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EFFECTS OF ULTRAVIOLET HEMO-IRRADIATION

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INTRODUCTION I

Since the procedure of ultraviolet hemo-irradiation was first introduced in 1934, there has been much written on the subject and much conjecture. The procedure has also been characterized by a slow acceptance by medicine in general. It is true that the main physiological processes and functions involved in hemo-irradiation are not known, and not evaluated, and that most of the work done on the subject is through clinical observation of treated cases. However, there are many effects noted, both experimentally and clinically, which warrant evaluation. This paper represents a compiling of available material of the effects of ultraviolet hemo-irradiation upon the blood stream, the total body, disease processes, and specific diseases.

The first therapeutic ultraviolet lamp was introduced in 1907 by the Quartzlampen Gesellschaft of Germany¹. Following this development ultraviolet therapy enjoyed a popularity and peak of experimentation before relegated to a lower place among the therapeutic armamentarium of the physician. The development of the antibiotics also helped to foreshadow some of the value of ultraviolet light. However, the experimentation which had been done and the many benefits from

its therapy led most of the authorities to believe that much, if not all, of the effect of ultraviolet was due its effect upon the blood stream and not the skin.

Knott² and Edblom, in the years between 1923 and 1928, attempted to evaluate this belief and began their series of animal experimentation in direct irradiation of the blood stream by ultraviolet light. Their results (confirmed by another laboratory) enabled them to try their procedure upon human patients. The first patient was irradiated in 1928, the patient first being ascertained as in a moribund state. The patient responded and is still alive. Attempts during the years 1928 through 1933 to discover the basic mechanism of ultraviolet irradiation failed for lack of equipment and techniques, and it was decided that clinical trials should be the next approach. Hancock and Mason in 1933 successfully treated a second case of septicemia by ultraviolet used directly upon the blood stream. This work was later reported by Hancock and Knott,³ the report being the first published article on such treatment.

TECHNIQUES II

Variations in technique as to the irradiation and the reinjection of blood have been proposed and used, both clinically and experimentally. The Knott technique is by far the most widely used but other methods are available, such as that of Frauhuf, and those means used experimentally with animals by Eidinow, and Avery and Mufarrij.

The Knott Technique using the Knott hemo-irradiator, named for the original worker in this field, consists primarily of a citration chamber, followed by a system of baffle plates wherein the blood is irradiated. As described by Knott², the blood is propelled (via vena puncture and rubber tubing) by means of an automatic transfusion pump. The blood is citrated (1 part 2.5% sodium citrate to 5 parts of blood) previous to entry into the quartz irradiation chamber. The system is entirely closed, the blood returning through the same needle used initially. The amount of blood withdrawn, irradiated, and returned, is determined as 1.5 c c. per pound of body weight. The time of exposure is that time required for 1.c.c. of blood to pass through the irradiation chamber, usually 10 seconds; wave lengths between

2,399 A° and 3,650 A° are used. The irradiation lamp is a water cooled mercury-quartz burner fastened approximately 1 c m. from the irradiation chamber, giving intermittent exposure by means of a rotating shutter.

Fruhauf⁴ describes a technique whereby the injection of irradiated blood is given intramuscularly. He draws 10 c c. of blood from the vein, citrates with Natriumcitratlösung, and irradiates in a U-shaped tube. His time of irradiation varies from 30 seconds to 2 minutes. This author also believes that ten such treatments are necessary at twice a week interval to obtain good effects.

Other methods which have been used are those of Eidinow⁵, Avery and Mufarrij⁶. The former irradiated small quantities of intravenous blood in a Petri dish after defibrination, previously determining that the fibrin had no effect upon the hypothesis of the experiment. He then returned this treated blood by an intravenous injection. Avery and Mufarrij used a quartz canula in the carotid artery of rabbits, giving mild irradiation several times the total blood volume. This method, however, would hardly lend itself to human application, in spite of working well in their experimentation.

EFFECTS OF ULTRAVIOLET HEMO-IRRADIATION III

Much data is available upon the effect to the blood stream by ultraviolet-hemo-irradiation, most of which is concerned with the changes in oxygen combining power. There are many authors, however, who write of a general improvement of the total blood picture and changes in protein constituents of the blood.

It has been generally true that one of the most obvious effects of hemo-irradiation is the relief within forty-eight hours from cyanotic and dyspneic states. This is seen clinically as a warm suffusion of color into the skin as respiratory difficulty ceases. At first, this was thought to be only vaso-dilatory in function but was later ascribed to be the result of a greater oxygen carrying function of the blood following irradiation.

As early as 1923, Harris⁷, in his experiments in exposure of blood serum to light (infrared through ultraviolet) discovered that the serum when irradiated in the presence of oxygen will take up oxygen to 15 volumes percent if its value was less, or give off oxygen if its value was greater than 15 volumes per cent.

Miley⁸ ran a series (Figure 1) wherein he found a 58% rise in oxygen combining power of the blood following ultraviolet hemo-irradiation, this effect occurring one hour following irradiation and lasting for several weeks. He⁹ later states that the greatest rise occurred in those who had low values before irradiation. Davidson¹⁰, as a Naval Officer, reported an alleviation of bend and anoxia susceptibility following ultraviolet irradiation of the blood, a finding which remained some three weeks. Many other workers report the increased oxygen combining power as a result of clinical observation, with a rapid relief of respiratory embarrassment along with the before-mentioned return of color and warmth to the skin.

Eberhard¹¹ and Barger¹² state that ultraviolet hemo-irradiation is especially good in raising protein values in cases of hypoproteinemia. They also claim that the albumen to globulin ratio improves to normal, and that the sedimentation rate falls to normal, shortly following injection of irradiated blood. Rebbeck and Glassburn¹³ noted a transfer to a normal state by means of hemo-irradiation of pathological blood fats (a condition of clumping of the chylomicrons associated with a loss of Brownian movements of the resulting particles, seen in severe toxic states).

Most authors theorize upon a general improvement of the total blood picture. Knott² writes of a beneficial alteration of such constituents of the blood as adrenalin, dihydroxyphenylalanine, cysteine hydrochloride, glutathione, and ergosterol, but gives no explanation of the effect. That there are many changes in the blood proteins following irradiation are shown by such workers as McLean and Giese¹⁴, and Rapport and Canzanelli¹⁵, who describe qualitative and quantitative changes following irradiation of blood. They speculate upon the action as being a disruption of the aromatic chains, probably the result of oxidations. Barrett¹⁶, states that most abnormalities of the blood tend to improve towards normal following ultraviolet hemo-irradiation. Hancock and Knott³ claimed a stimulatory effect on the blood forming organ, a claim also made by other workers as Eidinow⁵ who claims there is a leucocytosis following the injection of irradiated blood. Clarke¹⁷ also wrote of this phenomena stating that irradiated blood probably acted as a foreign protein. However, Miley¹⁸ found no deviations from normal of blood pressure, temperature, pulse, and respiratory rate, following ultraviolet hemo-irradiation in a series of 119 patients; no changes were found in hemoglobin value, leucocyte count, and erythrocyte count, in a series of 215 patients. It seems, therefore, that there

is as yet no concrete evidence upon which to base conclusions as to the overall effects upon the circulating blood.

The reports of the effects upon the body "in toto" are numerous, notably the autonomic nervous system changes, the increased resistance to infection, and the biochemical and metabolic effects.

Autonomic changes resulting from ultraviolet have long been observed. Most notable of these is the peripheral vasodilatation resulting from ultraviolet light. Like ultraviolet applied externally the irradiation of the blood also exhibits this effect. Barrett¹⁹, Miley²⁰, Neff and Anderson²¹, all describe this phenomena. Barger¹², states that vasodilatation in ultraviolet hemo-irradiation has a great advantage over that in heat treatment, as vasodilatation due heat is lost when the heat ceases as compared to ultraviolet which has a more lasting effect. Knott² also claims an increased blood flow and capillary dilatation, along with Barrett¹⁶ and others. Miley⁹ states that ultraviolet hemo-irradiation is responsible not only for the above effects but claims the ability of its influence to relieve bronchial spasm and to abolish a paralytic ileus in many instances.

The men using ultraviolet hemo-irradiation both preoperatively and therapeutically believe there is an increased resistance developed following treatment. Miley and Christensen²² state this routinely along with many others as Wassen, Miley, and Dunning²³, who show prophylactic value in Rheumatic Fever. Rebbeck²⁴ and Olney²⁵ report a decreased incidence of infection and other complications when hemo-irradiation is used preoperatively. Eidinow⁵ showed a decreased ability of bacteria to grow in blood from an irradiated animal. Beroza²⁶ demonstrated increased phagocytic properties of the leucocytes following injection of irradiated blood. Barger¹² states that ultraviolet hemo-irradiation mobilizes the defensive and reparative functions of the body. Hancock and Knott³ in the first publication on irradiation of blood write of increased germicidal properties and generalized resistance with stimulation of endothelial and hemoblast cells and increased antibody production. However, there is much supposition published and it is hardly fact as yet that general resistance is improved by the application of ultraviolet light upon the blood.

There are numerous speculations among the authors on the biochemical and physiological effects upon the

entire organism as a result of hemo-irradiation. However, there is little evidence for such theories. It has long been known that plants can be grown in almost complete absence of light if given necessary nutrients, and that people living in cloudy climates do not suffer from an increased incidence of disease of a metabolic nature. But many authors believe that ultraviolet metabolism is a specific body process, and others believe that ultraviolet is a necessary adjunct for normal body function and metabolism. Reed²⁷ in 1925 concluded that photodynamic effects are biological causing a stimulation of oxidation and an acceleration of metabolism. Miley²⁸ in studies with non-healing wounds believes that ultraviolet hemo-irradiation stimulates in part a healing mechanism. As mentioned previously, it has also been shown by many authors that proteins are altered following irradiation of the blood. Hancock and Knott³ claimed a general stimulation of the endocrine glands as well as a beneficial action upon Vitamin D and calcium metabolism. Barret¹⁶ states that he has noticed an increase in appetite following hemo-irradiation as well as a general sense of well being associated with this treatment. In fact, most authors comment upon the remarkable subjective feeling of euphoria that results in a short time following ultraviolet hemo-irradiation.

Many authors also write of the relief of pain and believe as Miley²⁹ who, in a series of thrombophlebitis patients, writes, "There is a rapid disappearance of pain, tenderness, and edema within 48 hours." However, in the face of the lack of conclusive evidence there remains much which can be discussed but little which can be evaluated. Certainly there is far too much clinical observation in proportion to experimentation. But it appears equally certain that there are certain "biological effects" as believed by Neff and Anderson²¹, and as have been proposed since the discovery of ultraviolet light.

Of primary interest is the effect of ultraviolet hemo-irradiation on disease processes. There is much clinical and experimental evidence to this effect coupled again with subjective evidence. Work has been done on the control of infections, bacterial and viral, and on the detoxification of products of several organisms. It has also been stated by various authors that there are improvements in the results of infections and other pathological processes; such as relief of pain, reduction of fever, decreased nausea, decreased edema, and increased opsonic index.

Again, the first work was done by Annett² and Edblom

on dogs. After first determining that sterilization of blood samples could be effected without injury to blood components, they undertook animal experimentation. The dogs were injected intravenously using strains of staphylococcus aureus and beta streptococci and then their blood irradiated. It was found that in irradiating the estimated total blood volume all the animals died, but with negative blood cultures. By further experimentation it was found that the partial irradiation of blood allowed injected dogs to survive the ultraviolet, still with negative blood cultures. The untreated dogs died of septicemia. Five years after the beginning of these experiments (1923), this treatment was undertaken on a human patient in a moribund state due to septicemia. The patient recovered uneventfully.

Eidinow⁵ in 1930 undertook a series of experiments in vitro upon rabbits. This work was done by injecting rabbits with irradiated blood and then using their blood as a culture media for bacteria at increasing time intervals. He found that the bacteriacidal qualities of rabbit blood was enhanced if irradiated sterile blood was injected intravenously, one to three hours previously. He also showed a striking increase in bacteriacidal powers of the blood when irradiated in a quartz flask over that

irradiated in a glass flask (Figure 2).

More experiments were done by Avery and Mufarrif⁶ in 1939, also on rabbits. They attempted to observe the influence of ultraviolet hemo-irradiation upon the course of the disease process. In these experiments the animals were injected with *Salmonella paratyphi* and typhimurium in doses calculated to be fatal in forty-eight hours, therapeutic radiation being given via quartz canuli inserted in the common carotid artery. They found a significant increase in survival and survival time in the rabbits whose blood was irradiated by ultraviolet. (Figure 3)

It has been shown by many men that the phagocytic properties of the leucocytes are improved following ultraviolet irradiation of the blood. In this original work in 1936 Knott² found more than a 50% increase in the number of bacteria ingested after irradiation. The work was later repeated in 1946 showing a 78% increase. Others as Barger¹², Rebbeck²⁴, and Beroza²⁶, describe this phenomena of increasing the opsonic index of the leucocytes with ultraviolet hemo-irradiation.

Much clinical data has accumulated since the first

patient was irradiated in the control of various diseases, both bacterial and viral in origin, as well as allergic and metabolic. Miley^{30, 11, 29, 31, 32, 33, 34}, et al, Rebbeck^{35, 36, 37, 38, 39, 40}, et al, Hancock^{41, 3}, Olney⁴², and Fruhauf⁴, all report control of invading bacteria. From their results, it would appear that ultraviolet hemo-irradiation is of value in controlling most common bacterial organisms both gram negative and positive. These workers report of success in bacteremia as well as local disease processes. They also claim a great benefit against penicillin and sulfa resistant strains of bacteria, and those bacterial infections which do not respond well with antibiotics.

Miley^{43, 9, 44, 45}, with Miley and Christensen²², claims ultraviolet blood irradiation effective against virus and virus-like organisms. In these reports virus conditions were handled more effectively by irradiation than by other means. However, Toomey⁴⁶, and Takacs, in an experiment with three monkeys concludes that ultraviolet hemo-irradiation did not alter the course of poliomyelitis in monkeys to an appreciable extent. Yet, the proponents of ultraviolet continue to claim therapeutic benefits, and present case histories illustrating the value of this treatment. It appears, that

the proof of the value of ultraviolet blood irradiation in viral conditions needs further validation and experimentation, inasmuch as the result of clinical work seems good. Workers as Wolf, Mason, Fitzpatrick, Schwartz, and Levinson⁴⁷, have demonstrated value in irradiation of plasma to prevent Homogous Serum Jaundice; others as Levinson^{48, 49}, et al, Morgan and Lavin⁵⁰, and Hodes, Webster, and Lavin⁵¹, show that ultraviolet irradiation may be used as an excellent method of preparing safe viral vaccines (as rabies, encephalities, etc.) without sacrificing antigenic properties.

In a discussion of the action of ultraviolet irradiation in disease processes it must be born in mind that many workers as Guttmacher, Manfred, and Mayer⁵², Blundell, Erf, Jones and Hoban⁵³, and others, have shown that bacteria, and viruses, and toxins are not inactivated by ultraviolet hemo-irradiation directly. It is inconceivable how partial irradiation of the blood stream with an irradiation as poor in penetration as ultraviolet could sterilize the entire blood stream. Indeed the above workers have shown that in blood, ultraviolet irradiation inactivates only the superficial organisms and toxins, whereas in peptone water or saline solutions, the sterilization is complete. Thus the

action of ultraviolet hemo-irradiation, if giving any effect at all, must be of greater diversity than that of direct sterilization.

However, Miley⁵⁴, presents a case of recovery from advanced Botulism coma with complete relief from toxic symptoms forty-eight hours following ultraviolet hemo-irradiation. Most of the aforementioned clinical workers agree that toxic symptoms from bacteria and viruses are relieved within the same number of hours. Miley and Rebbeck¹¹ state that rapid and efficient detoxification occurs after irradiation. Barrett^{16,19}, claims that inactivation of toxins and relief from toxemia is one of the advantageous results of hemo-irradiation. Wassen, Miley, and Dunning²³, in their series found ultraviolet blood irradiation valuable in terminating cases of Rheumatic Fever and as valuable in prevention of recurrences. Miley⁴⁴ claims that the toxic symptoms in viral pneumonia are easily controlled. In 110 different cases, Barrett¹⁹ concludes detoxification is an important effect of ultraviolet hemo-irradiation. Therefore, it may be said that if clinically ultraviolet has a detoxifying action, the action must be a total body function and not merely the result of toxin destruction in the blood stream.

Ultraviolet hemo-irradiation has also been reported to be of value in the allergic type disorder as asthma and eczema. Clinically, Fruhauf⁴ and Miley^{55, 56}, et al, report relief of symptoms following treatment. Most such disorders require multiple treatments according to the above authors, the former twice a week, the latter once every two weeks. These workers also believe that their results are best in young patients or in those whose disease has not reached long standing chronicity. Miley²⁸, also reports the ability of ultraviolet hemo-irradiation to stimulate the healing of old chronic lesions such as ulcers of the extremities, draining fistuli, and failures in wound closure.

Rebbeck^{24, 57}, and Olney²⁵, with verification by others, report beneficial results with pre and post operative irradiation of the blood in preventing complications following surgery. They report less pain, less nausea and vomiting, less distension, less edema, and less mortality. They also claim post operative fevers of non-specific origin will fall after irradiation, or do not occur with previous irradiation.

The number of patients being treated by ultraviolet hemo-irradiation has been increasing gradually since

1934, the latest report by Miley²², being some 60,000 treatments given as of 1948. These patients have been treated for a great variety of conditions ranging from bursitis to Rheumatic Fever, and hemo-irradiation has been reported of value in most. The greatest amount of work has been done with diseases of bacterial origin, but much also has been done with viral, metabolic, and allergic disorders.

Hancock and Knott³, and Rebbeck⁴⁰, conclude that ultraviolet hemo-irradiation is of value clinically in the treatment of puerpal septicemia presenting case histories of recovery of apparently moribund patients. Rebbeck^{38, 35}, Miley^{31, 32, 58}, Hancock⁴¹, all report beneficial results in varying other septicemias, many patients receiving multiple treatments. Olney⁴² gives excellent results in pelvic cellulitis. Miley^{33, 29} describes great relief in thrombo phlebitis, concluding that many patients do well on ultraviolet hemo-irradiation where medical treatment is of little avail. Miley and Rebbeck¹¹ also report excellent control in peritonitis with hemo-irradiation. Miley⁵⁴ describes a case of botulism with complete subsistence of symptoms within forty-eight hours following ultraviolet therapy. Cinelli⁵⁹ used ultraviolet hemo-irradiation

in his case of thrombosis of the posterior inferior cerebellar artery with dramatic benefit to the patient. Rebbeck and Lewis³⁷ report beneficial results in Typhoid Fever (Figure 4). The authors, Wassen, Miley and Dunning²³, claim termination of Rheumatic Fever cases within three weeks or less, with no intolerances of treatment. All writers claim a dramatic result following ultraviolet hemo-irradiation with a relief from toxic symptoms, the falling of sedimentation rate and temperature, and a great improvement in the mental state of the patient.

Miley^{43, 44, 45}, also reports beneficial results in polio, atypical pneumonia, and other virus diseases. Miley and Christensen^{22, 34}, in joint authorship, further describe benefits in virus diseases, one report claiming a nine per cent fatality in bulbar polio treated with ultraviolet hemo-irradiation, against forty per cent overall mortality in bulbar polios in the same epidemic treated by other means.

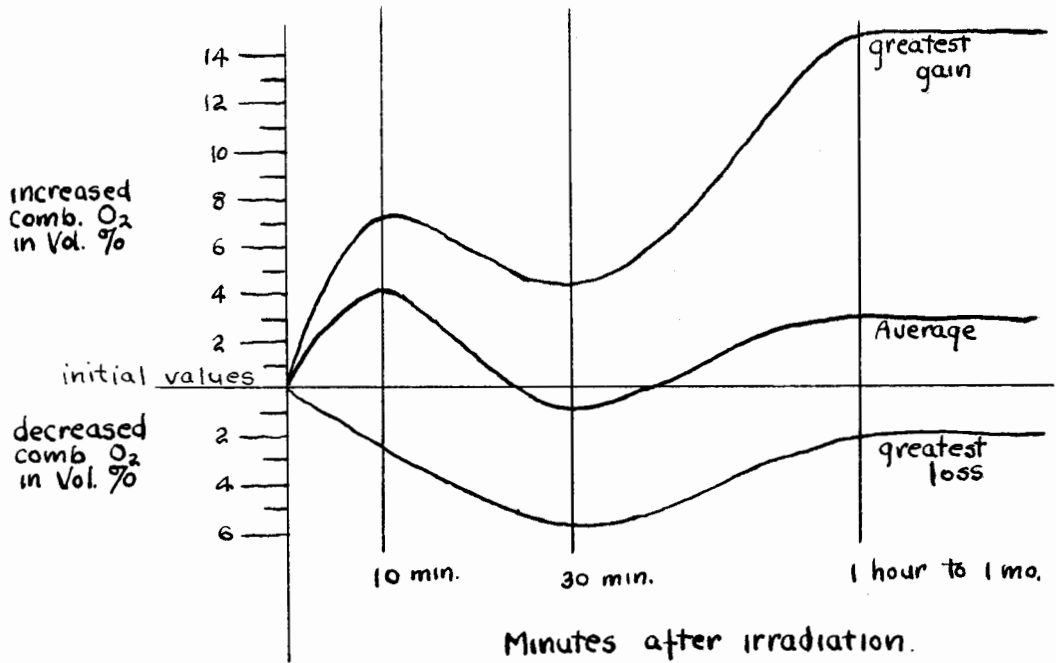
Miley, Seidel, and Christensen^{56, 55}, claim a definite improvement in seventy per cent of patients treated at two to six week intervals who suffer from bronchial asthma. Neff and Anderson²¹ present seventeen

cases of bursitis and tendinitis calcarea in which eighty two per cent received complete relief from ultraviolet hemo-irradiation. Fruhauf⁴ describes best results in chronic eczema, pyoderma, and arthritis deformans, using his technique of multiple intramuscular injections of irradiated blood.

Several authors have reported ultraviolet blood-irradiation therapy of value preoperatively and post-operatively and as a prophylactic measure in disease prevention. The supposedly increased resistance has been previously mentioned. Rebbeck²⁴, 57 and Olney²⁵ have also been mentioned as describing a decreased incidence of infection with less need for antibiotics and lower mortality with blood irradiation as a prophylactic treatment previous to surgery. A decreased incidence of thrombophlebitis and phlebothrombosis with prophylactic irradiation was also described. Wassen, Miley, and Dunning²³, on the basis of their Rheumatic Fever series, claim that blood irradiation is better in prophylaxis than sulfa derivatives with less intolerance and exacerbations. Indeed most of the above clinicians afford irradiation therapy a great value in prophylaxis. However, no really adequate series has been done, as mentioned by Bradley⁶⁰ in his review,

both from the standpoint of therapy and prophylaxis.

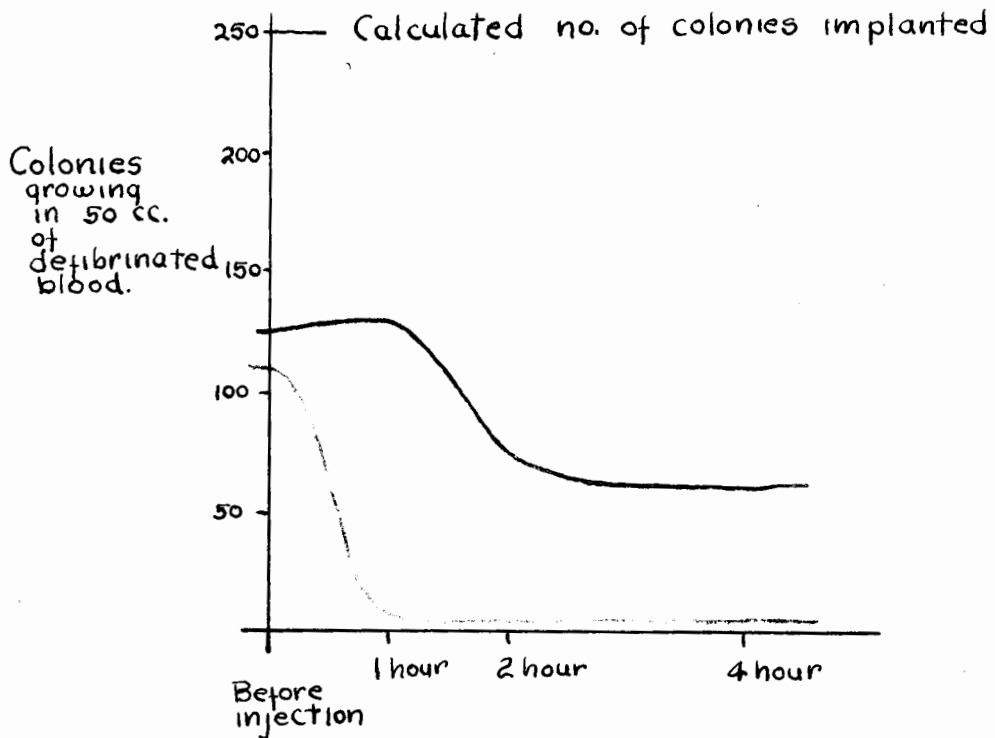
Figure I



Graph derived from Miley⁸ showing changes at time intervals in the combined oxygen values of the blood following ultraviolet hemo-irradiation. The patients were in various pathological states. Determinations were done with venous blood on a series of 83 patients.

Figure II

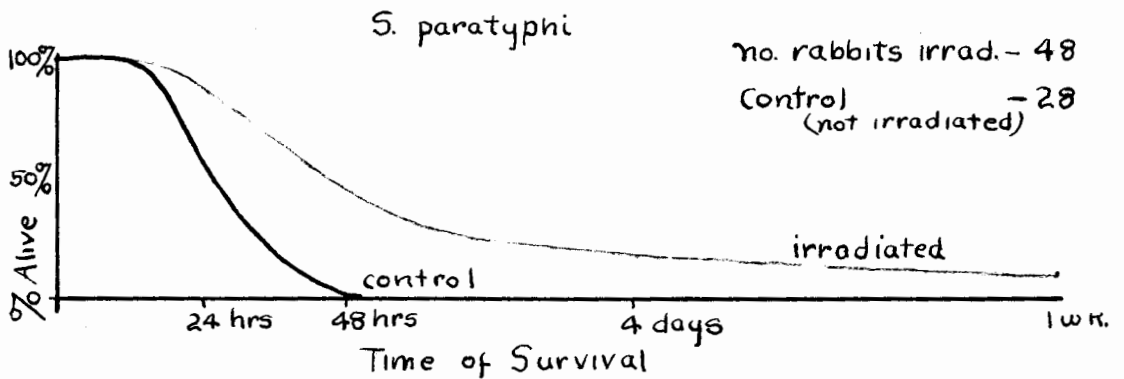
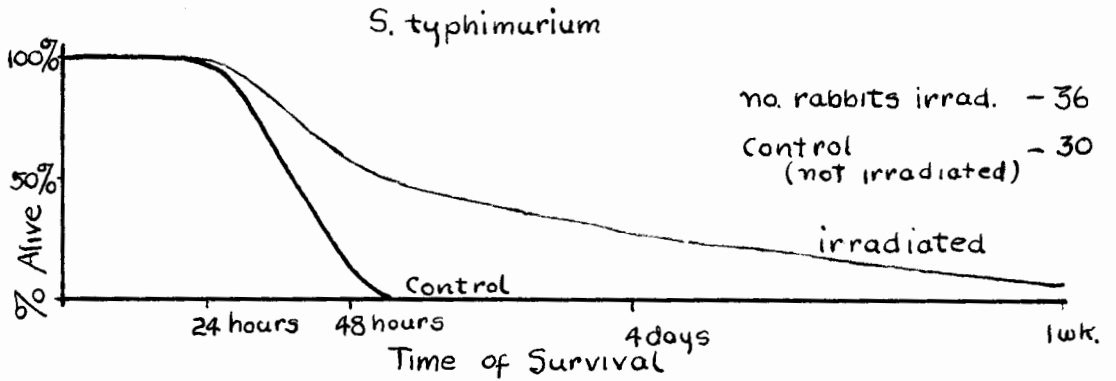
Graph taken from data by Eidenow⁵ showing increased bactericidal action of rabbit blood previously injected with blood irradiated in a quartz flask. Sterile samples were drawn at hourly intervals, tested against stock cultures of staphylococci, and incubated 24 hours.



Intervals at which samples were taken.

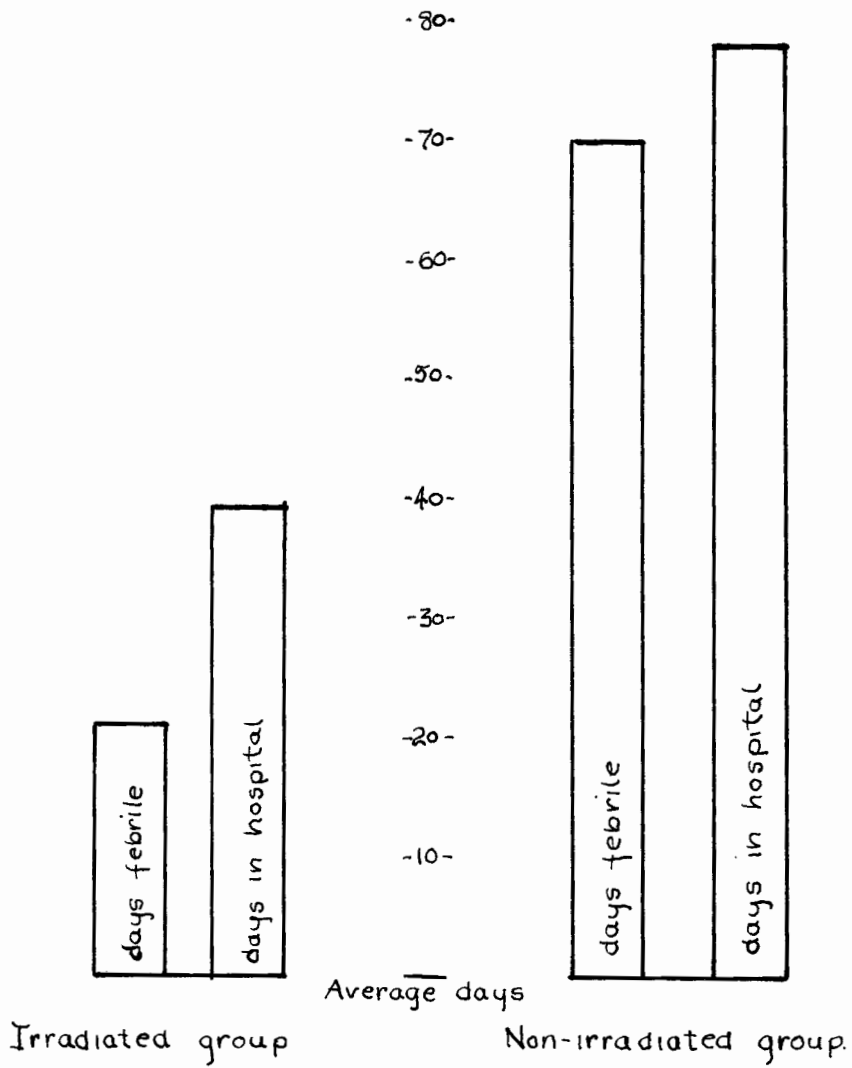
- Samples taken from animals who were injected with blood irradiated in a quartz flask.
- Samples from those who were injected with blood irradiated in a glass flask.

Figure III



Graph taken from the work of Avery and Mufarrrij⁶, showing decreased mortality and increased survival time in irradiated rabbits. Rabbits were injected with *S. typhimurium* and *S. paratyphi*. Experimental rabbits irradiated via a quartz cannula in the common carotid artery -- control not irradiated.

Figure IV



Graph derived from Rebbeck³⁷ in a series of 9 typhoid fever patients. Six irradiated patients showed quicker recovery than 3 not irradiated.

LIMITATIONS IV

Ultraviolet hemo-irradiation has few limitations as reported by various authors. Considering the many treatments which have been given with no ill effects, and the remarkable lack of evidence concerning ill effects, it seems hemo-irradiation is a safe procedure.

Of the many antibiotics and drugs which have in many cases been used following, during, and before blood irradiation, only the sulfa drugs have been found detrimental in combination. This is shown by Rebbeck and Lewis³⁷, and Miley^{30, 20}, who have found blood-irradiation more successful when used alone than with sulfa drugs. This phenomena is thought by Epstein⁶¹ and others to be due a photo-sensitization of the sulfas by ultraviolet light. The irradiation of blood containing sulfa drugs seems to activate this photo-sensitization thus combating the beneficial results of irradiation. However, the other antibiotics and drugs which have been used to date do not exhibit this effect and indeed are effective adjuncts to radiation treatment of the blood.

In disease processes of all the types treated, only

with subacute bacterial endocarditis and neoplastic processes has ultraviolet hemo-irradiation no apparent effect. This is reported by Knott² and others who can claim no advantage in the treatment of such conditions. It is believed also that hemo-irradiation is contraindicated in cases of newly arrested tuberculosis, although no series has been done.

The ill effects following hemo-irradiation are slight if any. Barger¹² states that in his series of 1,600 treatments in the age group of one through eighty-nine years, he has had no serious reaction. He has, however, on rare occasion noticed headache, dizziness, and vomiting. Barrett⁶² claims that there are citration reactions in one out of fifteen patients but these are of small consequence. There has never been reported a fatality due to ultraviolet hemo-irradiation. The work done by Wolf, Mason, Fitzpatrick, Schwartz, and Levinson⁴⁷, under the auspices of the U. S. Public Health, showed ultraviolet irradiated blood and plasma safe for injection purposes. In the original work on dogs, it was found that in therapeutic doses, ultraviolet did not shorten life or effect an organism detrimentally. None of the early patients treated have ever developed a disablement which could remotely be traced to ultra-

violet hemo-irradiation.

The procedure itself somewhat limits the use of hemo-irradiation. It is hardly adaptable for treatment on an out-call basis. However, it can easily be used in hospitals, clinics, and offices. It necessarily is a sterile procedure but warrants no more special care than in an ordinary transfusion of blood. The time fraction is small, only a few minutes required for the complete treatment. Thus, the actual limitations are very slight, and ultraviolet hemo-irradiation appears technically available for wide spread use.

SUMMARY V

The procedure of ultraviolet hemo-irradiation has been slowly accepted by the medical profession. This is due in part to the lack of concrete evidence of its effects, and to the poorly controlled clinical work. However it has been used therapeutically on humans since 1928.

The major techniques used in irradiating the blood stream are essentially those of auto-transfusion, or reinjection of a person's own irradiated blood. On humans the process requires citration or defibrination. Only a small portion of the entire blood stream is irradiated.

Ultraviolet irradiation has several effects upon the blood stream including changes in combined oxygen values, protein changes, and a change in the entire blood pattern. The combined oxygen value of venous blood is said by several authors to rise following irradiation of the blood. This phenomenon is accompanied by relief from cyanosis and dyspnea. There is also a reported relief from anoxia and bend susceptibility following irradiation. Protein values

are said to be raised following blood irradiation coupled with a general return to normal values on the part of other components. Reports also state that there are beneficial alterations in regards to many blood proteins.

Claims are made that the entire body is effected beneficially via the autonomic nervous system, the biochemical and physiological metabolic processes, and the general resistance mechanisms. One author reports the relief of paralytic ileus after irradiation and a stimulation of healing. That there is an increased general resistance is not well substantiated.

There is much experimental evidence, and clinical evidence as well, showing that hemo-irradiation is of benefit in eradication of disease processes. The main experimental evidence shows a definite bactericidal action and indicates a strong benefit in virus conditions. Reports indicate, as much as a 50% increase in phagocytosis following ultraviolet hemo-irradiation, and the clearing of organisms from the blood stream. It is also claimed that toxins are inactivated by ultraviolet, or at least relief from symptoms is obtained.

Rapid cure of many specific diseases has been proposed as due to ultraviolet hemo-irradiation. These conditions range from asthma and rheumatic fever through many viral and bacterial conditions including poliomyelitis. It is also claimed that ultraviolet has a prophylactic value in disease prevention.

Ultraviolet should not be used with the sulfa drugs due to photosensitivity which is developed after irradiation of blood containing the drug. Hemo-irradiation has not proven effective in subacute bacterial endocarditis or neoplastic conditions. Otherwise the treatment is harmless, being limited only as a sterile procedure.

CONCLUSION VI

1) There is indicated that an elevation of the combined O_2 values of the venous blood takes place following blood irradiation, especially in those who had previous low values.

2) There is a general tendency of the blood to return to normal values, or to values more compatible with the extent of the disease. This is seen in cell counts, protein values, and sedimentation rate.

3) There are chemical alterations in proteins of the blood following irradiation.

4) There are changes occurring after hemo-irradiation such as vasodilatation with possible other ramifications; as increased capillary dilatation, increased blood flow, bronchial dilatation, and abolition of a paralytic ileus.

5) There may exist an increased resistance to infection following irradiation of the blood.

6) No changes have been noted in the metabolism of the entire organism after irradiation.

7) There is an increased bactericidal action of the blood in disease processes following ultraviolet blood irradiation, and some evidence that a viracidal action exists. The opsonic index is raised after irradiation.

8) Toxins seem to be inactivated or their effects relieved by ultraviolet hemo-irradiation.

9) Ultraviolet has been shown effective in the treatment of many specific diseases; infectious, metabolic, and allergic.

10) Ultraviolet hemo-irradiation has no demonstrable ill effects, being contraindicated for use with sulfa drugs only.

11) Irradiation of the blood has not been found effective in neoplastic type diseases nor in subacute bacterial endocarditis.

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