellular physiology that leads to exudate formation as the secondary pathogenesis.

The secondary pathogenesis of pelvic inflammation is a factor that can be corrected through the proper administration of ultra-violet ray exposure. Stimulative erythemas are applied over the back and front of the nude individual (it is sufficient generally to expose from the waist up). The stimulation produced increases cellular metabolism in the surface structures. The radiations induce a change in the assimilative constant of the blood, making it more readily available for cells that are below par. This is another way of saying that systemic exposures to ultra-violet ray raise the resistance or immunity of the individual.

*Treatment of Pelvic Inflammation:* Primary pathologic factors, such as endometritis, fibroids, chronic salpingitis and similar infections must be removed by operative interference if the potential cause for pelvic inflammation is to be eradicated. In the acute stages of infection the amount of exudate reaction is an index of operative treatment; if the reaction is purulent and the exudate accumulates rapidly, drainage is indicated; if the reaction is fibrinous and goes on to chronic course, it is better to resort to measures that increase immunity and that will make for resorption of plastic exudation.

## REGIONAL ACTINOTHERAPY

In all cases stimulative ultra-violet radiations are indicated, whether or not operative interference is premeditated. When the attack is of non-operative virulence, this treatment may alone suffice to restore normalcy to the pelvic tissues.

Dose scheme:

	STIMULATIVE		REGENERATIVE	
	LIGHT	DARK	LIGHT	DARK
Initial.....	50 sec.	60 sec.	90 sec.	120 sec.
2d. ....	1 $\frac{2}{3}$ min.	2 min.	3 min.	4 min.
3d. ....	2 $\frac{1}{2}$ "	3 "	4 $\frac{1}{2}$ "	6 "
4th. ....	3 $\frac{1}{5}$ "	4 "	6 "	8 "
5th. ....	4 $\frac{1}{6}$ "	5 "	7 $\frac{1}{2}$ "	10 "
6th. ....	5 "	6 "	9 "	12 "
7th. ....	5 $\frac{5}{6}$ "	7 "	10 $\frac{1}{2}$ "	14 "
8th. ....	6 $\frac{2}{3}$ "	8 "	12 "	16 "

The treatment must be begun and maintained, allowing only minimum intervals to intervene between applications, usually 36 hours apart. When the primary pathologic focus is of intra-vaginal origin, usually bactericidal, the conjoint use of the bactericidal water-cooled lamp is at the same time indicated.

*General Comment:* There has been a tendency to over-treat, with actinotherapy, in gynecologic conditions. Use stimulative and regenerative erythemas, regionally applied, with intelligent discrimination; the stimulative being much more useful, as a rule, than the regenerative.

When combined with glandular extracts, corpus luteum, ovarian, and other organotherapeutic agents, actinotherapy furnishes a splendid gynecologic aid. Infection of

the urogenital passages is a bactericidal entity that will be discussed when the water-cooled lamp is considered.

Be careful of the diagnosis; use the radiant agent as a palliative measure, and complete the treatment, when necessary, by removing the prime cause. Ultra-violet may in many instances be of itself sufficient; but its capacity for doing clinical good must be judiciously assayed in terms of how the good is accomplished.

Avoid empiricism.



## CHAPTER VI

### FRACTIONAL ACTINOTHERAPY

**B**Y FRACTIONAL actinotherapy is meant the irradiation of the body in fractional portions for the purpose of establishing a strong tolerance to the rays in order that a more or less prolonged attack upon a general systemic condition can be made.

Those of us who are familiar with heliotherapy realize full well the entire significance of Dr. Rollier's teaching and practice; the gradual exposure of the nude body to the sun's rays as distinguished from an immediate thrust of the entire body into a highly active chemical environment such as actinic rays represent. In our own country, Lo Grasso, at Perrysburg, subscribes completely to the necessity for fractional irradiation (he uses heliotherapy) in the treatment of tuberculosis; and insists that a very great measure of the successful handling of surgical tuberculosis by actinic energy is resident in the use of the fractional method.

It is known that the limit of ultra-violet wave lengths reaching us from the sun is about 2900 Angström units. Spectrographic measures show, also, that the usual glass of window panes does not transmit shorter wave lengths than 3022 Angström units; and that heliotherapy, to be successful, cannot be employed behind windows, but must be in open light. In other words, glass filters off the ultra-violet wave lengths of sunlight that are essential in the treatment of tuberculopathies (and rickets).

Reproducing the wave lengths of the important bands of the biologic mercury vapor spectrum, we find:

	ANGSTRÖM UNITS
	{ 4000
	{ 3907
	{ 3821
Average limit of visible violet.....	{ 3752
	{ 3663
	{ 3650
	{ 3544
	{ 3391
Limit of Canada balsam transmission...	{ 3342
	{ 3126
Limit of usual glass transparency.....	{ 3022
Limit of cobalt glass transparency.....	{ 2967
	{ 2925
Extreme limit of sunlight ultra violet...	{ 2894

So that, obviously, the bands responsible for the actinic influence of ultra-violet in the treatment of constitutional states (tuberculosis, rickets and kindred aberrancies that will be discussed) are included between the limits of glass transparency and the sun's shortest ultra-violet wave lengths, or:

3022

2967

2925

2894

*Observe particularly that the sun's ultra-violet spectrum ends at the region where skin absorption of ultra-violet ends!*

The problem of the treatment of surgical and medical tuberculosis through the use of ultra-violet therefore resolves itself into:

1. Duplication of sun's spectrum
2. Fractional treatment
3. Proper adjuvant measures

Tests point out that the spectral region indicated is at its clinical best when the air-cooled lamp operates at 70 volts; but that at this voltage there are present also certain wave lengths shorter than 2894 Angström units that may reverse the biophotophysical effect of the longer rays. These, however, are practically nullified by increasing the distance which separates the tube from the skin to 40 inches. Hence, the most efficient results are to be expected with:

1. Air-cooled lamp
2. 70 volts
3. 40-inch tube-skin distance
4. Tangential (right angle) irradiation
5. Fractional irradiation

On this basis, the chart on following page is constructed, which serves as the method for treating every form of surgical or medical tuberculosis.

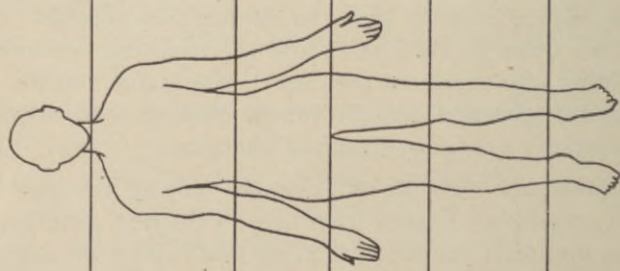
*First day:* The patient, with eyes protected from the rays (colored glasses or towel) is rested upon a table or couch. The feet are exposed anteriorly for one minute under the air-cooled lamp; then for one minute posteriorly.

*Second day:* The patient is covered over the head, chest, abdomen and knees, and exposed to the lamp for one minute from the knees to the feet; the sheet is then drawn down to the ankles and the exposure continued another minute over the feet. The same technic is pursued with the patient turned over so as to expose posteriorly over corresponding fractions.

*Third day:* The covering comes only to the level of the acetabula. Expose from here to the feet, anteriorly, one minute. Draw sheet to knees and expose one minute

VICTOR AIR COOLED QUARTZ LAMP. TANGENTIAL ILLUMINATION;  
TUBE - SKIN DISTANCE, ABOUT 40 INCHES; INTENSITY, LOW (ABOUT 70VOLTS)  
BACK AND FRONT TREATED AT EACH SESSION USING IDENTICAL PROGRESSION

1ST DAY	2ND DAY	3RD DAY	4TH DAY	5TH DAY	6TH DAY	7TH DAY	8TH DAY	9TH DAY	10TH DAY	11TH DAY	12TH DAY	13TH DAY	14TH DAY	15TH DAY
				1	2	3	4	5	6	7	8	9	10	11
			1	2	3	4	5	6	7	8	9	10	11	12
				1	2	3	4	5	6	7	8	9	10	11
					1	2	3	4	5	6	7	8	9	10
						1	2	3	4	5	6	7	8	9
							1	2	3	4	5	6	7	8
								1	2	3	4	5	6	7
									1	2	3	4	5	6
										1	2	3	4	5
											1	2	3	4
												1	2	3
													1	2
														1



AFTER THE FIFTEENTH DAY COMPLETE IRRADIATION  
OVER THE FRONT AND BACK FROM NECK TO FOOT  
1/2 HOUR AT EACH TREATMENT EVERY THIRD DAY

longer. Draw sheet to ankles and expose one minute more. Turn the patient over and repeat the exposures posteriorly in the same manner.

*Fourth day:* Cover only to a level opposite free borders of the ribs, anteriorly. Expose one minute. Draw sheet to acetabula and expose one minute more. Draw sheet to knees, expose one minute longer. Draw sheet to ankles, expose another minute. Repeat over corresponding posterior regions.

*Fifth day:* Cover only the head. Expose the entire anterior body that remains uncovered, one minute. Draw sheet to free borders of ribs and expose another minute. Draw sheet to acetabula, expose one minute more. Draw sheet to knees and continue exposure for another minute. Draw sheet to ankles and ray another minute. Repeat posteriorly.

These instructions are sufficient to explain the intent of the chart presented. It is advisable to prepare a chart such as the illustration shows, omitting the numerals in the squares. Leave a space to enter the name of the patient, and as each treatment is given fill in the date and the exposure time over each fraction treated. This gives an excellent permanent record of the therapy and serves as a reminder of the part and exposure time due at each treatment.

While this method is somewhat complicated, it furnishes desirable clinical results, especially in those patients who are not at all robust. Although there seems to be no accountable reason, the favorable progress of the cure appears proportional to the intensity of pigmentation produced; many patients showing no discernible improvement until the tanning begins.

Under this form of treatment, and providing further that the patient is instructed as to diet, hygiene, rest and the usual surgical measures that form an inherent part of established practice whether ultra-violet energy is or is not used, the various tuberculopathies respond well.

Objectively and subjectively there is elicited:

1. Practically an immediate reconstruction of mental assurance, manifesting in the patient by an appearance of good cheer and relivened vitality.
2. Rapid alleviation of pain which, as a rule, completely disappears.
3. Reduction of temperatures above normal.
4. The anorexia is dispelled; the appetite gradually returns.
5. Weight and strength increase.
6. The hemoglobin, red cell count and color index all increase to an approximate normal. The white cells rearrange their Arneth distribution and soon show a tendency toward preponderance of the lymphocytes.
7. In cases of joint tuberculosis not too greatly advanced, the motion is gradually restored, partially or completely (compare this to the ankylosis usually expected in treating alone with casts or operative measures; whereas in surgery the aim is to ankylose, in actinotherapy the ideal is restoration of physiologic joint function).
8. Radiolucent bone structures, as revealed by the X-ray, become normally radiopaque through the deposit of calcium and phosphorus. Sequestra tend to become spontaneously expelled.

9. Lymph nodes in the region of the pathology gradually shrink; or, if they are broken down, quite often resorb or calcify.
10. Effusions, in peritonitis and pleurisy, are partially or completely absorbed.
11. Abscesses are absorbed; or they may even calcify. Occasionally they must be aspirated repeatedly.
12. Sinuses react at first by an increasingly profuse discharge and sloughing. This is followed by the appearance of healthy granulations and the desiccation (drying up) and ultimate healing of the tract.

In actinotherapy, as in heliotherapy, a prerequisite is proper orthopedic fixation of the part undergoing treatment. What Lo Grasso says in connection with heliotherapy in tuberculosis applies with equal pertinency in actinotherapy, and is, therefore, reproduced here from the original: "The discarding of all casts in heliotherapy has led many to believe that immobilization is dispensed with in sun-cure. As I have brought out in previous articles, immobilization is one of the requisites in solar radiation. I cannot emphasize it too strongly that the Rollier method of heliotherapy is not mere insolation, but a combination of the sun treatment along with a specially devised method of fixation by rest in bed, by traction and by positions arranged with hard pillows—a combination which increases the resisting power of the patient, preserves or restores the natural function of the joint and prevents or corrects deformity.

"A bed with a surgical spring is employed in Pott's disease and in bone and joint tuberculosis of the lower extremities.

"In children, immobilization is accomplished by means of straps made of webbing placed around the chest and

legs and fastened to the side of the spring. Adults as a rule do not need any artificial immobilization. Traction is effected by leather cuffs that grip the thigh above the knee and the leg above the ankle. These are connected by straps that buckle at the side so that the pull will be at both the knee and the ankle and may be increased or decreased at will at either joint by shortening or lengthening the side straps. In case of tuberculosis of the knee the leather brace above the knee is discarded.

"In Pott's disease immobilization is accomplished in children as stated above while with adults we use absolute rest in bed. A hard pillow is placed under the kyphos and, when the patient is turned on his stomach, a triangular pillow with the base up is inserted under his chest, thus producing a compensating lordosis in both positions. In this way the deformity, unless very severe and ankylosed, is gradually reduced without interfering with complete insolation of the body.

"In tuberculosis of the hip, if there is a flexion deformity, the flexion is gradually reduced by traction, pulling in the direction of the deformity. The limb is supported on an incline of wood or hard pillows the angle of which is gradually reduced until the limb is in line with the body. When the patient is turned on his stomach the traction is removed and the incline is then placed in the opposite direction. Abduction, adduction and rotation are corrected by means of a side working extension that grips the leather cuff above the knee and fastens on a roller that runs along the side of the bed. After the flexion deformity, if present, has been reduced, the hips are placed in hyperextension by placing a small, hard pillow under the hips.

"In tuberculosis of the knee, immobilization is effected as in the case of spine and hip. Deformity is corrected



by traction as in this disease. Whereas in hip the traction pulls from above both the knee and ankle, in the case of the knee the pull is only from above the ankle. Subluxation of the tibia is prevented by placing a pad underneath the head of the tibia and corrected by placing the leg on a splint suspended with rubber bands. After the knee is straightened the whole limb is placed on an incline made of board or pillows to avoid equinus.

"In tuberculosis of the foot and ankle the limb must be placed, as in the case of knee tuberculosis, in an inclined plane to obviate equinus, which is sure to take place unless special precaution is taken. A splint may be used with a joint at ankle so that the foot may be kept, or brought, to its normal angle.

"In tuberculosis of the shoulder joint, no special immobilization or traction is used unless there is considerable displacement, in which case weights are hung from a leather cuff fastened just above the elbow. The weight of the arm itself, which acts as a natural tractor, is usually sufficient in these cases.

"In tuberculosis of the elbow, the joint is immobilized in half flexion by means of a wire or celluloid splint open in front. It is jointed at elbow and includes hand at slight radial flexion.

"In tuberculosis of the wrist and joints of the hand we use a similar splint, except that the arm is not included.

"In tuberculosis of all joints except the spine, after the flexion deformity has been reduced, we repeatedly flex and extend the joint by degrees so slight as not to produce spasm or pain.

"In peritonitis we keep the patient in bed until all sinuses have been healed and there is no more evidence of fluid present.

"In tuberculosis of the genito-urinary tract, if there is a marked cystitis we insist upon absolute rest in bed.

"In tuberculosis of the lymph nodes no bed treatment is required outside of the three or four hours of the sun treatment, unless it is indicated by poor physical condition.

"The same may be said in cases of tuberculosis of the eye, rib, face and upper extremities.

"Sinuses and ulcers are covered with a screen during insolation to protect from flies and to allow the sun access to the part. They are cleaned with alcohol and dressed with a gauze moistened with same.

"The only surgical interference that we have used is aspiration. Occasionally when the pus has been very thick, I have resorted to the use of a very narrow-bladed knife. A healthy part of the skin is always chosen for the aspiration or incision to avoid the possibility of a sinus. After the aspiration or evacuation of the pus, a slight pressure with a piece of gauze is applied to prevent bleeding into the abscess cavity.

"Dr. Rollier, outside of aspiration, condemns any and all surgical interference. We believe that there are times when surgery is advisable, but even then it should be judiciously combined with heliotherapy. The operation should be delayed until the sun has had a chance to do its work not only on the affected part but on the general condition of the patient, thus assuring a more favorable result. We have seen many instances in which a few months of sun-cure have changed the whole aspect of cases which at first had appeared hopeless."

Gassul has summarized his experience in the treatment of tuberculopathy by the use of various radiations (sun's rays, X-rays, ultra-violet rays, radium rays) in a mono-

graph entitled "Die Bedeutung der verschiedenartigen Strahlen für die Diagnose und Behandlung der Tuberkulose." Among the important messages conveyed by this thesis is the finding, conjointly arrived at by Levy and Gassul, that the irradiation of the entire body of animals under quartz light (mercury vapor lamp) leads to a visceral congestion of the dominant internal organs—the lungs, spleen, kidneys, liver; and, as Janet Clark says, it may well be that the empiric finding of Rollier, that fractional treatment must be used, finds a basis in the laboratory experiments of Levy and Gassul. This coincides, also, with the experience that in pulmonary tuberculosis, general body radiation is followed oftentimes by severe hemorrhage; the patients not doing at all well as compared to the results that accompany the more approved method of fractional actinotherapy.

Gassul, in a graphic table, shows that actinic energy is fraught with best results in the treatment of glandular tuberculosis. The order in which tuberculopathies respond are given as:

1. Glands
2. Joint
3. Pulmonary
4. Laryngeal
5. Skin and mucous membranes
6. Peritoneal
7. Urogenital

In this country, the general experience in the benefit that accrues from the use of actinotherapy in close accord with LoGrasso's findings with heliotherapy, about as follows:

"Historically, the J. N. Adams Memorial Hospital has shown a significant and increasing practice in heliotherapy since the inauguration of that work in 1913.

From the brilliancy of the results obtained the writer suggests that the medical profession generally devote closer study to the therapeutic possibilities of heliotherapeutic measures.

"Rigorous attention to established details of technic are imperative for best results. Various indications, contraindications and supporting adjuvant measures are recorded. It appears that the prognosis is favorable in proportion as the patient becomes pigmented. Pain is promptly dispelled. Temperature becomes normal. Appetite returns. Weight and strength improve, as does also the condition of the blood."

Here is presented a statistical table showing the results obtained in the treatment of surgical tuberculosis from 1913 to 1922 in many cases. Abridged, the findings are:

T. Bc. SITE OF INFECTION	CASES OBSERVED	RECOVERIES REPORTED
Eye.....	15	93.7%
Glands.....	244	83.0%
Peritoneum.....	63	81.8%
Wrist and hand.....	15	78.0%
Ankle and foot.....	13	72.2%
Epididymitis.....	6	66.6%
Hip.....	35	60.4%
Elbow.....	4	57.1%
Osteomyelitis.....	8	50.0%
Knee.....	13	46.0%
Spine.....	16	32.0%
Kidney.....	4	16.4%

The original table is more complete and includes also an expression of the percentages of arrested and improved cases, besides the failures. LoGrasso says also that heliotherapy is equally as useful in conditions other than

surgical tuberculosis; puerperal sepsis, anemia, rickets, osteomyelitis, non-healing wounds and convalescence from all wasting and infectious diseases; and, says the author, "the established prophylactic qualities of the rays are more marked even than the remarkable therapeutic properties."

## CHAPTER VII

### GENERAL OR SYSTEMIC ACTINOTHERAPY



WHEN a nude body is thrust quickly and entirely into the powerfully chemical radiation of the biologic air-cooled lamp, certain immediate physiological readjustments are effected in response to the unusual qualities of the strange environmental energy. This physiological response is an expression of the bodily forces to become adapted to the stimulus of the light. It is, therefore, photoadaptation. Practically every physiologic mechanism is attacked, depending upon the state of the mechanism at the time of environmental change. And it is singular and important that the induced physiological changes are wrought as the result of an absorption of the ultra-violet by the skin.

If we refer to the absorption characteristics of each band in the mercury arc spectrum, we arrive at the generalization that, beginning with the limit of visible violet (about 4000 Angström units), the depth to which each band of smaller wave length enters human tissue becomes less and less as the wave length decreases. No exact figures are possible owing to the extremely great variety of tissues and conditions that modify the absorption; but we are definitely informed that in the ultra-violet spectral region of 2900 Angström units, the ability of the rays to penetrate is lost; so that from 2900 to 1850 units, the latter being the limit of quartz transmission, ultra-violet wave lengths are stopped at the

immediate surface of the tissue which they strike.\* Hence the basic distinction between air-cooled and water-cooled lamps already presented, as follows:

ULTRA-VIOLET RADIATION  
(Mercury Arc in Quartz)

*Air Cooled*

*Water Cooled*

- |                                |                            |
|--------------------------------|----------------------------|
| 1. Near ultra-violet intensity | Far ultra-violet intensity |
| 2. Biologic (dominantly)       | Abiotic** (dominantly)     |
| 3. Chemically oxidizing        | Chemically reducing        |
| 4. Relatively penetrating      | Relatively superficial     |
| 5. Metabolic synergist         | Metabolic depressor        |

The better completely to understand the newer concept of ultra-violet therapy which is herein submitted, and since this newer concept is evolved on the basis of cellular physiology and ultra-violet absorption, there is reproduced in full an article on microscopy with ultra-violet light, from *Nature* (London), Nov. 18, 1920:

MICROSCOPY WITH ULTRA-VIOLET LIGHT†  
INCREASED RESOLUTION OBTAINED BY USING THE  
SHORT WAVE LIGHT BEYOND THE VISIBLE SPECTRUM  
By J. E. Barnard

The microscope is now so widely used in all branches of science and in industry that it is not surprising to find an increasing demand for greater optical efficiency. It must be admitted that in compar-

\*The detailed studies of ultra-violet absorption are recorded in the *Journal of Radiology*, for September, 1922, and subsequent issues.

\*\*Bactericidal.

†An expression of appreciation is extended to Prof. Wm. Bayliss, London, who so courteously directed the writer's attention to the brilliant researches of Barnard in this field of endeavor.

atively few cases is the instrument used under such conditions as to secure the best possible result; but this is due to lack of appreciation of the principles involved, and it will be remedied only by a wide educational effort. Even when the greatest optical efficiency is secured the limitations are soon felt. The chief need is for increased resolution, that factor on which the delineation of minute structure depends. Advances of great value have been made in methods of rendering visible minute objects, but it must be clearly realized that, while this greater visibility can be secured, no information as to the form or structure of objects which are below the resolution limits is to be obtained by this means. Increased magnification is by some workers still regarded as desirable, but unless this is accompanied by proportionally increased resolution, the results are worse than useless, and can lead only to serious errors of interpretation. Two factors mainly govern resolution—namely, the numerical aperture of the objective, and the mean wave length of the illuminant. No increase of numerical aperture has been obtained since the classic researches of Abbe, resulting in the production of apochromatic objectives; and in the present state of knowledge there appears little likelihood of any substantial advance in this direction. By using light of short wave length, a promising field of research is at once opened up. An increase of resolution is obtained even with visible light if the violet or blue end of the spectrum is utilized, but the increase is much more definite if ultra-violet light is used, although the image is no longer a visual one.

The computation of microscopic objectives for use with ultra-violet light presents considerable difficulties, as only two substances sufficiently transparent to these radiations are available—quartz and fluorite. So long ago as 1860, Spencer, in America, used fluorite for this purpose, and at a much later date Boys in this country suggested the possibility of using fused quartz. In 1904, Kohler, of Jena, succeeded in computing objectives entirely of fused quartz, some earlier ones which were fluorite-quartz combinations being thereby superseded. Ultra-violet light, therefore, became available for microscopic work, but the practical difficulties in the use of the apparatus are so considerable, calling for almost more knowledge of physical than of microscopical methods, that it has been used by few.

The results obtained, particularly in biological work, are in many cases of great interest, as, in addition to the advantages already indicated, there is the further important point that organisms are



dealt with and photographs obtained of them in the living state. The classic researches of Hartley showed that organic substances which are perfectly transparent to ordinary light have very definite absorption regions or bands in the ultra-violet, and that their absorption is, in many instances, so characteristic that it constitutes an accurate method of identification. To a considerable extent, this fact is of value when using ultra-violet in microscopy. Objects that show little or no structure by transmitted light are seen to be highly organized when examined by ultra-violet radiations, and the structure seen is in part dependent on the wave length of the light used. Objects for examination by this method must be dealt with in the living state, or at least in such a manner that no change takes place in their constitution. It follows that none of the ordinary methods of mounting such things as micro-organisms, in which staining, hardening, fixing, drying, or heating is resorted to, can be employed. The method is, in fact, its own staining process, differentiation of structure depending on the difference of absorption in ultra-violet, and not on complex staining processes, which are in some cases causing appearances not associated with the organism itself. Further, apart from the alteration that may take place in the tissues themselves as the result of such processes, their employment in the method under consideration would render them opaque to the radiations used, and, therefore, useless for the purpose. The organisms or tissues are simply mounted in any suitable fluid, such as water, normal saline, Ringer's solution, etc., which is transparent to ultra-violet light and the photograph is taken at once. The result is an image that, whether it shows more or less than a stained preparation, is a representation of the object in the living state, and with greater resolution than can be obtained in the microscope by any other process.

Such a method is obviously one to be tried to its utmost, whatever practical difficulties may be involved, and there is little doubt that in time it will be recognized as what it really is—the only great advance in microscopic technic for a generation. The apparatus as used by the present writer is in its essentials the same as that devised by Dr. Kohler (Fig. 1), although in many points of detail improvements have been devised.

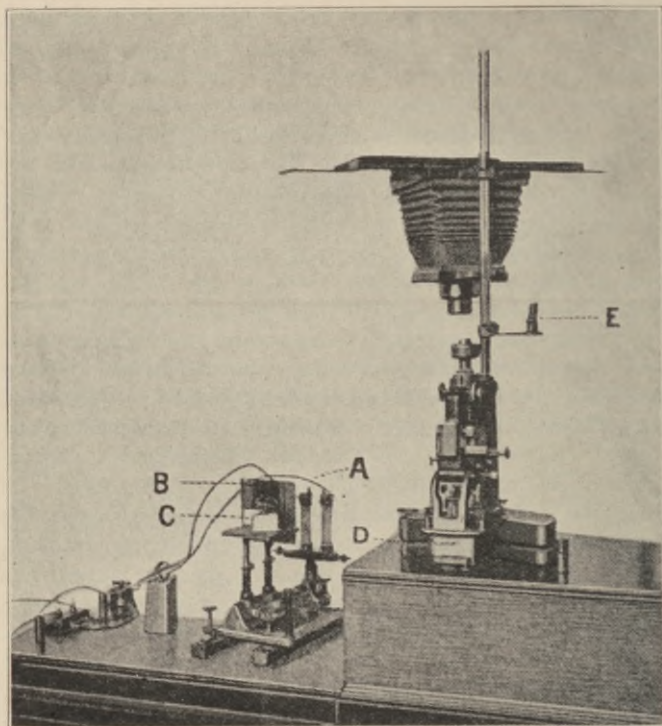
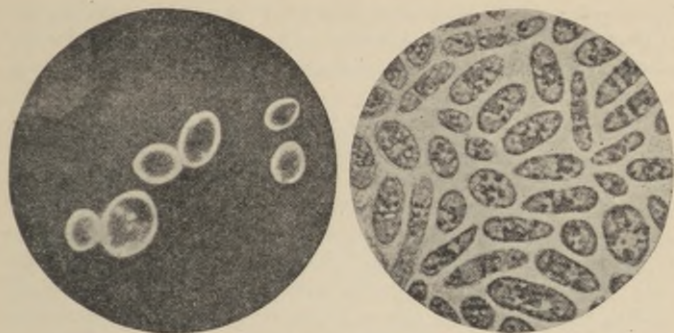


FIG. 1. APPARATUS FOR TAKING PHOTOMICROGRAPHS WITH ULTRA-VIOLET LIGHT

A, spark gap; B, quartz condensing lens; C, quartz prisms; D, box containing reflecting quartz prism; E, fluorescent ocular. The position of the other parts described will be evident to any microscopist.

The quartz objectives are three in number, their equivalent focal lengths being 6 mm., 2.5 mm., and 1.7 mm., their effective numerical aperture being respectively 2.50, 1.7, and 0.7. It will at once be appreciated that in cases where the full aperture can be utilized the two higher powers are of much greater N. A. when used with light of 275  $\mu$  wave length than any objective available for use with ordinary light. These two are glycerine immersion combinations, the refractive index of the immersion fluid being 1.447. As these systems are not homogeneous, the cover glasses are optically worked fused quartz of uniform thickness.



FIGS. 2 AND 3. SACCHAROMYCES PASTORIANUS (YEAST)

×1200

*Left* dark ground illumination; *right* ultra-violet light

FIGS. 4 AND 5. BACILLUS ANTHRACIS

×1000

*Left*, dark ground illumination; *right*, ultra-violet light

The slides are also of fused quartz, fitted into a carrier of a special type, which ensures that the surface of the slide is a constant distance from the objective, a point that in practice is of considerable importance. The quartz oculars are five in number and range from an initial magnification of 5 to 20, giving camera magnifications of from 200 to 3600 diameters. The latter is a good deal too high for satisfactory results with most objects—in fact, it is doubtful, on theoretical grounds, whether such a magnification is justified. The quartz substage condenser is made with a duplex top, so that a com-

bination is available for each objective to ensure that a suitable cone of illumination is used in each case. This is used as a glycerine immersion system with the two high-power objectives, and as a dry system with the lowest one.

The source of light is produced by a high-tension discharge in air between metal electrodes, usually cadmium or magnesium, although other metals may be used if they produce a suitable line spectrum. There are obvious limitations in this respect, as the character of the spectrum emitted must be such that the principal lines in the ultra-violet region are sufficiently separated and of considerable intrinsic brilliancy. The spectrum of iron, for instance, is excluded, as, although it is rich in bright lines, these are so numerous and therefore so close together that the isolation of one line is impossible under the conditions realized in this method.

The spark is produced by means of an induction coil of special design giving a heavy discharge of relatively low potential, the equivalent spark gap being about 5 cm. This is further reduced by placing a condenser immersed in oil in parallel with the spark gap. The interrupter may be either an electrolytic one or a mercury break, the latter appearing to be more satisfactory. Special arrangements are made for accurately adjusting both the length of the spark and its position in relation to the optic axis of the microscope. The image of the spark is projected by means of a quartz lens, so that, after passing through a pair of quartz prisms of opposite rotation, an image of the spark in one wave length is obtained approximately at the position of the iris diaphragm below the substage condenser. To facilitate adjustment, a disk of uranium glass is placed at the latter position so that an image of the spark can be observed and focused as required, after which the uranium glass in its carrier is swung aside. The direction of the illuminating beam is at right angles to the optic axis of the microscope; it has, therefore, to be reflected by a right-angled quartz prism along the axis in the same way that the mirror operates in an ordinary microscope.

The preparation being placed on the stage, the light adjusted, and the condenser accurately focused on the object, the actual focusing of the image has to be carried out. This is effected by means of a fluorescent searcher eye-piece which is mounted above the quartz ocular and by the use of which an image is seen on a fluorescent screen and focused by means of an auxiliary magnifier. This operation is one of considerable difficulty, and only after long practice

can success be assured. Its difficulty varies, too, according to the wave length used; in some cases the fluorescent image is bright, but in others it is much more difficult to see. Some objects themselves fluoresce, with a result that a sharp visual image cannot be obtained. The method now largely adopted by the writer is to observe the object by monochromatic light as emitted by a quartz mercury vapor lamp. This illuminant has bright lines in the violet, blue, green, and orange regions, and by means of screens any one of these can be transmitted.

The image having been focused visually in one of these lines, the fine adjustment of the microscope is moved by a predetermined amount so that the image is in focus for any desired wave length in the ultra-violet. This method is quite practicable provided that the fine adjustment of the microscope is of sufficient accuracy (the searcher eye-piece is not used in this case except to confirm the accuracy of the process). The focusing having been performed, the searcher eye-piece is removed, the camera placed in position, and the exposure made. The image is projected for a certain distance, so that it is in focus at the plane of the plate with a known length of camera. The exposures required are as short as two seconds under favorable conditions, even at high magnifications.

There was considerable difficulty in obtaining a suitable photographic plate, as one was required of fine grain and with the smallest possible quantity of gelatine on its surface. Gelatine is itself opaque to ultra-violet light, so that the photographic action is confined to the surface of the gelatine, little or no penetration in depth taking place as with ordinary light. The result is that plates must be prepared with the smallest possible quantity of gelatine, but with the maximum quantity of sensitive silver salts that the gelatine can hold together. Such a plate has been prepared by the Kodak Co., and has proved satisfactory. Plates as prepared by Schumann for work in the far ultra-violet have also been experimented with, but for various reasons have not proved so satisfactory. The resulting negatives are at first glance somewhat disappointing if judged by ordinary photographic standards. They are always thin and lacking in violent contrasts, owing to the superficial action of the light, but the detail and fineness of lines due to the shorter wave lengths used are evident to anyone having any knowledge of photomicrography. Whether the utmost resolution that theory demands can be achieved is at present unproved because of the difficulty of finding an object that can be regarded as a satisfactory test.

The accompanying illustrations give some idea of the comparative results obtained with living organisms. Figs. 2 and 4 are illuminated by a concentric dark-ground illuminator, the most satisfactory method available for observing living organisms by ordinary light, and Figs. 3 and 5 by a solid cone of ultra-violet light.

What we learn from this and similar studies by the same student (Barnard) is summarized by Bayliss ("Principles of General Physiology") about as follows:

The wave lengths able to reach deeply into the cell (near ultra-violet) attack preferably the nucleus or chromaffin structure. This is instantly revealed by ultra-violet microscopy; for under this type of special examination, it is seen that the nucleus so promptly absorbs the wave lengths as to appear dark (as if stained).

In other words, long or near ultra-violet wave lengths are selectively sought by nuclear or chromaffin structures; so that the physiologic activities of the nucleus of rayed surfaces may be

1. Stimulated
2. Increased
3. Exaggerated

depending upon whether we use biologic ultra-violet wave lengths (air-cooled lamp) in

Stimulative erythema  
Regenerative erythema  
Desquamative erythema

doses.

Functionally, the nucleus is the essential element of the cell. A nucleus isolated from its cytoplasm (cell body) may build or develop a new cytoplasm; but a cytoplasm deprived of its nucleus soon disintegrates and expires. Obviously the nucleus has to do with regeneration of the cell.

Osterbaut (*Science*, 1917; 46; 367) suggested, as have others, that the nucleus controls processes of oxidation.

Speaking generally, then, the systemic irradiation of the entire body, back and front, or as much of the entire body as propriety and conditions will permit, is indicated most in cases where

1. The action is desired to precipitate immediate results.

#### CALCIUM AND PHOSPHORUS METABOLISM

Among the proved effects of general irradiation under ultra-violet is the increase in the blood of calcium and phosphorus.

In a general way, the calcium and phosphorus metabolism becomes stable at about twenty-six years of age; when all the epiphyses have united and there is no longer any bodily requirement for excess calcium and phosphorus in the blood (see especially the studies of Tisdall). It happens, also, that the initiation of whatever pathology that attacks the mineral metabolism of bone, induces an immediate rise in the blood of calcium and phosphorus. Cases of fracture, for example, are attended by a rise in the calcium and phosphorus of the blood throughout the healing stages of the reunion.

Diseases or conditions showing a deficiency of calcium or phosphorus are, therefore, amenable or much aided by ultra-violet therapy. This includes:

1. Anaphylactic reactions
2. Tetany
3. Cancer
4. Rickets
5. Diseases of bone
6. Fractures

## ANAPHYLACTIC REACTIONS

Calcium salts reduce anaphylactic reactions (see Kastle, Healy and Buckner, *Jour. Infec. Dis.*, 1913; 12; 127), and it is clinically noticeable that systemic irradiations with ultra-violet produce sufficient calcium fixation as to be accompanied by a marked recovery from the allergy.

Hay fever and its various modifications; asthma; eczema (and other diseases of the skin); angio-neurotic edema and certain gastrointestinal disturbances show themselves to be, in a considerable number of cases, hypersusceptible to proteins of various origins. These may be quite accurately ascertained through the use of skin tests.

## TECHNIC OF CUTANEOUS TESTS\*

If the antigenic proteins are already in solution, as is the case with blood serum, no especial treatment is required other than suitable dilution under strictly aseptic precautions. If the protein is in solid form, as in the case of vegetable proteins and other cellular forms, extracts are required. The studies of Walker and of Wodehouse on the preparation of materials for the tests have been of the utmost importance. These are independent of the preparation of the various tuberculins, which will be discussed subsequently. They found that an excellent dried preparation of serum could be obtained by precipitating with several volumes of acetone, washing the precipitate centrifugally twice with alcohol and with ether, and drying to a powder. The powder may be applied to an incision in the skin and dissolved with N/10 NaOH solution. Bacteria are cultivated on solid media, washed centrifugally in salt solution, then twice in absolute alcohol with 0.5 per cent phenol added, twice in ether and then dried to a powder, which may be used as is the serum powder. Cereals, nuts and other seeds, roots and tubers, fruits, leaves and stems are extracted in water, precipitated with 95 per cent alcohol, washed with 95 per cent alcohol, absolute alcohol, ether, and desic-

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\*Verbatim from Karsner and Ecker, "Principles of Immunology."



cated over hydrochloric acid. Hair and dandruff of animals may be employed as a dissolved extract in 14 per cent alcohol, but for more accurate studies, dried preparations of acid metaprotein, alkali metaprotein and peptone extracted from the material are employed.

The methods of inoculation include introduction of the protein into abraded surfaces and intracutaneous injection through a fine needle. In special instances, as, for example, in the use of tuberculin, the material may be incorporated in an ointment and carefully rubbed into the skin; this is the so-called percutaneous test. Somewhat similar to the cutaneous tests is the ophthalmic reaction, more particularly applied in tuberculin tests, where the material is installed into the conjunctival sac. Subcutaneous injection of material is also resorted to, again with tuberculin rather than with other substances, but the determination of results is by means of the general rather than the local reaction. As with other reactions, controls are a necessary part of these tests. The cutaneous test, by which is meant introduction of material into an abrasion, is performed as in smallpox vaccination. Any part of the body may be selected, but we have found the arm most convenient. Walker advises making small incisions in the skin, deep enough to permit absorption, but not deep enough to cause bleeding. A small dental burr may be used, as in the Schick test. The material is placed on the abrasion or incision and allowed to remain one-half hour. If a powder, a solvent should be added after the powder is placed on the skin. If not completely soluble in water, a weak solution of sodium hydroxide, either 0.1 per cent, or N/10 may be employed, as it does not affect the reaction. Walker's studies show that for detecting hypersensitiveness in cases of asthma, hay fever, etc., the cutaneous test is more delicate and yields fewer false positive reactions than the intracutaneous test.

Whenever a diagnosis of anaphylactic reaction is made, a systemic ultra-violet irradiation is useful in striking the allergy from within by increasing the fixation of calcium. *Method:* Give calcium lactate by mouth in 20-grain doses. Expose the whole back and front of the nude individual under the biologic air-cooled lamp, 70 volts, 40-inch tube-skin distance, and give a stimulative erythema daily; or, in severe cases, twice daily, morning and evening. *Exposure:*

	FEMALE		MALE	
	LIGHT	DARK	LIGHT	DARK
Initial.....	50 sec.	1 min.	1 min.	1½ min.
2d.....	1⅔ min.	2 "	2 "	3 "
3d.....	2½ "	3 "	3 "	4½ "
4th.....	3⅓ "	4 "	4 "	6 "
5th.....	4⅓ "	5 "	5 "	7½ "
6th.....	5 "	6 "	6 "	9 "
7th.....	5⅝ "	7 "	7 "	10½ "
8th.....	6⅔ "	8 "	8 "	12 "
9th.....	7½ "	9 "	9 "	13½ "
10th.....	8⅓ "	10 "	10 "	15 "
11th.....	9⅓ "	11 "	11 "	16½ "
12th.....	10 "	12 "	12 "	18 "
13th.....	10⅝ "	13 "	13 "	19½ "
14th.....	11⅔ "	14 "	14 "	21 "
15th.....	12½ "	15 "	15 "	22½ "
16th.....	13⅓ "	16 "	16 "	24 "
17th.....	14⅓ "	17 "	17 "	25½ "
18th.....	15 "	18 "	18 "	27 "
19th.....	15⅝ "	19 "	19 "	28½ "
20th.....	16⅔ "	20 "	20 "	30 "

The purpose of the calcium lactate is to furnish a supply of the element in order that it may be more quickly assimilated by the blood.

*Comment:* A thorough knowledge of the pathology of serum disease will point out the many useful applications of this therapeutic measure. One should review especially the chapters on hypersusceptibility and anaphylaxis in: Wells, "Chemical Pathology;" Karsner and Ecker, "Principles of Immunology;" Hiss Zinnser and Russell, "Text Book of Bacteriology."

TETANY (PARATHYROID)

Nervous irritability is increased by the administration of calcium (as lactate or other therapeutic form); and if the use of calcium is accompanied by systemic ultra-violet treatments, the fixation of the element is more certain and the clinical response more definite and prompt. One uses a stimulative erythemic dose over the front and back daily, about as follows:

TETANY CHART  
(For Children)

	LIGHT	DARK
Initial exposure. . . . .	20 secs.	30 secs.
2d " . . . . .	40 "	1 min.
3d " . . . . .	1 min.	1½ "
4th " . . . . .	1½ "	2 "
5th " . . . . .	1¾ "	2½ "
6th " . . . . .	2 "	3 "
7th " . . . . .	2½ "	3½ "
8th " . . . . .	2¾ "	4 "
9th " . . . . .	3 "	4½ "
10th " . . . . .	3½ "	5 "

CANCER

Cancerous growth is sometimes checked when there is an increase in the calcium salts (see Goldzieher; Verhaudl. Deut. Path. Gesellsch., 1912 (15) 283). Cramer showed that isolated cancer cells exposed to calcium salts lose their growth capacity when inoculated. The blood, in cancer, contains less calcium than normal, which tends to result in an osteoporosis of the long bones, discernible with the X-ray.

In addition to the systemic uplift that influences the hemoglobin, red cells and color index, the increased calcium metabolism is an excellent accessory therapeutic

adjuvant in the treatment of cancer. Whether operation or deep roentgenization is contemplated, the patient should be prepared by systemic biologic lamp treatments, giving calcium lactate by mouth at the same time; and, in cases of deep roentgenization, the interim between X-ray exposures should be occupied with a course of ultra-violet treatments. Stimulative doses, applied daily, are indicated. The dose would be about:

	FEMALE		MALE	
	LIGHT	DARK	LIGHT	DARK
Initial.....	50 secs.	1 min.	1 min.	1½ min.
2d. ....	1⅔ min.	2 "	2 "	3 "
3d. ....	2½ "	3 "	3 "	4½ "
4th. ....	3⅓ "	4 "	4 "	6 "
5th. ....	4⅓ "	5 "	5 "	7½ "
6th. ....	5 "	6 "	6 "	9 "
7th. ....	5⅝ "	7 "	7 "	10½ "
8th. ....	6⅔ "	8 "	8 "	12 "
9th. ....	7½ "	9 "	9 "	13½ "
10th. ....	8⅓ "	10 "	10 "	15 "
11th. ....	9⅓ "	11 "	11 "	16½ "
12th. ....	10 "	12 "	12 "	18 "
13th. ....	10⅝ "	13 "	13 "	19½ "
14th. ....	11⅔ "	14 "	14 "	21 "
15th. ....	12½ "	15 "	15 "	22½ "
16th. ....	13⅓ "	16 "	16 "	24 "
17th. ....	14⅓ "	17 "	17 "	25½ "
18th. ....	15 "	18 "	18 "	27 "
19th. ....	15⅝ "	19 "	19 "	28½ "
20th. ....	16⅔ "	20 "	20 "	30 "

### RICKETS

Clinical and laboratory studies on the influence of actinotherapy in the treatment of rickets are already familiar to the therapist from the brilliant work at Columbia

(Hess), New Haven (Powers), Johns Hopkins (Shipley, *et al*), and Toronto (Tisdall). These original studies should be consulted, from which the following method of ultra-violet usage becomes obviously efficient: Knowing the actinic region of the sun's spectrum involved in the prevention and cure of rickets, this significant fact must be first realized: that the wave lengths of ultra-violet radiation concerned are those impervious to glass. The ultra-violet spectrum of the sun ends at 2900 Angström units, or thereabouts. Usual glass panes are transparent to 3022 Angström units. So that the sun's benefit in rickets lies in the ultra-violet wave lengths included between 3022 and 2900 Angström units,\* or that part of the ultra-violet spectrum that has been designated "biologic" in activity (see *Journal of Radiology*, September, 1922 issue, and subsequent issues). Obviously, the air-cooled, ultra-violet equipment, as distinguished from the water-cooled apparatus, is the instrument of scientific choice in the solution of the problem.

In applying the air-cooled, ultra-violet radiation, it is desirable so to arrange the necessary factors of radiation intensity and spectral formula as to insure a maximum energy distribution in the region of the spectrum that operates best in rickets. This is accomplished by regulating the wattage so that the voltmeter reads 70. At this voltage, the region indicated is at its best. The clinical elimination of shorter ultra-violet wave lengths is gained by adopting a long distance between the tube and the skin, which should be 40 inches.

With this intensity, and at that distance, the time of irradiation is next governed by the skin reaction mani-

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\*This subject was originally investigated and will appear in medical literature at an early time.

fested by the patient. For obvious reasons, this should not be too severe, and should be carried to a point usually designated "stimulative erythema." The factors involved include the endocrine type of the patient, the age and the sex. Speaking generally, with the air-cooled lamp operating at 70 volts, and at 40-inch distance, a stimulative erythema is obtained in the following intervals of time:

	LIGHT TYPES	DARK TYPES
Infants	15 seconds	25 seconds
Children	35	50
Females	1 minute	1½ minutes
Males	1¾ minutes	2 minutes

Each subsequent exposure is increased by the same amount of time assumed in the original. For instance, if the child undergoing the treatment is a dark type (brunette), the time for the initial exposure is 50 seconds, the second exposure is 100 seconds, the third is 150 seconds, fourth 200 seconds, etc. A good rule to follow in determining the frequency of exposure intervals is that generally recommended in all systemic ultra-violet therapy, as follows:

Initiate the degree of erythemic reaction sought, in this instance stimulative. Observe the erythema develop and note especially the beginning of recrudescence. When the erythema begins to disappear, it is an expression that the biologic phosphorescence induced is becoming exhausted, and a second application should be applied. This clinical determinant for the frequency of irradiations is useful in that it makes the reactivity of the patient the guide for the amount of treatment necessary. Usually the frequency is daily, or every second day. Occasionally, highly susceptible reactions are met that extend the intervals to three or more days apart.

In hospital practice, the air-cooled quartz lamp may be placed over the crib or cot of the youngster. The eyes are bandaged to preclude actinic conjunctivitis. The infant or child is bared and allowed to remain in the radiation. If the tube is directly over the center of the crib, and the radiation is at right angles to the plane of the bed, the time given in the preceding table is used. If the circumstances are such as to make it necessary to use oblique illumination, an approximate estimate of the angle made by the "central ray" and the bed plane is determined; and according to this angle, the exposure time must be increased.\*

ANGLE OF CENTRAL RAY WITH PLANE OF BED	ADDITIONAL TIME OF RADIATION REQUIRED
90°	0
75°	1/10
60°	1/5
50°	1/4
45°	2/5
30°	1/2

*Example:* A brunette (dark type) child is to receive bed treatment. The initial radiation should be:

Air-cooled lamp volts 70  
 Tube-skin distance 40 inches  
 Time 50 seconds

At the bed, the angle made by the central ray with the plane of the bed is 45 degrees; therefore, the additional time required because of this angle is  $\frac{2}{5}$  more than 50, 70 seconds (50 plus  $\frac{2}{5}$  of 50).

\*This is governed by the Cosine Law, elsewhere explained.

At the second treatment, the same angle should be used beside the same settings for the lamp (70 volts, 40 inch tube-skin distance), and the second exposure time is then 160 seconds (80 plus 80). The third treatment is for 240 seconds (160 plus 80). When the total time of radiation has reached fifteen minutes per treatment, it is no longer necessary to increase the time, but simply to increase the frequency of treatment.

#### DISEASES OF BONE

Barker conveniently subdivides his consideration of diseases of bone into the following headings:

- I The congenital osteopathies
- II The degenerative, the toxic, and the endocrinopathic osteopathies
- III The osteopathies of circulatory origin
- IV The inflammatory osteopathies
- V The neuropathic osteopathies
- VI The parasitic osteopathies
- VII The neoplastic osteopathies

In this group, those conditions listed as degenerative, toxic or endocrinopathic osteopathies show a deficiency in the metabolism of calcium, or phosphorous, or both; and in these conditions, the biologic energy derived from the air-cooled, mercury-vapor lamp is essentially helpful.

#### METHOD

Studies leading to the consideration of the quality of the ultra-violet spectrum necessary to effect calcium and phosphorous increase in the blood have elsewhere been submitted and should soon appear in print. Pambrun aptly speaks of this spectral quality as "spectral formula:" and we are now convinced that each type of path-



ology amenable to ultra-violet therapy requires its specific spectral formula to insure maximum efficiency in clinical result.

Calcium and phosphorous is influenced most by the ultra-violet spectral region included between 3022 and 2600 Angström units; a region which is most intense in the air-cooled lamp operated under the following characteristics:

Voltage across burner	70
Tube-skin distance	40 inches

At this voltage, the region discussed is at its best; and the tube-skin distance is purposely 40 inches to insure that shorter wave lengths, which are antagonistic to calcium and phosphorous deposition, are obliterated by passing through much air.

With the above characteristics of lamp operation, the nude body, or as much of the body as propriety and other conditions will permit to denude, is exposed, at the first treatment for:

	LIGHT TYPES	DARK TYPES
Infants	$\frac{3}{4}$ minute	$1\frac{1}{2}$ minutes
Children	1 minute	$1\frac{1}{2}$ minutes
Female adults	$1\frac{1}{2}$ minutes	2 minutes
Male adults	2 minutes	3 minutes

Each day the radiation is increased as follows:

Infants, children	$\frac{1}{2}$ minute
Female adults	1 minute
Male adults	1 minute

Eyes should, of course, be screened against the rays to prevent conjunctivitis. The radiations are continued daily until the X-ray study of the bone, or the clinical observation of the case, indicates maximum recovery.

Promptness of recovery and degree of benefit derived are contingent upon the character and severity of the pristine pathology.

#### CONDITIONS TREATED

*Osteoporosis:* When, for any reason, a part is immobilized, the disuse leads to an atrophy of the bone that likewise suffers immobilization. This osteoporosis of disuse, as the condition is called, is frequent in fractures and in all forms of arthritis. It is quickly revealed under X-ray examination and is a factor that militates against the prompt calcification and ossification of a fractured part.

So that the better to assist reunion and reossification of a fractured bone, and as a preventive against fragility that disused bone parts acquire incident to immobilization, the ultra-violet energy serves an excellent purpose. In general, such conditions as show, under X-ray examination, bone atrophy or osteoporosis, are those in which ultra-violet energy, used as described, is helpful.

*Rickets:* The characteristic skeletal changes in rickets are too well known to require comment; as is, also, the brilliant work of Hess, Powers, Shipley, *et al* who have afforded a great contribution in the progress of therapy by their unchallengeable studies on the preventive and curative effects of the ultra-violet energy in rickets.

For rickets, as for all conditions in which bone changes are present, the method of treatment is systemic, that is, general irradiation as discussed under method.

*Achondroplasia:* Formerly known as fetal rickets, achondroplasia is a disturbance of the skeleton occurring during fetal life. Its etiology is unknown. It is characterized by micromelia (undersized limbs), which comes from a premature closure of the long bone epiphyses.

Infants showing achondroplasia, which must be differentiated from rickets (in which the ossification is delayed instead of premature); from thyroaplasia and athyreosis (myxedema symptoms); and osteogenesis imperfecta (X-ray plates; frequent and multiple fractures); if exposed to ultra-violet energy, assume a renewed calcium and phosphorous activity that has led, in some cases observed clinically, to a general re-establishment of bodily proportion tending completely to eliminate the micromelic deformity. There is an instance somewhere recorded of an intra-uterine diagnosis of achondroplastic fetus of eight months arrived at through anthropometric X-ray examination of the mother. Ultra-violet irradiations of the mother two weeks before delivery resulted in an infant of practically normal limb measure. It is interesting to think of the possibility of precluding a "rickety diathesis" in the child by ultra-violet irradiation of the mother.

*Osteogenesis Imperfecta:* This, Lobsteins' disease, is a condition in which the bones are found to be exceedingly brittle. Fractures follow even trifling injuries. It is a dominantly minus calcium-balance entity. It is especially amenable to ultra-violet radiation.

Schabad, says Barker, studied a 7-year old child with osteogenesis imperfecta and found a deficient calcium retention. In addition, he obtained improvement under cod-liver oil therapy. Obviously, in the light of the recent studies of Hess, it is clear to understand now why ultra-violet is almost a specific therapy in the treatment of this obscure bone disease.

*Osteomalacia:* Much dispute exists as to whether or not osteomalacia is, after all, an aggravated form of rickets. Clinically, it is well to realize that the condition

affects women in the reproductive age, usually after they have borne children (puerperal osteomalacia); and that ultra-violet energy corrects the disorder. It should be applied during term, when the calcium needs of the fetus challenge the calcium metabolism of the mother, thereby insuring a stabilization of the calcium metabolism and averting osteomalacia in the mother, rickets and osteogenesis imperfecta in the child.

#### X-RAY AND ULTRA-VIOLET

We see at once that the X-ray study of bone leading to the X-ray inference of deficient calcium function, is a definitely certain clinical index for the use of ultra-violet energy. Possibly, the various calcium and phosphorus dystrophies affecting bones all arise from an aberrancy similar or identical to that including rickets; and in the ultra-violet energy, from its proved action of increasing calcium and phosphorus metabolism and its equalizing regulation of normal ossification and calcification, is a virtual therapeutic specific for the remedy of pathology derived from such causes.

#### FRACTURES

Recently, Tisdall and Harris point out that in adults there is an increase in the phosphorus of the serum following a bone fracture; and that the union of the fragments, like the fusion of an epiphysis, invokes a physiologic demand for phosphorus. This observation they supplemented and confirmed by animal experiments (with dogs).

From which basic considerations we may conclude, *a posteriori*, that there is a fundamental law in the physiology of the economy, as follows: *That a physiologic (as*

*in the case of epiphyses) or pathologic (as in the case of fractures) want in the continuity of a bone establishes a systemic demand for increased calcium and phosphorus necessary to effect complete fusion.\** Applied immediately to the question of the treatment of fractures, it is obvious that any factor threatening the ability of the system to furnish the necessary increase of calcium and phosphorus, makes for that clinical entity called "delayed union;" for instance, in the case of luetic infection.

It is an established surgical practice to administer certain drugs in cases showing delayed union of fracture, with the view, it was thought, of increasing the general well-being of the patient. Probably the most useful tonic usually selected for this measure is cod-liver oil; and it is significant to know that cod-liver oil raises the phosphorus content of the serum—a property which has made it beneficial in the therapy of rickets. What it is desired to consider at this time has to do with an ingenious application by the surgeon of biologic ultra-violet radiation to insure a maximum serum saturation with phosphorus and calcium, and therewith foster the speediest clinical reunion of fracture fragments.

The use of biologic† ultra-violet radiation in such cases depends upon the observation that this energy increases the calcium and phosphorus content of the blood; and, in addition, the radiation is bactericidal, a quality that augments its clinical value in the treatment of those open fractures where union is hindered through septic interference.

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\*More complete biophysical research data confirming the definiteness of this physiological law will be furnished in another paper.

†Air-cooled quartz lamp.

Since the war, the tendency has grown more and more to replace absolute fixation with methods in which the fundamental principle is extension of the member in the position of zero muscle pull. By zero muscle pull is meant the physiologic direction and position of the bone axis in a fashion that the muscle tension is so equally distributed as to preclude angular deviation of the fragments. The method is summarized in the formula, "suspension of the member combined with traction." The limb is suspended in a position of flexion, abduction or rotation coinciding as nearly as possible with the position of physiological rest for the opposing muscles; that is, for the muscles tending to cause deformity. When the position of physiological rest is attained, little force is required to keep the fragments in place, and it permits of better circulation and almost the complete elimination of all pain. Next to asepsis, mechanical efficiency of traction-fixation is of great importance in the proper treatment of fractures.

Assuming that the surgeon has furnished every mechanical aid to permit the fragments to reunite in their correct alignment (for which see BLAKE, "Gun Shot Fractures of the Extremity;" and SPEED, "Fractures and Dislocations"), the therapeutic measures that form an important part of the treatment are expressed by any method that will insure a maximum supply of calcium and phosphorus in the blood.

*Distance:* In clinical practice, the above desideratum is obtained by maintaining a tube-skin distance of 40 inches. It has been found that this furnishes an adequately satisfactory air filter which serves completely to eliminate the clinical antagonistic effects of shorter ultra-violet wave lengths.

*Time:* In ultra-violet therapy, as in X-ray therapy, the application time of the radiation is restricted generally to the amount of erythemic reaction that ensues. When a skin surface is exposed to ultra-violet for a brief time, a biologic phosphorescence appears after a latent period. The latent period is dependent upon the original intensity of the ultra-violet energy; so that when the energy is intense the reaction appears promptly, as distinguished from the delayed appearance of a reaction induced by low intensity.

After the exposure time is increased, the biologic phosphorescence produced presents various degrees of erythema; at first and under short periods of irradiation, the reddening is pale. More prolonged radiation produces an intense reddening approaching almost a scarlet coloration; and if the radiation is continued even a longer time, the intense scarlet reddening is accompanied by small vesicles or blisters.

Histologically, the various degrees of erythema just described correspond with certain important cellular activities, from which it is generally accepted that the erythemas and cellular histologic changes bear to each other the accompanying relations:

DEGREE OF ERYTHEMA	DESIGNATION	HISTOPHYSIOLOGY
1. Mild	Stimulative erythema	Stimulation
2. Moderate	Regenerative erythema	Regeneration
3. Intense	Desquamative erythema	Desquamation

Since, in the treatment of fractures, the effects sought with ultra-violet radiation are not focal epidermal ones, but rather a systemic uplift that is induced through the combined action of the energy acting upon the cellular nuclei, the capillary blood and the capillary lymph, the

total exposure time for each treatment is gauged by that amount of time that will produce minimum skin effect and maximum biologic uplift.

Skin reactivity is a complicated phenomenon dependent upon many factors, but particularly upon the endocrine status of the individual; the region of the radiated area; the thickness of the skin and the capillary distribution of blood in the area. So that it is impossible to furnish a simple statement of the exact time required for the production of similar degrees of erythemic reaction in different individuals of varying sex, age and color. But, generally speaking, the time indicated in the accompanying table represents a good working average for the production of stimulative erythemas when the voltage is 70, the distance 40 inches, and the angle of illumination is tangential.

	LIGHT TYPES	DARK TYPES
Infants	15 seconds	25 seconds
Children	35 seconds	50 seconds
Females	1 minutes	1½ minutes
Males	1¾ minutes	2 minutes

**ANGLE OF CENTRAL RAY:** It will be observed that the erythema is produced under the conditions above described when the illumination strikes tangentially. By tangential is meant that the "central ray" meets the plane of the surface irradiated at a right angle.

In radiation therapy the clinician must be perfectly conversant with the concept of the "central ray" or "Hauptstrahle." In ultra-violet therapy the central ray represents the shortest distance between the burner and the plane of the surface irradiated. In arranging the air-cooled lamp for irradiation over a large body surface, the casing of the instrument should be so placed as to permit



the central ray to strike at right angles to the plane of the surface rayed. This is generally obtained when the casing is directly over the patient so that the axis of the uviarc is parallel to the median axis of the body, and exactly superimposed.

When, for whatever reason, mechanical difficulties arise that preclude the position described, and it becomes necessary to tilt the casing in a fashion to permit the radiation to strike the body so that the central ray is other than at right angles, although the distance between the tube and the skin is still preserved at 40 inches, an increase in the radiation time is required to compensate for the loss of intensity incident to the angle made by the rays striking at less than 90 degrees. The law governing this loss of intensity was first formulated by Lambert and bears the name of the Cosine Law. The accompanying table gives the various angles that may usually be used in clinical practice, and the increased time necessary for the production of similar degrees of erythema:

INCIDENT ANGLE	TIME	COMPENSATORY INCREMENT		TOTAL TIME
90°.....	60 sec.	0	0	60 sec.
75°.....	60 "	1/10	6	66 "
60°.....	60 "	1/5	12	72 "
50°.....	60 "	1/4	15	75 "
45°.....	60 "	2/5	24	84 "
30°.....	60 "	1/2	30	90 "

FREQUENCY OF APPLICATION: There is a cogent rule in modern ultra-violet practice that determines the frequency of application intervals in accordance with the expression that "ultra-violet therapy is successful in proportion as the desired physiologic action through the use of the radiation is *initiated* and *maintained*." Since various individuals present varying degrees of reactivity,

this reactivity is utilized clinically as an index for determining the frequency of applications. In the treatment of fractures, systemic ultra-violet radiation is applied over the chest and back to the point of stimulative erythema. When the skin exhibits the pink reaction sought, maximum physiologic activity is in progress. As soon as the stimulative erythema is observed to disappear, the biophysical effects of the biologic phosphorescence are spent; and it is then time for the application of the second radiation. In this fashion each patient becomes an individual index whereby the clinician may determine the frequency of ultra-violet application. In general, it will be found that the intermission varies from twenty-four hours to three or four days, depending upon the tolerance of the case undergoing treatment.

**LABORATORY CONTROL:** There are a number of factors that influence the amount of good that can be obtained through ultra-violet radiation; and it is not an infrequent experience to find that certain instances arise in which the ultra-violet therapy, like any other form of therapy, produces no obvious good. In the treatment of fractures there are few subjective changes in the average case, and the clinician must depend upon frequent chemical examinations of the blood serum for the calcium and phosphorus content. In organized clinics and hospital practice, the calcium and phosphorus curve of the blood is plotted every second day; and ultra-violet therapy is continued until the curve assumed by these figures shows there is a maximum maintenance of calcium and phosphorus in the blood.

**X-RAY CONTROL:** A method which finds even wider acceptance is the frequent radiographing of the fractures. With modern methods, using double intensifying screens and duplitized films, the exposure time is so brief as to

preclude the possibility of retarding the growth or union of the fragments through any influence of the X-radiation. Roentgenography is preferable to blood chemistry; for it shows not only the increasing opacity of the fracture space due to mineralization of the callus, but it shows also whether immobilization and alignment are being maintained.

#### FRACTURE COMPLICATIONS AND TRANSPLANTS

When a fracture is complicated by septic infection, its treatment becomes increasingly difficult. In addition to correct immobilization by traction in the position of physiological rest and the increase in the phosphorus and calcium metabolism by the use of biologic ultra-violet radiation, the pathology of the infection must receive critical consideration. For this, there is much to approve the modern method of irrigating the infected area with a solution of photosensitive dye dissolved in physiological salt. An appropriate formula is about as follows:

Gentian violet	1
Salt	9
Sterile distilled water	1000

Following the irrigation, the area is focally rayed with the highly bactericidal water-cooled, ultra-violet energy. Although the number of cases in which this technic has recently been employed is still not very great, every report points to the unusual promise of the procedure.

In the case of transplants, the irradiation of the recipient bone under biologic energy previous to inserting the transplant has in some cases made for such marked refreshment of the fragments as to enable the transplant to become physiologically accepted in its new location.

We have just dealt with the principle that actinic radiation mobilizes the calcic and phosphoric element of the blood; and that when these minerals are wanting, or their increase would materially aid to overcome pathology, the administration of the mineral (as calcium lactate, or better, calcium phosphate) followed by ultra-violet raying of the entire nude body, was accompanied by good clinical success.

Similarly, the fixation of iron may be achieved; which makes for usefulness in the treatment of primary and secondary anemia.

Anemia, though originally conveying the meaning of lack of blood, has come to be used particularly with reference to those conditions in which the number of red cells, or the amount of hemoglobin to the unit of blood volume, is diminished. Skin palor and anemia are by no means interdependent, as the combination of hard work, poor food and ill-lighted dwelling produces skin palor, but not necessarily anemia. Following the classification that Hewlet adopts (*Functional Pathology of Internal Diseases*), anemias are conveniently classed as:

1. Those incident to increased loss of red cells
  - (a) As from hemorrhage
  - (b) From blood destruction (toxic)
2. Those incident to diminished formation of cells or hemoglobin
3. Anemias due to increased blood plasma

#### ANEMIA OF HEMORRHAGE

Unless the emergency is great, the loss in fluid volume incident to hemorrhage may be replaced by the injection of normal saline in the lower bowel and rectum. Having replenished the fluid volume by this means, the increase

in the red cells and hemoglobin is determined by the assimilation of iron, which is greatly accelerated under actinic radiation. The iron is given hyperdomatically, preferably with arsenic or strychnine, and the body daily exposed front and back to stimulative actinic erythema doses.

#### SIMPLE TOXIC ANEMIA

Various poisons hemolyze the red blood cells, and when this cellular destruction is slight and prolonged, there ensues an anemia unaccompanied by any additional striking manifestations, and often overlooked. This may be found in lead poisoning; infections; malignant tumors; bothriocephalus. The hemolytic destruction can be checked, in part, by systemic actinotherapy; but the cause should, of course, be sought and removed.

#### CHLOROSIS

In this peculiar form of anemia, ultra-violet finds an especial utility. This condition is a most brilliant example of actinic efficacy and emphasizes the concept of mineral fixation. Iron is present in the feces of chlorotic girls much before they are placed under any form of treatment; so that chlorosis is not a condition of iron deficiency, but insufficient iron assimilation. The treatment of chlorosis resides in whatever measure will insure the fixation, or better, the assimilation of iron. It consists in furnishing a preponderance of iron, in the form of Blaud's pills, in which each pill contains 2 grains of iron sulfate (so called Niemeyer's formula). During the first week of treatment, one pill three times a day is sufficient; and each day, a stimulative actinic erythema is produced over the back and front of the entire body. The actinic erythemas are continued, following the usual

rule for increasing the dosage; and each week, the pill dose is increased so that for the second week, two pills are taken three times a day; for the third week, three pills, three times a day, etc. A saline purge is given every second morning. In severe cases rest in bed is imperative.

#### LEUCOCYTIC PATHOLOGY

It is said (Wagner, "Die Kunstliche Hohensonne") that the leukemias and pseudoleukemias do well with combined therapy; roentgenization of the spleen, and ultra-violet radiation systemically. There is much to commend the combination upon purely theoretic principles; but a lack of definite information precludes further mention here.

## CHAPTER VIII

### INTENSIVE ACTINOTHERAPY



IS DISTINGUISHED from regional, fractional or systemic actinotherapy, intensive actinotherapy is characterized by:

1. High voltage
2. Short tube-skin distance
3. Short exposure time

The fundamental object being simply to induce a maximum focal reaction in the skin layers with minimum systemic changes in the blood and lymph. Intensive actinotherapy is, therefore, especially valuable in the focal handling of skin diseases.

The treatment of skin diseases demands a wide medical knowledge and attention to many points. General measures are of much importance. The state of the circulatory system demands attention, especially the integrity of the surface circulation. An example is acne. It is futile to treat systemically in order to enrich the blood in immunologic qualities if the surface circulation is so scanty and insufficient to saturate the site of the lesions. So that one should take precaution to strengthen the surface circulation, which, in acne cases, is usually anything but best. For this, photo-therapy is quite practical and efficient; since the heat and visible light issuing from the large 1500 watt bulb induces a flushing of the surface capillaries that is highly desirable.

In ultra-violet therapy, a great point is to know when to soothe and when to irritate; or, more properly, the

correct selection of the required reaction of actinic erythema; whether:

- Stimulative
- Regenerative
- Destructive

Speaking broadly, a heavy reaction in the chronic and a light reaction in the acute conditions is the rule. Mild and long continued treatment often succeeds in the long run, where heroic measures either fail or render matters worse.

Certain general diseases affect the skin, as for instance, myxedema, where the skin is thickened and harsh. Rheumatism is associated with rashes, more particularly in children. The most common are urticaria, multiform exudative erythema and erythema nodosum. Diabetes is connected with various erythematous and papular eruptions, and often with marked pruritis. It seems hardly necessary to point out that actinotherapy will fail if these quite obvious, though occasionally overlooked facts, are not definitely investigated and excluded.

Ultra-violet energy is valuable in the following conditions:

- Lupus vulgaris
- Lupus erythematosus
- Naevus flammeus
- Acne vulgaris
- Alopecia areata
- Chronic indolent ulcers
- X-ray and radium burns
- Pruritus cutaneous
- Dermatitis seborrheica
- Pityriasis rosea
- Furunculosis
- Neuralgia following Zoster



## LUPUS VULGARIS

Atrophic and ulcerative forms yield best. Hypertrophic forms are more successfully handled with X-rays or radium. Rather marked erythemic reactions should be produced. The exposed part being usually the face, it is important that the eyes be protected from the rays. They may be kept shut tight, or goggles may be worn. The affected part is sponged with hydrogen peroxide, one part in ten of water, and exposed to the air-cooled lamp, 90 volts across the burner, ten-inch tube-skin distance, for:

Initial treatment	30 sec.
2d "	60 "
3d "	1½ min.
4th "	2 "
5th "	2½ "
6th "	3 "
7th "	3½ "
8th "	4 "
9th "	4½ "
10th "	5 "
11th "	5½ "
12th "	6 "
13th "	6½ "
14th "	7 "
15th "	7½ "

The local treatments are given every third day; and in addition, a systemic treatment should be practiced such as was outlined in one of the preceding chapters, the better to insure a constitutional uplift. Iron, quinine, fresh air, good food, hygiene, systemic ultra-violet treatments and focal high intensity actinic treatments are all required. Allyl sulfide is helpful if applied in glycerine

just prior to the focal actinic treatments in place of hydrogen peroxide.

Other tuberculous affections of the skin, including:

Tuberculosis verrucosus cutis

Scrofuloderma

Tuberculosis orificialis

are similarly treated and offer encouraging results. It must be recalled that the various forms of tuberculosis cutis, unless they can be treated at an early stage, are exceedingly chronic and rebellious skin conditions that offer good prognosis as to life, but unfavorable prognosis as to cosmetic elegance unless ultra-violet is used. When ultra-violet energy is used the results are sometimes tedious to attain.

Dr. George C. Andrews, associated with Dr. George Miller MacKee,\* tendered a communication in which he says "we have frequently treated clinically identical lesions separately with X-rays and ultra-violet light to determine the most advantageous method of treatment, and while we favor X-rays, sometimes ultra-violet energy gives superior results."

#### LUPUS ERYTHEMATOSUS

Ultra-violet energy, in few treatments, furnishes quite gratifying results if measured in terms of immediate betterment. There is, of course, a tendency for the disease to recur, which tendency persists regardless of the character of the treatment used.

Actinic rays induce an absorption of the diseased process without scarring; a decided advantage over whatever other form of treatment employed. When the affection

\*170 West 59th Street, New York City

is chronic, ultra-violet generally excels X-ray or radium treatment.

A heavy raying should be sought. Cover the unaffected parts with chamois skins, or towels, and expose the lesions to the air-cooled lamp, 90 volts, ten-inch tube-skin distance for five minutes. A swelling and blistering results. This subsides and in a few weeks leaves only a slight erythema and very little swelling. The actinic treatment is then repeated and continued at intervals of about two weeks until the lesions have entirely disappeared, or until no further improvement is obtained. During the interval between treatments, any lotion, colored a skin pink with carmine, makes a useful application in that it tends to overcome the unsightliness of the lesions and the initial results of the treatment.

### TELANGIECTASES

*Definition:* Telangiectases represent dilatations or new formations of capillaries as the result of stagnant blood in the terminal venous vessels.

*Classification:*

#### I Congenital

- |   |   |  |
|---|---|--|
| <p><i>Primary</i><br/>(a) or<br/><i>Essential</i></p> | { | <ol style="list-style-type: none"> <li>1. Punctate</li> <li>2. Sinuous</li> <li>3. Spider naevi</li> <li>4. Macular</li> <li>5. Papular</li> </ol> |
|---|---|--|

#### II Acquired

- |   |   |  |
|---|---|--|
| <p><i>Secondary</i><br/>(b) or<br/><i>Symptomatic</i></p> | { | <ol style="list-style-type: none"> <li>1. Cutaneous symptoms</li> <li>2. Circulatory symptoms</li> <li>3. Visceral symptoms</li> <li>4. Occupational symptoms</li> </ol> |
|---|---|--|

*Congenital Telangiectases:* These are best considered under the heading of naevi. Port-wine marks and

similar vascular structural changes are at this time being extensively investigated by Fred Wise, especially with regard to their treatment through the agent of the ultra-violet ray. The subject of naevi is too great to include in a discussion of telangiectases.

*Acquired Telangiectases:* Convenient description permits acquired telangiectases to be divided into the following groups:

1. Primary or Essential Telangiectases
2. Secondary Telangiectases, symptomatic of some cutaneous disease, or internal disorder

*Primary or Essential Telangiectases:* These are arbitrarily divided into five classes, depending upon the anatomical appearance that the pathology assumes. Thus the lesion may be punctate; or it may present sinuous and branching lines; or it may be a very delicate cluster of radiating vascular branches with a centrally raised point, the entire structure closely resembling a spider and commonly known as "spider naevus." Or the lesion may involve a spot and be represented as a striated discoloration without elevation or displacement (macule); or, finally, the vessels may produce a flat or rounded papule, varying in size from a few to six or eight millimeters in diameter. Examination of these papules with a hand magnifying lense shows them to consist of a dense network of fine capillaries. Papular telangiectases are most commonly seen in elderly persons, the so-called senile angiomas of DUBREUITH.

*Pathogenesis of Primary Telangiectasis:* As for the symptomatic, so with the Primary Telangiectasis, the causative pathology is twofold: it resides first in a change

of the normal physiologic chemical composition of the blood, and second, in the impairment of the normal activity of the individual cells in the area where the telangiectasis occurs. The change in the composition of the blood makes it unsuitable for cellular assimilation. The change in the cellular activity of the immediately contiguous tissues predisposes to the lack of blood absorption. And, thus, these two changes, one complementary to the other, react to produce undue accumulation of blood at the site involved. The accumulating blood may distend the capillary vessels which already enclose it; or it may stimulate endothelial proliferation to the formation of additional capillaries for the store of the stagnant volume.

*Pathogenesis of Symptomatic Telangiectases:* These may be associated with certain skin affections, of which they may form the most important feature; or may be one of several and equally prominent symptoms; or they may be relatively unimportant and barely perceptible. In each case their formation has the same pathogenic initiation as in the instance of Primary Telangiectasis; impaired blood stagnation leading to engorgement of new vessels.

In young individuals, badly compensated valvular diseases of the heart are often found to enfeeble the peripheral circulation and the resistance of the tissues, so as to produce areas of telangiectases; and in older individuals, arterio-sclerosis may in a like manner lead to these vascular phenomena. They accompany diseases of the liver, especially where gallstones are present, with such frequency as to be a valuable clinical diagnostic sign in these conditions. Under exposure to inclement weather, to severe cold, sleet and rain, and to excessive heat, as in the case of bakers, stokers, etc., telangiectases frequently occur on the face.

Secondary or symptomatic telangiectases, in addition to the local pathogenesis described as for primary lesions, accompany always, obviously deranged general bodily metabolism. In fact, impaired bodily metabolism may be observed to exist in all forms of acquired telangiectases, whether primary or secondary; but this remains less obvious in certain cases, hence it receives the name of Essential Telangiectases, and becomes apparent in other cases when it is known as symptomatic telangiectases.

Naevus is a type of angioma in which ultra-violet furnishes better results than X-ray or radium. In children and in adolescents the response is better than in adults. Successive regenerative focal erythemas give good results, apparently, from the obliterative vasitis that follows. In small naevi, suitable tubular applicators are fitted to the air-cooled lamp casing, and the lesion covered with the applicator. Larger lesions are exposed, everything else covered with protective chamois skins or toweling, to the rays from the open casing at ten-inch tube-skin distance. 90 volts are used. The first exposure is seven minutes; the second, about ten days or two weeks later, ten minutes.

#### ACNE VULGARIS

Indurated types are unsuited for ultra-violet therapy; but papular and pustular forms yield well in many instances.

Acne that recurs after X-ray treatment is suited to ultra-violet therapy; and the converse is likewise so.

Systemic ultra-violet measures should first be given (as for anemia, which see). After the second or third general or systemic treatment, the focal attack is begun with the photo-therapy lamp and the high intensity actinic dosage. The affected region is brought to a marked hyperemia by exposure to the photo-therapy lamp.

Adjust the photo-therapy lamp at the distance where the patient can just tolerate the heat. As tolerance is established, decrease the distance. This photo-therapy treatment should last not less than twenty minutes. When the hyperemia is induced, apply the rays from the air-cooled lamp at 90 volts, ten-inch tube-skin distance, as follows:

Initial treatment	30	seconds
2d	1	minute
3d	1½	minutes
4th	2	"
5th	2½	"
6th	3	"
7th	3½	"
8th	4	"
9th	4½	"
10th	5	"

Space the focal intensive treatments two days apart. Before each focal treatment, use the photo-therapy lamp to produce hyperemia. Maintain an ultra-violet systemic treatment at the same time.

#### ALOPECIA AREATA

There is a consensus of opinion that expresses occasionally favorable clinical results in the treatment of alopecia areata with ultra-violet rays. The technic suggested is the application once a week of regenerative intensive doses. The hair is first wet so as to part easily in order to make the scalp accessible. At 90 volts, and ten-inch tube distance, each parted stripe is treated for one minute. An effort should be made to ray the scalp area showing the alopecia, keeping out of the way such interfering hairs as may occlude the energy.

## PRURITUS CUTANEUS

Pruritus is a symptom of great importance and frequent occurrence, sometimes arising without any visible cutaneous lesion and meriting independent consideration. Several different sensations are grouped under the heading of pruritus, including pricking, tingling, formation, and itching. Convenient description would discuss the subject of pruritus under two groupings; first, symptomatic pruritus; in which the itching is a symptom of an obviously manifest cutaneous affection; and then, essential pruritus, which is not accompanied by any obvious skin condition. Whether essential or symptomatic, the fundamental pathology of pruritus is similar and resides in a functional derangement of the nerves of common sensibility. Pruritus seems to arise from the stimulation of the nerve endings of the interepithelial plexus ramifications that reach the spaces between the epithelial cells comprising the prickle-cell layers. It is predisposed by an existing idiosyncrasy or by age; the age of the patient furnishing often a good indication of the probable cause. For instance, it is commonly due to papular urticaria in infants and young children; to scabies in young adults; to diabetes in the middle aged; and to senile skin in the old aged, and also among the poorer classes, to pediculi vestimentorum. It may be excited by certain internal causes, including some blood diseases, disorders of the alimentary tract, disorders of the liver, disorders of the nervous system—diseases of the genital system, and drugs. A large number of external causes may precipitate pruritus, such as temperature extremes, irritating garments and local irritants.

Pruritus may often be overcome entirely by the application of successive regenerative doses of ultra-violet ray.



In producing regenerative erythema, the cells of the stratum Malpighii proliferate; the intercellular spaces become engorged with lymph and products of cell metabolism, and the bare nerve endings gain additional protection from this regenerative activity.

Successful correction of the various individual skin lesions commonly met in the clinic depends upon careful recognition and identification of the causative agent and the existing pathology.

Dose: (90 volts and ten-inch tube-skin distance, best every three days).

Initial	$\frac{3}{4}$ minute
2d	$1\frac{1}{2}$ minutes
3d	$2\frac{1}{4}$ "
4th	4 "
5th	$4\frac{3}{4}$ "
6th	$5\frac{1}{2}$ "

#### DERMATITIS SEBORRHEICA

When the condition is limited to the scalp, and is accompanied with defluvium, occasional stimulative erythemas, about four to five days apart, appear of value. The first treatment, intensive, should be about one-half minute; the second, one minute.

#### PITYRIASIS ROSEA

This condition yields quite promptly, almost every case showing a rapid disappearance of the lesion after two or three intensive rayings. The accompanying itching is almost at once checked. A satisfactory technic is:

Initial treatment	1 minute
2d	2 minutes
3d	3 "
4th	4 "
5th	5 "

## FURUNCULOSIS

Intensive radiation often aborts early lesions. If the furunculosis is confined to the nuchal region, a cure is nearly always effected after a regenerative erythema applied every five days. Factors:

Initial	1 minute
2d	2 minutes
3d	3 "
4th	4 "
5th	5 "

## NEURALGIA (FOLLOWING ZOSTER)

If the course of the nerve tract is heavily irradiated, many cases (Michall says 50 per cent) are cured, and all cases are relieved. Irradiations are given every five or seven days. The course of the pain is charted with a wax pencil and the entire zone so rayed as to have each area receive, at ten inches from the tube and 90 volts across the burner, one and one-half minutes for the first raying, and three minutes for the second, five days later.

## X-RAY AND RADIUM BURNS

It is difficult to say, definitely, that a skin area may be so prepared with ultra-violet tanning, as to permit a greater use of the X-ray (or radium) without causing a burn; but there is little doubt that after the X-ray or radium has induced its trauma to the skin and flesh, the erosions can be in part, and sometimes completely controlled, by judicious actinotherapy.

*First degree:* In radiodermic trauma (whether resulting from X-ray or radium) it is essential to avoid any form of irritation; a bland ointment being quite useful and sufficient. Itching may be controlled with any form of

analgic preparation, such as the addition of phenol or menthol to the ointment. Of course, the phenol is irritating and may then be best replaced by regenerative doses of ultra-violet, which control the *itching* more effectively than phenol or its equivalent. During the acute stage, omit water and soap, and use instead any cleansing mixture in which liquid petrolatum is the base. If the reaction is severe, and the burning intense, a wet dressing of aluminum acetate proves useful.

*Second degree*, trauma means a break in the epidermis with more or less exudate. The exudative drainage should be encouraged, so that ointments are not used. If the surface is coated with an ointment, the serum infiltrates the space between the ointment layer and the skin, and induces eczema—a most dreaded complication. MacKee mentions Pusey's liniment, so useful in inflammatory dermatoses generally, as having especial merit. As soon as the acuity of the symptoms subsides, regenerative actinic erythema doses are helpful to reconstruct the broken epidermal fissures. Pain is somewhat lessened under ultra-violet treatment, but seldom to the extent as to preclude the use of anesthesin. Case, applies Hull's ordinary treatment for burns, which is:

Resorcin	1.00%
Oil of eucalyptus	2.00
Olive oil	5.00
Petrolatum	25.00
Paraffin	67.00

Melt the hard paraffin; stir in the petrolatum and olive oil; add the resorcin which is first dissolved in half its weight of absolute alcohol; and when the mixture has cooled to about 55 degrees, add the eucalyptus.

*Third degree*, trauma offers pain as its most severe symptom requiring treatment; and for this, the phototherapy light is indeed helpful. The burn should be exposed to the light and gentle heat from the lamp, the distance being determined entirely by the patient's tolerance. During the stage of sloughing, no remedies seem to offer any aid whatever. After the slough, the control of pain through the use of the lamp becomes more certain; to which must be added actinic stimulative erythema to foster granulations. Carefully guard the granulations, being especially solicitous about preserving their integrity. Use only very short ultra-violet exposures, often repeated; say twice daily, 90 volts, ten inches, air-cooled lamp, 15 seconds per area.

Should the granulations become exuberant, it seems better practice to curette them than to desiccate with long exposures to ultra-violet. The short abiotic wave lengths of the water-cooled lamp are less useful than the long biologic wave lengths of the air-cooled lamp. It seems infinitely wiser to depend upon the gradual cellular reconstruction imparted by small and frequently repeated ultra-violet doses, than to superimpose violent actinic reactions upon already sensitive and radiotraumatized tissue.

#### ULCERS

Chronic indolent ulcers of various etiologies are benefited by stimulating exposures to ultra-violet. Marked improvement is manifested in the ulcers that arise as the result of trophic conditions; and when of bacterial origin, results are obtained that cannot be achieved by other measures. *Ulcus cruris* (varicose), *ulcus perforans pedis*, diabetic ulcers, chronic ulcerative radiodermatitis, trophic ulcerations of leprosy and syphilis, tuberculous

ulcerations, mycotic amebic and chancroidal ulcerations—all are markedly benefited by ultra-violet therapy.

It is advisable to irrigate the ulcer with calcium chloride solution, about one per cent in distilled water. This concentration gives the proper salinity for isotonic effect, and provides also a biosensitization that is markedly helpful.

Good results are obtained in diabetic ulcerations by submerging the affected limb in a tub of hot water, and raying the water surface at the same time. Not only does the water evenly diffuse the energy so that it strikes the entire affected part, but the residual bactericidal qualities of the solution, imparted by the raying, lend much to the treatment.

For ulcers, the average dose would be 90 volts; ten-inch tube-ulcer distance; initial time, 30 seconds. Each subsequent exposure, two days apart, is increased by 30 seconds.

#### TABULAR SUMMARY

Biologic air-cooled, ultra-violet therapy may be:

Technic	$\left\{ \begin{array}{l} 1. \textit{Regional} \\ 2. \textit{Fractional} \\ 3. \textit{General or systemic} \\ 4. \textit{Intensive} \end{array} \right.$	$\left\{ \begin{array}{l} \text{Lamp at 40 inches;} \\ \text{volts across the} \\ \text{burner, 70.} \end{array} \right.$

## CHAPTER IX

### BACTERICIDAL ACTINOTHERAPY



RECALLING the biophysically established distinction in the properties of the energy issuing from the water-cooled lamp, as contrasted from those furnished by the air-cooled lamp, the three dominant actions upon which the therapeutic quality of short ultra-violet wave lengths depends are classified as:

1. Bactericidal
2. Abiotic
3. Metabolic depression

These properties are, after all, simply expressions of various degrees of the same underlying change—protoplasmic coagulation. It must be remembered, also, that the short wave lengths, less than 2900 Angström units, are entirely superficial in their effects; and that when the convection or direction of the rays is required in deep recesses, such as sinus tracts, an “optical contact” must be established through the use of quartz or light conveying or light sensitive solutions.

#### TONSILS\*

In the child the lymphatic system is dominantly active, and since the tonsils may really be considered an integral part of the lymphatic system, we may expect hyperactivity in those organs in early age. Those of us who are in accord with the teachings of Colonel Bushnell with regard to the immunizing dose of tubercle infection sus-

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\*Read at the annual meeting of the Radiological Society of North America, Chicago, December 7, 1921.

tained in childhood by repeated ingestion and aspiration of tubercle bacilli can see in the tonsils a locus through which the circulating tissue of the infant derives its immunologic defense against usual pathogenic bacterial flora. It is not improbable that the physical texture and the chemical constitution of the tonsillar glands are purposely adapted to bacterial culture; for, whether purposeful or not, in children it is a frequent finding to observe subacute infections commonly present.

Assuming that the tonsil, by reason of its position, its histologic texture, and its chemical constituency marked by lymphatic preponderance, is charged with the duty of collecting ingested and aspirated organisms, and also breeds pathogenic organisms in a subactive fashion, it is possible to conjecture a threshold of maximum activity at which pathogenic organisms thrive to a point where focal or systemic infection is not clinically established, though the products of their elaboration are osmoted into the lymph and circulated and distributed throughout the body, raising generally, the immunologic titer of the tissues against various infections. Or, to speak in terms of an established science, it seems probable that the tonsils are likely to contribute, during childhood, to the establishment of an immunity. An immunity acquired at so early a date as to be inseparable from the defense usually recognized as natural immunity.

Speaking only of hypertrophied tonsils in children, there will be observed in the clinic, in the light of the hypothesis presented, three types of tonsillar conditions:

1. Those in which the tonsils are obviously hypertrophied, but are not excessively reddened, suggesting by their appearance a minimum bacterial activity.

2. Those in which an obvious reddening is present, suggesting a bacterial activity, but an activity below the point of clinically established infection.
3. Markedly reddened and congested tonsils in which infection is clinically established as is evidenced by the accompanying systemic manifestations.

In the first instance, careful observation will develop the singular fact that the child may be classed as a hypo-ontomorph of Bean and shows a form of clinically recognized signs indicating a trend in the direction of status lymphaticus. In these cases, according to the terms of the hypothesis presented at the beginning, it would seem fitting to argue that the defensive processes against invading organisms outweigh the power of attack in such fashion as to preclude the establishment of any obvious degree of immunizing infection. Tonsils of this type are, therefore, hypoactive and bear treatment along the lines that will establish some degree of activity. It would seem that their surgical removal is not at all warranted; for the physical removal would not assist in accelerating a hypoactive function, but would, rather, by total removal of the immunizing organ, preclude the possibility of any degree of immunizing activity. And in this type of case, if the premises of the immunizing hypothesis are correct, the therapeutic use of the X-ray should be followed by marked success.

Here, the X-ray will reduce the size of the tonsil, through which reduction there will be a proportionately less volume of immunizing surface and material; and, if the reduction is carried to the degree where the usual pathogenic organisms may establish their subactive function, the immunologic defense of the child will be placed at normal adjustment. In support of this hypothesis



may be cited the unusually brilliant results that follow the reduction of hypertrophied tonsils in hypo-ontomorphs by the use of X-rays. In observations confined to school children of the lower grades the outstanding feature of the improvement seems to be the reflection in the intellectual background and study interest; both are awakened in the previously dulled and intellectually insipid pupil.

The second type, pursuant to the theme submitted, comprises the large majority of school children, in which the tonsils present what we should like to refer to as a state of active immunization. The glands are enlarged, less spongy than the previous type, reddened, but not abnormally so, and give, on culture, more numerous and greater varieties of organisms than the hypertrophy of the first class. In these cases it is contrary to best judgment to intercede with an agent or means that will totally remove the tonsil should indications arise for their treatment. The tonsils appear to be playing a markedly active part in the physiology of the child; and should conditions arise that demand treatment, such as physical obstruction to proper aeration, it is the better course, at least at first, to resort to the use of X-rays in preference to surgery.

In this second type, however, the general systemic level of the child may, for whatever reason, fall markedly below par; and when it does the tonsillar infection acquires a new proportion requiring clinical intervention.

Any form of intervention should be based upon two fundamental principles: First, the immediate correction of the excessive bacterial activity, and secondly, the moderate reduction of the immunizing capacity of the tonsils so that any future impairment of systemic normalcy will not be followed by outburst of focal tonsillar

infection. And with these two indications there is a contraindication, the strict avoidance of the removal of the tonsils. The very fact that the tonsils are subacutely inflamed at all times is sufficient index to show the necessity for raising the general immunity of the individual. Surgical removal of the tonsils would preclude the possibility of maintaining this immunizing mechanism after the acute aberrancy has subsided. In this type of cases the X-rays were not as singularly successful as in type one; and the difference in success was attributed to the nonbactericidal action of the X-ray. In other words, the X-ray accomplished the second indication, but entirely failed in the first indication for treatment; that is, it eventually reduced the immunizing activity of the glands, but it failed immediately to correct the acute infectious exacerbation. So that the X-ray treatment in class two should be supplemented by a form of treatment aimed directly at the immediate cessation of the infectious activity. An agent remarkably suited for this indication is the ultra-violet ray. Through its bactericidal influence the acute infection is quickly dominated and the clinical symptoms are, therefore, speedily removed.

Coming now to the discussion of the third clinical class of hypertrophied tonsils in children we observe the manifestly infected glands. There is a clear and distinct difference between the gland showing active immunologic processes, and the obviously infected tonsils. The characteristics of the former type have been discussed; the features of this third type are well known and may be summarized by saying that the differentiating symptom is the presence of purulent accumulations. Not simply leukocytes scattered over the surface, but definite gatherings of pus in the crypts and spaces on the surface and in the mass of glands.

This type of tonsil is decidedly pathologic. The use of the X-ray, owing to the lack of immediate bactericidal effect is wholly impractical; and even the powerfully germicidal ultra-violet ray alone is far from the most efficient treatment. The indication is not to relieve the pathogenic infection, for even if it were relieved, the major immunizing influence of the gland has been lost through the changes induced by the severe pathogenic inflammation, and will, therefore, contribute little to the immunologic well-being of the child. In these cases, again in the light of the hypothesis presented, the indications are for the surgical removal of the gland.

All of this may be summarized by saying that tonsils in children are divisible into three groups, based on their supposedly immunizing function:

First, the hypoactive

Second, the active

Third, the infected

In which we distinguish between immunologic activity and pathologic infection. The immunologic activity is characterized by the thriving of many organisms, saprophytic and pathogenic, below the threshold of clinical infection; whereas, infection is characterized by the presence of one dominant strain of organism that has established an activity that no longer contributes to the physiologic manifestations.

In these cases our experience with school children has been that when treatment is indicated because of the temporary establishment of an acute infection, or because of the mechanical impediment to normal physiologic processes, better results are obtained in the discriminate use, either alone or conjointly, of the X-ray, the ultra-violet rays and surgery; the X-rays being reserved for

the hypoactive tonsils, the conjoint use of X-ray and ultra-violet rays being especially beneficial in the cases of type two, and surgery being reserved for cases of type three.

The use of the X-rays is already well familiar to every roentgenologist in the form of the Witherbee technic. When it is to be supplemented by the use of ultra-violet rays, the X-ray applications are given every two weeks, as is generally advocated by Witherbee and others; the ultra-violet irradiations are applied directly to the tonsil through a pharyngeal applicator in units of actinic saturation, alternating days in the usual case, and daily in the more severe infections.

The choice of surgical operation is left for surgical specialists to decide.

Since the active immunizing types are by far the most frequent that are to be observed clinically, it is obvious that the ultra-violet ray plays a significant role in the treatment of tonsillar pathology. The indications are plain, the application is simple and the results obtained through the conjoint use of the X-ray and ultra-violet ray in hypertrophied tonsils are eminently brilliant and deserve every consideration.

Many claim that enlarged tonsils are reduced in size by actinotherapy; but the mechanism of the reduction is misinterpreted. As a general rule, the enlargement of a tonsil is reduced in proportion as the hypertrophy is due to edematous swelling. The greater the amount of edema, the more marked the reduction. This is to be observed, also, in the X-ray treatment of tonsils. True shrinkage of hyperplastic connective tissue has not been proved for actinotherapy, though Witherbee seems to have shown that it does occur as a consequence of X-ray radiation.

Infected tonsils are often overtreated with ultra-violet. Too long an exposure (more than one minute) coagulates the mucosal protein covering of the gland. The resulting incrustation temporarily occludes surface drainage and serves to retain the purulent activity under the incrustated shell. It is far better to depend upon very short exposures, say not more than thirty seconds, repeated two or even three times a day, than to irradiate heavily and produce a coagulation of the tonsil surface.

Spraying the surface with a photosensitive dye is a great help. One may use eosin or methyl violet, about 1 to 1000 in saline, to which a few drops of adrenalin chloride have been added. Hydrogen peroxide diluted 1 in 10 makes an excellent preparatory spray; under the influence of the light the peroxide liberates nascent oxygen that readily enters the crypts and effects a more speedy sterilization. Diluted solutions of iodine, or the colorless tincture, are likewise beneficial expedients.

The treatment is quickly summarized by saying that the water-cooled energy is focalized over the tonsil area with any form of instrument that will best accomplish the purpose. The exposures are brief—30 seconds with the lamp operating at 50-65 volts. The tonsil is first sprayed with a dye solution, or diluted hydrogen peroxide, iodine or similar toxicide. Avoid heavy exposure. Depend upon the bactericidal action of the rays, which is prompt, and not upon tissue destruction.

#### HUMAN INFECTION CARRIERS

This extremely important problem deserves particular study; more especially because the water-cooled bactericidal energy lends itself admirably to the preventive control of carriers, "Simon's Human Infection Carriers,"\*

\*Lea and Febiger.

should be diligently studied. For the presentation here, frequent and verbatim quotations are made from the work of Simon.

*Diphtheria: Habitat of the Organisms.*—"As in the case of various other pathogenic organisms there is steadily increasing evidence to show that the normal and exclusive habitat of the diphtheria bacillus is the diphtheria patient and the diphtheria carrier. In both, moreover, it is exclusively the mucous membrane of the nose, the throat and the mouth, with the communicating structures, which enter into consideration.

"In the great majority of cases the carriers harbor the bacilli in the tonsils. In a small number the organisms are found only in the nose and in the most persistent carriers of this type chronic inflammatory or atrophic processes are almost invariably demonstrable.

"The middle ear is apparently infected in many cases of the disease and it is noteworthy that this frequently occurs at a time when the patient has, apparently, already entered upon the stage of convalescence. Wolff mentions that in nasal diphtheria the corresponding sinuses are always involved. In one case of this order he could demonstrate diphtheria bacilli in the nose on the one-hundred and twenty-first day following the beginning of the disease. Those relatively rare cases in which the disease attacks the skin, the genitalia and the stomach hardly enter into consideration from the standpoint of the carrier."

*Meningitis: Habitat of the Organisms.*—"As regards the manner in which an individual becomes a carrier, and more particularly of the predisposing causes, very little is known. The fact that the organism's resistance outside of the body is so very slight suggests, of course, that in the human nasopharynx it must find special conditions

favoring its growth. Bearing in mind the common occurrence of catarrhal conditions associated with lymphatic involvement in civilized races more particularly, one cannot help but think that the ready availability of certain serum constituents which are poured out upon the surface and which collect in the various nooks and corners of the mucous membrane of the nasopharynx may prove to be the point of attraction. Some writers lay stress upon an increased secretion of mucous as a factor favoring the development of the organisms in the throat, but it seems more likely that the underlying inflammatory process with the resultant exudation of serum is the more important. Unfortunately no systematic bacteriological examinations of the lymphatic structures of the throat have thus far been made in carriers, but we may logically assume that the organisms do not develop to any special extent upon the exposed surfaces of the mucous membrane, but more likely in its depth, and particularly in the clefts of the larger lymphatic structures, such as the pharyngeal and faucial tonsils. In actual cases of meningitis, both acute and chronic, in children as well as in adults, Westenhoeffer invariably found a very considerable hypertrophy, hyperemia and hypersecretion of the pharyngeal tonsil, and both he and v. Lingelshheim, as well as Meyer, could demonstrate the meningococcus directly in the secretion taken from the depths of the recesses. Meyer, moreover, found them in the peripheral portion of the pharyngeal tonsil, while in the deeper parts they were lost. The faucial tonsils in contradistinction to the pharyngeal gland Westenhoeffer found less frequently involved.

"Similar conditions no doubt exist in the carriers, though in these the pharyngeal tonsil cannot play the prominent role which Westenhoeffer has assigned to this structure in cases of the actual disease. According to

Trautmann the pharyngeal tonsil usually disappears after the eighteenth year. In view of the fact that in adults the carrier state is decidedly common, whereas the malady itself has a special predilection for children in whom the gland is present, and whereas all adults contracting the disease showed the same hypertrophy as children, this observation would suggest that this structure may play an important role as portal of entry when it is developed, but that it is not essential as a nidus for the development of the organisms in carriers. In the latter the remaining lymphatic structures and mucous glands no doubt serve as points of anchorage for the organisms.

"A careful study of the distribution of meningococci in the upper respiratory tract of carriers has been made by Herrold. This investigator examined 93 segregated men with the results presented in the following three tables:

TABLE I—THE INCIDENCE OF POSITIVE CULTURES OF MENINGOCOCCI FROM DIFFERENT SOURCES OF THE UPPER RESPIRATORY TRACT OF NINETY-THREE CARRIERS

SOURCE OF CULTURES	POSITIVE	
	NUMBER	PER CENT
Nasopharynx.....	66	70.9
Tonsils.....	29	31.2
Anterior superior nares.....	16	17.2
Sputum.....	12	12.9

TABLE II—SUMMARY OF RELATIONS OF POSITIVE CULTURES FROM ELSEWHERE THAN THE NASOPHARYNX

	NUMBER
Positive tonsil, negative nasal and sputum cultures..	25
Positive nasal, negative tonsil and sputum cultures..	11
Positive sputum, negative nasal and tonsil cultures..	8
Positive tonsil and nasal, negative sputum cultures..	2
Positive tonsil and sputum, negative nasal cultures..	1
Positive nasal and sputum, negative tonsil cultures..	2
Positive tonsil, nasal and sputum cultures.....	1



TABLE III—A COMPARISON OF THE PERSISTENCE OF THE CARRIER STATE ACCORDING TO THE DISTRIBUTION OF MENINGOCOCCI

TYPE OF CARRIER	NUMBER IN EACH GROUP	INCIDENCE OF PERSISTENCE AFTER SIX WEEKS	
		NUMBER	PER CENT
Positive nasopharynx and elsewhere.....	39	28	73.0
Positive nasopharynx, negative elsewhere.....	27	17	63.0
Negative nasopharynx, positive elsewhere.....	11	6	54.6
Negative nasopharynx and elsewhere.....	16	3	18.8

“The results speak for themselves and warrant the conclusion that cultures should be taken not only from the nasopharynx but from the tonsils and anterior superior nares as well.

“Practically important, further, according to Westenhoeffer, is the fact that in children median otitis frequently, in fact invariably, develops, and that in this situation the organisms may possibly persist for some time in some of the convalescent carriers.”

*Pneumonia: Habitat of the Organisms.*—“Regarding the habitat of the pneumococci in healthy carriers our knowledge is practically nil. The results reached by the investigators mentioned in the foregoing pages have reference either to cultures taken from the saliva or the sputum, but this does not of necessity imply that the organisms multiply on the free mucous surface. From corresponding observations made in connection with diphtheria and meningitis we have reason to assume that organisms found upon the free surfaces are there more or less accidentally, and that their actual habitat is in

the crypts of the tonsils or the various nooks and corners connected with other lymphatic structures of the throat and the posterior nares. In cases of pneumonia, of course, we know that the pneumococci are present in abundance in the exudate, and it is easily conceivable that from here they may be distributed upward over the bronchial and tracheal mucosa, and that during the act of coughing and expectoration the larynx, pharynx and mouth of the individual also become contaminated. This, however, raises the question whether pneumonia is not a descending infection, which is the view that is now generally held. But in that case we would have a right to assume that every pneumonic was for a while a passive carrier until a sufficient number of organisms became available to bring about such a complete overthrow of the natural defenses as to render an infection of the lung possible. And in that case the question, where does this initial development take place, still remains unanswered. But supposing even that the infection were an ascending one, it is more than likely that the primary focus is nevertheless located in the upper respiratory tract. In the healthy carrier, of course, there is no reason for assuming that the organisms come from the deeper portion of the respiratory tract. In the absence of definite information on the subject we can only surmise that in the pneumococcus carriers also the crevices of the lymphatic structures of the upper respiratory tract contain foci in which the organisms find suitable conditions for their development, and from which they find their way to the surface and into the saliva. The fact that they are so frequently present in the latter, in which the diphtheria bacillus and the meningococcus are only exceptionally found, would further suggest that they might develop in diseased areas about the teeth. Streptococci are here so constantly

met with that it would not be at all surprising if pneumococci also here found conditions favorable for their growth. Dochez, Avery and Stillman when speaking of their findings in individuals who were not or had not been suffering from pneumonia quite constantly refer to 'normal mouths.' But every one knows that relatively few mouths are normal, and from the standpoint of the epidemiology of lobar pneumonia it would seem most important to ascertain whether or not pneumococcus carriers actually do have 'normal mouths,' which would, of course, include the condition of the teeth. A systematic investigation in this direction would suggest itself as a most promising field for future investigation."

*Streptococcus Infections:* Habitat of the Organism.—“The habitat of the organisms in the upper respiratory tract is as yet unknown, but we may well imagine that like other pathogenic organisms which gain access to the human body through the air, they probably lodge in the crypts of the tonsils and other nooks and corners connected with the lymphatic structures of this region.”

*Influenza:* Habitat of the Organism.—“As regards the habitat of the organism in healthy carriers, Scheller found that positive cultures are most apt to result if the secretion is obtained from the pharyngeal tonsil. This should be borne in mind, if a bacteriological diagnosis is desired, in clinically doubtful cases.”

From Simon's summary of the habitat of the organism in active and passive carriers of diphtheria, meningitis, pneumonia, streptococcic infection and influenza, the offending structures are, in the order of their importance:

1. Tonsils
2. Nasopharyngeal mucosa

These passages are readily reached by sprays, and the spray should contain a photosensitive dye that will be carried, by infiltration, into the structures for some considerable depth. In order to increase the mucosal tolerance to the ray, there may be added some adrenal chloride for its dehematizing effect.

With this photosensitive solution, the structures are sprayed and the energy applied for brief periods, using whatever form of quartz or tubular applicator that will insure reaching the parts. In the nose, the spatulate applicator is good. For the nasopharynx, one of the curved quartz rods introduced passed the soft palate and the curved end directed upward. For the tonsils, a metal tubular applicator with or without a quartz lens at its end.

The exposures are not longer than thirty seconds. Even better results follow two exposures a day, morning and evening, each exposure twenty seconds. Donnelly, in the "Journal of the Michigan State Medical Society,"\* reports that two or three exposures suffice to make laboratory cultures negative. These results can be certainly confirmed and point to unusually many important applications in preventive medical practice, particularly as it affects school and municipal authorities.

#### PARANASAL SINUSITIS

Certain cavities communicate with the nasal chambers; these are:

1. The Antra of Highmore
2. Anterior, middle and posterior ethmoid cells
3. Sphenoid cells
4. Frontal sinuses

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\*March, 1921.

The mucosal linings of these cavities are evaginations of the mucosa of the nose chambers, being lined with identical epithelium derived from the same blastic origin; and this in turn is of the same blastic origin as the epidermis of the skin. So that whenever a beginning infection spreads from the nasal chamber to any of the adjacent paranasal cavities, there is a sympathetic reflex incited in the contiguous layers of epidermis that arise from the same germ layer. On this basis, the so-called "blau-licht" (blue light) therapy of the Germans appears to depend wherein they use a special blue glass filter over the water-cooled lamp and claim deeper penetration and longer irradiation with less chance of burning the skin.

It can be speedily proved, by spectroscopic measure, that the glass filters used absorb everything shorter than about 2900 Angström units; leaving only a spectrum that simulates the air-cooled lamp, but *much less intense*. Obviously, any good effects derived from the use of the energy in paranasal infection must be due to the counter-irritant effect rather than to an impossible penetration of bactericidal wave lengths. As can be surmised, only in beginning infectious pathology, when the mucosal membranes are first inflamed, can this counter-irritant action be useful (and it is useful) in aborting progress.

After the infection is established, and the accessory cavities accumulate purulent exudate, the superficial counter-irritant effect can no longer be of great service. The sinus must be surgically drained.

Following the drainage, in the case of the maxillary antra, a quartz rod may be introduced and the cavity irradiated; a procedure that makes for splendid recovery in short time. Here again, the exposure should be brief—not over one minute. The cavity had better be first

lavaged or irrigated with an antiseptic dye solution, such as:

Eosin.....	1 part
Glycerine .....	5 parts
Phenol.....	5 parts
Water.....	1000 parts

Infections attacking the mucosa of the urogenital tract, particularly in the female, are amenable to ultra-violet treatment. In the male urethra, because of the difficulty involved in applying the energy, the results are less certain and may often be discouraging.

#### VAGINITIS

This may be:

- (a) Simple catarrhal
- (b) Gonorrhœal
- (c) Ulcerative
- (d) Croupous

In simple catarrhal vaginitis, an unusually excellent treatment consists in frequent vaginal douching with rayed water containing an ounce of borax to the pint. Just before using, a pint of water, to which the ounce of borax has been added, is placed in an open basin and exposed ten minutes to the rays of the air-cooled lamp at ten inches from the burner. It is then used as a douche. The raying imparts a peculiarly accelerated bactericidal quality that makes the solution quite effective. The douche should be taken in the dorsal, not sitting, position. No other local treatment is required. Cathartics, light diet and alkaline diluents are used.

In chronic forms, focal raying is employed, using any convenient vaginal speculum and exposing the mucosal walls to the bactericidal energy for 30 seconds over each area.

## GONORRHEAL VAGINITIS

Keep the patient quiet; move the bowels; attend to the diet, which should be light. During the acute stage, douche with freshly rayed water (as above) holding 1-10000 bichloride of mercury, three times a day. After the acute stage has passed, thoroughly disinfect the vagina with bichloride of mercury, 1-1000 and *loosely* pack with sterile gauze in a manner to insure maximum drainage. Each 24 hours remove and replace the packing, first exposing the walls to a short ultra-violet exposure from the water-cooled lamp, using a quartz speculum to distend the cavity and unfold the mucosal rugae. Ultra-violet exposures must be brief—not over 30-45 seconds per area. If the draining tends to persist too long, douche with rayed eosin solution, 1-1000, and with the mucosa still wetted from the wash, ray the mucosa through a speculum, 30 to 45 seconds.

## ULCERATIVE VAGINITIS

Touch the spots of desquamated epithelium using any of the straight quartz rod applicators attached to the water-cooled lamp. Treat the attendant leucorrhea, which is most always present, by frequent douching with rayed eosin solution. Sometimes pruritus is present which requires ultra-violet care (see pruritus).

CHAPTER X  
ABIOTIC ACTINOTHERAPY



ULTRA-violet absorption increases as the wave length of the energy decreases; from which it follows that chemical action also increases as the wave length decreases. Downes and Blunt pointed out that the destructive action of light upon protoplasm increases as the wave length decreases.

Much evidence points to the fact that elements, exposed to ultra-violet, undergo change. Oxygen, for example, becomes converted to ozone, and Bovie mentions that the transformation is of interest to biologists, for ozone is more opaque to ultra-violet than oxygen, so that life on our planet is made possible only because the ozone formed in the upper layers of the atmosphere by the ultra-violet of sunlight serves as a filter and protects the organisms on the surface of the earth from these shorter and more destructive rays.

In consequence of the many changes produced by light, it is often found, says Bovie, that many compounds containing the same element are photosensitive. For example, light affects many of the compounds containing silver. Protoplasm contains many photosensitive elements, and it is found that a large number of the substances elaborated by protoplasm, such as sugar, starch, cellulose, chitin, are decomposed when exposed to ultra-violet light.

Dreyer and Hanssen showed that albumins and globulins were coagulated when exposed to ultra-violet light;



and Bovie pointed out that ultra-violet coagulation involved two reactions:

1. A chemical change in the albumin
2. The precipitation of the albumin

Henri has shown that a thin layer of egg white is opaque to ultra-violet wave between 3000-2000 Angström units (far ultra-violet of the water-cooled lamp); and that the opacity is greatest for the shorter wave lengths. If the absorption coefficient of egg white can be applied to living protoplasm, and the later studies of Glitscher, Hasselbach and Pacini indicate that they can, then obviously the far ultra-violet energy exerts its extreme destructive effect as the result of a strong superficial absorption.

This abiotic or coagulative effect has been used in the treatment of naevi, a review of which study will make clear the method involved.

#### PORT-WINE MARK

*Classification:* Naevus is a term used generally in connection with congenital new growths of blood or lymph vessels, though in Europe it is used in the wider sense to include all circumscribed and regional cutaneous deformities of embryonic origin. A most comprehensive classification of naevi is that given by McLeod, and reproduced here:

#### I VASCULAR NAEVI

1. Derived from blood-vessels
  - (a) Capillary naevi, or port-wine stains, macules or patches
  - (b) Raised haemangiomas, cavernous naevi
  - (c) Stellate or spider-naevi
2. Derived from lymphatics
  - (a) Lymphangiectases
  - (b) Lymphangiomas

## II NON-VASCULAR NAEVI

1. Plane pigmented macules and patches
2. Raised

	Non-Pigmented
A. Soft naevi	Pigmented
(moles)	Hairy
	Giant-naevi
B. Hard naevi	
	Verrucose
	Linear
(a) Circumscribed	Ichthyosis
	Hystrix
	Keratosis
	Palmaris
(b) Regional	et
	Plantaris
C. Fibromatous naevi	
(a) Fibroma molluscom	
(v. Recklinghausen's Disease)	
(b) N. Lipomatodes	
D. Adenomatous naevi	
(a) Adenoma sebaceum	
(b) Syringo-cystadenoma	

In this discussion it is desired to consider only the clinical conception and the ultra-violet ray treatment of naevi derived from blood vessels, more especially the capillary variety commonly designated port-wine stains.

*Etiology:* Other than ascribing the etiology of naevi to peculiar developmental anomalies, little is yet known regarding the cause of these exceedingly common manifestations. Heredity appears to play a significant part in their appearance, certain types of naevi recurring in the offspring of several generations. One significant factor in their obscure etiology is their undoubted rela-

tion with imperfect development; as may be gathered from the frequency with which these marks are associated with other physical defects, such as harelip, cleft palate, webbed fingers, and syndactylism. Virchow's conjecture, that naevi were of anatomical origin and situated at embryonic fissures, is not entirely applicable to all cases; many instances being observed of naevi situated in portions other than embryonic clefts. Unna's hypothesis, that naevi result in consequence of uterine pressure, though applicable to some, is wholly unsatisfactory in explaining the great majority of cases.

*Capillary Naevus; Port-Wine Stain:* It is better to refer to this type of naevus as capillary rather than port-wine stain; for the latter terminology, though applicable to a goodly number of cases, is prone to be misleading owing to its suggestion of a dark port-wine discoloration of the skin; whereas, in clinical reality, all grades of color may be observed varying from the faintest pink to the most livid purple. Capillary naevi may occur anywhere on the body surface, but they seem to favor the face and the upper parts. Their most frequent situation is in the region of the posterior fontanel, fully one-fourth of infants showing naevi having them in this region. They are also present on the forehead, cheeks, and lips, and occasionally they involve an entire half of the face.

*Pathology:* Capillary naevi result because of dilatation or new growth of venous capillaries. They may be superficial, in which the venous capillaries involve mainly the lower layers of the epidermis; or they may be deep, when the capillary engorgement is situated principally in the corium. For the treatment of naevus, the clinician is guided in a large measure by the depth to which the lesion is situated; and this must be tested with a glass slide such as is used in microscopic work. This slide is placed

against the naevus. Under exertion of moderate pressure, superficial naevi show their capillary network, and their redness is in part or wholly obliterated; while the deep naevi show little or no change under similar conditions.

*Newer Concept of Wine-Mark Pathogenesis:* Naevi consist of newly formed blood vessels. They are benign tumors and never form metastases. Early in the formation and derivation of the blastodermic layers, at a period before definitely organized vascular structures exist, the interchange of material necessary for the proper metabolism of the growing cells, is carried in the intercellular spaces and taken up by various processes of absorption and osmosis. As the cells differentiate and assume independent histologic identity, the rate of metabolic exchange likewise varies in proportion to the character and structure of the tissue; so that some areas demand a moderately lessened stream of nutrient supply, and others a greatly increased source of metabolic materials. In the fetus, the cells of the skin surface require a comparatively great nutrient supply, owing to the fact that metabolic exchange must be carried on with rapidity and proficiency in order that the skin may undergo the necessary metamorphosis so as to withstand the forces of exposure (air, light, and gaseous exchange) in which the born body will eventually be immersed.

It is, therefore, a natural proclivity for the skin of the embryo to show exaggerated metabolism; an activity that demands a maximum quantity of blood for the use of the embryonal skin cells. Any factor that interferes with the physiologic activity of the skin cells is conducive to passive venous congestion. It may be through trauma, as Unna described, or through anatomical situation calling for cellular stress, as in the fissural concept of Virchow, or from any similar cause, that cellular avidity for blood

nourishment is impaired in an area. There being established proclivity for exaggerated blood supply, and a focal reactivity against the consumption of blood, the physiologic expression for the correction of the anomalous lesions is the formation of many and new blood capillaries into which the volume unused by the perverted cells may naturally accumulate—the process of an embryonic example of the establishment of compensatory capillary circulation.

So that the newer concept of the pathogenesis of naevus is found to begin with any disturbance in the metabolic avidity of the skin cells. Their nourishment impaired through whatever cause, new vessels are formed in amount sufficient to accommodate the volume of blood that would otherwise go for the physiologic consumption of the cells.

*Treatment:* Previous to the introduction of the concept for the pathogenesis of naevus as above propounded, contemporaneous dermatologists make for the basis of treatment a method aiming at the destruction of the capillary network; and for this destruction, radium, refrigeration, electrolysis, X-ray, electrocoagulation and ultra-violet light, have at different times been suggested with indifferent success. Of these, radium yields the best results. It appears to exert a selective action on blood vessels which causes them to shrivel and disappear, the capillary network being eventually replaced by a new connective tissue manifesting as a delicate white scar. There are many points of favor in the use of radium; it is painless (an attractive treatment for children) and its results are reasonably certain. Against its use may be mentioned the long and tedious applications; the great quantity of radium necessary when large areas are being treated; the fear of producing an uneven and mottled scar, often

more unsightly than the original stain, and the tremendous expense and care that must be exercised in its judicious use in order to avoid the production of telangiectasis.

*Treatment:* Since the shorter wave lengths are the ones desired for the coagulation of the capillary net that naevus represents, the use of the "blau-licht"\* filter in connection with the water-cooled lamp is to be deprecated. Heavy irradiation under reasonable pressure with unfiltered water-cooled energy is certainly more effective. When the lesion is small, a hole is cut in a chamois skin that corresponds with the area of the lesion. The patient is comfortably posed and shielded so that only the lesion presents through the opening in the chamois. A quartz lens is selected that fits the area; or, if the area is large, it is marked off with a wax pencil in squares, and each square separately treated, much like the multiple portals of entry in attacking a cross-fire X-ray treatment. Pressing the quartz firmly against the lesion, the water-cooled lamp is held in this position for ten minutes over each portal of raying.

A severe blistering follows, which, when it has subsided, leaves the lesion paler in color. At this time, about two weeks, a second intensive radiation is applied in a like manner. The treatments are continued at the intervals named until the lesion has disappeared. It may not disappear completely, leaving a slightly noticeable pinkish discoloration; but the majority of cases, depending upon the initial character of the lesion and the age of the patient, improve to a remarkable extent. Children respond well to the treatment; adults less well.

It is advisable to follow each irradiation by daily bathings, locally, of boric acid to prevent infection of the vesicles.

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\*Blue light; blue glass filter.

## FINSSEN TREATMENT OF LUPUS VULGARIS

At the International Congress of Medicine in Paris, 1900, Finsen presented a thesis entitled "The Treatment of Lupus Vulgaris by the use of Concentrated Chemical Rays."\* Because of its historical value as the contribution that directed the attention of the medical world to the first modern re-establishment of scientific therapy, it will be reproduced (translated) and commented upon in the light of newer researches.

"In the course of several years of study dealing with the physiological effect of light, I observed in the first place that its capacity to produce a more or less intense cutaneous inflammation was accompanied by a desirable influence in certain affections, as for example, in variola. In comparing this effect with the bactericidal property of light, definitely attested to by many researches in which the ability of the energy to penetrate tissue has been pointed out,† the concept struck me to try light in the treatment of various bacterial affections of the skin. In October, 1895, I began my first practical investigations commencing with a case of lupus vulgaris.

"In the first place, it must be reported that in the method which I shall indicate it is not a question of the thermic effect of light. My method is based exclusively on the employment of the chemical rays (blue, violet and ultra-violet) of light.

"It is necessary, therefore, to use a source of light that is rich in these rays and to concentrate it as much as is possible. In the next place, since it is necessary to exclude the thermic rays, it is essential to "cool" the light,

\*Traitment Du Lupus Vulgaire Par Les Rayons Cliniques Concentres.  
Niels R. Finsen.

†This is, of course, fallacious for ultra-violet.—A. J. P.

with maximum effectiveness. It is with the double viewpoint that our apparatus is constructed. For the source of light we are using at this time the light derived from an arc or even sunlight. The light is concentrated through a system of convex rock crystal lenses, and it is cooled by having it pass through a layer of distilled water. It is necessary to observe also that blood offers an obstacle to deep penetration of light in the tissue, and that the region undergoing treatment must be exsanguinated as completely as conditions will permit; a result obtained through the use of compression appliances, applied during the treatment directly upon the skin. These applicators may also be arranged so as to permit water circulation in them and so insuring a complete elimination from the possibility of the accompanying thermic rays.

“The treatment is effected in seances lasting one and one-quarter hours.

“Each individual is treated once or twice each day.

“At each seance the patient maintains a definite position throughout the entire hour, during the action of the light.

“The area of the lupus is brought in contact with the concentrating lens of the apparatus in such fashion that the radiation strikes the field at right angles over a space of two or three centimeters in diameter.

“The treatment is entirely free from pain although this may occasionally exist for a short time during the seance. If ulceration is present, the continuous pressure incident to the treatment may occasionally induce a little pain.

“The effect of such a treatment is characterized by local erythema, generally accompanied with the formation of a vesicle, but never with any loss of substance. This reaction subsides, and after six or eight days is accompanied by an epidermal exfoliation.



“In order to avoid an infection of the vesicles, a boric acid solution or an ointment of zinc oxide is applied (after the treatments).

“When the lesion of the lupus is reasonably extensive the treatment is begun at the periphery. It is generally necessary to irradiate the same spot more than once, which may be done from eight to fifteen hours after the initial treatment.

“The effect of the treatment is characterized by successive and gradual involution of the affection, ulcerations diminishing in size and in depth, and finally disappearing completely; hypertrophic nodules become level and smaller; confluent nodules are transformed into smaller nodes that become separated by healthy skin and finally disappearing entirely. The healing process may last a longer or shorter time depending upon the original intensity and extent of the lesions; but the treatment is at no time interrupted, being maintained until the patient exhibits no more traces of the disease. At this stage, however, the patient is not yet totally cured. At the end of this first course of treatments the patient is kept under observation. In the more favorable cases, the patient remains in perfect health, without additional treatment; but more often comes the unnoticeable lesions that persist in the depths of the skin, and reappearance is newly instituted at the surface. A second course of treatment, of shorter intensity and duration than the first, is then begun.

“In the numerous cases in which we have applied these principles, we have never observed a relapse. But if the patient neglects the second course of treatments, the deeply situated small foci may take on a considerable extension of pathologic invasion.

"In order to obtain a mean average I studied carefully the results in the first hundred cases that were cured. It seems established that the effects of the first course of treatments persist for four and one-half months. Twice it was necessary to apply a second course of treatment so that the effective treatment for each patient can be established as occupying six months.

"The advantages of the method are the following:

1. The effect is remarkably constant, being as successful in the more severe and extended cases where an absolute cure can hardly be expected, though a complete arrest of the process is certainly realized. Cases that are wholly refractory never amount to more than two or three per hundred.

2. The results are satisfying because of the good plastic effect and the conservatism of the method.

3. Contiguous lesions, beyond the periphery of the obvious pathologic area, also respond to the treatment without leaving scars.

4. There are no secondary or retroactive sequelae.

5. The method is free from pain.

"The inconvenience of the method is its shortcoming. This is being eliminated by progressive studies in technic. We have used the method not alone in lupus vulgaris, but likewise in various other conditions, such as:

#### LUPUS ERYTHEMATOSUS

38 cases

12 cured

13 still under treatment

13 discontinued

## ALOPECIA AREATA

- 36 cases
  - 28 cured
  - 2 still under treatment
  - 6 discontinued

## CUTANEOUS EPITHELIOMA

- 22 cases
  - 10 cured
  - 4 still under treatment
  - 8 discontinued

NOTE—Only small superficial epitheliomas are conveniently treated by this method.

## ACNE VULGARIS AND ROSACEA

- 20 cases
  - 7 cured
  - 5 improvements
  - 1 still under treatment
  - 7 discontinued

## NAEVUS VULGARIS PLANUS

- 13 cases
  - 2 cured
  - 9 still under treatment
  - 2 discontinued

“These cases are interesting as they do not represent a bacterial infection. One must believe, therefore, that the inflammatory effect of the light is involved in the cure.”

Of Finsen's work, this must be said: that a critical study of most of his reports reveals a reasonable conservatism in the expression of the results obtained. This conservatism was overthrown by writers subsequent to the time of Finsen. One may profit much by the original studies issued from the Finsen Institute, if allowance is

made for the increased knowledge of our own times and the mechanical perfection of the apparatus involved.

With the water-cooled lamp, the same basic principles are carried out, using a compression treatment under any adequate size of lens. The skin may be wetted with diluted hydrogen peroxide. The treatments are given for five to ten minutes when there is much hypertrophy. When the vesicles form, they are bathed in boric acid solution. It is not necessary to wait longer than two days between treatments if the scales of dried serum are removed with peroxide previous to each exposure.

CHAPTER XI  
ACTINOTHERAPY IN METABOLISM



**M**ETABOLISM must be conceived in its broad sense—the changes that substances introduced into the body undergo while passing through it, or on becoming incorporated with it, and the transformations of energy that accompany these processes.

When speaking of the action of light on metabolism, many have referred to the case of the plant and its chlorophyll, which has been compared to the animal and its hemoglobin. But this is not at all an analogy, for the plant, aided by and dependent entirely on sunlight, has to do with the synthesis or building up of the compounds that compose it; whereas the animal has to do with the analysis or breaking down of already formed compounds, which it does through the processes of cleavage and oxidation. Of course, both sets of processes occur in the plant and in the animal; but the dominant function of the plant is to synthesize, and that of the body to analyze.

Substances taken into the human body as food and drink are disposed of as follows:

1. Analyzed into simpler products
2. Taken up by protoplasm for growth and maintenance
3. Leave the body, changed in the form of secretions and excretions; or leave the body in an unaltered condition

This constant coming in and going out of substances is a process aptly described by the Germans as "Stoffwechsel."

In addition to the changes undergone by protoplasm as the result of food ingestion, there must be considered also the changes in energy. The potential energy of the intake is far greater than the potential energy of the output; or, what amounts to the same thing, in passing through the body, food intake is accompanied by an actual conversion of energy, which appears as heat, mechanical work, and electricity. The study of metabolism, therefore, demands a consideration of:

1. The chemical, or material phase
2. The dynamic, or energetic phase

Chemically, metabolism has to do with the physiological studies of foods, grouped commonly as:

Proteins  
Carbohydrates  
Fats  
Minerals  
Water

and so we speak of the metabolism of protein, of carbohydrate, etc.

Proteins, as is known, are composed of entities called amino-acids; and the quantity and character of amino-acids are constant for every protein. From the viewpoint of actinotherapy, it is important to remember that certain amino-acids, or certain proteins rich in certain amino-acids, display photosensitivity when exposed to light. Soret, Kober and Harris and Hoyt have begun to throw light on this topic; so that their researches should be well studied. Harris and Hoyt presented a thesis\* in the University of California *Publications in Pathology*, which is reproduced here in full:

\*The action of ultra-violet light on certain bacteria in relation to specific absorption by amino-acids.

"Within recent years considerable interest has been shown in the study of the ultra-violet radiations in relation to their toxicity for living protoplasm. It was early found that these radiations exert a highly toxic influence on protoplasm exposed to them. Henri, in conjunction with various co-workers, has done pioneer work in this field, and was the first worker to point out the possibility of a practical application of this subject, namely, in the sterilization of various substances and solutions. Further work on the germicidal effect of ultra-violet light has been done by Houghton and Davis, who found that the rays produced by the Cooper-Hewitt mercury arc exert a strong bacterial action on various species of bacteria, including spore-forming organisms.

"The action of these radiations was recognized as a photochemical process, and was supposed to be due to the absorption of the rays by the bacterial protoplasm. In a previous report we studied this phase of the problem and proceeded on the basis of the first law of photochemical action, that in a photochemical system, to be effective, the rays must be absorbed, usually by specific constituents. We have further shown that the toxic action of ultra-violet light obeys this law and is due to the absorption of the rays by certain constituents of all living protoplasm, namely, the tyrosine and phenylalanin radicals of the protein molecules. These two acids are the specific absorbents in living protoplasm for the rays of the mercury arc.

"The object of the present work was to confirm this work, using bacteria as a biological test, and further to study the relative speed of absorption of the ultra-violet rays by the protoplasm of the various types of bacteria."

## METHODS

“Three organisms were selected as typifying three general groups of bacteria, which are classed on the basis of the possession or lack of protective structures, spores and capsules.

1. A non-sporulating, non-capsulated organism, staphylococcus aureus
2. A sporulating, non-capsulated organism, bacillus subtilis
3. A capsulated, non-sporulating organism, *B. mucosus capsulatus*

“For the exposure of these organisms various methods were tried. The organisms were grown on agar slants for twenty-four hours, and then washed off with sterile 0.85 per cent NaCl. A preliminary exposure was made with a given amount of each saline suspension exposed directly to the rays. As no consistent results were obtained by this method, due undoubtedly to the absorption of the rays by the upper layers of the bacterial suspension, this method was abandoned.

“A number of plating methods was then tried. Melted agar was poured at 42 degrees C and allowed to harden in ten centimeter petri dishes. To prevent condensation it was found best to cover with sterile tile covers. After hardening, three methods of inoculation were tried.

“(a) Two separate streaks were made with a loopful of saline suspension, one on either side of the diameter of the plate. Half of the plate was then exposed, the other half being protected by a glass cover, covered with black paper. The plate was then incubated twenty-four hours, and the colonies were identified directly, or, in suspicious cases, smears were made. The objection to this method



was that there was no certainty that the control streak and the exposed streak were similarly inoculated.

“(b) To overcome this objection a single large streak in the shape of the letter ‘Z’ was made of one loopful of bacterial suspension, and half the plate exposed as before.

“(c) Another plating method experimented with was to flood the entire plate with a definite amount of saline suspension and then expose one side, as in the above.

“Plating methods were also abandoned finally because they did not yield uniform results, due undoubtedly to some organisms getting in under the agar and being protected by the protein material.

“The method finally employed was a cover slip method suggested by Professor Ivan C. Hall. Upon one surface of a sterile cover slip one loopful of saline suspension of a twenty-four hour agar growth was placed and allowed to dry in a sterile petri dish. Assuming the saline suspension to be uniform each cover slip, therefore, had approximately the same number of organisms. When dry the cover slips were exposed directly to the rays by placing them in a petri dish 12 cm. below the arc of the Cooper-Hewitt machine. After the given exposure the cover slip was picked up with sterile forceps, dropped into a tube of broth (the broth was incubated for forty-eight hours) and the results observed. The growth of these three organisms in broth is quite characteristic, and no further examination was usually necessary. In doubtful cases agar plates were streaked from the broth and the organisms were identified by the usual methods.

“The exposures varied from 5 seconds to 200 seconds. Somewhat over 100 exposures were made, and although there were slight discrepancies in the results, due to the

objections mentioned to plating methods, consistent results were obtained by the cover slip method, so that we may definitely say that:

Bacillus mucosus capsulatus was killed after 20 seconds

Staphylococcus was killed after 90 seconds

B. subtilis was killed after 150 seconds

These figures represent the relative resistance of these three organisms.

“The protective action of the amino-acids was then studied. The cover slips were exposed as before, but between the cover slip and the arc a quartz beaker containing the given amino-acid was interposed, so that the rays before striking the organisms passed through the amino-acids. The results obtained confirm our previous work. With *B. subtilis*, whose normal extermination period is 150 seconds, we found exposure for forty minutes to ultra-violet light passed through one per cent tyrosin solution exerted no toxic effect upon the bacilli, a good growth being obtained in forty-eight hours. Similarly, *staphylococcus aureus* gave good growth after forty minutes; *B. mucosus capsulatus*, though not tested after longer exposure, gave satisfactory growth after ten minutes.

“A good growth was also obtained with amino-benzoic acid after exposure of these organisms for 3200 seconds to ultra-violet light detoxicated by passing through this substance. Phenylalanin could not be secured, but there is little doubt that similar results could be obtained with it.

“These results confirm those of our previous report and indicate that the aromatic amino-acid radicals are the absorbing substances in bacteria as well as in protozoa. Kober's work placed the absorption band for

tyrosin at 248 to 297u, or 2480-2970 Angström units of wave length, and for phenylalanin 236-271u, or 2360-2710 Angström units.

"Therefore, ultra-violet light, of wave lengths 2360-2970 Angström units, should contain practically all of the rays toxic for protoplasm. Two recent papers have appeared, however, which report different results. Browning and Russ found the toxic action of ultra-violet light falling off sharply at 2960 A. U., which would apparently correspond with one edge of the tyrosine band. They report, however, an apparently constant toxicity from 2960-2100 A. U., and did not investigate below 2100 A. U. Newcomer reported also a constant toxicity from 2100 A. U. up to a little less than 2900 A. U., the toxicity falling off to practically zero at 2970 A. U. The region in which tyrosine and phenylalanin are both absorbed, i.e., 2480 to 2710 A. U., should be the most toxic for protoplasm, whereas the region containing wave lengths shorter than 2300 A. U. should be relatively non-toxic.

"Our former experiments conclusively demonstrated that a solution of tyrosine will absorb practically all of the toxic rays, those getting through not being sufficiently toxic to kill paramecia after exposure for forty minutes, whereas if the rays absorbed by tyrosine were allowed to act the paramecia were killed in 100 seconds."

### CONCLUSIONS

"1. The aromatic amino-acid radicals are among the substances in bacteria affected by the action of ultra-violet light, as was shown for paramecium in a previous report.

"2. The ultra-violet radiations produced by the mercury arc of wave lengths not absorbed by tyrosine and phenylalanin are relatively non-toxic. Therefore, using

Kober's determinations for the wave lengths corresponding to these two absorption bands, the ultra-violet radiations which are toxic for protoplasm are of wave lengths from 2480-2710 A. U.

"3. In the three types of bacteria studied capsulated organisms were found to be most susceptible and sporulating organisms most resistant to the action of ultra-violet light. The work suggests strongly that the protoplasm of *Bacillus mucosus capsulatus* contains greater amounts of the above mentioned substances than the non-capsulated staphylococcus and the sporulating hay bacillus."

A most important message, as conveyed by this study, is that the amino-acids tyrosine and phenylalanin impart photosensitivity to the protein of which they are a part; and it is reasonable to infer, further, that the photosensitivity is great in proportion as the amino-acids are high in the composition of the protein. This generalization leads at once to a critical survey of the protein composition of foods. Sherman gives the following table for the relative percentage of tyrosine and phenylalanin in various common proteins used as food:

PERCENTAGES OF AMINO ACIDS FROM HYDROLYSIS OF VARIOUS PROTEINS

	ALBUMINS					GLOBULINS						
	Egg Al- bumin (hen's eggs)	Lactal- bumin (cow's milk)	Legume- lin (pease)	Leucosin (wheat)	Amandin (al- monds)	Edestin (hemp seed)	Excelsin (Brazil nuts)	Glycinin (soy beans)	Legumin (pease)	Phaseo- lin (white beans)	Vicilin (pease)	Vignin (cow pea)
Glycine . . . . .	0.00	0.00	0.50	0.94	0.51	3.80	0.60	0.97	0.38	0.55	0.00	0.00
Alanine . . . . .	2.22	2.50	0.92	4.45	1.40	3.60	2.33	*	2.08	1.80	0.50	0.97
Valine . . . . .	2.50	0.90	0.69	0.18	0.16	6.20	1.51	0.68	*	1.04	0.15	0.34
Leucine . . . . .	10.71	19.40	9.63	11.34	4.45	14.50	8.70	8.45	8.00	9.65	9.38	7.82
Phenylalanine . . . . .	5.07	2.40	4.79	3.83	2.53	3.09	3.55	3.86	3.75	3.25	3.82	5.27
Tyrosine . . . . .	1.77	4.90	1.56	3.34	1.12	2.13	3.03	1.86	1.55	2.84	2.38	2.26
Serine . . . . .	*	*	*	*		0.33			0.53	0.38		
Cystine . . . . .	*	*	*	*		1.00						
Aspartic acid . . . . .	2.20	1.0	4.11	3.35	5.42	4.50	3.85	3.80	5.30	5.24	5.30	3.97
Glutamic acid . . . . .	9.10	10.1	12.96	6.73	23.14	18.74	12.94	19.46	16.97	14.54	21.34	16.80
Arginine . . . . .	4.91	3.23	5.45	5.94	11.85	14.17	16.1	5.12	11.71	4.87	8.91	7.20
Lysine . . . . .	3.76	9.16	3.03	2.75	0.70	1.65	1.64	2.71	4.98	4.58	5.40	4.28
Histidine . . . . .	1.71	2.06	2.27	2.83	1.58	2.19	2.50	1.39	1.69	2.62	2.47	3.08
Proline . . . . .	3.56	4.0	3.96	3.18	2.44	4.10	3.65	3.78	3.22	2.77	4.06	5.25
Oxyproline . . . . .	*	*	*	*	*	*	*	*	*	*	*	*
Tryptophane . . . . .	present	3.	present	present	present	present	present	present	present	present	present	present
Ammonia . . . . .	1.34	1.32	1.26	1.41	3.70	2.28	1.80	2.56	2.05	2.06	2.03	2.32
Summation . . . . .	48.85	63.97	51.13	50.27	59.00	82.28	62.20	54.73	62.21	56.19	65.74	59.65

\* Not determined.

## PERCENTAGES OF AMINO ACIDS FROM HYDROLYSIS OF VARIOUS PROTEINS

	GLUTEINS		ALCOHOL-SOLUBLE PROTEINS				ALBU- MINOID	PHOSPHOPROTEINS		FLESH (NOT SINGLE PROTEINS)			
	Glutenin (wheat)	Maize Glutelin	Glialin (wheat)	Hordein (barley)	Prolamin of Rye	Zein (maize)	Gelatin	Casein (cow's milk)	Ovovul- telin (hen's eggs)	Beef	Chicken	Halibut	Scallop
Glycine . . .	0.89	0.25	0.00	0.00	0.13	0.00	16.5	0.00	0.00	0.68	0.00	0.00	0.00
Alanine . . .	4.65	?	2.00	0.43	1.33	13.39	1.6	1.50	0.75	3.72	—	—	—
Valine . . .	0.24	?	3.34	0.13	—	1.88	1.0	7.20	1.87	0.81	0.79	—	—
Leucine . . .	5.95	6.22	6.62	5.67	6.30	19.55	9.2?	9.35	9.87	11.19	10.33	8.78	8.78
Phenylalanine	1.97	1.74	2.35	5.03	2.70	6.55	1.0	3.20	2.54	3.53	3.04	4.90	4.90
Tyrosine . . .	4.25	3.78	1.50	1.67	1.19	3.55	0.0	4.50	3.37	2.16	2.39	1.95	1.95
Serine . . .	0.74	?	0.13	?	0.06	1.02	0.4	0.50	?	?	?	?	?
Cystine . . .	0.02	*	0.45	1.00	*	*	—	0.06	*	?	?	?	?
Aspartic acid	0.91	0.63	0.58	?	0.25	1.71	1.2	1.39	2.13	3.21	2.73	3.47	3.47
Glutamic acid	23.42	12.72	43.66	43.20	38.05	26.17	16.8	15.55	12.95	15.49	10.13	14.88	14.88
Arginine . . .	4.72	7.06	3.16	2.16	2.22	1.55	9.3	3.81	7.46	7.47	6.34	7.38	7.38
Lysine . . .	1.92	2.93	0.92	0.00?	0.00	0.00	6.0	7.61	4.81	7.59	7.45	5.77	5.77
Histidine . . .	1.76	3.00	1.84	1.28	0.39	0.82	0.4	2.50	1.90	1.76	2.47	2.55	2.02
Proline . . .	4.23	4.99	13.22	13.73	9.82	9.04	10.4	6.70	4.18	5.82	4.74	3.17	2.28
Oxyproline . .							3.0	0.23					
Tryptophane	present	present	1.0	present	present	absent	absent	1.50	present	present	present	present	present
Ammonia . . .	4.01	2.21	5.22	4.84	5.11	3.64	0.4	1.61	1.25	1.07	1.33	1.08	1.08
Summation . .	59.68	45.53	85.99	79.14	67.55	88.87	77.2	67.21 <sup>1</sup>	53.08	67.30	50.25	52.51	52.51

\* Not determined in these cases and presumably not, in the cases left blank. In other cases the figures given for cystine may be much too low because of decomposition of this amino acid in the process of hydrolyzing the protein.

<sup>1</sup> Fischer and Abderhalden report also diamino-trioxy-dodecanic acid 0.75 %.

A study of Sherman's tables and Harris' and Hoyt's premises, reveals important findings. For example, the glutelin from maize contains a very high percentage of tyrosine as compared to other proteins. Maize and pellagra have been associated for some time.\* The skin changes in pellagra occur first in the parts exposed to sunlight. LeRoy and Pacini, in 1911, showed that pellagra lesions could be quickly induced by exposing a small section of a pellegrin's skin to the highly actinic light of burning magnesium ribbon. Obviously, tyrosine photosensitization plays a significant role in this condition.

It is curious to observe, also, that all of the proteins occurring in foods for which hypersensitization is a common finding, such as wheat, egg albumin, lactalbumin, are those that in Sherman's tables show a high content of phenylalanin, tyrosine, or both. The question of diet is therefore an important consideration in prolonged (fractional or systemic) actinotherapy. Where photosensitization is required, seek protein diets rich in tyrosine and phenylalanin; and where photosensitization is not desired, eliminate from the diet the proteins rich in these two amino-acids.

In physiological value, proteins vary according to their elementary amino-acid composition. Superior proteins are classed as milk, meat, eggs, and fish; and inferior proteins as bread and Indian corn.

An important part of protein metabolism is the study of nucleic acid and the purins. The nuclei of the cells have a very different chemical constitution than the protoplasm.

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\*The Italian adage "Poverta, Pollenta, Pellagra:" (Poverty, yellow corn meal, pellagra).

In states of under-nutrition, much may be accomplished by increasing the energy factor of metabolism through the external application of a chemical energy, such as ultra-violet represents. The form of therapy would be systemic, already described. The biologic air-cooled lamp is used; and the conditions treated would include:

Marasmus  
Scurvy  
Beri-Beri  
Pellagra

The cachexias of:

- (a) Cancer
- (b) Grave anemias
- (c) Hyperthyroidism
- (d) Banti's disease

The usual diet regulation essentially along the lines discussed, must be observed, in addition to the stimulative erythema of biologic energy according to instructions already furnished.

Just as the biologic synergism displayed by the air-cooled lamp in the states of under-nutrition are benefited by the biologic energy, so it is proper to infer that the abiotic energy of the water-cooled lamp might serve useful in checking or arresting the condition of metabolism in states of over-nutrition. Here, the short wave lengths are efficient; so that the lamp must be used at distances of six inches from the body, or less. Longer distances diminish the intensity of the short wave lengths owing to the increased air filter that automatically enters into play. The lamp is held six inches away and kept over the area illuminated for the time necessary to produce a regenerative erythema, usually one minute. After this exposure, another area of the body is similarly treated;



and this treatment continued until the whole of the body has been attacked. The conditions thus treated would include various:

1. Fatty diatheses, and
2. Amino-acid dystrophies

Speaking generally, the basal metabolic rate is an excellent index for the indication of the use of air-cooled, or water-cooled ultra-violet. High rates may be lowered, low rates may be raised, depending upon whether the metabolic synergistic or metabolic depressing energy is used.

Finally, it must be remembered that if a chemical process is initiated in the body through the use of internal medication, such as organo therapeutic agents, that process may be accelerated through the use of the air-cooled lamp. That is, pituitary extract fed by mouth, will produce its effects quicker and more characteristically if the body is then rayed by ultra-violet. From which the conjoint use of endocrine therapy and ultra-violet offers a most valuable clinical measure. Osborne\* summarizes the uses for various glands; to which may be added that the additional use of ultra-violet makes for a more certain and more prompt expectation of the action.

1. Thyroid absent = a cretin
2. Pineal disturbance = precocious sexuality
3. Thymus insufficiency = too early sexuality
4. Thymus too long active = delayed puberty
5. Pituitary hypersecretion = a giant
6. Pituitary posterior hyposecretion . . } = overgrowth;  
     Pituitary anterior hypersecretion . . } = a fat child

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\*Principles of Therapeutics.

7. Thyroid subsecretion = slow growth; poor mentality; obesity
8. Suprarenal hypersecretion = early maturity; mentally active; physically active; if a female = masculinity
9. Suprarenal hyosecretion = general weakness; non-aggressive mentality; if a male = femininity
10. Gonads hypersecretion = sexual perversity  
Gonads hyosecretion = sexual insufficiency; obesity
11. Thyroid hypersecretion = Graves' disease  
Thyroid hyosecretion = many types of abnormal conditions

#### TEETH

1. Thyroid normal = good white teeth
2. Pituitary hypersecretion = large incisors, separated
3. Gonad hyosecretion = small lateral incisors
4. Suprarenal hypersecretion = sharp, long canines

#### HAIR

1. Thyroid normal = fine hair; normal growth
2. Thyroid hyosecretion = loss of hair
3. Suprarenal hypersecretion = hairy; eyebrows heavy and meet
4. Suprarenal hyosecretion = scanty hair; moles and pigmented spots
5. Pituitary hypersecretion = hairy

*Uses of Thyroid Preparation:* "Ordinarily, thyroid preparations are indicated only when there is some form of hypothyroidism. However, in some depressed conditions in acute infection without delirium and without a rapid heart, small doses of thyroid may be of benefit, and perhaps when the detoxicating power of the thyroid gland has been exerted to exhaustion during an infection a little help may be of advantage to the patient. How-

ever, generally, such stimulation or aid to the thyroid may be given by a small dose of an iodide once or twice a day.

"When there are indications of defective growth in children very small doses of thyroid are generally indicated. This is true when the teeth do not well develop, the hair does not grow, the skin is dry, and there are enlarged tonsils and adenoids, subnormal temperature, and especially when there is sluggish mentality. The nearer the child approaches a cretin, the larger the dose of thyroid required, for a time at least. When the symptoms of hypothyroidism are but few and not very marked, the dose should be small, if it is given at all.

"It is difficult to determine that a child is a cretin until at least he is six months of age, and perhaps it cannot be determined until he is a year old, and if the secretion is only deficient and not absent, such deficiency may not be determined until after the child is two or three years of age. A cretin is evidenced by a thick tongue generally protruded between the lips, more or less drooling, sluggish dentition, imperfect hearing or at least imperfect recognition of sounds, the eyes are far apart, there is often conjunctivitis and eczematous patches about the face, there is likely to be enlarged tonsils and adenoids, and perhaps puffing of the eyelids, especially in sporadic cases. These symptoms are associated with slow development of the teeth, slow growth, and later the mentality is that of a moron, or even that of idiocy.

"The dose for a cretin a year old may be considered as 0.06 gm. (1 grain) two or three times a day. If the thyroid is begun when the child is older, the dose is larger. Its favorable action is shown by an improved mentality, increased general growth, and a better growth of the

hair, nails and teeth. When improvement is in evidence, the dose should be diminished, although a small dose should probably be given daily, or at least every other day, for months and perhaps years. In these cases the undesired action of thyroid is generally a tachycardia, and when this occurs the dose is too large and the administration should be stopped. After the heart has returned to normal rapidity, smaller doses should be given.

"Thyroid transplants have been tried in cretinism, but they must be termed a failure. They may help the child until the transplanted gland is absorbed, but the transplant does not continue to grow. When the thyroid secretion is not entirely absent in a child, thyroid treatment for a time may stimulate the gland to increased activity, and the dose of thyroid extract may then be much diminished.

"With the minor symptoms of subthyroid secretion in children the dose is very much smaller, even as little as 0.005 gm. daily being often sufficient, and certainly 0.01 or 0.02 gm. daily is generally enough.

"Certain types of eczema which occur in children are typical of subthyroid secretion, such as occur at the orifices of the body, and as fissures under the ears, at the corners of the mouth or around the nostrils. These patients are often improved by thyroid.

"At any age dry, scaly skin, of all grades up to actual ichthyosis, with profuse desquamation, are benefited by thyroid, as all such cases have subthyroid secretion.

"Some children have a great deal of headache, cold hands and feet, and sometimes great lassitude, showing sluggish circulation. Many times these patients are improved by small doses of thyroid, all of these symptoms disappearing and the child becoming much improved,

even when all other treatments have failed. The dose for such patients is not more than  $\frac{1}{4}$  grain, sometimes less, once a day for two or three weeks. In the beginning one larger dose may be given, as 1 grain. Many of these children show signs of insufficient calcium, and especially if there is irritability of the nervous system, which suggests parathyroid disturbance, calcium is indicated. Sometimes in imperfectly developing children a combination of a small dose of thyroid and a fair dose of thymus extract is indicated, or calcium in some form may be given without the thymus extract.

"Infantile obesity may be associated with subthyroid secretion, but is more likely to be associated with a disturbed pituitary secretion, probably a subsecretion of the posterior lobe of the pituitary. These children improve on small doses of thyroid and coincident doses of pituitary. But these cases are likely to be associated with disturbances of other endocrine glands, and a careful study of the patient may show what combination is needed and what the exact treatment should be. The abnormal growth associated with more or less obesity is generally due to pituitary disturbance.

"If puberty does not occur at the proper time, and especially in girls, there is generally a lack of thyroid secretion, and small doses of thyroid, with perhaps ovarian extract, or perhaps only small doses of iodine, is what these patients need, and such dosage should be given for a considerable period. Symptoms of nervousness, sleeplessness, and tachycardia, show that either the treatment is not needed at all, or the dose is too large.

"Chlorosis is often as well cured by the administration of thyroid extract as by the administration of iron, and when normal menstruation develops and continues the chlorosis disappears. Too profuse menstruation in young

girls shows, generally, too much thyroid secretion, and mammary extract should be given as advised under the uses of the mammary gland.

“The importance of iodine saturation in young girls at or before puberty has already been described, and such iodine or iodide treatment will prevent the development of simple goiter, to which they are prone if they do not have sufficient iodine in their circulation.

“Sometimes thyroid extract in small doses combined with pituitary extract will cure nocturnal enuresis in children, especially if these children show symptoms of lack of development.

“Amenorrhœa is of frequent occurrence in women who are not pregnant and is generally associated with more or less muscular weakness, a tendency to sleep in the daytime, more or less indigestion, and with the deposit of fat on the breasts, over the shoulders, on the hips, and sometimes on the upper part of the arms. When this development is excessive, the type of disease termed *adiposis dolorosa* is in evidence, and that disease is undoubtedly due to a disturbance of the endocrine glands, and is always associated with subsecretion of the thyroid. This disease occurs in all degrees of intensity. At least in all of the moderate types, and generally in the more severe types, thyroid treatment is successful in aiding the patient, and sometimes in curing the condition. As soon as the woman menstruates normally and sufficiently, all the other symptoms are ameliorated; she loses more or less weight, although it may not come down to normal. On the other hand, having once shown this type of condition, unless her whole life is changed, either she marries, she becomes pregnant, or something changes the whole condition of the endocrine glands.

She is likely to have recurrences of this condition throughout her life. Sometimes such patients do not menstruate for months, to again begin for a period or two, and then stop again. Whatever the other treatment is, whether ovarian extract, ovarian residue, or corpus luteum, thyroid extract is always of great value. Sometimes an iodide is all that the patient requires. The value of thyroxin for these patients has yet to be determined.

"When the menopause develops in women, weight is always added, and if the secretion of the thyroid is too greatly deficient at this time, weight is added rapidly, and more or less symptoms of hypothyroidism occur. Thyroid extract is the treatment for this condition. The dose required is generally not large, often best associated with an iodide. The pulse is always slow in these sub-thyroid cases, the skin dry, and there is puffiness under the eyes, on the hands, or on the feet without any actual edema, *i.e.*, there are symptoms of mild myxedema.

"If myxedema is really in evidence, the eyelids are swollen, the teeth decay, the hair falls, hearing becomes impaired, mentality sluggish, the blood pressure low, the pulse-rate slow, and there are more or less digestive disturbances. Thyroid is the treatment, and it is curative. The dose of thyroid is always less when an iodide is added do it, and thyroxin may be found to be a most successful treatment. The dose of thyroid extract should be sufficient to cause improvement, and after improvement is in evidence, the dose should be diminished and then continued at the amount required to keep the patient normal.

"Although there are many causes for obesity that occurs before the age of forty-five or that occurs as an individual condition in a family that is not prone to stoutness, endocrine disturbance is generally at the bottom of the

condition. Thyroid feeding for this kind of obesity has often been carried to excess and has often caused very undesirable symptoms; but associated with the proper diet and the proper amount of exercise, some thyroid treatment is generally advisable, perhaps associated with other glandular extracts. It should always be remembered that with patients who do not show other signs of sub-thyroid secretion, thyroid treatment may precipitate hyperthyroidism. On this account, many of the so-called obesity cures are dangerous, and the sale of thyroid extract should be subject to the same restrictions as are the narcotics.

“Thyroid extract has been given in some of the toxemias, and particularly in the vomiting of pregnancy, and many times it is successful in this condition, although corpus luteum is now suggested for that disturbance; but certainly normal thyroid secretion is necessary for the health of the mother during pregnancy and if that gland is subsecreting, thyroid should be administered in small doses. Puerperal eclampsia, in which the urine gives no evidence of insufficiency of the kidneys, has been attributed to thyroid disturbance, and certainly in these cases thyroid extract in very large doses has been successful in preventing and stopping convulsions. Also, large doses of thyroid will at times prevent the convulsions of uremia. But thyroid is only a small part of the treatment of the serious condition of either puerperal eclampsia or of uremia, and is only mentioned here to state that all these patients in this serious condition are improved by the administration of thyroid associated with other proper treatment. The dose in these conditions should be 10, 20 or even 30 grains of the extract in the first six hours, and then repeated only as indicated, depending on the results and the symptoms of its action.



“At times epileptic attacks are associated with subthyroid secretion, especially the epilepsies which occur at the time of the menopause. Many of these cases may have their actual cause in mouth infection, which has irritated not only the brain, but the thyroid and parathyroid glands. It is possible that the parathyroids are always disturbed in an epileptic attack. Suffice it to say in this connection that cleaning the mouth and throat of infection, the administration of thyroid extract and of calcium salts will always ameliorate and sometimes cure this type of epilepsy. Also, the epilepsies that are aggravated at the time of puberty, or are aggravated during pregnancy should be managed on this same plan. More or less bromides should of course be given while the system is righting itself and the irritating substances, or the causes are being eliminated, but to perpetuate the detoxication of the system, unless there is a contraindication against it, thyroid should be given with alkaline salts, and especially the calcium salts. All intestinal fermentation and putrefaction should be prevented in these cases, and generally the patients are better without animal proteins. The dose of thyroid in epilepsy cases need not be large, perhaps 0.05 Gm. a day, and if this causes increased heart action the dose should be reduced.

“In some forms of digestive disturbances, especially in spastic constipation, small doses of thyroid are beneficial provided such a condition is associated with other signs of subthyroid secretion. Quite probably very small occasional doses of thyroxin will be found to be of great benefit in these conditions, but it should be emphasized that thyroxin is very potent, and as it is urged that thyroid extract should be given with the greatest of care, it should be more strenuously urged that thyroxin should be given with still greater care.

"In increasing blood pressure as age advances, small doses of thyroid, given daily, or less frequently, especially if the skin is dry and there is a tendency to chronic eczema, and the pulse is slow, are of very great benefit. Thyroid secretion is generally what the patient has begun to lack at this age. This evidence of lack of thyroid secretion may occur earlier in life, depending upon what the thyroid has had to do. If it is a woman and she has had many pregnancies, or if it is an individual who has had many serious illnesses, or has had some chronic disease that has caused more or less overaction and finally lessened action of the thyroid gland, thyroid extract is indicated and will be of benefit.

"Not infrequently the asthma which occurs in old age is prevented by thyroid, perhaps because it aids in properly combating the irritations from mal-nitrogenous metabolism. At any rate, with high blood pressure associated with asthma, thyroid is of benefit. Perhaps at times the reason that iodides have been very successful in certain forms of asthma is because they increase thyroid activity.

"While theoretically thyroid extract is contraindicated in profuse hemorrhages, as it generally increases such hemorrhages, occasionally in hemophilia thyroid has been curative, but generally it has been a failure. However, in the peculiar hemorrhages seen at the time of the menopause in women, thyroid extract is sometimes a specific. The dose for this condition should be large for a few days, and then it should be given in daily, smaller doses. Sometimes this treatment is successful after all other treatments have failed, it causing cessation of hemorrhage, even when the bleeding has been from the bladder, rectum, mouth, nose and many other parts of the body.

“Thyroid treatment is contra indicated when there are symptoms of hypersecretion of the thyroid, when there are toxic symptoms from hyperthyroidism, when there is sleeplessness, delirium, or any cerebral excitation, when there is a rapid heart or any irritability of the heart, generally when there are acute inflammations of the skin, and when there is progressive loss of weight.

*Uses:* “The administration of pituitary extracts for disturbances of the secretions of the gland have not been very successful. Not infrequently, however, pituitary headache is cured by the administration of extract from the whole gland. If the patient is stout and is a woman, and amenorrhea is also a symptom, the combination of thyroid and pituitary treatment is very successful, unless the headache is due to a tumor. It has been stated that posterior lobe extracts would increase the mammary secretion, but this has not stood the proof of test. When administered by the mouth, instead of increasing the blood pressure, it may occasionally cause some depression, loss of heart strength, and if long given, emaciation. These symptoms may develop because these extracts are likely to contain large amounts of extracts of nervous tissue or histamin. Abel and Nagayama have found considerable histamin in commercial post-pituitary extracts.

“The administration of anterior pituitary has its greatest value in dystrophy adiposogenitalis, but such treatment is more successful if combined with appropriate thyroid treatment, and probably it is well, in females, to add ovarian extracts and, in males, testicular extracts to the treatment.

“The most important use of extract made from the posterior lobe (often termed infundibular extract) is in obstetrics. For this purpose it is always given hypoder-

matically in doses of  $\frac{1}{2}$  to 1 mil. The drug has been used too frequently, and it may cause asphyxia of the child or rupture of the uterus. It should never be used unless the cervix is completely dilated and there is no obstruction to the free passage of the child through the pelvis, and it may always be advisable to administer an anesthetic as the head of the child is passing over the perineum, if the contractions of the uterus have been increased by the pituitary injected. Infundibular extracts should not be used in normal labor, and perhaps never should be used in a primipara, and the dose should be small in a multipara. Under its action the uterine contractions are brisk and frequent, and unless the child is rapidly born it becomes asphyxiated from interference with the placental circulation. In post-partum hemorrhage this preparation is not as valuable as is ergot.

"Pituitary extracts administered by the mouth have sometimes been given in menorrhagia or metrorrhagia, but they are not as efficient as ergot unless pituitary disturbance is a cause of the bleeding. If there is no evident cause for menorrhagia or for too frequent menstruation in young girls, mammary extract represents the best treatment, although if the girl shows signs of pituitary disturbance a combination of these two glandular extracts will be of greater value.

"In conditions of cardiac failure and in shock with low blood pressure and whenever there is dangerous low blood pressure, extracts of the posterior lobe given hypodermatically in 1 mil doses are of benefit. It acts less rapidly than epinephrine preparations, but its action is much more prolonged. It also has an advantage in these conditions of promoting activity of the kidneys.

"After abdominal operations when normal intestinal peristalsis is not present and there is a tendency to

tympanites pituitary extracts given hypodermatically are of great value. One mil may be injected hypodermatically every twenty-four hours for two or three days, and then less frequently until normal tonicity of the intestine has returned. If from the paralysis of the intestines gas is pressing on the diaphragm and interfering with the heart, a second dose of the hypophysis preparation may be given within a few hours after the first.

“If after a laparotomy or after parturition the bladder does not act and is semi-paralyzed, pituitary injections are of benefit. It is also of value, both when given hypodermatically and by the mouth, in continence of urine both in adults and in children, and it sometimes acts very satisfactorily in nocturnal incontinence.

“In diabetes insipidus which seems so frequently due to hypophysis disturbance, hypodermatic injection of posterior lobe extracts often act almost as a specific, causing the output of urine to be decreased, the urine to be of higher specific gravity and thirst to be stopped, and at the same time the headache which so frequently accompanies this condition ceases. This preparation or any preparation of the pituitary will not have this satisfactory action if given by the mouth. Also this treatment, even hypodermatically, does not cure the condition unless the pituitary becomes normal in its activity; consequently the injections must be repeated.

“Some vasomotor disturbances may be due to dysfunction of the pituitary, and neuralgias, weariness and muscular weakness may be due to such a condition, and may be helped by administering by the mouth extracts of the whole gland. When the mother, after parturition, does not gain her strength and is weak and miserable,

there may be pituitary deficiency, and pituitary feeding, associated with other proper treatment, will benefit her.

"It is possible that some cases of epilepsy, especially in children and youth, are due to dysfunction of the pituitary, probably associated with disturbed function of other glands, perhaps more especially of the parathyroids. In appropriate cases administration of preparations of the whole gland should be tried.

"Even when pituitary preparations seem positively indicated, if extracts of the whole gland are long given there is likely to be an increase in the formation of uric acid, and joint pains may occur. Consequently the results of such treatment should be carefully watched.

"The exact cause of rickets is still not known, although it is apparently a mistake of nutrition, but probably not entirely one of privation. It has not been shown that disturbance of the thymus gland is related to rickets. It also has not been shown that disturbance of the anterior lobe of the pituitary body is a cause of rickets, but it is a fact that this portion of the gland is closely related to the formation of solid bone. Consequently, in the disease of rickets, besides administering cod liver oil and phosphates and good nutritious food, anterior pituitary extract should be tried.

"Charles E. De M. Sajous, who has done so much research on the adrenal glands, rightly asserts that some of the sudden deaths seen in soldiers after violent exertion, without apparent heart lesion, is due to hypoadrenia; and it has been shown that although the heart may be normal and even enlarged and ready to do extra work, very small adrenals prevent the possibility of severe muscular strain, and such individuals fall, faint, are prostrated, or may even suddenly die after hard exertion.

Sajous states, as has long been known, that digitalis is of no benefit in this kind of circulatory weakness, while suprarenal gland is at times of benefit, and, if 0.001 gm. (1-60 grain) of epinephrine, dissolved in physiologic saline solution, is injected hypodermatically, it may save life in these shocked cases. Later suprarenal gland extracts may be given by mouth, daily, with benefit.

"Sajous also emphasizes what Crile has also stated, that prolonged excitement, fear, rage, and the general strenuousness to which a soldier in active warfare is subjected may use up his reserve adrenal secretions, and the medullary portion of the adrenals become insufficient, and he suddenly becomes weakened or shocked. This probably represents an important cause of the "shocking" of soldiers, and explains the considerable length of time necessary for them to build up their reserve secretion and become again physically fit.

"In all shocked conditions from injury, in prostrating acute infections such as dysentery, typhoid fever, and especially in diphtheria, pneumonia and influenza, the adrenals have become insufficient, and from infections they may become actually pathologically disturbed. There may be hemorrhages into the glands. In all these cases suprarenal extracts should be given, but in not too large doses, as a secondary fall of pressure may occur; also large doses have caused death. Rest, heat, suprarenal feeding, and strychnine in not too large doses is the treatment. Of course, the blood-pressure-raising properties of caffeine and atropine may be needed to tide over the condition, but the cure is brought about by the administration of suprarenal, or by the return of the adrenals to normal secretion.

"While part of the neuro-circulatory asthenia of enlisted men is due to thyroid hyperactivity, part is also due to

suprarenal insufficiency. Rather typical of adrenal insufficiency are cold hands and feet, and bluing of the lips on the least exertion. Although it has been shown that epinephrine secretion does not seem necessary for the maintenance of normal blood pressure, it is very necessary to develop an increased blood pressure when the pressure is subnormal and the circulation insufficient.

“The rise in blood pressure after the administration of epinephrine, when given on the tongue or hypodermatically, or when it is absorbed from mucous membranes other than the stomach, quickly occurs, but it does not last long. This action is not, however, the action that causes the greatest help; it is the stimulation that it causes to the suprarenal glands. A blood-pressure-raising treatment that lasts such a short time could be of only momentary help, consequently, as soon as the emergency is past, after administering epinephrine hypodermatically or on the tongue (though such treatment may be repeated a few times, especially on the tongue), the greatest advantage from suprarenal treatment is obtained by giving the whole gland extracts by the mouth. When given in tablet, the tablet should be crushed and swallowed with water. The blood-pressure-raising substance seems to be changed chemically in the stomach, so that it does not cause the usual rise of arterial pressure, but the rest of the gland seems to stimulate and help a depressed circulatory condition. Also, as above stated, in Addison's disease with pigmentation administering the chromaffin part of the glandular substance either directly causes a diminution of the surface pigmentation, or else it stimulates the adrenal glands to furnish the substance which is lacking. The gland by the mouth is active, as the author has seen pigmentation disappear and a blackened skin become white, when the suprarenal



glands were later found, after death, to be riddled with tuberculous disease.

"Too much epinephrine given hypodermatically or on the tongue, may cause a low blood pressure and a serious disturbance of the respiratory center. The treatment of such overaction would seem to be atropine and caffeine hypodermatically, and artificial respiration. Suprarenal extracts often stimulate the heart to better activity. After injection of epinephrine the first rise in blood pressure may be soon followed by a fall too often to be followed by a second slight rise.

"Development of the genitalia, especially of the testes, may be stimulated by the administration of suprarenal, and at times sexual precocity in young children has been shown to be associated with disturbances causing hypersecretion of the adrenal cortex. In these young children who have this abnormal sexual development, it has been generally found that there was a growth of the adrenal cortex, most frequently, perhaps, a hypernephroma. In milder forms of hypersecretion of the adrenal cortex in children there is a more rapid development than normal of the pubic hair and of the external sexual organs. This condition more frequently occurs with females than with males.

"It is impossible to decide what relation the suprarenal glands have to high blood pressure which is so much in evidence today. There is no justification for removing the suprarenal glands for such a condition at the present time, because the exact relation of constant high pressure to the suprarenal has not been proved. X-ray treatment of these glands has been suggested, but such treatment seems of doubtful value, as it would be impossible to treat these glands without treating other parts of the

abdomen or back, probably to the disadvantage of other organs.

“Serious burns of the body have sometimes caused adrenal insufficiency and hemorrhage into the tissues of the glands. Seriously burned, as well as other shocked patients, therefore, should receive suprarenal extracts.

“It has been shown that patients who have the morphine habit have insufficiency of the suprarenals, and that they are also more susceptible to all kinds of poisoning. It has also been experimentally shown that any insufficiency of the suprarenals increases the susceptibility to poisoning.

“Chloroform and ether anesthesia more or less inhibit the output of the suprarenals, and depression following anesthesia is well-treated by suprarenal and pituitary extracts.

“Associated with Bright’s disease there may be stimulation of the suprarenals, and this may be a cause of the increase of blood pressure besides what is caused by the abnormal amount of irritants in the blood.

“Just what is the relationship of tobacco to the suprarenals has not been determined, especially as nicotine has been shown by Stewart and Rogoff to inhibit the epinephrine output of the suprarenals. Certainly, men who are used to smoking have their blood pressure raised by tobacco, but the excessive use of tobacco does cause low blood pressure and weakening of the circulation. This has been supposed to be due to action on the heart muscle, but as these experimenters state, it may also be due to the inhibition of the epinephrine output, and therefore to a lack of tone of the splanchnic vessels.

“In any condition of low blood pressure, depression and circulatory weakness, whether suprarenal will be of bene-

fit, or not, cannot always be determined before the clinical trial. If there are other symptoms of adrenal insufficiency, suprarenal feeding is often of value, but in ordinary fatigue and in low blood pressure from many conditions, the treatment is very disappointing.

"Many times with indigestion of a functional type suprarenal helps the patient and corrects the condition. It has not been determined why hypersecretion and hyposecretion of the thyroid cause so many gastro-intestinal disturbances, but the interrelations of the endocrine glands should always be kept in mind. Certain it is that sufficient suprarenal secretion seems necessary for normal gastrointestinal digestion, and adrenal extracts are sometimes especially valuable in weak muscle activity of the stomach and intestines.

"In Addison's disease there may be periods of intermission, therefore when suprarenal extracts have been given and improvement occurs such improvement may not be due to the treatment. However, it seems to be a fact when the suprarenal glands are not too seriously injured that there is some improvement from feeding suprarenal extract, and naturally the whole gland must be given, the administration of epinephrine representing only a small part of the activities of the adrenals. It should be given for a long time, a small dose once a day. Although some symptoms are improved by such treatment, especially the pigmentation on the skin and mucous membranes, if the adrenal glands are seriously diseased this treatment cannot save life. Pituitary extracts in small doses may be added to the suprarenal treatment, as pituitary extract is known to stimulate the adrenals. If the patient is benefited by these glandular treatments, there is a rise in blood pressure, a better circulation, and

an improvement in digestion and nutrition, and, as just stated, the pigmentation disappears.

“The value of suprarenal and especially of epinephrine in asthma has now long been noted. An epinephrine tablet crushed with the teeth and allowed to absorb in the mouth, or five to ten drops of epinephrine solution of 1 part of 1000, will usually stop an asthmatic attack. Also, the solution has been sprayed directly into the larynx with success. Large doses of epinephrine intravenously or hypodermatically have caused death. Not every patient, however, is helped by epinephrine treatment; some patients are more benefited by nitroglycerin.

“It is not always possible to foretell which patient will be improved by which method of treatment, as the two treatments are opposed to one another. Theoretically, if the blood pressure is high, nitroglycerin would be the treatment; if the blood pressure is low, adrenal or epinephrine preparations would be the treatment. There has seemed to be some relation between disturbances of the suprarenal glands and asthma, and perhaps, the adrenals are disturbed in various anaphylactic reactions, especially in those that are associated with shock, and asthma many times represents an anaphylactic reaction. Rarely, however, is suprarenal treatment a cure for asthma, even if it is successful in stopping the paroxysms. The cause of the action must be sought and treated.

“It has been suggested that a dose of epinephrine, to be absorbed from the mouth, should be given before the intravenous injection of arsphenamine, as tending to prevent some of the unpleasant symptoms that may follow such an injection. The dose should be given an hour before the injection, and then perhaps another dose just before the intravenous injection is given.

"Auer and Meltzer have shown experimentally that there is more lasting blood-pressure-raising effect from epinephrine if it is given intraspinally. This would seem to be a valuable suggestion for trial in every shocked condition that did not react to other methods of treatment. Sajous advises that in acute shock and in heart failure (acute adrenal failure he terms it) during an acute infection, hypodermic injections be given of 10 minims of a 1 to 1000 epinephrine solution, in a syringeful of saline solution, every two hours for three doses, and then four times daily, if needed.

"In morphine and opium poisoning when artificial respiration is apparently saving life, many times death is finally due to heart failure. Therefore if the pulse is not good, or at any time becomes feeble in such poisoning, epinephrine solutions on the tongue, hypodermatically or intraspinally, should be considered.

"Suprarenal sprays and snuffs have been used frequently in hay fever, and in the eye in certain inflammations, and locally to cause blanching of a part to prevent hemorrhage before minor operations; it has, also, been sprayed into the throat or larynx, or swabbed over irritated regions of the tonsils or pharynx, to control acute congestions. The relief from shrinking of the tissues and a diminution of the swelling is very great, but unless used repeatedly, there is likely to be renewed swelling and, sometimes, a greater congestion than before. Occasionally a patient has considerable irritation from suprarenal sprays in the nose or mouth, such as serious sneezing and even pain. There is no habit formed from the use of suprarenal extracts.

"Epinephrine is added to different preparations of cocaine for local anesthesia, and renders the anesthesia more lasting and the bleeding during the operation less.

There may be a considerable rise in the blood pressure from the use of epinephrine solutions on the mucous membranes, but it should be remembered that the blood-pressure-raising substance is destroyed when the solution tablets or powders are taken into the stomach.

“The value of suprarenal in hemorrhagic conditions and purpura is not very great. Occasionally, it has seemed to have been of some value, but other treatments are better.

“With patients who are neurasthenic and always have a low type of circulation, suprarenal may be of benefit, but it must be given for a long period, and unless there is good suprarenal tissue to be stimulated, any permanent success is doubtful. There seems to be no question that there are individuals who always have an insufficient secretion from the adrenals.

“Just how much of the activities of the ovaries may be given a female patient by feeding preparations of the whole gland is difficult to determine, but many times feeding of these extracts after ovarian extirpation has caused a cessation of the disturbing symptoms of the artificial menopause. Frequently a better treatment is to combine ovarian substance with a small dose of thyroid, if this gland is apparently under-secreting.

“Ovarian extract will sometimes wake up a lackadaisical patient and greatly benefit the individual, while at other times it fails to show any activity. This may be because ovarian extracts deteriorate and the active elements in them may become disorganized. If there are indications for administering corpus luteum, there is no question about the activity of that extract; but it cannot be long given as it is depressant to the circulation. It is quite possible, although not yet well demonstrated, that in slowly developing girls the administration of ovarian extracts is of value.

"If for any reason both ovaries must be removed, the administration of ovarian extracts is logical and may be a help while the other endocrine glands are re-arranging their functions to meet the new condition; there is no doubt of such an interrelationship or that the glands endeavor to minimize the disturbance caused by the loss of one of their number. Whatever the disturbance of the individual is, the physician with a knowledge of what has happened, plus a study of the symptoms present, and a thorough knowledge of the function of each gland, can determine what is best for him to give in the way of glandular medication. The physician, frequently, should prescribe an appropriate combination of the glands whose functions he thinks are insufficient.

"It is probably very frequent in older girls and in young women that there is an insufficiency of the ovarian secretion. Whether this deficiency is best met by stimulating the thyroid with iodine, by feeding ovarian extract, by small doses of corpus luteum, or by giving ovarian residue, must be decided by clinicians, and by clinical studies. When the right combination or the right glandular extract is found and given, the improvement in the patient is sometimes phenomenal. Digestive disturbances, headaches, and dysmenorrhea disappear, and the whole mental and physical condition of the patient is improved.

"With the advance of the science of surgery and the ability to preserve normal tissues for most any length of time, it will probably be found advisable and possible when total extirpation of the ovaries must be done, or when both ovaries are seriously diseased, or when they have not developed and apparently there is an absence of ovarian secretion, that transplantation of healthy ovarian tissue will be more frequently and successfully accomplished.

"It has not been shown that the administration of thymus is of value in the development of young children, although when associated with the administration of calcium preparations and phosphates, it may be of some value. There would seem to be no question that the thymus has something to do with bone formation, but whether its oral administration is of any advantage in insufficient bone growth is still a question for future decision.

"It has been suggested that it may be of advantage in certain mental conditions, but success with such treatment has not been proved. Rickets is undoubtedly, partially at least, due to a vitamine deficiency which may be furnished by cod liver oil, or perhaps by butter, but the addition of thymus gland extracts to the treatment of the child can do no harm.

"Although thymus extracts injected hypodermatically lower blood pressure, given by the mouth it does not seem to cause any disturbance of the circulation. The administration of these extracts is often of value in some of the disturbances of Graves' disease, some patients being repeatedly made better by thymus treatment when they have recurrences of the thyroid disturbance. Thymus feeding is probably inadvisable when there is uric acid disturbance, or in leucocytosis in any form.

"The dose of thymus is uncertain. Tablets may be obtained made from the thymus of the calf, each tablet representing five grains of the fresh substance of the gland."



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