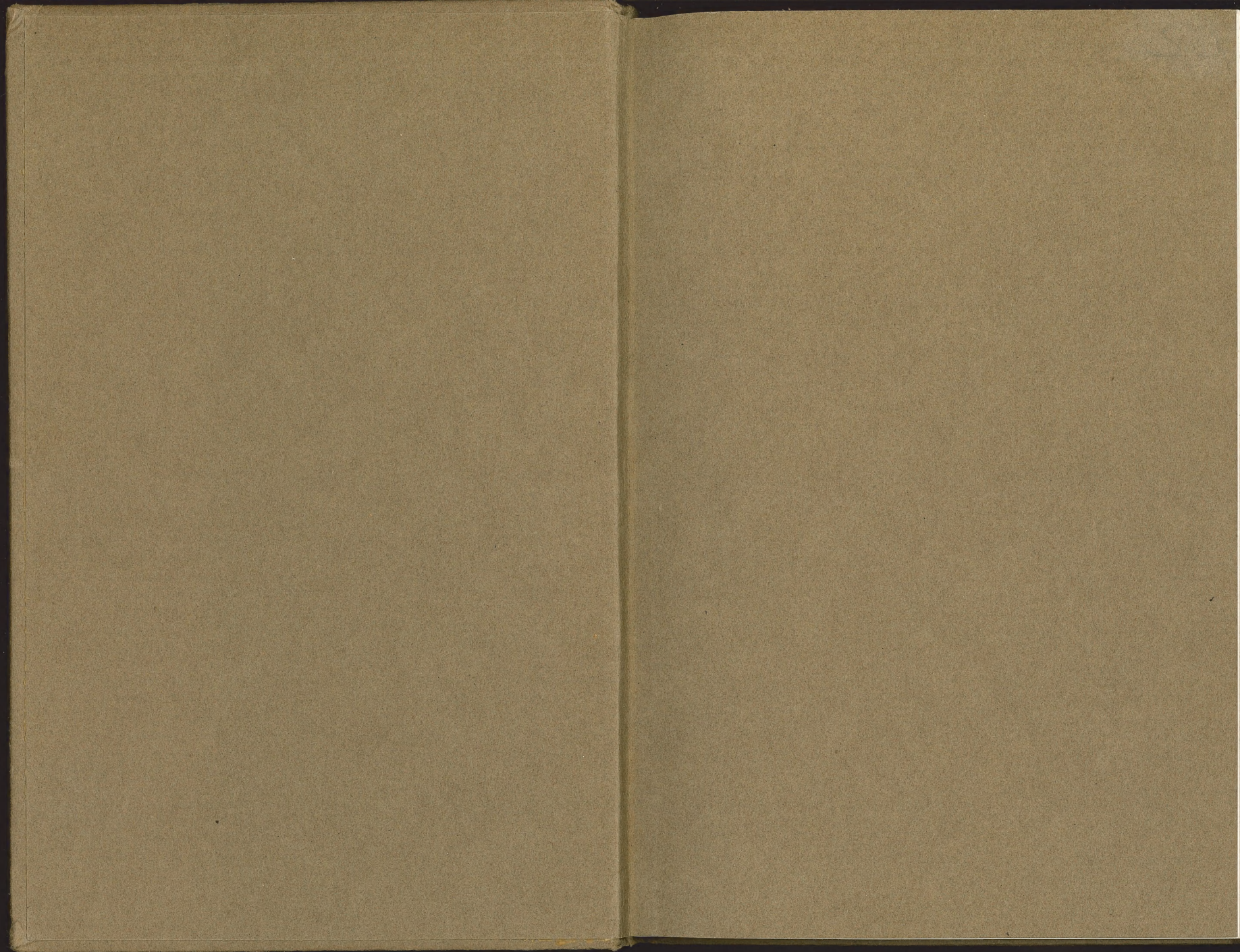


ULTRA-VIOLET
ENERGY
IN DENTISTRY



BIOPHYSICAL STUDIES



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ULTRA-VIOLET ENERGY

IN

DENTISTRY

Biophysical Studies

By

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VICTOR X-RAY CORPORATION

CHICAGO

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1923

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INTRODUCTION

WHEN an organism invades a human tissue there is instituted a defense against the intrusion. The defense is characterized by the classical symptoms of inflammation which are:

redness,
swelling,
heat,
pain,
diminished function.

These reactions continue and are accentuated in proportion as:

1. The virulency of infection is great;
2. The physiologic ability of the body to provide the defense is low.

When the virulency of the attacking organism is high, or when the physiologic ability of the body to provide adequate defense is low, infection is established which manifests as oral pathology.

Ultra-violet energy destroys the virulency of the attacking organism. It increases the physiologic capacity of cellular functioning tissues. In addition, it induces an increased metabolism which takes on a renewed assimilation of calcium in the case of those cells, like alveolar cells, whose metabolism has to do with calcium. It diminishes pain. And upon all of these specific characteristics depends its efficient usage in the treatment of those many oral pathologies in which infection is the pristine cause.

On the basis of material which has been collected:

1. By observing competent users of equipment at work in their offices, dispensaries and hospitals;

2. By maintaining an intimate correspondence with distinguished clinicians who are utilizing ultra-violet energy with obvious success;
 3. By studying the literature that has appeared in Italy, France, England, Denmark and Germany;
 4. By studying American literature;
- and more especially from the work that intensive biophysical investigation has afforded in the study of this unique energy, it is possible to present certain basic principles and generalizations that make for an intimate understanding of what ultra-violet does and how this good may be accomplished in the application of this strange radiation in the solution of dental therapeutic problems.

In addition to its many remarkable qualities, ultra-violet radiation displays a "selectivity" that enables it to destroy bacteria and regenerate living cells. Until recently this selective action was difficult to explain; but it seems established that the mechanism of selection rests with the amino-acid constitution of proteins.

All proteins, whether they form bacteria or form living tissue cells, are composed of amino-acids. The studies of Soret, Kober and Harris and Hoyt, show that practically all amino-acids have only a general ultra-violet absorption; but that two amino-acids, namely tyrosin and phenylalanin, have an unusually strong ultra-violet attraction. This attraction is so strong that when one or the other, or both, of these amino-acids are present in the protein molecule, the enormous ultra-violet absorption that results leads to such violent chemical action as to result in the death of the cell. Since the tissue cells that comprise oral structures are singularly deficient in tyrosin and phenylalanin, and many bacteria are relatively rich in these two selective amino-acids, it is at once evident how one energy, ultra-violet, falling upon a tissue cell and a bacterial cell will cause a regenerative and life-sustaining effect in the first, and at the same time destroy the second. This important mechanism, which is distinctive for ultra-violet and is not duplicated by other known germicide, is more fully discussed in the Dental Summary for February, 1923. It is summed up by saying that ultra-violet energy is *bactericidal*, but not *cytotoxic*.

Nothing has been said about the treatment of pyorrhea with ultra-violet energy. There are two reasons for the omission. In the first place pyorrhea is a pathologic concept that permits of an extremely varied interpretation. Nothing definite is conveyed to all minds under the heading of pyorrhea. There are many incipient pyorretic pathologies for which ultra-violet energy has been shown to afford much good. There are equally as many severe and intensive pyorretic conditions in which ultra-violet energy displays no brilliant accomplishment. Inasmuch as the question is still undergoing research investigation, a discussion of the use of this energy in pyorrhea must be reserved for a future contribution.

Remembering, after all, that successful therapy is the keynote of efficient dental practice, it is easy to see why many dentists who are progressively inclined have demanded an exacting scientific analysis in explanation for the great clinical good that ultra-violet indisputably accomplishes in the service of the oral specialist; and it is hoped that these intensive studies, representing much arduous labor and directed entirely to investigating the *modus operandi* are met with the hearty approbation of the many as conspicuously as these studies have already met with the striking approbation of the scientifically qualified leaders who have expressed their commendation and inspiring support.

Chicago, Illinois.
March, 1923.

PART I

ULTRA-VIOLET RADIATION

IF ELECTRONS, obtained from a glowing filament as in the case of the Coolidge tube, are hurled with great force against a body of still greater resistance, such as a tungsten anode, there is developed in the impact a vibration in ether of exceedingly small wave-lengths, designated X-rays.

If electrons are caused to collide with an impact force less than that used for the generation of X-rays, there is created a vibration of longer wave-lengths which is designated ultra-violet.

If electrons are only moderately disturbed so that their colliding pressure is comparatively slight, there is generated a vibration of still longer wave-lengths which becomes manifest as visible light.

Thus, visible light, ultra-violet radiation and X-rays are examples of wave motion in ether produced as the result of the impact of colliding electrons.

To generate ultra-violet energy it is necessary that there should be

1. A source of electrons,
2. A containing vessel,
3. An energy that will occasion electronic collision.

Physical research has demonstrated that the vapor of mercury metal furnishes a quickly available supply of electrons. These are contained in a vessel whose walls are of fused quartz, which is highly transparent to the ultra-violet radiation. The force utilized to bring about the collision of the electrons composing the vapor is a direct electric current.

So that when a direct current passes through the vapor of mercury enclosed in a quartz tube, there are occasioned varying degrees of electronic disturbances which manifest as

Heat,	Light	Ultra-violet.
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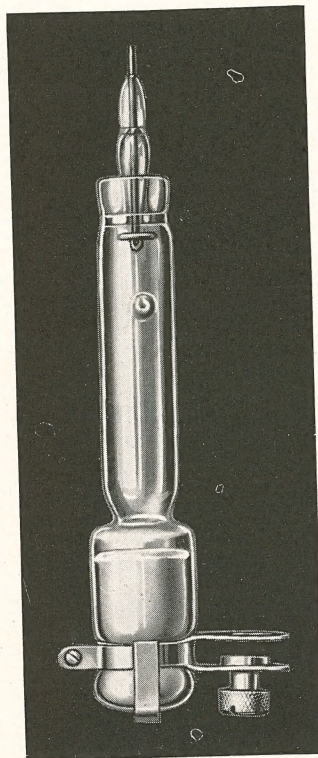


Fig. 1.
Water-Cooled Type
"Uviarc" Quartz Tube

- 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
- G. Cathode Mercury Pool

These disturbances are elicited pursuant to a definite law; the more heat the more light, and the more light the more ultra-violet. This law bears the name of Wien's displacement law which in its physical statement says: that in the case of temperature radiation, the higher the temperature the shorter the wave-lengths of the rays emitted.

It is important to remember, therefore, that ultra-violet radiation represents an energy generated in every way similar to the method utilized for the generation of X-rays.

The tube used for the generation of ultra-violet energy is known as the Uviarc and is illustrated in Figure 1.

A diagrammatic representation of the water-cooled Uviarc is shown in Figure 2 and is explained as follows:

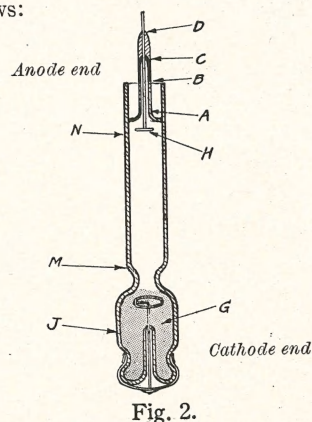


Fig. 2.

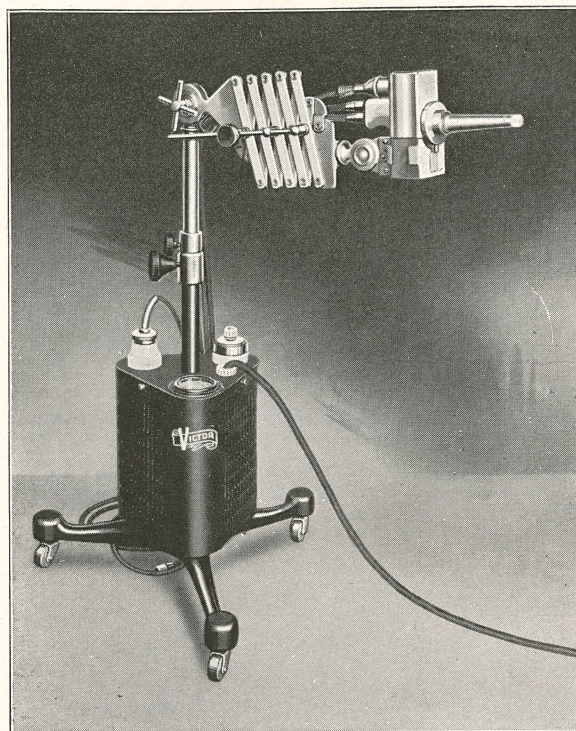


Fig. 3

BW200—Water-Cooled Outfit. Mounted on adjustable floor stand, with extension truss. RHEOSTAT control for DIRECT current.

- H. Anode Target
- J. Cathode Chamber
- M-N. Luminous Portion

The portion A to D is the seal structure which supports the tungsten electrode F. The portion A to B is the quartz stem. From B to C is the graded portion of seal consisting of three graduated glasses for the purpose of compensating for the appreciable

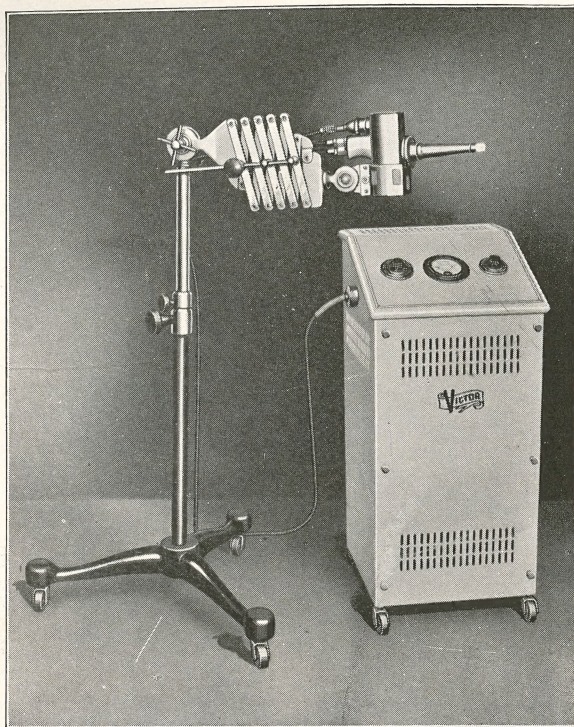


Fig. 4.

BW500—Water-Cooled Outfit, mounted on adjustable floor stand, with extension truss. RECTIFIER control for ALTERNATING current.

expansion of electrode with practically zero expansion of the quartz stem. The portion C to D is the vacuum tight seal, the tungsten wire being coated with a glass having the same co-efficient of expansion as tungsten.

The mercury pool G forms the Cathode end of Tube and the tungsten target H is the ANODE. When the Tube is tipped so mercury flows against anode target, electric current flows through mercury which causes an Arc as soon as the Tube is tipped back to its normal position.

BW504—Water-Cooled Outfit, with Receptor mounted on Rectifier Control; for ALTERNATING current.

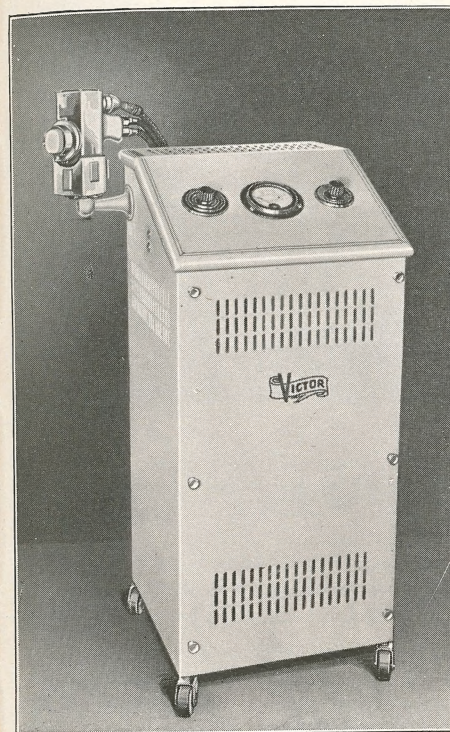


Fig. 6

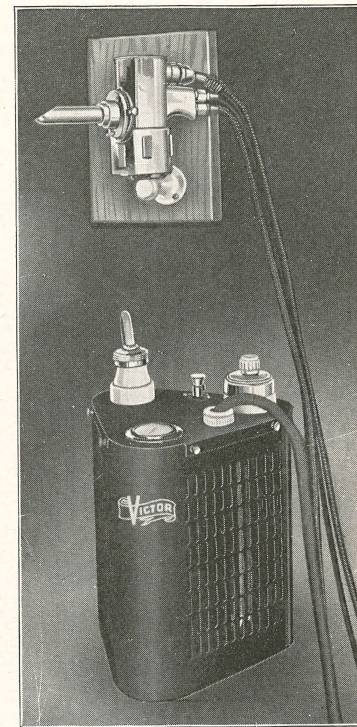


Fig. 5

BW204—Water-Cooled Outfit with Receptor (mounted on wall) instead of floor stand. RHEOSTAT control for DIRECT current.

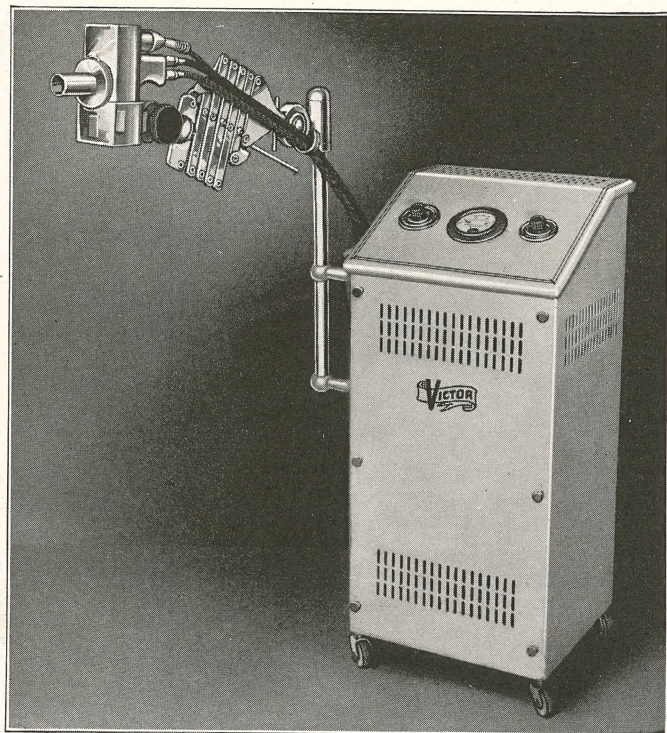


Fig. 7.

BW505—Water-Cooled Outfit, with side-arm and truss mounted on Rectifier control; for ALTERNATING current.

Around this tube there is furnished a casing in which the water-cooling takes place. The tube and its casing is mounted for clinical purposes depending upon the type of lamp necessary to meet the clinical requirements of the user. In the case of the Direct Current lamp, the outfit is furnished with a rheostat which serves to ballast electrical energy so that the operating Uviarc will not be subjected to variations in the line condition. In the case of Alternating cur-

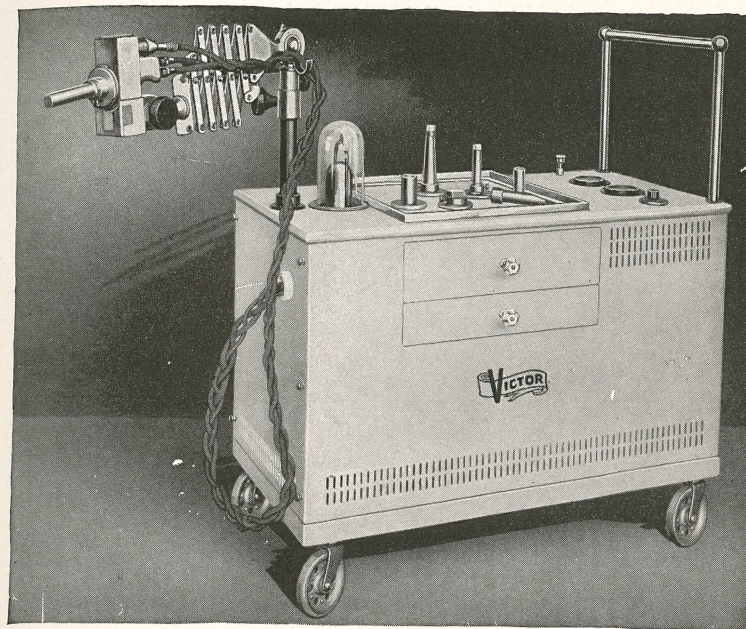


Fig. 8.

BW976-983—Victor Hospital Unit

rent, there is furnished in addition to the rheostat control an adequate tungar rectifier whose function it is to provide a direct current flow. The lamps assume various models and are illustrated in Figures 3 to 9.

For a more complete distinction of the physics of ultra-violet generation, and of the physics of its properties, reference may be had to the Dental Summary for November and December 1922, and January and February 1923. Also, to the Journal of Radiology for September and November 1922, and March, 1923,

Whereas the physics of ultra-violet generation is intimately kindred with the physics of X-ray generation, it is imperative and fundamental to observe that ultra-violet rays, by reason of their

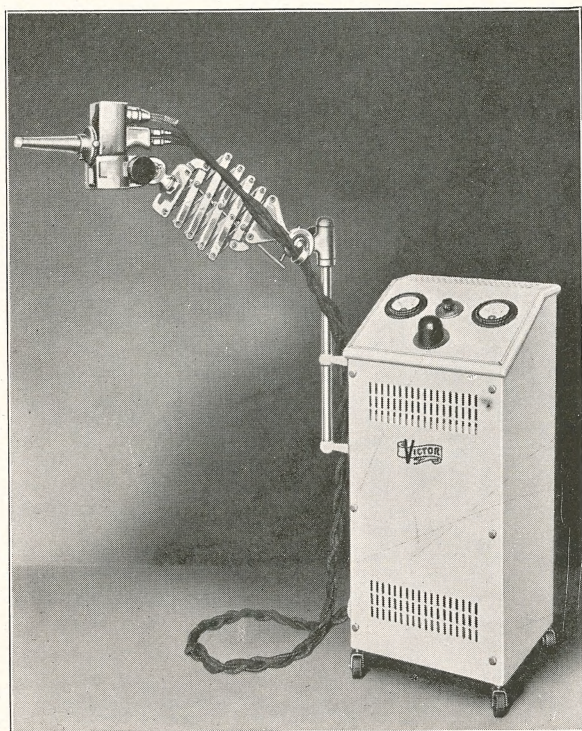


Fig. 9.

BW977—Portable Unit, with side-arm and extension truss

longer wave-lengths as compared to X-rays, are unable to induce any deep tissue changes and disintegration; so that their use is at no time attended with danger from the viewpoint of permanent or disastrous effect. Indeed, it is possible to characterize ultra-violet energy as a cellular or tissue reconstructor and regenerator, upon which striking properties much of its clinical effectiveness depends.

It seems hardly necessary to point out that ultra-violet radiation is in no way identified with or comparable to the high fre-

quency discharges in glass vacuum tubes popularly known as "violet ray." This distinction must be well appreciated inasmuch as so-called "violet rays" have neither the physical properties nor the chemical influences that distinguish ultra-violet radiation.

REFERENCES

- Pacini, A. J.: Dental Summary November, December 1922, January, February, 1923.
- Pacini, A. J. Journal of Radiology, September, November, 1922; March, 1923.
- Pacini, A. J. Outline of Ultra-Violet Therapy.

PART II

GENERAL METHODS

THE efficient installation of ultra-violet equipment includes:

1. Choice of lamp best adapted to meet individual requirements.
2. Satisfactory electrical conditions that will insure proper fuses (15 to 20 amperes).
3. Sufficiently adequate line to obviate unnecessary losses and fluctuations.
4. A supply of clear water.
5. An adjustment of the equipment that will permit the Uviarc to accept 50 to 65 volts during its operation. Voltages below or above these limits are not satisfactory for best results.

Assuming that the installation is properly completed, the operation of the lamp requires only few attentions. These include:

1. Certainty that the water is circulating before the lamp is lighted. Should the lamp be lighted when the water is not circulating, and this error is discovered, turn off the operating switch and allow the lamp to cool completely before attempting to relight it. It is needless to indicate that the neglect to have water circulation may make for Uviarc damage which will necessitate the replacement of the burner.
2. With the water circulating the casing is held in a vertical position as indicated in Figure 10. It is then tilted to the horizontal position as illustrated in Figure 11.

This tilting brings the mercury metal from the cathode to the anode and completes an electrical circuit through the tube. *The casing should not be held in this position longer than a few seconds,*

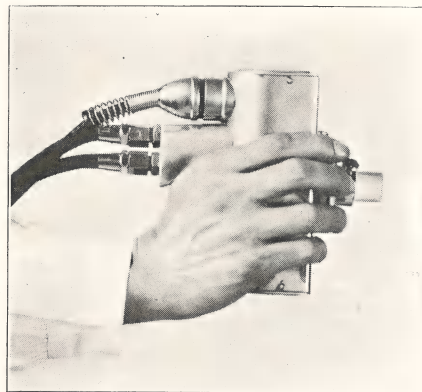


Fig. 10

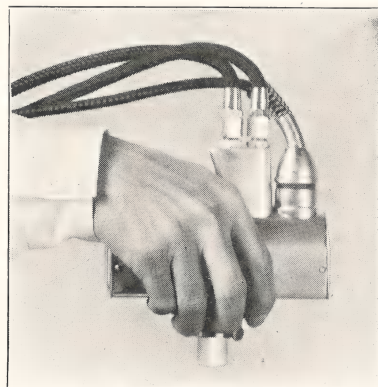


Fig. 11

when it is immediately righted to its original vertical posture shown in Figure 10. Immediately following this procedure the electrical current continues to pass through the mercury vapor, and at first the lamp shows a very low voltage and a high ampere reading. Gradually, the voltage becomes higher and higher, and the amperes drop more and more. This is the period during which the Uviarc

secures its proper electrical equilibrium, and is generally known as "building up." In a few minutes the lamp is built up to its optimum characteristics, which means that the voltmeter reads between 50 and 65. It is then ready for use.

Each lamp is furnished with a mica window which is shown in Figure 12.

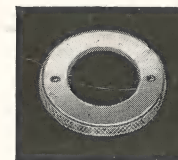


Fig. 12.

A screen of white mineral (mica) spectroscopically tested to insure the complete obliteration of Ultra-violet wave-lengths shorter than 3130 Angstrom units. This insures protection against conjunctivitis incident to accidental exposures of either the patient or operator. (This accessory forms part of each Water-cooled outfit.)

The mica window screens off the ultra-violet rays which produce a painful conjunctivitis. The rays from the lamp should never be directed into the eyes of a patient or an operator. The patient, during treatment, may wear protective goggles such as are illustrated in Figure 13.

Protective Goggles, with ventilated rims; can be worn over glasses—used to shield the eyes against accidental over exposure—of special value to dentist or technician as well as patient or spectators.

When the lamp is used during the treatments it is desirable so to adjust the patient's head in the dental chair that the application can be made to the proper site with the lamp casing held in the vertical position. For momentary exposures, other than a vertical position of the casing may be used; at which time the casing should

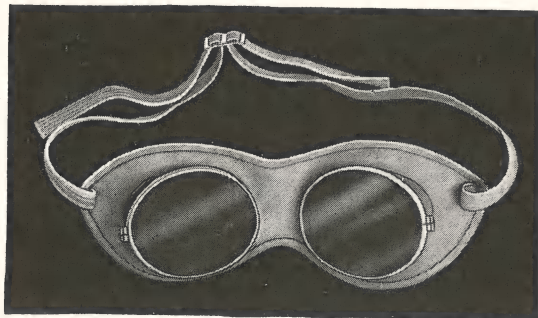


Fig. 13.

never tilt more than 45 degrees in any direction from the vertical. To operate the casing other than in the vertical position brings the light stream in the Uviarc out of a vertical alignment and permits it to strike the wall of the tube. In so doing, it may eventually lead to a devitrification of the quartz which somewhat impairs the efficiency of ultra-violet output. It is a simple matter to adjust the head of the patient in some fashion that the lamp casing can always be held perfectly vertical.

Any convenient grasp of the casing that will insure a secure firmness is adequate. No especial method of holding the casing is superior to any other.

The first important accessory is the chuck or adjustable metal holder shown in Figure 14.

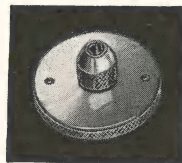


Fig. 14

This holder replaces the mica window and accepts the various quartz rod applicators necessary for conveying the energy and

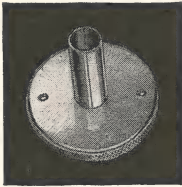
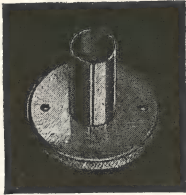
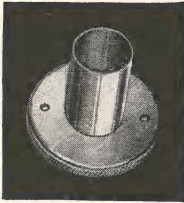
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stable metal

the various
energy and

ILLUSTRATION	INTENSITY RECORD	APPROXIMATE FACTOR	REMARKS
		1	The unusually even distribution that this and the two following applicators afford is due to the excellent alignment of uviac and applicator; that is, the applicator is situated exactly in front of the axis of the mercury arc.
		1	
		1	
		2	The minor differences in intensity need no clinical correction.
		1	
		$\frac{3}{4}$	
		2	Has an olivary tip, which diffuses light.
		2	Note pin point distribution of light.
		2	
		2	

localizing the radiation upon a definite site. Quartz rod applicators are of various lengths and diameters, as are also the various tubular applicators used in the correction of mouth infection. Depending upon the length of the applicator and upon whether or not the end of the applicator is a right angle, the amount of Ultra-violet rays delivered at the applicator tip varies.

All of the various applicators that may be of use have been tested and their intensity record determined. This photo-chemical test is illustrated in the accompanying diagram.

In the diagram, those applicators having an approximate factor of 1 are standards against which the others are compared. Those showing an approximate factor of 2 give $\frac{1}{2}$ of the ultra-violet intensity. Those showing an approximate factor of 3 give $\frac{1}{3}$ of the ultra-violet intensity. So that the dose that would require one second with an applicator showing an approximate intensity factor of 1 would have to be doubled when the applicator shows a factor of 2 and trebled when the applicator shows an intensity factor of 3.

The quartz rods and the metal tubes may be cleaned by boiling. Or they may be washed in cold water to remove any accumulation of dried secretions and then cleaned by immersing in alcohol or similarly adequate solvents. Quartz is intermediate in brittleness between glass and porcelain. It is less brittle than porcelain but more brittle than glass; so that the quartz rods must receive reasonable attention avoiding unnecessary rough handling which may lead to their breakage. A quartz rod is fitted into the chuck, Figure 14, and the end brought against the site where the treatment is to be administered.

RELATIVE INTENSITY DELIVERY OF WATER COOLED QUARTZ LAMP APPLICATORS.

Figure 23 shows a straight quartz rod which is being applied to the gingival margin of the lower central incisors. If the patient is prone to salivate copiously, a cotton or gauze roll or sponge should be placed between the gum and lip. If the left half of the mouth is being treated it can be best approached from the buccal aspect

by using a straight quartz rod which is directed inwardly from the right lower end of the mouth. This is shown in Figure 24.

If the right half of the mouth is being approached, a curved rod may be utilized which is then introduced from practically the central plane, as is shown in Figure 25.

Each operator soon selects a convenient applicator and adopts a suitable approach.

In addition to quartz rod applicators, quartz lenses are also used which are shown in Figures 16, 17, 18 and 19.



Fig. 16.



Fig. 17.



Fig. 18.



Fig. 19.

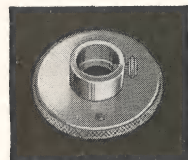


Fig. 20.

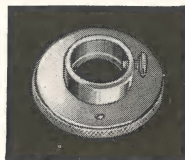


Fig. 21.

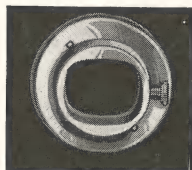


Fig. 22.

These lenses fit into metal holders such as Figure 20, 21 and 22.

Quartz lenses are pressed firmly against the gingiva, as is shown in Figure 26.

It is always desirable to use cotton rolls in order that the saliva will not interfere with the treatment, when lens compression is used.

It has been found that ultra-violet energy is quickly absorbed by the blood. If the effects of the ultra-violet energy are desired



Ffig. 23.



Fig. 24.

at deeper levels than the surface, it is necessary to expel the blood from the overlying tissue. This may be done by firm pressure, which pressure must be sufficiently great to insure an obvious blanching. Or it may be accomplished by the use of adrenalin which is painted over or injected into the area receiving the exposure.

Aniline dyes, because of their photosensitizing effect, are useful. They are useful also in providing a path, virtually, along which the ultra-violet energy may pass and by means of which it may, therefore, be conveyed into the periodontal tissues. Probably the best aniline dyes for this purpose are brilliant green and crystal violet. Others are satisfactory, but these have the added advantage that they also possess a strong bactericidal quality which is much enhanced under the influence of ultra-violet energy. The dyes may be dissolved in distilled water, or preferably 50% alcohol. They should be used together in the concentration of 1% of each dye. A convenient formula is:

Brilliant green	1:0 grams
Crystal Violet	1:0 grams
95% ethylic alcohol	50:0 c. c.
Distilled water	50:0 c. c.

Eosin, gentian violet and other dyes may sometimes prove useful; but in general, brilliant green and crystal violet serve best.

There is nothing difficult in the concept of ultra-violet application in dentistry. The fundamental principles involved have been presented. Technic means simply whatever means will bring the bactericidal and cellular regenerative ultra-violet energy to the focus that is undergoing treatment.

There are two general opinions as to the time of application. Some advocate a prolonged attack at each sitting and less frequent sittings. Others prefer short attacks at each sitting and more frequent visits. In general, it seems certain that smaller doses often repeated prove of better clinical efficacy than prolonged exposures less often repeated.

With those applicators whose intensity factor is recorded as 1 in Figure 15, the initial dosage with the lamp operating between 50



Fig. 25.



Fig. 26.

and 65 volts, is one minute. Where the factor is 2 or 3 the initial dose is correspondingly two or three minutes. The physiologic effects invoked by the first dose last from 18 hours to 36 hours or more. One effect of the physiologic action consists in establishing the tolerance of the tissue so that the second exposure can be for a longer time; and it is the general rule to add one minute to each subsequent exposure. For example, a molar on the right side is being treated with the curved rod such as is shown in Figure 25, the end of which is brought against the buccal aspect opposite the tooth. The factor for this rod is shown to be 2; which means that the initial dose with the lamp operating between 50 and 65 volts will be two minutes at the initial treatment. The second treatment, which should occur on the second day following the initial treatment, will be 2 plus 1 or 3 minutes; the third treatment which follows on the second day after the second treatment, will be for 3 plus 1 or 4 minutes; and so on. Often, it is desirable to repeat the treatments at more frequent intervals, say every other day or even every day; and in still other cases the reaction may be sufficient as to warrant an interval of three or four days between each exposure.

There is only one rule to remember in connection with the frequency of treatments, and that is: that the physiologic mechanisms set into being by ultra-violet energy are initially established at the first application, and are then maintained until the desired clinical effect which may be expected of the energy is reached.

PART III

ALVEOLAR OSTEOLYSIS, INFECTIOUS

DEFINITION: A decay or necrosis of alveolar bone as the result of infection, sustained, usually, consequent to the extraction of an apically infected tooth.



ODONTOGRAPHIC INTERPRETATION

The root fragment is not discussed. The alveolar structure is in places absent and in other places shows areas of *radiolucency* and *radioparency*, indicative of infectious disintegration of bone in the region of the missing first and second molar roots. Diagnostic inference; alveolar osteolysis, infectious. (Interpretation confirmed by F. F. Molt, D.D.S.)

PATHOLOGIC ANALYSIS

Osteolysis, or dissolution of the bone, involves

- (a) The presence of an agent that exerts a solvent effect on bone; such as bacterial enzymes.
- (b) The absence of the physiologic force that maintains a positive calcium and phosphorus balance; such as the constitutional impoverishment that accompanies tuberculopathy.

In the case under consideration, infection is the obvious agent responsible for the disintegration. Infection is a sum of two reactions, one active, the other passive. The active action is due to the attack offered by the invading organism. The passive action is the physiologic resistivity of the invaded tissues, generally designated focal immunity. Of course, infection may be controlled by

1. Destroying the invading organism.
2. Raising focal immunity to the point where infection cannot exist.
3. A combination of 1 and 2, or the simultaneous destruction of bacterial organisms and the raising of cellular resistance.

Bone cannot regenerate in the presence of most infection. So that the destruction of the infection is the first requisite in the correction of the pathology presented.

THERAPEUTIC INDICATIONS

There are three desired therapeutic effects.

1. The destruction of the infection.
2. The stimulation of cell regeneration.
3. The reassimilation of calcium and phosphorus for the reconstruction of new bone tissue.

These indications are efficiently and promptly met with ultra-violet energy, which displays.

- (a) A powerful bactericidal action.
- (b) A cellular regenerative effect.
- (c) An increased calcium and phosphorus metabolism.

METHOD OF ULTRA-VIOLET APPLICATION

The powerfully bactericidal ultra-violet energy must be conveyed into the infected area. For this, resort is had to the use of

- 1 Quartz rod applicators.
- 2 Photosensitive dye solutions.

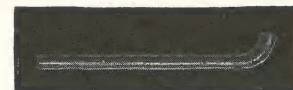
Quartz is exceptionally transparent to ultra-violet, being excelled only by native calcium fluoride (fluorite). So that applicators of appropriate design constructed of quartz may be attached to the water-cooled ultra-violet lamp and used to convey the energy into sinuses, softenend tissue, cavities, etc.

As they are usually constructed, the rod applicators deliver their maximum intensity from the end, only a small minimum issuing from the sides. If it is desired to increase the lateral transmission of ultra-violet, the applicator may be ground.

Useful dental applicators are illustrated:



BAW41



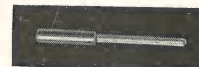
BAW46



BAW47



BAW58



BAW61



BAW95

ing forms innumerable miniature prisms which disperse the radiation. This preparation is called "prismatizing," and is clinically useful in increasing the efficiency of the applicators. Because of the great brittleness of quartz, it is best to entrust the "prismatizing" to experienced hands,

The use of aniline dyes arises from the phenomenon of photosensitization, a discussion of which is reproduced from "Dental Summary" (February, 1923), as follows:

"Although Ultra-violet light has so much action on protoplasm than visible light has, it has been found by several observers that, light which has no action by itself on infusoria, bacteria, or blood, produces the effect of Ultra-violet light when certain dye-stuffs are present. Although the dyes used were, for the most part, fluorescent, this does not seem to be an essential factor. For a complete account of the work, the reader is referred to the monograph by Tappeiner and Jodlbauer (1907). The general nature of the phenomenon will be clear from the few remarks following: Hertel (1905) exposed certain bacteria to light of 4480 Angstrom units. This had no effect on them, either with or without the presence of eosin, 1 part in 1,200. Eosin has no absorption band in this position. Ultra-violet light of 2800 Angstrom units killed them in sixty seconds, without eosin. A third experiment consisted in taking light of 5180 Angstrom units, that is, in the position of the absorption band of eosin, and making it of about the same energy as that of the Ultra-violet light previously used. Alone, this light had no effect, as would be expected, since it has a longer wave-length than that found ineffective in the first experiment. On the other hand, in the presence of eosin, which has no action in itself as the first experiment showed, the bacteria were killed in seventy to ninety seconds. It appears that the action of the eosin is to be compared to that of an optical sensitizer. The above results may be put in a table as follows:

Wave-Length In Angstrom Units	With Eosin	Without Eosin
5180 (eosin absorption band)	Dead in 70 to 90 sec.	No change in half an hour.
4480 (eosin absorption band)	Nothing in half-hour	No change in half an hour.
2800 (eosin absorption band)	Nothing in half-hour	Dead in one minute.

An excellent formula for photosensitizing infected structures preparatory to Ultra-Violet irradiation, consists of

Aniline dye.....	2 Parts
Distilled water.....	50 Parts
95% ethylic alcohol.....	50 Parts

For the aniline dye, one may use

Brilliant Green
Crystal Violet
Eosin
Gentian Violet
Fluorescein
Cyanosine

These need only be of laboratory purity.

Cavities and sinuses are irrigated with the solution insuring as complete a saturation of the involved tissues as irrigation can afford. The solution may be slightly warmed before using. After several thorough lavages, any convenient quartz rod applicator, one end of which is attached to the lamp, is thrust into the sinus and gently brought into contact with as much tissue as mild manipulation will permit. The irradiation, at the first exposure, lasts one minute, the lamp operating at 50 volts. Each subsequent exposure is increased by one minute. The exposures are made every third day, in cases that are not severe; every day in badly involved cases.

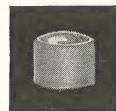
Ultra-violet rays irritate the eyes; so that the patient should wear glass goggles, or should have a towel folded over the eyes.

If there are no adequately large sinuses leading into the area of necrosis, so that the insertion of quartz applicators is practically precluded, the area is injected and the gum overlying the focus is painted with the dye solution. Since blood is opaque to Ultra-Violet, it should be removed by

1. Compression of the gum obtained by firm pressure of the quartz lens or applicator against the blood-free region.
2. The use of adrenalin, which may be added to the dye solution so as to present a total strength of 1 to 5000 or 1 to 10000 adrenalin chloride.



BAW54



BAW55



BAW56



BAW63

A proper lens is selected, such as one of the above.

It is brought into firm and pressed contact with the gum, where is held for one minute at the first exposure, one minute additional upon each subsequent exposure.

The clinical results are excellent.

DISCUSSION

Alveolar osteolysis is a form of osteomyelitis, such as the surgeon sees frequently and treats successfully with ultra-violet energy. If alveolar osteolysis, infectious, occurs, it can be controlled with ultra-violet radiation. But more important than this, alveolar osteolysis may be entirely precluded if, following an extraction of an infected tooth and the curettement of the infected focus, the cavity is irrigated with the dye solution, and then prophylactically irradiated with ultra-violet energy. Says Inglis, "The editor has had quite a number of cases of necrosis following extractions at the hands of specialists, and believes they and he should have been more watchful in such cases."

So that ultra-violet is indicated

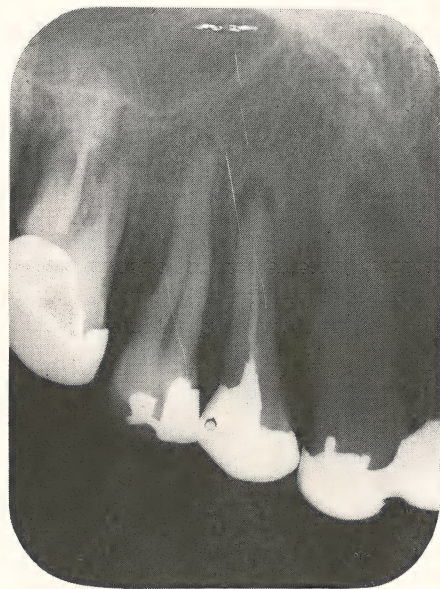
1. When an odontogram shows pathologic radioparency or radiolucency.
2. When there is infection present.
3. When cells need to be stimulated.
4. When calcium and phosphorus are missing.
5. After the extraction of every infected tooth as a certain insurance against the frightful consequences of alveolar necrosis.

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ABSCESSSES

DEFINITION: A localized focus of purulent accumulation that has disintegrated the tissue that includes it.



ODONTOGRAPHIC INTERPRETATION

At the apex of the first bicuspid there is a stripping of the stratum durum, and a locus of radiolucency, surrounded by a crescentic zone of radiopacity. The pulp canal is imperfectly filled. Diagnostic inference; post infectious repair of an abscessed locus. (Interpretation confirmed by F. F. Molt, D. D. S.)

Note: When the stratum durum has been perforated and the pus has entered the alveolaris the condition is known as alveolar abscess.

The alveolodental membrane is delicate and is protected in part by the mantle of stratum durum that overlaps it. When the stra-

tum durum is removed either by trauma or as the result of osteolytic destruction, two important phenomena arise; first, in proportion to the amount of stratum durum divested, support of the tooth by the alveolodental membrane is lost; and secondly, in proportion to the amount of alveolodental membrane exposed, an area for supply of tooth nutriment is destroyed. In a great number of cases operatively controlled by careful dental surgical technology, it was determined that when an amount of stratum durum equivalent to the distal third of the root was divested, the impaired support and the loss of nutriment resulting was such as to preclude the possibility of operative interference (apiectomy) with the view to saving the tooth; but if one-third or less of the distal root area of stratum durum is divested, apiectomy should be tried with the hope that successful rescue of the tooth results. Success rests in proportion as less stratum durum is lost. From this it is clear that the X-ray identification of the stratum durum is useful for two cogent reasons. First, its continuity must be elicited, and if broken, evidence is certain of an alveolar invasion; secondly, the extent of stratum durum destroyed must be determined for guiding the dentist in positively indicating the advisability to operate or not to operate (1)."

PATHOLOGIC ANALYSIS

It is important to review the physiological defense that is inaugurated at the pathological inception of an apical abscess. Wherever the organism invades, an intense arterial hyperemia is produced. The hyperemia is followed by a venous obstruction into which there exudes a great number of leucocytes purposefully brought to the site to defend the tissue against the invasion of the organisms. Upon the virulency and promptness of the leucocytic accumulation depends entirely the adequate defense of the invaded tissue; or, what amounts to the same thing, the cellular resistivity determines whether infection or non-infection shall gain the upper hand. If infection gains, the apical abscess is instituted, which means that the leucocytes are destroyed and become pus; and the pus, through its high content of enzymes, exerts an osteolytic disintegration of the alveolar bone.

When cellular resistance is great, apical abscesses are performed small; but when cellular resistance is mild, the ravages of infection makes for voluminous destruction. So that the size of the abscess is a rough clinical index of

1. The virulency of the attacking organisms.
2. Cellular resistance.

As in the case of alveolar osteolysis, which see, the dissolution of the bone is contributed to by

- (a) The presence of an agent that exerts a solvent effect on bone; such as bacterial enzymes.
- (b) The absence of the physiologic force that maintains a positive calcium and phosphorus balance; such as the constitutional impoverishment that accompanies tuberculosis.

THERAPEUTIC INDICATIONS

The therapeutic indications for abscesses in which one-third or less of the radicular stratum durum is stripped by purulent pathology comprise

1. Sterilization of the cavity contents.
2. Production, by the biologic irritation caused by ultra-violet energy, of marked engorgement to supply increased quantity of fresh and oxygenated blood and great numbers of actively stimulated phagocytes.
3. The reassimilation of calcium and phosphorus which is imparted to the bone cells in the vicinity.

PRINCIPLE OF ULTRA-VIOLET APPLICATION

To produce immediate bactericidal effects in the pus pocket, the highly bactericidal ultra-violet energy must be conveyed into the area; and this can be accomplished best by insuring what is called "optical contact." Optical contact means simply an unbroken path along which the ultra-violet energy may travel uninterruptedly. It can be obtained quickly by injecting into the periodontal membrane a solution of optical sensitive aniline dye, such as the one used in the treatment of alveolar osteolysis, as follows:

Aniline dye.....	2 Parts
Distilled water.....	50 Parts
95% ethylic alcohol.....	50 Parts

It has been found that the aniline dye can be made to saturate the membrane promptly if rubber syringe filled with the dye solution be emptied with moderate pressure under the gum at the cervix of the tooth whose apex holds an infection; and in many instances, an equally excellent saturation of the membrane can be obtained by painting, simply, with a camel's hair brush saturated with the dye, the gum and tooth margin. One-half dozen successive paintings about one-half minute apart, entirely around the tooth are usually sufficient to impregnate the periodontal membrane and all the soft and absorbent structures that are contiguous with the periodontal membrane (such as the purulent accumulation in an abscessed cavity that connects with the periodontal membrane).

METHOD OF APPLICATION

In a case of a small abscess the quartz rod applicator designated BAW58 is introduced into its holder so that the flat end presents, the rounded fitting into the chuck. The flattened end of the rod is pressed firmly against the marginal gingiva, with the lamp operating at 50 volts, and with this applicator an exposure of one minute is made. Following this, a quartz lens such as BAW54 is placed over the alveolar gingiva exactly opposite the infected site. Exposure is for one minute. This procedure is repeated every alternate day, or daily if more prompt results are required. At each subsequent exposure after the first, the time is increased by one minute.

It is strikingly remarkable to see the stalactite accretions that this form of therapy induces in the cavity, the lumen of which is gradually occluded until it finally disappears.

A good clinical axiom that makes for conservative dental therapy is: to irradiate with ultra-violet energy every apical abscess in which one-third or less of the radicular stratum durum of the tooth is stripped. Extraction is the last resort and can always be performed. Ultra-Violet radiation can be exceedingly successful;

and since this may insure the saving of a functional tooth, it should invariably have therapeutic precedence in the choice of treatment. Proper X-ray control of the therapy is as desirable as it is convincing of the great good that ultra-violet can oftentimes accomplish.

DISCUSSION

It is assumed, of course, that the degree of stratum durum stripped is commensurate with the area of pus accumulation. There are occasions when only a minor fraction of the stratum durum is stripped, but which present at the same time an exaggerated pus cavity. This form of apical abscess presents a different consideration and will be discussed subsequently.

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CIRCUMSCRIBED ABSCESS

DEFINITION: A circumscribed focus of necrosis in which the purulent activity is rigidly confined, probably by a membranous deposit that involves the walls of the cavity.



ODONTOGRAPHIC INTERPRETATION

There is a circular area of radiopacity situated between the cuspid and first bicuspid on the left. It connects with the periodontal space of each of the teeth. The first bicuspid holds an obviously patulous pulp canal. It is carious. Diagnostic inference: intra-dental abscess. (Interpretation confirmed by F. F. Molt, D.D.S.)

PATHOLOGIC ANALYSIS

It is obvious that the tooth structures are functional; and such intervention as might spare their loss would be clinically desirable in such an instance. Observe that the stratum durum is stripped

so that the periodontal space on the lateral aspect of each tooth is in physical communication with the cavity. This path may be used to secure an avenue for the establishment of "optical contact." It is not sufficient to direct all of the therapy against the abscessed locus; the dental caries should also be treated.

THERAPEUTIC INDICATIONS

It is necessary to attack the accumulation of pus and render it sterile. Following this, the lining wall of the cavity must be refreshed in order to insure a new surface from which stalactite calcium and phosphorus deposition can accrue in the process of occluding the cavity. When the infectious site has been destroyed and obliterated, it is further necessary so to treat the channels leading into the area (pulp canal and periodontal space) as to insure the arrest of progressive infection.

INDICATIONS FOR ULTRA-VIOLET

The sterilizing qualities of ultra-violet energy are needful (1). A point may be inserted into the open pulp canal and some aniline dye then introduced into the pulp chamber. By quickly withdrawing the point there is established a suction along the walls of the canal which makes for the influx of dye; and it is projected through the foramen into the abscessed cavity. In this manner an optical contact is established through the foramen. In addition, the dye may be painted on the gums opposite the lateral periodontal spaces of both teeth which will insure the invasion of the pocket through these avenues. An irritant may be employed to destroy the limiting membrane of the pocket. An increased stimulation of cellular regeneration and of calcium and phosphorus metabolism is necessary and required for the obliteration of the pathology.

METHOD OF ULTRA-VIOLET APPLICATION

The optical contact has been achieved in the manner described. So that it is necessary only to apply the quartz rod against the marginal gingiva, the first exposure for one minute and each subsequent exposure, which should be given daily or every second day, one minute additional. Besides this treatment, the quartz lens should

be firmly pressed against the alveolar gingiva opposite the pocket. The first exposure should be for three minutes which will produce a marked blistering of the area. This marked blistering is accompanied also by an intense biologic irritation which brings a large volume of fresh blood, leucocytes and repair material, all of which is essential and active in overcoming the cellular inertia that the infection has inaugurated. With the cellular inertia overcome, a speedy repair is practically insured.

Abscesses of this type require a somewhat longer treatment period than those of the preceding type; but they yield satisfactorily and without the loss of teeth.

DISCUSSION

Sometimes the membranous lining of the pus cavity is so thick as to preclude its prompt disintegration. When this is so, the return to normal is much delayed. Some have used fibrolysin, which they incorporate in the solution of aniline dye used as a sensitizing medium. The reports from this method are too few to permit of much discussion; but the results seem to have justified the measure. Others prefer to acidulate the dye solution, using hydrochloric or sulphuric acid. This measure is too drastic and may exert evil consequences that are wholly undesirable. Probably the most satisfactory method is to include in the dye solution 1 part in 100 of tricresol. This derivative is often sufficient to irritate the lining membrane to the point where its destruction by the remaining normal cells can be effected.

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INCIPIENT ALVEOLAR OSTEOLYSIS; PERIODONTITIS

DEFINITION: An infectious involvement of the periodontal structure* which exerts a lytic effect upon the stratum durum. After overcoming the resistance of this compact layer, the infection spreads quickly to the more susceptible alveolar tissue and occasions its prompt disintegration. Every virulent periodontitis is a potential infectious alveolar osteolysis.



ODONTOGRAPHIC INTERPRETATION

The alveolodental space surrounding the mesial root of the first molar is widened and radioparent. There is a radiopacity in the alveolar structure about the distal root. Much radiolucent erosion of structure is apparent around both roots of the second molar. Diagnostic inference; mesial periodontitis, distal alveolar inflammation at the first molar roots. Necrotic disintegration surrounding both roots of the second molar. (Interpretation confirmed by F. F. Molt, D. D. S.).

*Pericementum; alveolodental; synonymous with periodontal. We prefer periodontal, reserving pericementitis as an accretion of hyperplastic cementum activity. See Odontopathies, Pacini, A. J., Medical Record, March, 1921.

PHYSIOLOGIC DISCUSSION

This newer therapy of pathology involving the alveolar process is superstructed upon a definite understanding of the physiology of this structure. A clear concept of this can be gained from Stillman and McCall's *Clinical Periodontia* (1), as follows: "The Alveolar Process is developed for the purpose of giving support to the teeth, a function which it performs through the medium of the pericementum. It is developed coincidentally with the development of the tooth root. In healthy mouths, where normal function is enjoyed, the teeth are retained throughout life together with their alveoli. To consider this form of bone a transitory structure is therefore incorrect, since it has all the anatomical and histological characteristics of true bone. It is only lost through pathological change or tooth extraction, neither of which should occur in a normal mouth. The fact that changes in the position of the alveolar process may take place when the teeth are moved, does not invalidate this statement. For sufficient continued pressure applied to any bone will invariably change its shape. The so-called "senile atrophy" of the periodontium, which has been explained upon the ground that the alveolar process was a transitory structure, should really be considered a pathologic process rather than the inevitable accompaniment of old age. It is interesting to note that modern pathologists are abandoning the older theories regarding senile changes in various parts of the body, and are assigning to them, in part at least, a pathologic etiology."

"The function of the alveolar process is to furnish a foundation on which the teeth may rest in the performance of the functions of prehension and mastication. Nature is never lavish in tissue formation. Hence we observe that the alveolar process consists of dense labial and lingual plates, which give a definite and necessary support whereby the buccal and lingual movements of the teeth are limited. On the other hand the interdental alveolar tissue is not of compact form, but is of the cancellous type. It is evident that Nature expects the teeth to give a mutual approximal support from their fellows are apt to develop an excessive, and hence a pathologic mobility. The effort to maintain the normal, which is inherent in all tissues, often shows itself in the laying

down of a denser approximal bone formation when the interdental contacts are deficient. While this process borders upon the pathologic, it still may properly be considered a normal exercise of the functions of the part, being Nature's method of meeting this requirement for mesio-distal support."

"Bone repair and development proceed from the proliferation of previously existing osteoblasts or from cells of mesoblastic origin. It does not arise from any activity of the periosteum or pericementum. When the alveolar process has been absorbed, new bone formation may be obtained by proper stimulation. It will however be built up only from the remaining healthy bone, or from fibroblasts near such bone. If the pericementum had an osteogenetic function, as has been claimed, the rebuilding of the alveolar process might be expected to occur wherever the previously intact pericementum could be restored to a healthy condition. Observation of cases in which new bone formation has taken place about the teeth, invariably shows that the new bone is a direct proliferation from the surface of the remaining alveolar structure, irrespective of the extent of healthy pericementum *in situ*."

What it is desired to emphasize especially is the concept of bone repair, which must proceed from the proliferation of existing osteoblasts or from cells of mesoblastic origin; and this repair can be obtained under proper stimulation. Cellular stimulation and regeneration is a function of ultra-violet energy which has made it especially useful in medical practice wherever cellular repair is a prerequisite (2) (3).

But osteoblasts are different from all of the cells of the body in that their existence is intimately associated with the metabolism of calcium and phosphorus. And calcium and phosphorus are the two elements of the blood that show definite laboratory increase under the influence of ultra-violet energy (4). It seems strikingly singular, therefore, that ultra-violet energy finds so unusual an application in stimulating osteoblasts to greater function, which it does because of

1. Its general cellular stimulating effect.
2. Its selective stimulating effect upon the metabolism of calcium and phosphorus.

PATHOLOGIC ANALYSIS

The periodontitis that involves the first molar threatens advancement and progression, obviously the state of affairs incident to the second molar. There can be no check to the progression of pathology unless the virulence of the bacterial invasion is threatened and destroyed.

THERAPEUTIC INDICATIONS

The second molar had best be removed. Its necrotic socket must be completely lavaged and irrigated with a photosensitive dye, and the infectious alveolar osteolysis must be checked. The periodontitis must likewise be checked through the use of an agent that will destroy the bacterial invasion and that will maintain a high calcium and phosphorus content in the area.

For both of these effects, the ultra-violet energy is cogently efficient.

METHOD OF ULTRA-VIOLET APPLICATION

Following the extraction of the second molar, the area is treated as for alveolar osteolysis, which see.

The periodontitis is quickly reached by infiltrating the periodontal space with a photosensitive solution and irradiate. Use the water-cooled lamp and applicator such as BAW58, and a marginal gingival exposure under moderate pressure of one minute; 2, 3, and so forth, minutes for every subsequent exposure, which should occur at intervals of one or at most two days. In addition, a quartz lens should be pressed opposite the root region, against the alveolar gingiva to produce a strong hyperemia which will bring the natural defense of an increased arterial blood supply and invoke thereby its natural immunity. The reaction to this form of treatment is vividly illustrated at the distal root of the first molar, where the radiopaque areas show the congestion such as results from the ultra-violet exposure. Under quartz lens compression, the treatments, that are given at the same frequency as the periodontal treatments, should be intense; the first for two minutes, each subsequent treatment should be increased by one minute. The frequency is coincident with the frequency of the periodontal treatments.

DISCUSSION

In acute periodontitis, which is clinically attended with much pain, the effect of the ultra-violet is highly desirable because of the analgesic properties that it displays. It is not at all uncommon for an acute periodontitis to yield immediately after a single exposure to quartz lens compression for a single treatment.

In a structure such as the first molar presents in the odontogram, proper dental surgery, such as the filling of the root canal, and the refilling of the pulp chamber and carious region, should, of course be practiced. Ultra-Violet energy will insure relief from the immediate pathology.

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OCCLUSION OF POTENTIAL INFECTIOUS LOCUS

DEFINITION: A locus, such as may be formed by tooth extraction, that may favor the acceptance of infection and thereby contribute to the systemic disability of the individual.



ODONTOGRAPHIC INTERPRETATION

The socket of the first molar on the upper left shows an occlusion which is developing consequent to a stalactite accumulation of newly developed cancellous bone. The limits of the stratum durum are still observed, within which limits the newly developed tissue has accumulated. Diagnostic inference; bone regeneration in a sterile alveolar space. (Interpretation confirmed by F. F. Molt, D. D. S.).

CONCEPT OF INFECTION AND RESISTANCE

It is an error to fail to recognize that the clinical concept of infection implies two important factors:—

1. The presence of an infecting organism.
2. The lowering of tissue vitality to the point where the infected organism can become clinically established.

A summary of this concept is given by Stillman and McCall (4) who, in their chapter entitled "Infection and Resistance" have this to say: "In considering the subject of diagnosis, it seems well at the outset to review briefly the main facts concerned in the questions of infection, immunity and resistance. The high percentage of incidence of localized infection, especially about the mouth, has already been stated. The greater number of the individuals so affected, both young and old, do not develop symptoms of acute disease therefrom. A majority of children suffer from chronic tonsillitis and alveolar abscesses, with only occasion acute secondary exacerbations, such as in acute arthritis. But chorea and endocarditis are common. These diseases are unquestionably in the majority of cases the result of focal infection of the mouth and throat. A majority of the urban population carry about the evidences of latent foci, as for instance tuberculous scars. Yet a comparatively small number develop clinically recognizable tuberculosis."

"Microorganisms are universally distributed in nature. They gain access to the body at all times, and many varieties are constantly found in various locations in the body. Especially is this true of the mucosa of the alimentary tract. In the intestines certain varieties of bacteria are present in such large numbers, yet without evidence of injury to the host, that their presence is considered normal. These bacteria are even considered essential to the performance of normal intestinal function."

"Presence of Bacteria in Body—It will thus be seen, that the presence of microorganisms in the body tissues, is not of itself significant. They become important only, when by their presence they inaugurate disease. To produce disease it is necessary that the pathogenic bacteria shall do more than gain entrance to, and proliferate within the host. It is necessary in addition, that the invader shall maintain itself and functionate within its new environment. Whether it has the ability to accomplish the latter, depends not only on virulence, but upon the resistance which it meets in its new

environment. Infectious disease is therefore the product of two opposing factors, viz. the invading germ and the resistance of the invaded subject.

"The production of infectious disease however is not a simple process. Both of the factors involved are influenced by several modifying circumstances. The virulence of the germ has already been mentioned. Other modifying circumstances are the path of entrance, previous habitat of the organisms, the location of the infection, and the type of tissue which has been invaded. For instance the staphylococcus if taken into the stomach produces no apparent harmful effects. If however it gains entrance through the skin, an abscess or so-called boil, may be produced which may terminate in a septicemia or a pyemia with secondary metastatic foci. The science of immunity is concerned with the study of the opposing forces of bacteria and body resistance, together with a consideration of the varying conditions under which each operates."

When the virulency of an organism is high, it incites, in the locus where it infects, certain phenomena of inflammation which express the attempt on the part of the body to overcome the ravages of infection. These changes are clinical and are characterized by redness, heat, swelling, pain and diminished function. The redness is due to the increased supply of blood in the part,—a hyperemia. The heat is consequent to the increased chemical activity at the site which is put into chemical action through the attack of the blood elements on the invading bacteria. The diminished function is the momentary perversion of physiology that is suffered by the part undergoing invasion. The swelling is the result of the accumulation of these additional products in the area which, by their mechanical impinging upon the nerves of sensibility, produce the symptom of pain. This is the natural defense against infection. If this defense is successful, the infection is overcome. If this defense fails, infection is established.

Ultra-violet energy induces a "sterile" inflammation which includes a gush of blood charged with many chemically attracted leucocytes, an increased temperature due to the augmented metabolism imparted to the tissues of the blood; but instead of producing

pain and diminished function, it relieves pain because of its analgesic effect and it stimulates functional activity because of its stimulative and regenerative effect. It is fitting to speak of this reaction as a "*biologic inflammation*" as distinguished from the pathologic inflammation that is invoked by a bacterium.

THERAPEUTIC INDICATIONS

Whenever infection is present, and the infection threatens to overcome the natural resistance offered by the changes of inflammation, it is obviously desirable to re-institute and create all of the conditions that simulate nature's own method in attacking the invading offender. This, ultra-violet does through its capacity to induce a biologic inflammation; so that by repeated productions and continued maintenance of biologic inflammation, an infection of any virulency must ultimately yield with the resulting elimination of pathology.

METHOD OF ULTRA-VIOLET APPLICATION

For the production of biologic inflammation, useful in all forms of infection of low virulency, subacute or subchronic, it is necessary only to apply a suitable quartz lens opposite the alveolar gingiva in the area of the infection; which, with the lamp operated at 50 volts, with moderate pressure on the lens held in contact with the gum, an initial exposure of two minutes, and each subsequent exposure increased by one minute, furnishes a biologic inflammation that is helpful in:

1. Bringing a new supply of blood to the part.
2. Invoking the chemical attraction of white blood cells.
3. Oxygenating and refreshing the immunological qualities of the blood.
4. Imparting a cellular stimulation and regeneration which dispels diminished function.

In this manner, ultra-violet energy is distinguished by producing an exact duplication of all of the natural methods used in the attack on infection without having any of the undesirable consequences that other methods are likely to produce.

DISCUSSION

It is difficult to estimate the significant importance of ultra-violet energy because of its ability to imitate all of the desirable qualities of the natural attack upon infection, eliminating at the same time all of the unhelpful qualities that are present in the natural attack and absent in the ultra-violet attack. In a word, ultra-violet establishes acquired immunity in the presence of subacute and subchronic infections through a process in every way identical with the mechanism whereby the body establishes its own acquired immunity against any organism.

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PERIODONTAL ABSCESS

DEFINITION: An abscess, which may be periapical or parietal.



ODONTOGRAPHIC INTERPRETATION

There is a divestment of stratum durum at the apex with a radiolucent invasion of the alveolar structure. Diagnostic inference; periodontal abscess. (Interpretation confirmed by F. F. Molt, D. D. S.)

PERIODONTAL DISEASE

In assaying the clinical significance of periodontal disease, there should be considered

1. The radiographic and clinical detection of the disease.
2. An evaluation of the harmfulness that the lesion may afford to the patient.
3. The possibility of prompt repair.

Periodontal disease is meant to include parietal and periapical abscesses. Say Stillman and McCall (4), "Parietal and Periapical.—Generally speaking the parietal lesion is less harmful to the system than the periapical. The reason for this lies in the usual free drainage provided for this lesion through the agency of the gingival crevice. From the standpoint of metastatic disease, the exudation of pus from this crevice need not in many cases cause the alarm usually aroused by its discovery, since the fact of its exudation usually indicates a minimum absorption into the circulation. And when so excreted from the gingival crevice, it is moreover, usually capable of digestion by the gastric fluids. It is not here maintained that pus taken into the stomach is without harmful possibilities. Relatively speaking however, it has been found that the periapical lesion which has no external drainage, and whose inflammatory exudate is absorbed directly and only into the blood and lymph channels, is the more injurious agency. And this in spite of the fact that the periapical lesion in the majority of instances produces no visible pus."

"The Significance of Pus.—It may be well to state at this point that pus is not a disease but is a manifestation of Nature's reaction to a pathogenic agent. The presence of pus is an indication of the need of treatment. Its continued presence is not to be tolerated. But pus does not in itself connote for the tooth involved a negative prognosis.

"Types of Parietal Disease.—Briefly there are five types of periodontal disease. They may occur as pure types or two or more may blend to produce a fusion type. They are named to indicate the tissue most prominently involved, with the exception of the fifth, whose varied locations make necessary for it the use of a title descriptive of its pathology. These types are as follows,—Ulatrophia, Gingivitis, Alveoloclasia, Pericementoclasia and Periodontal Abscess.

"1. Ulatrophia is a word signifying a wasting away of the ula, or gingival tissue. This wasting away is usually preceded by a variable absorption of the crest of the alveolar process. The end result is an exposure of the cervical enamel and usually of the

cementum. In the pure type there is no redness or swelling of the marginal gingiva, no pus, no pocket formation or mobility of the tooth."

"2. Gingivitis is an inflammation of the marginal and cemental gingiva. It is characterized chiefly by redness of these tissues. There is also a rounding of the crest of the marginal gingiva and some thickening of this tissue, but no perceptible pocket formation. There is usually no pus although it is sometimes possible to express a little from the gingival crevice, even where no pocket formation has taken place. There is usually a tendency to hemorrhage upon contact with the brush, etc."

"3. Alveoloclasia is an absorption of the alveolar process, either of its crest, or of the inner wall of the alveolus. Absorption of the crest results in a recession of the marginal gingiva, previously mentioned under ulatrophia. Absorption of the inner wall and crest of the alveolus results in a thickening of the pericementum and mobility of the tooth. In either case the pure type exhibits no pocket formation, no pus, no visible signs of inflammation."

"4. Pericementoclasia is a dissolution of the pericementum. In the typical case the overlying gingival tissue is not destroyed, but the intervening alveolar bone is absorbed, resulting in pocket formation. The resulting ulcer on the inner wall of the gingival tissue is the source of the pus, which is always formed, either visibly or microscopically, in this type. The gingival tissue may not exhibit visible evidence of inflammation, but the microscope will invariably reveal the inflammatory reaction. The tooth may not be loose. The only definite diagnosis of this condition is by exploration under the marginal gingiva with a blunt probe. The accompanying alveoloclasia will be demonstrable in the radiograph. But if the buccal or labial alveolar plate only is involved, the radiograph will exhibit no alteration in structure from the normal."

"5. Periodontal abscess is of two main types,—periapical and parietal. Periapical abscess is invariably the result of infection of the pulp or the pulp canal contents. When acute, it is usually readily differentiated from parietal abscess, chiefly by the fact that

the affected tooth is either non-vital or can be demonstrated as having an infected pulp."

"Parietal abscesses are of two types, pericemental and gingival. The pericemental abscess occurs in a previously intact pericementum, and upon a tooth with a vital pulp. Its symptoms however are similar to those of periapical abscess. Gingival abscesses occur either at the base of the gingival crevice without previous pocket formation, the abscess being localized in the cemental gingiva, or they may occur in the gingival tissue overlying the pocket in a previously established case of pericementoclasia. These types may occur around pulpless teeth or teeth having vital pulps. Their location establishes the diagnosis."

"In chronic cases having a fistula, the course of the fistulous tract should be carefully traced, preferably by a radiograph taken with a wire inserted in the tract. This is frequently the only means of distinguishing the responsible tooth."

"Prognosis of Periapical Lesions.—While the prognosis of suppurative parietal disease is not necessarily negative, the presence of pus in the periapical lesion especially if persistent, does usually indicate a negative prognosis. The reason here is somewhat complex. We have in the first place a pulpless tooth, or one, with a hopelessly infected pulp. This means an obliteration of the vessels in the apical foramina and a certain amount of destruction of the pericementum in this region. Under such circumstances the infection penetrates the canaliculi and tubuli of the tooth apex, and regeneration of the pericementum is thereby rendered impossible."

"Even when periapical disease has developed without pus formation, the lesion which may be either a granuloma, a cyst or an area of condensing osteitis, produces changes, which make repair difficult and frequently impossible. The pericementum in this region is either destroyed, or hopelessly degenerated. In the cases exhibiting condensing osteitis, the infected bone area has been found to be particularly intractable to treatment. In all of these cases the contents of the canaliculi, lacunae and tubuli, become contaminated, and because of the loss of the pulpal circulation cannot again be restored to a normal condition."

"Another factor in periapical cases which is frequently overlooked, is the character of the predominating organism, the streptococcus viridans. This is an organism of low virulence. Hence, when it penetrates to the periapical tissues, it excites only a mild reaction. Phagocytosis is induced to only a slight extent. Inflammation is limited. It accordingly follows, that regenerative responses are likewise inactive. The sum total of these elements leads inevitably to the conclusion that periapical lesions which have persisted for an appreciable length of time, have a negative prognosis."

"Bacteriological Examination.—The basis for making the preceding statement, lies not only in anatomical and biological characteristics, but in the results of bacteriological examinations of many extracted teeth. These examinations have shown that bacteria were present in the apical tissues of pulpless teeth presenting any one of the following conditions:

1. Teeth filled according to older methods.
2. Teeth having incomplete root fillings.
3. Teeth having deep periclasial pockets.
4. Teeth having a history of persistent pericemental disturbance.
5. Teeth having a periapical lesion observable in the radiograph, even if this area has been reduced in size by treatment.

"Parietal Lesions.—Attention should be called however to a peculiarity occasionally observed in cases exhibiting parietal disease. The cases here referred to, usually show no pocket formation, hence no exudation of pus, or other fluid. Radiographs in the molar regions show rarifying osteitis in the bifurcation and other evidence of the presence of granulomata. In addition there is usually enlargement of the lumen of the alveolus, as evidenced in the radiograph by what appears to be a thickening of the pericementum. These cases also are apt to exhibit a diffuse condensing osteitis in the periapical region. Since all of these phenomena point to the presence of an infection, whose products are absorbed into the circulation instead of being drained through the gingival crevice,

the prognosis is usually negative. This however is the only type of parietal disease which has a negative prognosis, aside from those cases of pericementoclasia, whose pockets have extended so far as to cause infection of the pulp. It will thus be seen that nearly all types of parietal periodontoclasia, have a positive prognosis, especially if only moderately advanced, in contradistinction to periapical disease. The analogy however is incomplete. That portion of the parietal cementum which is usually encountered in the so-called pus pocket is without canaliculi and lacunae, and is in fact a nearly homogeneous tissue. Neither bacteria nor the products of infection can penetrate more than a few microns into its substance. Given controllable etiological factors the parietal lesion can be cured, and a physiological union secured with the overlying vascular tissue."

THERAPEUTIC INDICATIONS

Pus is an expression always that the defences of the tissue involved are engaged actively in the attack upon the infecting organism. It is, therefore, desirable that the physiologic mechanisms leading to the production of pus be at all times encouraged and aided by suitable means. The physiologic mechanism that invokes pus formation has to do with inflammation; and an agent that induces a biologic inflammation, free from the toxins and poison of bacteria or harmful drugs, is of utility.

METHOD OF ULTRA-VIOLET APPLICATION

The locus of infection is reached by applying an aniline dye solution, which may be of the following composition:

	Gms. vel C. C.
Brilliant green.....	10:00
Crystal violet.....	10:00
Alcohol, ethylic, 95%.....	500:00
Distilled water.....	500:00

A quartz lens is then pressed over the area of infection by holding the applicator in firm contact with the alveolar gingiva. The application is, for the first sitting, one minute; and is increased one minute at each additional sitting which should take place

every second or third day, depending upon the severity of infection. In addition, a quartz rod is pressed over the marginal gingiva gently massaging this membrane by a delicate sweeping movement of the applicator inducing thereby a deep vibratory massage. The pressure of the quartz rod applicator should be sufficient to induce a visible blanching of the tissue. This pressure expresses the stagnant blood supply which is then replaced by a refreshed supply. This refreshed supply of blood assists in the function which the marginal gingiva has of protecting the pericementum from infection. The time of application at each treatment, as in the case of the quartz lens compression, is one minute initially, and one additional minute at each subsequent irradiation.

DISCUSSION

The problem of the use of dyes as oral antiseptics is not at all new, and has been presented by Berwick (7). The use of the dyes themselves, as antiseptic agents, is accompanied with good results; but when combined with ultra-violet energy, the effect of the dyes is many times enhanced as is also the effect of the ultra-violet energy; and the combination should be justly appraised with the high esteem that dental clinicians have already placed upon it from the success that attends such usage.

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PART IV

INDICATIONS FOR THE USE OF ULTRA-VIOLET ENERGY ABNORMAL TISSUE TONE

This may be a primary factor in periodontalclasia, and may be induced by

1. Abnormal systemic condition.
2. Abnormal local condition.

It appears that the only systemic conditions which have a primary influence are those identified with the pathology of scurvy,—reflecting a deficiency in the nutritive elements of the blood.

This may be corrected by the general irradiation of the body with air-cooled or biologic ultra-violet energy, such as is everywhere recommended in the attack of rickets and allied diseases involving the integrity of the calcium-phosphorus-organic metabolism. See Dental Summary, April 1923.

It is much more common to find abnormal local conditions responsible for an influence on tissue tone, an influence generally designated functional insufficiency, which will be separately considered.

ABSCESS

Abscesses may be considered under two general groups, septic and nonseptic; and each of these groups may again be divided into lesions which begin at the apex of the root, lesions which begin at the gum margin and lesions which begin at some intermediate portion of the pericementum. See G. V. Black, American System of Dentistry, Volume 1.

All suppurative or septic involvements of the pericementum require the bactericidal ultra-violet energy. The basis for the treatment consists in establishing an optical contact between the septic

locus and an open surface. This is best accomplished by the use of the mixed aniline dyes, brilliant green and crystal violet, such as have been discussed in the part dealing with general methods.

In addition to the immediate bactericidal attack, the quality that ultra-violet energy has for producing hyperemia forms a second and important therapeutic adjunct in the treatment of these conditions. The induced hyperemia establishes a biologic inflammation, and biologic inflammation is a direct reduplication of the natural mechanism whereby physiology attacks infection anywhere in the body. The production of the biologic inflammation is brought about through the use of the contact technic, wherein a suitable quartz lens attached to the water-cooled lamp is firmly pressed against the alveolar tissue opposite the area of pathology. See General Methods.

The question of necrosis from apical abscesses is summarized by saying that it represents an extremely exaggerated loss in tissue vitality which enables the infection quickly to spread in the alveolar process. This has been discussed under the title of alveolar osteomyelitis, infectious, in part three, which see.

Chronic abscesses represent a long continued yet attenuated infection. There may be present a discharging sinus which occludes the channel through which the photosensitive anilin dye solution may be injected in order to establish the necessary optical contact. The basis for the treatment of the chronic abscess rests with the destruction of the residual inflammation and the chemical irritation of the chronically diseased tissues which leads to a subsequent cellular proliferation that occludes the area of pathology. The attack is made with the bactericidal technic and with the contact method of producing an intense biological inflammation.

In pericemental infections which may or may not lead to the establishment of an acute or chronic abscess, three biophysical qualities of the ultra-violet energy make for high efficiency in the dental therapy of these conditions:

1. The immediate bactericidal effect of the short wave-lengths which must be conveyed into the area by establishing an optical contact.

2. The biologic inflammation that the ultra-violet energy induces which is an exaggerated imitation of the natural defense established by the body in the attack of any inflammatory process.
3. The imparting of cellular regenerative qualities to the diseased cells that harbor the inflammation, leading, in the case of the cells that have to do with bone regeneration and proliferation, to the increased metabolism of calcium and phosphorus.

ANTRUM EMPYEMA

Empyema of the antrum implies an infection and purulent accumulation in Highmore's cavity. The cavity may be drained through the alveolar socket following the removal of the cuspid; or by puncturing the partition that separates the antrum from the nose. When surgical draining has been established the cavity is irrigated with a dye solution and a quartz rod applicator is inserted into the antrum which is then irradiated for two minutes with the water-cooled lamp using the voltage of 50 to 65 across the tube. The specialists in diseases of the nose and throat find this procedure efficacious.

APICOECTOMY

In any surgical interference such as apicoectomy represents, the operation should be followed by an irradiation with ultra-violet energy which will insure;

1. The destruction of residual infection.
2. Imparting of cellular regenerative qualities to the traumatized cells which have suffered as the result of infection and instrumentation.

It must not be overlooked that the ultra-violet energy displays a desirable analgesic quality which makes it of additional advantage in allaying the pain that generally follows operative interference.

Ultra-violet energy is useful in dispelling edema, which it does promptly and with marked efficacy; so that whatever degree of cellulitis is established incident to operative interference, the infec-

tion and the edema are corrected or aborted by the proper prophylactic use of the radiation. The time of exposure is for one minute. The area exposed is the open operative field.

BACTERIA

The death points of various bacteria when exposed to ultra-violet energy have been determined as follows;

<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.)

BLEACHING AGENT

It is established that ultra-violet energy dissociates hydrogen peroxide with liberation of nascent oxygen. This action is useful in treating dental stains other than those induced by metallic

deposits. The involved tooth is isolated by rubber-daming and is then exposed (everything else shielded from the light by cloths, towels, goggles and other adequate protection) for thirty minutes to the water-cooled ultra-violet energy which is played on the tooth through the use of a tubular applicator. The method which is outlined by Thedering for bleaching teeth, and which has been employed by Rosenthal is described as follows:

"The teeth to be treated are isolated with a rubber dam, the four corners of the dam being fastened with an elastic or rubber band to the tubular applicator which is so applied as to be enclosed by the rubber and directed opposite the stained teeth. Absolutely neutral hydrogen peroxide is dropped on the teeth during treatment. This must be constantly replaced throughout the entire exposure. The pulp chamber of a devitalized tooth is packed with cotton which is saturated with hydrogen peroxide. Ordinarily one or two irradiations for one-half hour suffices to bleach a stained tooth to a normal white."

Metallic discolorations of the teeth do not yield to this form of treatment. Stains arising from the products of decomposition of hemoglobin, and decayed food particles are especially benefited. It is claimed that this method of bleaching is superior to older methods because of the shorter time required to effect bleaching and because of the greater assurance of success.

CALCIFICATION OF THE TEETH

In such disturbances as involve a perversion of the normal calcification of the teeth, the use of the ultra-violet energy is beneficial owing to the enhancing of the calcium and phosphorus metabolism imparted by this radiation. See Grieves, Howe, Shipley, Bell and Harter, in the February 1923 number of the Dental Summary; also Pacini, April 1923, Dental Summary.

CARIES

Modern researches seem to point out that the metabolism of calcium and phosphorus is concerned with the etiology of caries. The studies have been recorded in full in the references given under the concept of calcification of the teeth, which see.

Such bacteria as are involved in the pathology of caries may be destroyed by the suitable use of dyes.

Recently it has been suggested that a carious tooth should be treated by the method used for the bleaching of teeth. It is claimed that under prolonged irradiation the ultra-violet energy finally permeates the entire calcific structure of the tooth and effects a sterilization of the enclosed infection.

CELLULITIS

Cellulitis represents the reaction against a spread of infection through the lymphatics of the tissue of an area. The phenomenon is attended with edema. The ultra-violet energy is useful in destroying the organism responsible for the pathology and dispelling edema. For this purpose irradiation is an excellent preventive not only against cellulitis, but also against the possible blood infection that may attend this serious consequence.

DEGENERATION

This implies a retrograde process in the cells which suffer changes because of a disturbed cellular nutrition. If the histologic changes are profound, the cells usually die. This form of death is designated necrobiosis. In degeneration and necrobiosis it is important to remember that the tissue, as a whole, is still living.

The ultra-violet energy, because of its cellular regenerative qualities may check the process of degeneration, and may even effect a repair.

The pathology of degeneration should be studied, from which the uses of the ultra-violet energy in the various manifestations of the pathology become apparent.

DENTITION

Perversions of metabolism that effect the first and second dentition are becoming more and more recognized. They have been identified with a lack of integrity of the calcium-phosphorus-organic factor. And these factors may be controlled in many in-

stances by the proper use of the biologic ultra-violet energy. See Dental Summary for January, 1923.

ENDAMEBA

Endameba, like bacteria, are destroyed by ultra-violet radiation. It is not improbable that certain endameba play a role in the pathology of dental infections. When they are present they may be destroyed in every way similar to the method utilized for attacking bacterial infections.

FISTULAE

In the pathology of a fistulous tract the therapeutic indications are for sterilization of the locus which gives rise to the infectious strain, and biologic irritation of the tissues that line the tract in order that they resume a normal proliferation and occlude the channel. A fistulous tract may therefore be injected with the dye solution such as has been discussed under general methods, using a fine quartz rod inserted into the fistulous opening. For the biologic irritation, a quartz compression method may also be used.

When the pathology inducing the existence of the fistula is corrected, the fistulous tract is soon obliterated.

FRACTURES

A fracture of the jaw bone is a surgical consideration for which the ultra-violet energy finds an especial usefulness. In these cases the ultra-violet effects a sterilization at the fracture site, it reduces edematous swelling; it relieves the pain; it stimulates an assimilation of calcium and phosphorus that make for the speedy reunion of the bone fractures.

GINGIVITIS

All the inflammatory diseases that begin at the gum margin and that have an infective local irritant as an etiologic factor, are quickly and properly attacked with the water-cooled ultra-violet energy. There are many phases of gingivitis; marginal which can be treated promptly by painting the gum margin with the anilin dye solution

and then irradiating with a fine quartz rod applicator which is pressed gently over the infected edge so that each site receives a one-minute application. Deeply seated or interstitial gingivitis involves changes in the connective tissue elements which must be attacked by a biologic irradiation produced under moderate pressure of a quartz lens placed against the margin.

HEMOPHILIA

It is interesting to observe that the feeding of calcium lactate by mouth, and the subsequent bodily irradiation with ultra-violet energy, has, in medical experience, led to the control of bleeding in cases showing hemophilia.

HYDROGEN PEROXIDE

The use of this agent, in the bleaching of teeth together with the ultra-violet energy, is successful if the peroxide is neutral. Absolute neutralization is imperative.

HYPEREMIA

The physiology of hyperemia must not be underestimated. The biologic irritation produced by the water-cooled ultra-violet energy is a desirable means for providing a focalized hyperemia. This insures the institution of a natural means for attacking the pathology which invokes the presence of hyperemia.

It may be advanced as a dental therapeutic axiom that every dental condition in which hyperemia forms a portion of the pathology, that condition shows a clinical indication for the use of ultra-violet energy. The hyperemia produced by ultra-violet energy is free from the toxicity of the hyperemia produced by infection; it is therefore a refinement upon the natural method of combating dental disease.

The concept of infection, that it consists of diminished cellular resistance invaded by a bacterial organism, is fundamental as an index to the use of ultra-violet energy. This radiation destroys infection and imparts a regenerative quality to the cells whose vitality is impaired.

LUDWIG'S ANGINA

It has been reported that the conjoint use of mercurio-chrome and ultra-violet energy makes a most successful clinical attack upon this infection. The pathologic locus is treated with mercurio-chrome and then irradiated, as in the case of any infection, one minute initially and one minute more at each subsequent exposure.

MUCOUS MEMBRANE

The mucosa everywhere is more tolerant to ultra-violet energy than skin. Exposures that would require 60 seconds on the mucosa must be shortened to 20 or 30 seconds on the skin. Over-exposures of the mucosa leads to a burn which is accompanied by a desquamation of the superficial layers with a subsequent replacement by normal and healthy tissue. There is no danger in excessive exposure, but only the discomfort that attends a reasonably severe burn.

NECROSIS

Following of extractions, the possibility of alveolar necrosis must not be overlooked. It may be entirely obviated by the adequate prophylactic use of the bactericidal energy, such as has been discussed under acute alveolar osteolysis, infectious; which see.

OSTEOMYELITIS

The pathology of osteomyelitis is essentially that of necrosis. There is a difference only in degree. It may be prevented, and in the case of dentistry, it may be treated with much success by the use of the ultra-violet energy.

OSTEOPOROSIS

This is a rarefaction of bone consequent to a resorption of calcium and phosphorus. There is a fundamental postulate in ultra-violet therapy that wherever the X-ray reveals osteoporosis there exists an indication for the use of ultra-violet energy. This postulate is based upon the fact that ultra-violet energy corrects and re-establishes a normal calcium and phosphorus metabolism.

PAIN

The analgesic qualities of ultra-violet energy are helpful in controlling pain, particularly when this comes as the result of post-operative trauma.

PULP CANAL

It is not definitely established that the sterilization of the pulp canal can be effected by ultra-violet energy. There is every reason to believe that ultra-violet will prove useful for this condition. A method such as that used in the bleaching of teeth seems to furnish excellent results. The ultimate success in the sterilization of pulp canals is dependent upon the proper introduction of the energy by suitable means into this tract.

STOMATITIS

Various varieties of stomatitis that have as their origin an infectious basis, are amenable to the bactericidal qualities of the ultra-violet energy.

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