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COUNTRY Western Europe

CIA [REDACTED]

SUBJECT Medical Ultrasonics

DATE 18 Dec 53

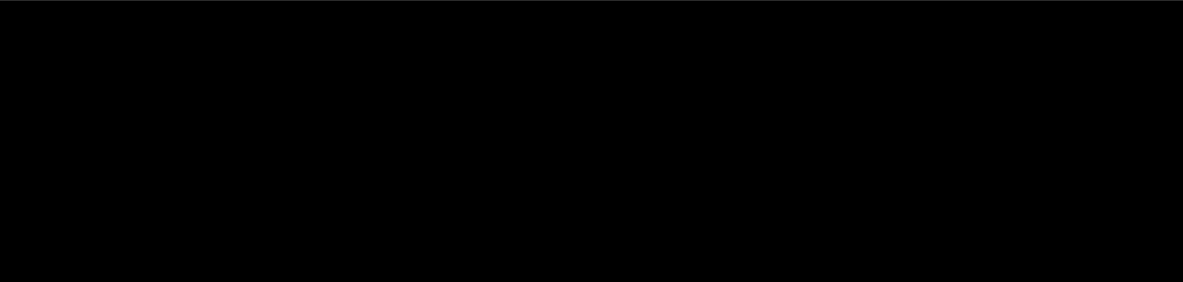
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Supplemental to:

DATE ACQUIRED [REDACTED]
DATE (OF INFO) Sep 52

Responsive to:

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1. In the field of acoustics and especially ultrasonics the European scientists are doing much more research and study than we are doing here in the US. [REDACTED] doubt [REDACTED] there are 10 men in the US who are following the application of ultrasonics in medicine. In Europe at the International Medical Ultrasonics Congress there were more than 200 foreign scientists, medical doctors, and engineers. Some of the outstanding leaders in the field appear in the pamphlet "Impressions from Third International Congress on Ultrasound, Austria, 1952" by R J Lindquist.

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2. [REDACTED] a condensed report of the Congress; however, printing of the complete report as planned was never realized because of financial limitations and will therefore be presented piecemeal in the British Journal of Physical Medicine.

The following documents are available on loan from the CIA Library:

- (1) "Impressions from Third International Congress on Ultrasound, Austria, 1952" by R J Lindquist.
- (2) Condensed Report on the International Medical Ultrasonics Congress, Bad Ischl, Austria, September 7-10, 1952.]

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IMPRESSIONS FROM THIRD INTERNATIONAL CONGRESS ON ULTRASOUND, AUSTRIA, 1952

CPYRGHT

by R. J. Lindquist

Doctors, engineers, and physicists from 12 countries gathered in Bad Ischl, from the 7th to the 10th of September, 1952, to discuss the technical, medical, biological, and diagnostic application of Ultrasonics. After an impressive ceremonial opening of the Congress on Sunday, September 7th, the following three days were filled with presentation of papers and discussions on Ultrasound.]

This meeting was called under very difficult and trying conditions. Its success was a tribute to Dr. Dussik, Dr. Eckel, Dr. Lettowsky and many others. The logical meeting place would have been Vienna, but that would have meant incurring unwarranted risks for some of the men in crossing "red" lines. Vienna is under the joint control of 4 countries, and is entirely surrounded by Russian occupied territory.

The first International Congress on Ultrasound was held in Erlangen, Germany, in 1949. The second Congress was in Rome in 1950, no meeting was held in 1951.

The first group of papers was on the general subject of Dosage of Medical Ultrasound. The principal speaker was Doctor R. Pohlman of Zurich, author of "Die Ultraschalltherapie". His theme was "Dosage Regulation for Medical Application of Ultrasound".]

The "Kurhaus" where the meeting was held was built originally by the father of Baron Franz Von Woeltzky especially for a gala royal wedding. Later it was turned into a casino, but since the passing of Emperor Franz Joseph it has been used as a public hall. At one time Bad Ischl was the summer headquarters of royalty. Royal splendor has departed, but the lasting beauty of the high mountains, the lakes, the glaciers and the forests will remain.

Dr. Dussik, who has been associated with Dr. Eckel in Bad Ischl, will come to the United States soon. He will be affiliated with a hospital in Boston, where he plans to continue his investigations with the therapeutic and diagnostic application of ultrasound.

Pain is always an effective indication of excessive therapeutic dosage. If we do not exceed the pain threshold, there is no danger of causing damage to tissue.

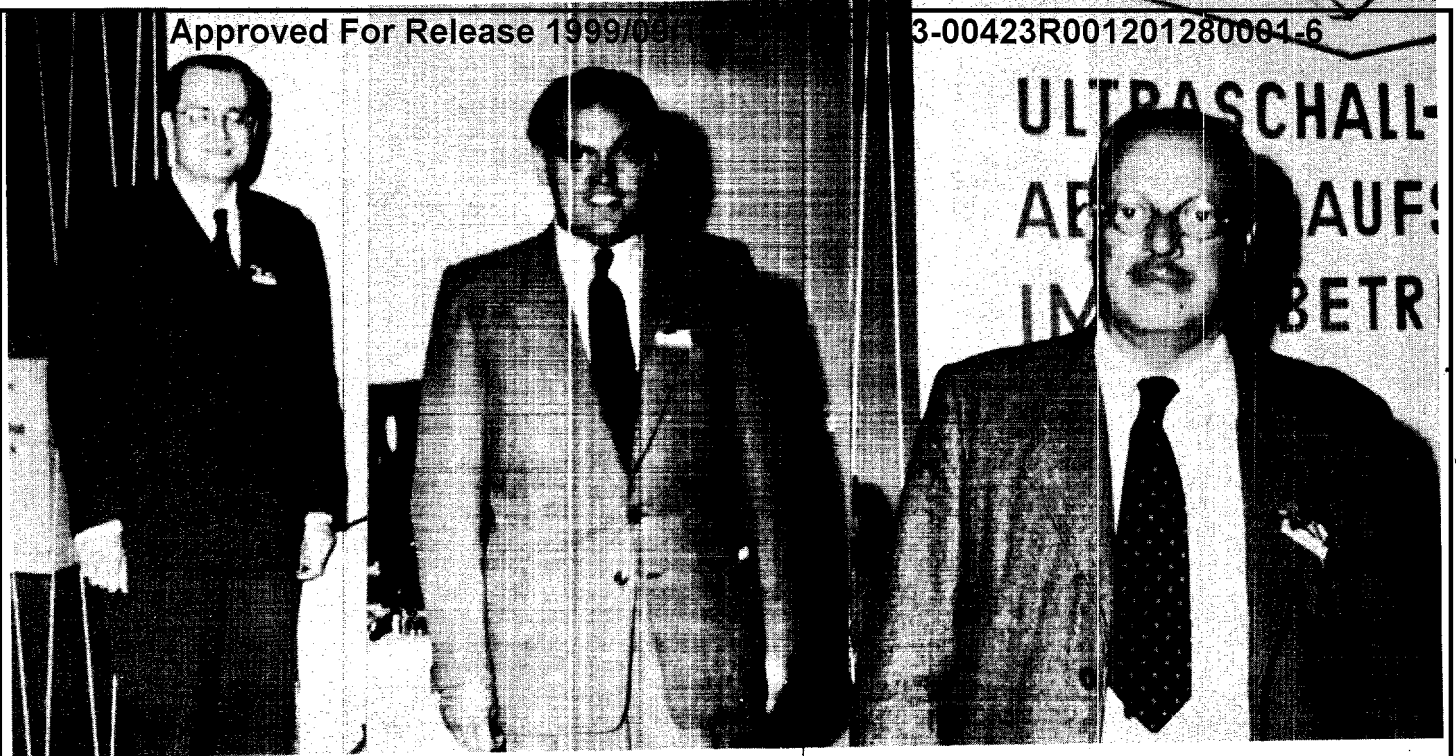
Dr. Lettowsky says a maximum of 7 watts is adequate for all therapeutic applications.

NOTE: Dr. Van Went expects to have her new book on Ultrasound Therapy ready for publication in April, 1953. It will be in English. (good news!)



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Prim. Dr. K. Th. DUSSIK
Vorsitzender

Dr. K. ECKEL
Schriftführer und 2. Vorsitzender

Doz. Dr. F. LETTOWSKY
Beisitzer

C. Florisson, of France, discussed "An Experimental Method of Dosage Measurement". Other representative papers in the field covered "Ultrasound Dosimetry"; "Transmission and Absorption of Ultrasound"; "The Coupling Factors"; "The Biological Effects of Ultrasound"; and "The Mechanism of Absorption." Several of the papers in this group were by physicists and were quite technical.

An interesting part of Dr. Pohlman's presentation was the demonstration of a multiple-crystal flexible applicator for shoulders, knees, and other irregular areas. With this type applicator longer treatments (up to one hour) with small doses. (less than 1 watt per crystal) are employed.

The main point of agreement in the presentation of the first group of papers was that high intensities of ultrasound energy were not necessary for therapeutic dosages.)

A question discussed in a special session was, "Should there be established a central point, or agency, for the collection, recording, and dissemination of information relative to workers and coworkers, and material in the field of ultrasonics?" Also "Should the work of the physicist and the medical clinician be assembled together?"

Die ERÖFFNUNG der Tagung findet am Sonntag, den 7. September 1952, um 19 Uhr, in der Trinkhalle (Auböckplatz) statt. Die Begrüßung findet in Anwesenheit des Herrn Landesrates Franz PLASSER als Vertreter der oberösterreichischen Landesregierung, des Herrn Obermedizinalrates Dr. Karl NIEDERBERGER, Präsident der o.-ö. Ärztekammer, und Landtagsabgeordneter Bürgermeister Fridolin SCHRÖPFER als Vertreter der Stadtgemeinde Bad Ischl statt.

"Further Progress in Medical Ultrasound Technique" was the subject of a discussion by Dr. F. Lettowsky and Dr. K. Eckel of Bad Ischl. It was stated by Dr. Eckel that temperature distribution with ultrasound is far more uniform than that of heat sources. Also biological effects of ultrasound seem to be entirely independent of frequency except insofar as frequency effects penetration of ultrasound.

Dr. Grunzmacher and Dr. Oberst of the Physical-Technical Institute. (the German equivalent of the U. S. Bureau of Standards). have established standards for testing of European ultrasound instruments. Four firms in Europe have submitted their equipment for testing and calibration, others have expected to follow. Both men were very helpful with suggestions and in answering many questions.

In London I contacted the editors of the British Journal of Physical Medicine. I was told that the response to the special January issue of 1952 was overwhelming and unexpected. As a result, further papers on ultrasound will be published from time to time. Watch for them. Send your subscription to Butterworth & Co., 4,5,6, Bell Yard, Temple Bar, London W.C. 2, England. This publication is worthy of the support of everyone interested in physical medicine.

Ultrasound generators are available in Vienna, but I was told by a doctor that they do not have microtherapy.

G. Ungeheuer and C. Glenk of Germany discussed the importance of ultrasound therapy in sciatic neuritis.

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Dr. Pohlmann Dr. Tschannen Dr. Stuhlfauth Dr. Von Sanden Dr. Lehfeldt

The second group of papers dealt with the working mechanism of ultrasound; biological and biophysical questions and experiments; and pathological and physiological influence of ultrasound.

The "keynoter" of this group was A. Dognon, of Paris, with a discussion on the "Influence of Ultrasonic Energy on Cells in Suspension". The influence of various frequencies on bacteria was presented (on typhus bacteria, and on mold spores). Reflection studies with pulsed energies were discussed.

The study of irradiation of human blood with ultrasound energy was especially interesting. No toxic effects from reinjection of irradiated blood were observed. This method was originated by Dr. Eckel and was presented to the congress by Dr. Hilbert.

Dr. Tschannen read a paper on the Neurological Influence of Ultrasound as illustrated by electromographic studies. Dr. Kolle of Berlin illustrated the importance of reflections from various media, and their relations to therapeutic application. Dr. Wh. Woeber gave the result of combined x-ray and ultrasound therapy on experimental cancer in animals.

In general, all were in agreement that ultrasound energy is not dangerous to human tissue, when applied in therapeutic dosages. This reaffirmed the findings of the 1950 Congress when everyone agreed that the danger of injury could be completely avoided by correct technique; that there was no damage from "summation effects". The possible danger of late injuries received not the slightest support, either from previous experience or biological considerations.

K. Schikorski gave an explanation of the neural mechanism of ultrasound.

SAFETY- The first question I asked of many of the doctors present was, "Do you consider ultrasound to be a safe therapy in competent hands?" The answer was always an unqualified, "Yes". I further interrogated several leading physicians about any evidence of malpractice damages resulting from ultrasound treatments. None was able to recall a single instance of such action, either in Germany, or in the whole of Europe. As one prominent doctor told me, "This is not true of any other therapy."



Mr. Reprich Dr. Woeber

Dr. K. Woeber, of Bonn, Germany, edits a quarterly publication devoted entirely to U. S., "Der Ultraschall in der Medizin". He recently published an article by Dr. Aldes and Mr. Jadeson, of Cedars of Lebanon Hospital, Los Angeles, California, on "Ultrasound in Geriatrics". This article was also published in the "Annals of New York Medicine."

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Dr. von Sanden Dr. Pohlmann



Dr. Keller Dr. Oberst



Dr. Grützmacher Dr. Guttner



Dr. & Mrs. Stuhlfauth Dr. & Mrs. Tschannen

The third group of papers discussed "Indications and Clinical Applications of Ultrasound;" new questions, theoretical considerations, and combined applications with other therapies.

K. Stuhlfauth of Munich, led off with the "Application of Ultrasound in Internal Disease". Dr. Dussik discussed "Problems of Application of Ultrasound in the Therapy of the Central Nervous System". V. Buctala, of Würzburg, compared the use of the fixed soundhead technique and the moving massage technique.

In Italy, ultrasonic energy has been used very effectively in the treatment of Buerger's disease.

Diagnostic possibilities in use of ultrasound are limited by the extremely high absorption of high frequencies. The maximum useable upper limit is 5 to 7 megacycles.

Papers were presented on the treatment of various specific ailments, such as peri-arthritis, muscular diseases, traumatic conditions and many others.

A summation was made by G. Williams of Lenz, on the practical work of material from 300 papers on ultrasound.

In accepting the invitation to attend the Congress in Austria I was in search of answers to three questions concerning the Safety, Dosage, and Calibration of Ultrasound. These I received, and much more. I had not planned the many friendships made with persons from different countries, all with a common interest. Everyone was courteous and helpful in spite of language difficulties. Many letters have arrived since my return, and I no longer feel that I am a complete stranger in Europe.

Thanks to air travel I was able to accomplish the entire journey in a very short time. Airlines used were P.A.A., B.E.A., K.L.M., Airfrance, and T.W.A. Rail transportation was used only twice, in Austria and in Germany. Countries visited were England, France, Austria, and Germany, with short stops in Switzerland, Holland, Scotland, Iceland and Labrador. A total of thirteen landings were made.

Travel companions at various times included the Commissioner of Labor of Nigeria, a musician from Scotland, a young architect from San Francisco, a Fulbright scholar from Vienna, a business man from Calcutta, an engineer from the U.S.F.A., Dr. Bolt from M.I.T., and various vacationing members of the Armed Forces in Europe.

Because of time limitations I was unable to take advantage of many invitations to attend other meetings, and visit various medical centers and laboratories.

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Mr. Strunz-Vienna Dr. Barone-Rome Prof. Dr. A. GIACOMINI, Dr. V. HINTZELMANN, Wiesbaden

Referate:

R. POHLMANN, Zürich, Schweiz: Voraussetzungen und Möglichkeiten der Dosisfestlegung für medizinische Ultraschallanwendung.

Professor Amedeo Giacomini, of Rome, was very helpful, and was most insistent that I visit him in Rome before returning to America. He was a "powerhouse" at this meeting, volunteered to carry the burden of being the "clearing house" on information on ultrasound, and information about workers in the field

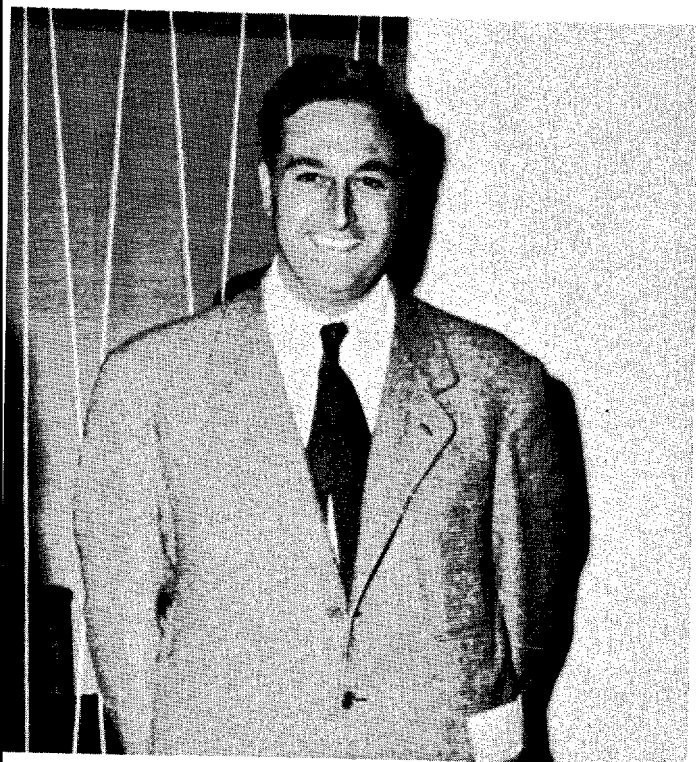
Dr. Hintzelman, of Wiesbaden, discussing the use of ultrasound in the treatment of rheumatic diseases. V. Buctala contributed a second paper on "Ultrasound in Orthopedic Conditions."

Dr. Van Went of Amsterdam, stressed the necessity of an accurate diagnosis preceding treatment of spinal conditions. "Know what lesions you are treating!" She says that long periods of bed rest are not necessary. Most of the patients are off work only a few days or return to work almost immediately.

Dr. Eckel read a very important paper on the treatment of muscular disease with ultrasound.

Following this comprehensive report there was confirming discussion by Doctors Stuhlfauth, Zach, Mayr and Pavelka. In answering the question as to whether ultrasound treatment of heart and stellate ganglion in cardiac region brings about complication, Dr. Zach said that "no injury was done to myocardium by ultrasound treatment. Well conditioned hearts do not show any disturbance even in case of excessive treatment.

W. Degner of Berlin, Germany, presented a method for measurement of ultrasound intensity by means of fluorescence and phosphorescence in crystals.



Dr. Batalla

Batalla, Rotes and Zannu of Barcelona, Spain, had an interesting paper on "Ultrasound in the treatment of Rheumatic Diseases." F. Fanucchi and M. Girelli of Milan, Italy also discussed the same subject with summation of results of ultrasound therapy one to four years after treatment.



Dr. Zach

Dr. Schikorski

Dr. F. Zach, of Vienna, gave a very comprehensive paper on "The Influence of Ultrasound on the Vegetative System."

An English translation of Dr. Zach's paper will be published in a forthcoming issue of the British Journal of Physical Medicine.

Dr. Van Went, of Amsterdam, who has had such outstanding success in treatment of diseases of the spine with ultrasound, demonstrated that apart from the neurological effects, ultrasound has a direct effect on the connective tissue of the spine.

The influence of the French, and one of their favorite diagnostic methods, (chronaximetry), was shown in a paper by four collaborators in making a comparative study of ultrasonic and diathermy as influencing chronaxy determinations.

M. Carlos, of Concepcion, Chili, was not present in person, but he was represented by a paper (in Spanish). Others too, sent their papers to be read, although they were not able to be present. Among these were J. Wild (on Reflections) and J. Hurich (on Therman Changes in Tissues), both doctors from U.S.A.

Schneider of Innsbruck discussed the use of ultrasound in tendopathy. He reported no success in only five out of sixtyfive cases of calcification of tendons. He recommended starting the treatment as early as possible. "Positive results after ultrasound treatment can be seen within a shorter time than with x-ray while the performance of ultrasound treatment is easier."

The meeting was partially financed by the Education Consultant Office of the U.S. Forces in Austria. The official report of the meeting will be edited by Dr. Eckel and will be published in "Der Ultraschall in Der Medizin."

L. Barbe of Bourdeaux, France, discussed the use of ultrasound in ear, nose and throat applications.

Dr. K. Wollmann with a background of ten thousand ultrasound treatments discussed the question of local versus segmental treatment.

Absorption of ultrasonic energy in living human bone according to Dr. Bolt of M.I.T. is (per cm), 5 decibels at .5 mc, 10 db at 1 mc, 40 db at 2 mc and 70 db at 4 mc.



Mr. Hoffman



Mr. Reprich Dr. Lehfeldt



Lab. Physiologie Acoustique -France



Dr. Tschannen

The fourth group of papers discussed the diagnostic possibilities of ultrasound. Dr. Dussik sees a great future for the use of ultrasound in diagnosis through hyperphonography. Dr. Gütner, of Erlangen, could not share Dussik's enthusiasm. Dr. R.H.Bolt, of M.I.T., U.S.A., took a middle of the road course, summarized the work up-to-date as still obscure, but hopeful. His most effective point was made when he compared the diagnostic possibilities of ultrasound with Radar. "The little "pip" that means an enemy bomber is all the information we need. May be some obscure finding of U.S. diagnosis may be just as important." All were in agreement, however, that there is nothing in a diagnostic way about ultrasound that is of benefit to the average practitioner, at the present state of knowledge.

Dr. Tschannen said he had over 40 cases of facial paralysis where great improvement was shown during the course of 10 to 15 treatments. (Chronaxie values approached normal rapidly during course of series of treatments.)

T. Hüter, formerly of Erlangen, Germany, and one of the foremost acoustic physicists in the world, is now permanently in the U.S.A. as head of the acoustics laboratory of Massachusetts Institute of Technology, Boston. Hüter is the inventor of the Siemens Acoustic Intensity meter.

"GRAY PASS"

This was my permit for travel in the Russian Zone.

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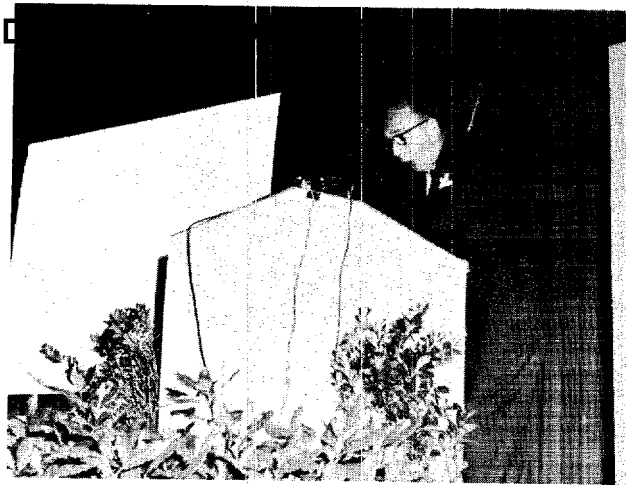
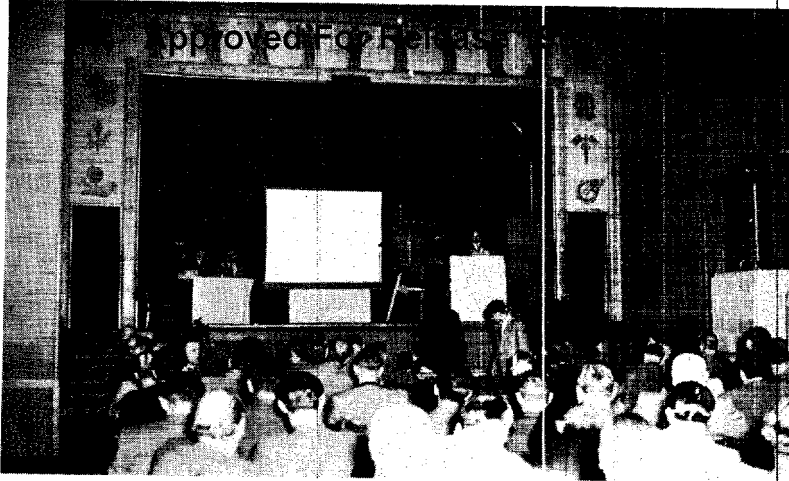
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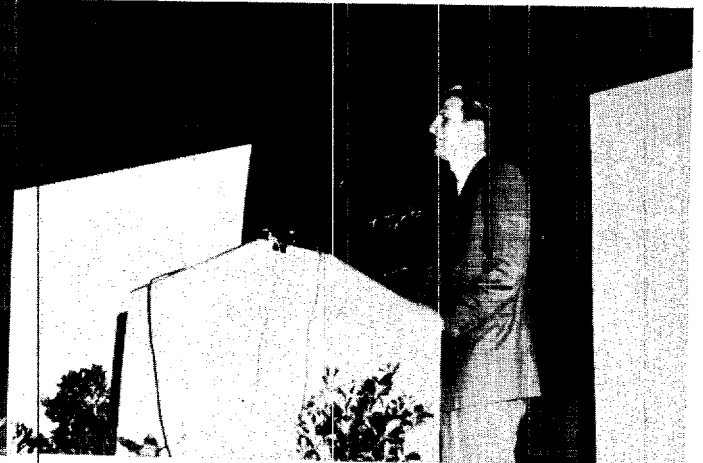
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Robert Jerome Lindquist
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Prof. Dr. L. BERGMANN, Wetzlar



- ³⁴ V. BUCHTALA, Würzburg, Deutschland: Vergleichende Untersuchungen der Ultraschallwirkung mit bewegtem und stehendem Schallkopf auf den Prothrombin-Index.
- ³⁵ B. BRUNI, Udine, Italien: Ultrasonoterapia e malattie dell'apparato digerente.
- ³⁶ E. DIETZ, Freiburg i. Br., Deutschland: Die Ultraschallresistenzkurve der Leukozyten und ihre diagnostischen Möglichkeiten.
- ³⁷ P. BUGARD, Paris, France: Le Syndrome Traumato-Vibratoire.
- ³⁸ F. FANUCCHI — M. GIRELLI, Milano, Italien: Effetti degli ultrasoni su alcuni distretti neurovegetativi.
- ³⁹ J. VAN WENT, Amsterdam, Holland: Biological Investigations of the Change-ment in the Connective Tissue in Relation to Diseases of the Spine.
- ⁴⁰ F. ZACH, Wien, Österreich: Beitrag zur Ultraschall-Verfahrenstechnik des System.

Für das EHRENPRÄSIDIUM der Tagung haben sich in dankenswerter Weise zur Verfügung gestellt:

- Prof. Dr. L. BERGMANN, Wetzlar
- Prof. Dr. R. H. BOLT, Cambridge, USA
- Prof. Dr. A. DOGNON, Paris
- Doz. Dr. V. HINTZELMANN, Wiesbaden
- Prof. Dr. A. GIACOMINI, Rom
- Dr. R. POHLMANN, Zürich
- Prof. Dr. F. SCHEMINZKY, Innsbruck
- Prof. Dr. F. SEIDL, Wien

R E P O R T

on the

International Medical Ultrasonics Congress

Bad Ischl, Austria, September 7-10-1952

MEMBERS OF PRESTIDIUM

PROF. DR. L. BERGMANN, Wetzlar	DR. R. POHLMAN, Zurich
PROF. DR. R. H. BOLT, Cambridge, USA	PROF. DR. F. SCHEMINZKY, Innsbruck
PROF. DR. A. DOGNON, Paris	PROF. DR. F. SEIDL, Vienna
PROF. DR. U. HINTZELMANN, Wiesbaden	PROF. DR. VOSS, Berchtesgaden
PROF. DR. A. GIACOMINI, Roma	

EXPENSES

The meeting has been considerably financially subsidized by:

EDUCATION CONSULTANT OFFICE
UNITED STATES FORCES IN AUSTRIA

PARTICIPANTS

203 participated fully through the entire session, and 32 more partially, adding to 235 persons, from 12 different countries.

OFFICIAL REPORT OF THE MEETING

The official report of the meeting, containing most of the papers in full extension will be edited by DR. K. ECKEL in the review: DER ULTRASCHALL IN DER MEDIZIN, S. Hirzel Verlag, Stuttgart, Germany.

THE PRESENT CONDENSED REPORT WAS PREPARED BY:

K. ECKEL, F. LETTOWSKY: Excerpts 1-7, 12-20, 23-25, 28, 29, 31, 32, 34, 36, 40-47, 51. (Including preparation and translation of complete report.)

F. DUSSIK: Excerpts 8, 9, 11, 37-39.

K. TH. DUSSIK: Excerpts 21, 22, 26, 27, 30, 33, 35, 48-50.

SCIENTIFIC ULTRASONICS SOCIETY

MONDAY, September 8, 1952 Morning Session.

Presiding: U. HINTZELMANN - K.TH. DUSSIK

1. R. POHLMAN, Zurich, Switzerland

Voraussetzungen und Möglichkeiten der Dosisfestlegung für medizinische Ultraschallanwendung (Assumptions and Possibilities for Determination of Ultrasonics Doses for Medical Treatment.)

At first, a summary was given of the difficulties encountered in fixing the dosage of ultrasound for medical treatment. These difficulties are due to 1. Determining the energy of the transmitter itself. 2. Control of the energy transferred to the body. 3. Irregularities due to interferences in the ultrasound field. 4. The different absorption of the parts of the human body under treatment. 5. The reflection and dispersion on bones and due to the non-homogenous character of human tissue. 6. The fact that the product of intensity (watts per square centimeter) and time does not give a figure which is equivalent to the effect.

Further difficulties arise in the use of different frequencies and in the use of pulsed sound, since all six parameters will then change again. A further question arose on transferring results of experiments with ultrasound on small animals to human beings. Several investigations, however, showed that the non-homogeneity of the field of ultrasound, the absorption, the reflection, and the dispersion are of minor importance, and that stress should be laid on the determination of transmitters energy and control of the energy transferred to the body. An interesting comparison was given on the possibility of determining the intensity and effect of 19 different therapies. In 15 therapies a change of intensity could not be substituted by a change of time. It has been stated that today it is possible to obtain a sufficient physical control of the energy produced by a generator, and the amount of energy transmitted to the body. The maximum possible instrument error in measuring the absorption of energy by the body is 2½%. New experiments with prolonged ultrasonic treatments with the new equipment called "Schwingkissen" (moving sound pad) have been reported. It transfers the energy of, for instance, 6 transmitters (placed over the part to be treated), and, because of its motion reduces the intensity (watt/sq cm) applied to the treated area to 1/10.

Discussion

H. BORN: The possibility of concentration of energy in the tissue by reflection represents a hazard.

F. TSCHANNEN: The moving sound pad brings a lack of medical control.

F. ZACH: Because of the general-effects on the brain stem, prolonged ultrasonics treatment must be avoided.

2. C. FLORISSON, Paris, France.

Mesure absolue de la puissance acoustique d'un flux ultrasonore. (Absolute Measuring of Acoustical Intensity of an Ultrasonic Beam.)

The fact that the reflection coefficient of acoustical energy in case of reflection on an air-water surface is very near to unity (0.9987), has been used to effect an absolute device for measuring acoustical intensity. An almost flat bell, containing air, is suspended on a spring and submerged into water, in equilibrium. The transmitter of ultrasonics is fixed at an angle below, so that the flux of ultrasonic energy "W" travels from below at an angle to the flat bell containing air. The angle of the ultrasonic beam will be made practically about 60°. The vertical component of the ultrasonic pressure will be equalized by a weight "P". A flux of ultrasonics yields $W = \frac{PV}{2 \cos \alpha}$,

where "V" is the velocity of sound in water. It is of importance that it became possible in this way to design an ultrasonic radiometer for simple and quick determination of the average total intensity of ultrasonic apparatus for medical purposes. This method is expected to be approved officially for calibration of ultrasonic apparatus. (Very important paper. (The reviewer)

3. W. GÜTNER, Erlangen, Germany.

Über Ultraschalldosierung. (About dosage of ultrasonics.)

For medical purposes it is sufficient to indicate the influx of energy necessary for the particular part of the body. Because of coupling difficulties, there are always considerable losses in intensity. If the ultrasonic generator (transformer) is operated with constant current, (the system is inherently underdamped; (The reviewer),

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small coupling variations will have a big influence on the acoustical output, and an instrument for measuring the intensity shows big oscillations. On the other hand, an apparatus operated by a constant-voltage transformer is emitting a constant sound intensity. Construction and action of an alarm has been described, which is controlled by changes in radiation resistance, which cause changes in transformer impedance, so that the surgeon can notice big changes in coupling.

4. G. KOLLE, Berlin - Germany.

Der heutige Stand der Ultraschalldosimetrie (Today's Knowledge about Determining Ultrasonics Doses.)

Assumptions in determining ultrasonics doses depend on knowledge about:
 a) primary effects of ultrasound in the medium, b) secondary effects resulting from transmission through the medium c) process of absorption. The unity of measurement should be easily reproducible. Biological units of measurement can not be defined with sufficient accuracy, because the product intensity x time does not determine the effect of the energy applied. By sound velocity and resistance, the transmitted medium becomes characterized. Velocity and acoustical resistance are characteristic quantities of the transmitted medium. Since the pressure of ultrasound can be easily measured, unit intensity or total intensity of ultrasound can be considered quantities easily determinable. Whether the primary effects of ultrasound are thus sufficiently determined is not yet known; same is true for secondary effects of ultrasound, like the formation of H_2 , O_2 or luminescence. It was announced that attempts are being made to connect luminescence with some other physical-chemical process in order to enable finding of a useful way for a direct determination of doses.

Discussion

WENK, BUSNEL, SCHUMACHER: They suppose that luminescences can be found in human tissue also.

5. H. BORN, Frankfurt a.M. Germany

Der Kopplungsfaktor bei der Ultraschall-Dosierung. (The coupling factor in determination of ultrasonics doses.)

Some technical descriptions which emphasize preference for use of the coupling factor for devices for measuring intensity. A

method was explained in which, by means of relays, a signal flashes in the Schallkopf (part of the apparatus for medical treatment which is in direct contact with the patient), when the coupling factor falls too low. In practice it is very difficult to perform treatment in such a way that the coupling factor would only seldom fall below 80%.

6. F. SEIDL, Vienna, Austria

Über die Ultraschalldurchdringung am menschlichen Schläfenbein. (About the penetration of ultrasound on the human temple bone.)

The problem of propagation of sound in the human tissue, which is an extremely non-homogenous medium, have not yet been cleared. Physically expressed, this seems clear since the resistance of the ultrasound (given by the product of density x sound velocity) is very variable. Many fine pictures have been shown, which demonstrate, with many examples the propagation of ultrasound. It has been pointed out that plexiglass, which has an ever increasing usage in plastic-surgery, will show cracks even at low intensities (below 0.5 W per sqcm). Sound transmission through various bones showed that treatment from front side and back side of the auditory passage did not lead to transmission of sound through the human temple bone detectable by the striae method, not even for 4 W per sqcm. Since 0.1 W per sqcm represents the lowest limit detectable in the striae pictures, the effects of any possible lower amounts present in the inner ear would be highly questionable.

Discussion

WENK, GÜTTNER, WILLIAM: According to experiences of the 1st Chirurg. Univ. Clinic in Vienna ultrasound has had very good effect against the violent regular pains after operations to replace the head of the femur with plexiglass.

KELLER: Even in cases where medium intensities of ultrasound are being used possible liquefaction of plexiglass must be taken into consideration.

7. F. LETTOWSKY - K. ECKEL, Bad Ischl, Austria

Fortentwicklungen der medizinischen Ultraschalltechnik. (Further progress in Medical Ultrasonic Techniques.)

Any further development of medical ultrasonic techniques depends first on elucidation

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artificial objects. Transmission and reflection of an ultrasonic beam through a human forearm are shown in very instructive striae pictures.

11. H. HOMPESCH, Dortmund, Germany

Weitere Untersuchungen zum Mechanismus der bakteriziden Wirkung des Ultraschalles. (Further investigations concerning Mechanism of the Bactericide Effect of Ultrasound)

The effect of ultrasound on bacteria can be regarded as a colloidal chemical phenomena leading to cell dissolution. Behavior of bacterium pseudo anthracial, pseudo monas pycyanea and colon bact. was investigated in this paper. About 70% of bacteria nitrogen was dissolved two hours after exposing them to ultrasound, which fact can be regarded as criterion of progressing cell dissolution. The bacteria flotation was effectuated in a physiological salt solution. Intensities of 3.5 - 4 W/sqcm at 800 kc were used. Autolytic processes could be avoided. The results of this investigation are quantitatively the same for spore forming as for gramnegative bacteria and appear to be independent of temperature. The biggest decrease of the amount of bacteria nitrogen was already observed within 30 minutes, in the case of bact. pseudo anthrac. Former measurements of transparency loss of solutions proved to be nonconclusive concerning ultrasonics effects, because then grampositive especially spore forming bacteria showed less clarification than gramnegative ones.

12. KH. WOEBER, Bonn, Germany

Vergleichende Untersuchungen Über die Primärwirkung des Ultraschalls, der Ultrakurzwellen und der Hyperthermie auf die Mitosen des Walker - Carzinoms als Beitrag zum Wirkungsmechanismus dieser physikalischen Therapeutica. (Comparative Experiments about Primary Effects of Ultrasounds, Ultrashortwaves and Hyperthermy on Mitoses of the Walker - Carcinoma as Contribution to the Mechanism of Ultrasonic Effects of these Physical Therapeutics.)

Criteria were sought for determining the primary effects of different physical therapies on living cells. The cellular - mitoses of the Walker carcinoma from white rats have been examined and the results compared. Ultrasound waves, ultra-short waves & hyperthermy were included in the treatment. Various frequencies were applied. The carcinomatous tissue was examined immediately after treatment in order to avoid, as far as possible, biological consequences. After the ultrasonic treatment

there were observed quantitative and qualitative irregularities of the mitoses with conform histological details; furthermore clinical pictures change in zones, which do not show any alteration. Hyperthermy produces alterations (clumps) depending on duration and temperature but equally distributed. Alterations in case of treatment with ultrashort waves are similar to those in case of hyperthermy. Thus a positive criterion has been found for biological-morphological differences between ultrasonics and pure heating effects.

13. KH. WOEBER - W. KLUG, Bonn, Germany

Ergebnisse kombinierter Röntgen - Nah - und Ultraschallbehandlung auf den experimentellen Tierkrebs (Results of Combined Adjacent X-Ray - and Ultrasonic Treatment of Experimental Cancer of Animals.)

In course of studies on the primary effect of ultrasonics treatment on carcinomatous tissue and on the effect of combined X-ray and ultrasonics treatment after Chaoul, investigations were made by the authors on Walkerscarcinoma, implanted subcutaneously to a white rat with a specially constructed apparatus, permitting adjacent X-ray and ultrasonics treatment simultaneously and from the same direction. With this oscillator acting almost purely thermically as far as histological effects are detectable the following results were accomplished: in 30 experimental series, containing 4 animals each, 120 animals were observed. One animal was used for control purposes, the 2nd was treated with X-rays only (350 r Chaoul), the 3rd with 1.0 w/sqcm ultrasound of this oscillator, the 4th with ultrasound and X-rays, conditions and doses being identical with animal 2nd and 3rd simultaneously. While all animals 1, 2 and 3 always died on cachexy as a result of the permanently growing tumor, all 30 tumors exposed to combined treatment decreased and remained for 90 days of further observation time without relapse. A possible explanation for those results was given.

14. W. KNAPP, Tübingen, Germany

Die immunogene Wirkung beschallter Typhusbakterien (Immunization Generating Effect of Typhoid Bacteria, Treated with Ultrasound)

The question whether typhoid bacteria treated with ultrasound, their filtrates, or solutions, obtained by centrifuging cultures treated by ultrasound could be used for manufacturing inocula and if this method is advantageous, was analyzed. It was known by preliminary experiments that neither

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of the mechanism of ultrasonic effects in living organisms. The fact that the therapeutic effects of ultrasound apparently depend very little on frequencies or intensities, and the special character of this dependency permit the establishment of definite criterions to determine, whether a certain physical factor (for instance acceleration forces) is responsible for these effects. Only non-reversible, energy exchange processes, yield an effect which in case of mechanical effects could be established as non-reversed deformation. The significance of physical irregularities in ultrasonic fields with regard to the effect of heat generation has been, in general, overestimated, as can be concluded from mathematical analysis of extreme cases, in which it has been shown that temperature distribution is far more uniform than that of heat sources. The establishment of high temperatures in boundary interface planes can be easily shown by an explicit formula. The ultrasonic effect of nervous excitement, probably caused by changes of ionic mobility, being entirely independent of frequency and intensity over a wide range (according to chromaxy measurements by Busnel it must be regarded as a specific effect. (the reviewer)), leads to most favorable results in case of optimum temperatures, at which action voltages have their highest values. (careful experimental investigations made by ZACH confirm this statement. (The reviewer) Modern therapeutic apparatus already complies with all requirements; certain possibilities for improvement are briefly discussed.

Discussion:

POHLMAN: Quotes diagrams of haemolysis with regard to influence of frequency and emphasizes the significance of eigenfrequency in case of cavitation.

K. ECKEL: It cannot be overemphasized that no important physical effect especially any which would depend on frequency seems to be of any significance as far as biological effects of ultrasound are concerned. In fact the biological effects of ultrasound seem to be entirely independent of frequency except for the fact that the degree of ultrasound penetration (which has some biological influence) depends of course on frequency.

F. LETTOWSKY: (Conclusion) It is not probable that in case of therapeutical doses even mild cavitation (as meant by POHLMAN) will appear in living tissue. It would not depend on frequency as in the case of cavitation formed by vibrating gas bubbles, and it would be detect-

able by the random character of any measured quantities, even a minor degree than in the case of real cavitation.

8. H. KELLER, Reinbek, Germany

Über den Mechanismus der Ultraschallabsorption im Gewebe. (About the Mechanism of Ultrasound Absorption in Tissue).

Absorption of ultrasound in tissue is similar to absorption in suspensions. This hypothesis has been of value, as suspensions can be easily treated mathematically. The investigations on a suspension model lead to the result that absorption by tissue was caused by motion of particles, leading to variation of density in areas of 10^{-4} cm. Bigger unhomogeneities cause prolonging the length of path, and additional absorption by scattering.

9. W. DEGNER, Berlin, Germany

Ausmessung des Schallfeldes durch Fluoreszenz und Phosphoreszenz von Leuchtkristallen. (Measurement of Ultrasound Fields Intensities by Fluorescence and Phosphorescence of Crystals.)

Experiments are described in which ultrasound fields are measured quantitatively by a new method. For this purpose, fluorescence phenomena are used directly through the excitation of crystals by ultrasound. Very good photographic pictures have been shown. Converging rocker arms are used for calibration. The crystals require very sharply pointed probes. The surprising simplicity of this method is very advantageous. Leaves of artificial resin were used, either coated with ZnS activated by means of Cu, or also with ZnCuS.

Monday, September 8, 1952 Afternoon Session

Presiding: R. H. BOLT - K. BEREK

10. W. DAUM, Braunau, Austria

Beitrag zur Schalldarstellung mit der Schlierenmethode. (Contribution to Sound Picturing by Means of the Striae Method)

Showed some studies on propagation of ultrasound on different specimens, all pictures made by means of Toepler's striae method. Precise coupling of the Schallkopf is required and this requirement holds too for investigation of all problems of penetration of ultrasound through biological objects as this is incomparably more complicated than investigations on non-living or

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dissolved nor not-dissolved antigens could be activated by ultrasound (5 W/sqcm) within one hour. The following results were obtained: 1. Inocula containing bacteria manufactured after treatment with ultrasound from Na Cl suspensions or broth-cultures, did not show better immunizations in experiments with animals than inocula used in practice. 2. It was shown by using filtrates of flotations of agar or broth cultures exposed before to ultrasound for manufacturing inocula, that by treatment with ultrasound richer of immunizing substances with clearly increased degree of protection by vaccination would be achieved. 3. Optimum enrichment of solved immunizing bacteria substances has been achieved by 30 minutes treatment with ultrasound.

15. G. VELTMAN, Bonn Germany

Über ein neues, mittels Ultraschall hergestelltes Tbc. -Antigen zur Komplementbindungsreaktion (About some new Tbc.-Antigen Produced by means of Ultrasound for Reactions with Complement - Fixation.)

Some Tbc - antigen has been produced by exposing a bacteria suspension to ultrasound, and in this way an alcoholic extract has been obtained free of all morphological remains or other admixtures. Investigation of 70 series of tuberculous people to which it had been administered showed through correspondence between our antigen and the "Antigen Essen", used for control purposes. In twenty series with luctics, whoes reaction otherwise was strongly positive, the new antigen showed an advantage, because reaction was only weakly positive in 16 cases, so that the new antigen proved to be more specific. Also by treatment of 10 healthy people and in case of other illness better specificity of the new antigen was shown. So this new antigen always proved to be advantageous.

16. W. SCHUHMACHER, Berlin, Germany

Ultraschallversuche an Schimmelpilzen.
(Ultrasonic Experiments with Mould Oidia.)

Mould oidia spores are biologically very suitable objects for ultrasonic experiments. They were ultrasonically irradiated with 800 kc half cycle operation, 1-3 w/sqcm. The spores were suspended in distilled water. Electron-microscopic controls showed that no cellular destruction occurred with this method. From the results it follows that the germ velocity of the spores was considerably decreased by exposing them to ultrasound. Constant product intensity x time similar to other biological measurements

does not yield constant effects. This became especially clear from investigations with repeated short time exposing to ultrasound. It was striking that these effects were more intensive at 5° temperature than at 45°, in evident contrast to results of haemolysis investigation. This is regarded as further indication for existence of mechanical ultrasonic effects.

17. A. BARONE - L. VIVALDI, Roma, Italy

Der Proteusbazillus unter Ultraschallbestrahlung. (Reaction of Ultrasonics Treatment in Proteus.)

The authors exposed a suspension of proteus to ultrasound. An ordinary cylindrical vial as is used for biological experiments contained the preparation. It was exposed to ultrasound traveling along the same axis, generated by an ultrasound transmitter with conical reflector. Intensity of the cylindrical waves on vial surface was approximately 16 W/sqcm, (considering all losses in transmitter.) The bacilli were exposed to ultrasound of this intensity at which cavitation appears for different periods of time (5,10,15,25 min). Then they were put on nutrient broth, where only bacilli exposed to ultrasound for more than 15 minutes proved to have died out entirely. Electron-microscopic photos showed that after 5 minutes exposure destruction of membran and flagellum begins. Bacilli exposed to ultrasound for more time were deprived of their membranes, they had considerably reduced dimensions, and measurably larger protoplasm densities.

18. W. D. KEIDEL, Erlangen, Germany

Lassen sich bei inadeguater Reizung des Ohres mit Ultraschall über die Knochenleitung Cochlea-ströme ableiten? (Is it possible to shunt cochlea currents by bone conduction from the ear inadequately excited by ultrasound?)

Objective hearing thresholds measured by cochlea currents (currents in consequence of nervous excitement) were plotted, whereby ultrasound at frequencies from 2 to 57.5 kc had been introduced by bone conduction. Thresholds plotted against frequencies showed between 16 and 60 kc a sharp increase (20 db). The break at 18 kc known from subjective threshold measurements on human beings is however missed. Above 18 kc a slightly painful high sound sensation yields, showing no further pitch change. At the experiments in question with animals the frequency of the cochlea currents has been established, that the sensorial cellules had been exposed to pressure oscilla-

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tions precisely in agreement with sound frequency. It has been concluded that hearing sensation in the range of ultrasonics comes from adequate excitement.

Discussion

M. V. GIERKE: It does not seem to be clear enough whether sound sensation in the range of ultrasonic frequencies was not influenced by subharmonic vibrations, caused by nonlinear characteristics of the ear.

19. **K. SCHIKORSKI**, Hamburg, Germany

Der neurale Wirkungsmechanismus des Ultraschalles. (Neural Mechanism of Ultrasonic Effects.)

Some theoretical consideration based on SCHEIDT's theory of nerve function (synallaxy theory). It is supposed that Ultrasound interferes with the potential gradient resulting electrically from unidirectional arrangement of non-spherical molecules.

Discussion

ZACH: Neural effects are generated just at smallest ultrasonics intensities. According to EPPINGER tissue potentials, which are to be understood literally in the sense of electrophysiological ones, are increasing the trophotropic phase, decreasing in the ergotropic phase.

TUESDAY, September 9, 1952 Morning Session

Presiding: **L. BERGMANN - K. ECKEL**

20. **M. von GIERKE**, Ohio, USA

Propagation of Mechanical Energy in Biological Tissues. Investigations about complex acoustical impedance of body surface in the frequency range from 0 to 30 kc showed that soft muscle tissue is a medium with compressibility, elasticity and viscosity. Elasticity was found to be $2.5 \cdot 10^4$ dynes/sqcm, shear viscosity 150 dynes sec/sqcm. These values approximately are in accordance with calculated ones from measurements of penetration depths in the range of a few megacycles. Therefore viscosity of tissue has a relatively large value (5 times larger than that of glycerine) and it causes shear waves, generating at the surface of the transducer and at boundary plains in case of inclined incidence of an acoustical beam, where far more energy than in case of normal value of the absorption coefficient dependent on frequency becomes absorbed. Viscosity shear waves are strongly damped,

therefore their penetration depth is very small. Most local generation of heat at skin and muscle boundaries is due to them. Also the fact that sound absorption is different for penetration of ultrasound along or normal to muscle tissue, can be explained easily in considering that, besides longitudinal waves, there are also transversal ones (the above-mentioned viscosity waves).

Discussion

LETTOWSKY: It seems necessary to assume two different absorption coefficients for explaining POELMAN's measurements of temperature rise in ultrasonically radiated tissue.

POELMAN: Absorption in the field near the transducer is different of that in the field far from it.

BERGMANN: It would be of interest to calculate the difference in absorption of longitudinal and transducer shear waves characteristics.

M. v. GIERKE: This problem is mathematically too complicated because surface waves with propagation speed dependent on frequencies are present on transducer surface and on boundary planes.

ECKEL: Apart from the importance of the above mentioned results, it can be concluded from the shown diagrams that these are nonvariable conditions at frequencies above 100 kc. It can be assumed that thus has been found some physical reason for the clinical non specificity of frequencies, which fact should be emphasized.

21. **W. GLOGGENGIESSER**, Munich, Germany

Die Pathologie der Ultraschallwirkung. (Pathology of Ultrasonics Effects.)

Morphological investigation, based specially on experiments with animals. First of all, abnormal changes were discussed and also phenomena having some relation with physiology. Intensities used considering size of experimental animals, are above therapeutic doses. Today, different groups of changes and reactions can already be distinguished, and they can be classified from the following points of view. 1. Degenerative changes 2. Reactive inflammatory and reactive hyperplastic changes 3. Functional circulatory disturbances acting probably on arterial nervous system.

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ad 1. With the exception of bone lesions caused by ultrasound, which might be attributed to mechanical ultrasonics effects, most degenerative changes are non specific ones.

Experiments about ultrasonics effects on muscular tissue yield both non-characteristic changes and muscle lacerations. (mechanical factor). Characteristic degenerative changes are furthermore infarct looking necroses. The author could produce them in lungs, heart, hepar, and stomach. They are caused by functional circulatory disturbances. It has not been decided yet whether completely developed or not yet fully developed materials are injured by ultrasound. Some experiments by the author give evidence of an ultrasonics effect in stimulating growth of juvenile cells.

ad 2. Reactive granulous and fibrous overgrowths, originating after ultrasonics treatment, are generated from excess material. Mesenchymal overgrowths, remaining on a low differentiation stage, give evidence of elective ultrasonics effects of growth stimulus to mesenchyme.

ad 3. New experiments by the author give evidence of functional circulatory disturbances, acting probably on arterial nervous system (experiments on kidneys and suprarenals of rabbits and rats.) The experimental results probably might be best classified as "initial reactions" of the living organism to ultrasonics. (effect on terminal vascular system). The circulatory disturbances proved to be big enlargements and hyperaemiae of capillaries and veins. They lead to isolation and detachment of epithelial tissue shreds, in more intense stages to haemorrhages, and finally they cause infarctial desintegration of tissue. These experiments confirm RICKENS' theories about effects of physical or chemical stimuli to terminal vascular system.

Discussion

BORN: These experiments should be repeated on bigger animals with regard to insufficient heat convection.

BUCHTALA: More recent investigations of my own give evidence for higher sensitiveness of juvenile tissue.

LETTOWSKY: It should be emphasized that more intensively cooled nervous tissue did not show any morphological changes at ultrasonics intensities, by far exceeding the above mentioned. (up to 145 w/sqcm; mechanical effects are seemingly bound to cavitation, and, in case

of less efficient cooling, the cavitation threshold is reached at lower ultrasonics intensities).

GLOGGENGIESSER: (Conclusion) It seems that temperature does not influence the above mentioned ultrasonics effects. Higher sensitiveness of juvenile cells can be probably confirmed.

22. G. BAUER, Munich, Germany

Experimentelle morphologische und biologische Untersuchungen über die Wirkung des Ultraschalles auf die Ovarien des Kaninchens. (Experimental Morphological and Biological Investigations about Ultrasonics Effects on Ovaries of Rabbits.)

The author reports about results of ultrasound treatment of full grown rabbits. (24 animals, 18 of them were exposed to ultrasound, 6 of them served as controls). Total ultrasonics intensities were 15 - 35 Watts. Hyperplasia of theca, inhibition of follicular ripening, acceleration of corpus luteum involution, and in case of larger doses atrophy of ovarian stroma were shown.

FRIEDMANN's pregnancy test was negative for almost 50% of animals having been exposed to ultrasound, while ovaries not treated with ultrasound showed the well known aspect of positive FRIEDMANN's test.

Discussion

HINTZELMANN: Doses used are relatively very large ones.

HOWANITZ: In contrary to the above mentioned effects some chronic adnexae tumor could be influenced favorably, whereby pregnancy could be achieved only after treatment with ultrasound for the first time.

WOEBER: Warns of too extensive conclusions from morphological findings. These are mostly irreversible changes, while the sought primary effects are reversible ones, and therefore only could be found with difficulty.

BAUER: (Conclusion) It should not be forgotten that irregular prolonged blood discharges were frequently observed at routine treatment with ultrasound.

23. M. CARLOS, Concepcion, Chile

Einfluss des Ultraschalls auf das Ovar mit Berücksichtigung des Scheidenabstriches nach Papanicolacu. (Influence of Ultra-

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sound on the Ovary with Consideration of the Vaginal Smear after Papanicolacu.)

The ultrasonics therapy is still little known in Chile. Investigations are being made to find out whether in Amenorrhoea cases results can be obtained by ultrasound therapy of the ovaries. Of ten cases of secondary amenorrhoea menstruation was affected in three cases. No ill after-effects.

24. S. KOEPPEN, Wolfsburg, Germany

Zusammenfassende Darstellung der bekannten Reaktionen des Ultraschalles in vegetativen Nervensystem, an den Eingeweiden und den Blutgefäßen. (Summary of known reactions of ultrasound in the vegetative nervous system, on the intestines and blood vessels.)

The chief point of the paper is about RICKER's gradual action law. Weak and medium strength intensities irritate the vasoconstrictors, stronger intensities can paralyze them. The result is a collapse of the circulatory system and finally necroses of the tissue. Biological effects of ultrasound are attributed as caused and set off by the thixotropic effect of ultrasound. Brain changes from mechanical vibrations (commotio) are shown in comparison with them. This stage of ultrasonics effects is irreversible.

25. V. TOMBERG, Bruxelles, Belgium

Zum Einfluss der Kavitationsschwelle auf den biologischen Vorgang. (On the influence of the Cavitation Threshold on Biological Processes.)

The biochemical effects of ultrasound depend on cavitation. The cavitation threshold depends on the ultrasound intensity and frequency and furthermore on the nature of dissolved gases and the kind of wave set up in the ultrasonically radiated medium. The addition of substances can raise the biological ultrasound effect especially the bactericide efficiency, as far as these substances lower the cavitation threshold. This fact has been proved by the author in certain experiments on ciliata and parasites.

26. F. TSCHANNEN, Bern, Switzerland

Neurale Wirkung des Ultraschalles nach elektromyographischen Forschungen. (Nervous effects of ultrasound in electromyographic research.)

Indications are that the tonus relaxation effect of ultrasound is transmitted over the

spinal centers. This explains the good results in case of non infective rheumatism, at radicular treatment with ultrasound because reflexes and muscle spasticity improve. Pulsed sound seems to be better than continuous. A series of interesting observations on electromyograms are described, whereby relaxation of reflexogenic excitement seems to be well proved in case of muscle spasticity.

Discussion

KEIDEL: In the shown myograms changes are striking, referring to influence of reflex center. Continuations of electromyographical research for explaining ultrasonics effects was suggested.

VAN WENT: In case of light neuralgias and muscle spasms short wave therapy seems to be better.

ZACH: Confirms the good therapeutic effects of pulsed sound in general and when arthroses were ultrasonically radiated at radicles.

27. R. G. BUSNEL, H. MAZOUÉ, P. CHAUCHARD, J. GRIGORJEWITCH, Jouy-en-Josas, France

Comparaison entre l'action spécifique des ultrasons et l'effet thermique sur le system nerveux. (Comparison of specific influence on nervous system in case of specific ultrasonics and thermal effects.)

The authors have analyzed the effects of ultrasound on rats and frogs measured by chronaxy. Ultrasound causes decrease of chronaxy being always larger than that in case of equivalent thermal effects. The return to normal values is also much slower.

The response on excitement of reflex phenomena is different for reflexes generated by temperature. The last ones are suppressed by anesthesia, the other, caused by ultrasound, survive and disappear only if the nerves are dissected or if the medullary sheaths are destroyed. The effect of ultrasound appears also at intensities, which practically have no thermal effects at all, and are below cavitation threshold.

28. N. VYSLONZIL, Vienna, Austria

Über die Beeinflussung des Vestibularapparates durch Ultraschall (About the influence of ultrasound on the vestibular apparatus.) Film.

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Some impressive experiments demonstrating the vestibular reaction by rabbits and guinea pigs including all irritation phenomena of the equilibrium organ up to exhaustion and total paralyzing of labyrinthine system, were shown. (film) The animals indicated from head motions mystagm to circular motion, and complete inability to go in any direction. These investigations are part of general endeavor to reduce the sensibility of the vestibularis nerve without damaging the cochlearis nerve, primarily with respect to the Meniere's syndrome.

29. K. ECKEL - T. MILBERT, Bas Ischl, Austria

Über den therapeutischen Wert des mit Ultraschall vorbehandelten Blutes.

(About the Therapeutic Value of Blood Treated with Ultrasound.)

This work is based on the biological and colloid chemical effects of the ultrasound on cell suspensions and blood albumin, and deals with these effects. The changes of the native blood-albumin by ultrasound in vitro and the reinjection are introduced by ECKEL as an essential enlargement of the well known blood-reinjection therapy. A very favorable change of stage in the autonomic nervous system is brought about as was shown in a series of chemical analyses of examined cases. Demonstrable changes of stage as well as therapeutical observations apparently go beyond the effect of the simple blood-reinjection or the effect of blood-reinjection combined with ultraviolet treatment.

Discussion

BUSNEL: Inquiry on blood-reinjection treatment techniques. It seems incredible that no toxic effects can be noticed.

ECKEL: The change of autonomic tonus is very interesting, although we cannot say anything on the importance of this effect. It certainly cannot be described only with ergotropic and trophotropic reaction stages. (In German: ergotrope and trophotrope Reaktionslage, in English the word trophotropic is used in other sense than in German (the reviewer). Attention might be paid to the fact that also little quantities (i.e. 0.5 cucm) cause very distinct reactions.

TUESDAY, September 9, 1952 Afternoon Session

Presiding: A. GIACOMINI - CH. KUBASTA

30. K. STUHLFAUTH, Munich Germany

Die Anwendung des Ultraschalle bei internen Krankheiten und ihre Grundlagen. (The use of Ultrasound in internal diseases and its basis)

For internal medical applications ultrasound is of importance in cases of spastic and degenerative diseases, and chronic inflammations. Such therapy successes are obtained for asthma bronchiale, tuberculosis and exsudative pleurisy. All these are examples of diseases where effects can only be achieved by affecting the autonomous nervous system. Heart diseases, especially angina pectoris are hardly treated with ultrasound because of unfavorable effects. Two cases of esophgospasm were treated with success. In case of gastritis and ulcers as well as at spastic obstipations etc. are sometimes achieved very good results, but the therapy causes too great expenditure of time and physical effort by the physician. To another group of indications, partly topical and partly centrally regulated, belong vasodilatations affecting the level of blood sugar, arteriosclerosis and autonomic blood circulation disorders at essential hypertonic stage, and potency disorders. In the experiment is proved that ultrasound on isolated animal organs sets free acetylcholine, adrenalin and histamin. The former assumption by the author that some damping of nervous conductivity, caused by heat, occurs, and that it is responsible for reducing of different effects of the disease in internal organs, in the vascular system, and in muscles, could not be accepted. The mechanism of the effects is more complicated and concerns the autonomic reflexive system. Because stabilization of external membrane potentials caused by ultrasound appears too in case of isolated muscles (otherwise the sensible production of pertaining reflexes in situ would not change) it can be attributed also from this point of view to an effect caused chiefly by autonomic receptors.

Discussion

KEIDEL: The assumption that actual sensation of heat is caused by ultrasound, leads to important theoretical considerations. The thermal receptors immediately below the skin only are struck by unidirectionally moving molecules excit-

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ed by ultrasound. Had the receptors themselves been excited, thermically, then it would follow that multidirectional motion (heat) and unidirectional motion (ultrasound) should not make any difference. This is of great importance in understanding the physical-physiological transforming mechanism of thermal receptors. The free pain perceptive ends of nerves are located in deeper layers and they will be in the field of multidirectional molecular motion because of scattering. It is possible to distinguish the two kinds of receptors by measuring action potentials because pain perceptive fibres do not show adaptation.

31. K. Th. DUSSIK, Boston, USA

Probleme der Ultraschallanwendung in der Therapie der krankungen des Zentralnervensystems. (Problems in Application of Ultrasounds to Therapy of Diseases of the Central Nervous System.)

Ultrasonic treatment in case of neurosis, solves a series of important problems that otherwise therapeutically cause great difficulties. It is the only means of producing heat and influence on different systems in a limited area of the central nervous system. (ZNS). The experiments, causing destructive effects on ZNS in case of high intensities, are no counterproofs, since there are extreme intensities. A series of results have been obtained, in order to establish the threshold effects for functional and histological alterations. The cranial bone causes a high attenuation. Usually only a small fraction of 1 W/sqcm enters the brain. For valuating the therapeutic effect there must be: 1) Exactly neurologic experiments 2) A sufficient number of cases in order to differentiate from spontaneous remissions, 3) over sufficiently long periods after treatment has been finished and 4) Controlling test observations on other cases. Until now, there have been no statistical experiments. These can only be performed in especially equipped mental hospitals with properly experienced staff. Other results about pathophysiological effects of ultrasonic treatment on ZNS may be expected from the last works of FRY, FALL and coworkers, who apply very high intensities (up to 400 Wsqcm)

32. B. BRUNI, Udine, Italy

Ultrasonoterapia e malattie dell'apparato digerente. (Ultrasound Therapy and Digestive System Disease).

12 patients suffering from cholecystitis with gallstones, pericholecystitis, spastic colitis, duodenal ulcer, pericolicitis with postoperative adhesions at abdominal tuberculosis were treated exclusively with ultrasound. Before all of them had taken other treatments with non satisfactory results. All diagnoses were confirmed exactly. All of them showed excellent results, whereby also clinical changes were controlled. Ultrasound of 1 mc and 0.75 - 1.5 W/sqcm was used. Before each of 10-30 treatments some liquid was given to every one for drink.

33. P. BUGARD, P. VALADE, E. COSTE, J. SALLE, Paris, France

Le syndrome traumatique-vibratoire experimentale. (Experimental Traumatic Vibratory Syndrome.)

The paper deals with disturbances appearing on test animals (dogs, rabbits, guinea pigs) if they are exposed to large ultrasonic intensities. Noise from pulso- and turbo-reactors were used, also Pimonow's sirene and ultrasound. Red and white blood corpuscles, leucocyte forms (blood sedimentation rate) quantity of urine and properties of 17-ketosteroids, electroencephalogram and histological aspect of tissue were observed. The progress of the traumatic vibratory syndrome is characterized by two phases. In a first nervous and neurovegetative phase some reaction of medulla of the suprarenal gland appears, especially distinctly if influenced by reactor noise, less distinctly in case of ultrasound. In a second phase the participation of endocrine systems becomes more important: pituitary gland, thyroid, and adrenal cortex become more active in blood and tissue.

34. F. PANUCCHI, R. PARISCENTI, M. GIRELLI, Milano, Italy

Effetti degli ultrasuoni su alcuni distretti neurovegetativi. (Ultrasonic Effects on some Neurovegetative Zones.)

Experiments were made to investigate the ultrasonic effects on the nervous mechanism; heart and vessel reactions were especially tested (dogs and rabbits). Stellate ganglion, carotid sinus, vagal nerve on the region of the neuro-vascular fascicle and splanchnic nerves were treated with ultrasound. The experiments demonstrated: 1) At the stellate ganglion there was no remarkable change of the arterial pressure and no acceleration of pulse rate and no change of

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the electrocardiogram. 2) The carotid sinus treated with ultrasound showed an arterial rising of the blood-pressure and an acceleration of pulse rate. 3) The vagal nerve shows a reaction only in case of more intensive ultrasonic energies. These cause an acceleration in pulse rate and a slight, but immediate rising of arterial blood pressure. The splanchnic nerve does not show any ultrasonic response.

35. J. VAN WENT, Amsterdam, Holland

Biological investigations of the Changes in the Connective Tissue in Relation to diseases of the Spine.

A report was given about investigations of the changes in the connective tissue in relation to diseases of the spine when treated with ultrasound. In case of bony fusion of vertebrae and its stiffness, herniation of the nucleus pulposus in the course of ultrasonics treatment, changes of deformity were recorded on graph paper by means of a simple instrument. Tissues were examined for changes. (The vertebrae and intervertebrae disks were examined on the spine of a pig. When the preparation was treated with ultrasound and some drops of Ringers solution added, after 5 minutes one could see that the preparation dissolves 9-10 drops and the control preparation only 1-2. The volume of small pieces of the ligamentum anterius and posterius was determined and it was noted, that the volume of small pieces treated with ultrasound had grown by 2-6 tenths cm. Heat did not produce the same results. Micro-photography with incident light and in the phase contrast microscope were then taken. It was noted that the changes do not affect the fibres but the interstitium. Better effects were observed in case of smaller doses ($\frac{1}{2}$ W/sqcm) than in case of longer and stronger dosage. In case of bony fusion of vertebrae and its stiffness and spondylosis deformans, the neutrophil leucocytosis, being 60-70% at beginning has been reduced to 45-50% after ultrasonics treatment. Conclusions by lecturer: 1) Beneficial effects of ultrasonics treatment on various diseases of spine. 2) Deformations of spine formerly considered as fixed, can be mobilized by means of ultrasonics treatment. 3) Operation for degeneration of intermediate spine should be made only when ultrasonics treatment is not successful. 4) In case of diseases of spine ultrasound treatment probably is successful because of effect on the connective tissue. Liquid is absorbed by the surrounding tissue and not by the fibres, but by the environ tissue. 5) Besides a neural effect, a local effect is assumed. The influence of ultrasound on

the tissue is specific, besides the heating effect. If there are no counter-indications, low doses (low intensity and short time) give the possibility of a long ultrasonics treatment without any damage. 6) The per cent of neutrophil leukocytes, which rises greatly in case of bony fusion of vertebrae and its stiffness and spondylosis deformans, is often normalized with ultrasonics treatment.

Discussion:

HINTZELMANN: The effect of ultrasound on the water absorption of connective tissue presented by Mrs. VAN WENT by means of simple experiments is very impressive. The oldest opinions concerning ultrasonics effect were: the tissue treated by ultrasound absorbs liquid and thus the elasticity of the connective tissue grows. The lecturer's own opinions in this case were advocated 11 years ago. The neurovegetative effect being in the foreground today, has been justly emphasized, however, it is not the only effective component.

VAN WENT: (Conclusion): Since the vertebrae never shows observable changes but muscular causes of diseases of the spine react very well to ultra short waves, however, these do not show any effect in case of morb. Bechterew; there remains only the assumption, that ultrasound affects the elasticity of the intervertebrae discs, which are also traumatically or degeneratively changed.

36. F. ZACH, Vienna, Austria

Beitrag zur Ultraschallwirkung am vegetativen System. (Contribution to Research on Ultrasonic Effects on Autonomic Nervous System.)

In many considerations on responses to stimuli in the organism studies about the autonomic nervous system are first undertaken. Knowledge of centrally regulated phase variations after W. R. HESS and W. BIRKMAYER gives us the base for all pathophysiological considerations. An ergotropic and trophotropic phase is known by measuring variations of the secondary electromotor phenomena of skin, by polarization voltage. Electrodermatometry has been developed according to own scientific work (Constant-current-device, 1.5 V and about 1 A). whereby at 10 minutes intervals measurements were undertaken on 24 spots, on each side of the body. Large variations in polarization voltage indicate trophotropic neurohumeral phase brought about, low polarization voltages ergotropic phase. Twenty convalescents were treated with ultrasonics (1.2 mc, pulsed sound 1:15

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- 1:13, intensity 0.75 - 3 W/sqcm) partly on extremities, partly paravertebrally. The autonomic phase variations in the electrodermatogram and gas exchange were observed. Results show that ultrasound effects in any case local and general reactions. Even the smallest intensities of pulses sound can be demonstrated by tangible signs. The reaction time depends also on intensity and localization of ultrasonics treatment. Clinical improvement is accompanied by decrease of measured values (increase of polarization potentials in trophotropic phase) in segments and also almost anywhere in the body. Small doses are especially effective in case of ergotropic stage at beginning, in the sense of physiological progress of the reaction and, by using them, it is possible, to establish the "vegetativer Dreitakt" (vegetative reaction in three phases after SIEDEK) while larger doses rather become effective at trophotropic stage at the beginning, and frequently are followed by dystonic regulation.

Discussion

PAVELKA: Ultrasonic treatment of the cerebrum in dement infants shows, regarding the psychical expressions a pronounced effect of three phases: for the first days the infant becomes more quiet and calm and sleeps better. From the 5th to the 14th day, a pronounced activity starts with restlessness and erethism; following this condition, it changes to a permanent state of quickness and it can be affected more easily.

ZACH: In 6 control cases no changes after fictional treatment. (without ultrasound)

VAN WENT, SCHIKORSKY: Doubts whether the subtle reactions like metabolism of gases and the electrodermatogram are precise enough to determine the vegetative reactions. In many cases of vegetative irritations, already minor external causes are answered violently. That is proved by the well known psychogalvanic reflex. The patients for the control test have to be of the same group of patients.

VAN WENT: Because of the marked sensibility asthmatic patients should not be exposed to extreme ultrasonics treatment.

ECKEL: The reproach that the experimental neurovegetative research uses too intricate methods, should be rejected as well as the reproach that the pathological i.e. the morphological examinations are performed too late. Between

these two fields of research, up to now, there is an unknown space, where we will find the answer for the mechanism causing the effect.

ZACH: Conclusion: The changes of the vegetative tonus by pharmacodynamic, physical and physical causes can be distinguished exactly and sufficiently. The reported cases shall explain mainly how sharp the reactions to ultrasonics treatment fit all other experiences we have learned about the vegetative nervous system. Especially the reported cases with bronchial asthma can explain this. In one case, too intensive irritation by ultrasonics effects a sudden change in the reactive stage and produces a fit. In the other case the stimulus meets the organ in such a way that the fit can be stopped. The positive action of ultrasound, as said before, in cases of sympathetic stage is to act in a damping way, and the clinical observations show any effective stopping of an asthmatic fit, as the practical value of this precisely aimed use.

WEDNESDAY, September 10, 1952, Morning Session

Presiding: R. Pohlman - F. Dussik

37. U. HINTZELMANN: Wiesbaden, Germany

Der Ultraschall im Rahmen der Rheumatherapie (Ultrasound in Rheumatism Therapy)

Between the medical praxis and the scientific research in the field of ultrasonics there exist still great differences. Empiricism is far more advanced than theoretic knowledge. In the field of the rheumatic disease, much progress has been made since the last explanations by the author in the book about the ultrasound-therapy (R. POHLMAN (1950), which can be found in the following report. The experimental examinations of HORNKIEWITSCH with the use of therapeutic doses showed, from which dosage on the shift of the reaction of the tissue goes to the basic side and the relations of the pH in the artificially inflamed tissue. The conclusion has been reached, that the local or topical treatment in rheumatic cases will furtheron be of therapeutic value. HOLZ and coworker from the pharmacological standpoint found the formation of pharmacodynamic substances of the tissue in isolated organs if therapeutic doses are used. Whether these substances will also be produced if spinal roots are treated, is not sure. Anyway, all other clinical measures based upon rheumatic etiology may still be observed. Also the perception about the

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disbalanced mechanism of immunity and the accumulation of muco-polysaccharides and protein substances in the tissue, which produce auto-antigene in the rheumatic body, is not touched. According to the opinion of the author, the Bechterew's disease and the deforming spondylopathy still rank under the first indications for ultrasonics treatment. Emphasis is laid upon simultaneous treatment of peripheral and central segmental parts of a zone in the nervous system, with different intensities (relation of intensity 7:1)

Discussion

VAN WENT: She confirms that and points to the fact that successful treatment requires early beginning.

LEHMANN: In cases of Bechterew's disease these good results have never been seen as **HINTZELMANN** and **VAN WENT** reported. But only such cases have been treated where the blood sedimentation rate was normal. He expresses the thanks of the French delegation and affirms that by this session the practical importance of the u.s. has been affirmed.

ZACH: In an acute arthritic state of a joint the combination of a central analgesic drug (Irgapyrin) and ultrasound is of great importance. The segmental ultrasonics treatment plays the role of the so-called = segmentale Entwarnung = (all clear signal in segments (FENZ.)) In cases of spondylopathy pains after ultrasonics treatment indicate herniation of nucleus pulposus in the vertebral disc. The osteoarthritis of the hip joint (Malum coxae senillis) shows good results after treatment.

38. **E. BATALLA, J. ROTES, A. ZAUNER,**
Barcelona, Spain

Die Ultraschallbehandlung bei rheumatischen Affektionen. (The Ultrasonic Treatment in Rheumatic Affections.)

Reports of 200 cases particularly good results in cases of arthrosis; muscular rheumatism, neuralgia, sciatic neuritis and neuritis cervicobrachialis. As an additional treatment in cases of Bechterew's disease. A selective influence upon nerve roots, muscles and tendons is assumed, as such as its analgesic action; further a lissive action on muscular contractures, myogelosis, fibrositis. The superior value is accented in relation to other means of physical therapy in the cases indicated above.

39. **E. UNGEHEUR, C. GLENK,** Frankfurt/Main
Germany

Bedeutung der Ultraschallbehandlung bei rezidivierender Ischialgie. (The importance of Ultrasonics.-Therapy in Recidivation of Sciatic Neuritis.)

Both, the acute as well as the chronic sciatic neuralgia are in the domain of ultrasonics treatment. **ROSENBERG** found by animal experiments good results of ultrasonics treatment in neuritis (sciatic), because of a pronounced selective influence upon the medulla oblongata. Within 4 years, 473 cases have been reported, including many herniations of nucleus pulposus. The most cases with recidivations showed pathologic changes in the X-ray reading.

40. **F. FANUCCHI, M. GIRRELLI, S. INGEGNEROS,** Milano, Italy

Risultati raggiunti con Is terapia ultrasonics dopo 1 - 4 anni. (Results of Ultrasonic Therapy 1 to 4 years after treatment.)

In 318 cases the frequency of recidivation has been studied. 150 cases have been excluded from test series because of the short time of possible observation. Anyway this group had 60% to 80% good effects upon treatment. The percentage of cure and improvement (relief) is about the same in the different groups of diseases. Recidivation appeared in 60% of the cases and has been more frequent in cases where only a slight improvement was present. Dosage used: 1 MHz 1 to 1.5 Watt per square centimeter 3 to 20 minutes. It is said, that the elementary mechanical and the thermal factors because of the simultan and synchron action, cannot be separated as to its effect.

41. **W. A. DALICHO,** Gera. Germany

Die Behandlung der Periarthritis humeroscapularis. (The treatment of Periarthritis Humeroscapularis)

Comparison of 100 patients each treated with ultrasound and X-rays. Among causes are included mechanotraumatic, infective-toxic, endocritic-hormonal and vascular disturbances. From the pathologic standpoint it is a deposit of phosphorated and carbonated calcium into the inflamed tissue of the tendons. Besides the elimination of a present focus, the treatment of the periarthritic region has to be performed. X-ray therapy achieved complete cure in 54% and relief in 37% that means successful treat-

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ment in 91% ultrasonics treatment (800 KHz) with topical application over the shoulder joint and the related segmental paravertebral region. Cure in 50%, significant relief in 38%, total 88%. That shows the same therapeutical value as the X-ray treatment, approx. the same number of times. Also calcification disappears with both methods of treatment. Relapse seems to be more seldom after X-ray treatment. The segmental application brings also many advantages for X-ray treatment. No beneficial results have been observed if osteochondrosis was present. Failures with one method can mostly be compensated by the other method.

Discussion

MAYR: Report of a case that during a treatment of the shoulder joint a concealed disease of the heart became manifest.

42. H. SCHNEIDER, Innsbruck, Austria

Die Ultraschallbehandlung der Tendopathie. (Ultrasonics Treatment of Tendopathy.)

Report of studies, according to which a group of degenerative diseases are caused by affection of the tendon, i.e. Epichondylitis, Coracoiditis, Deltoidalgia, and styloiditis. Report of experiences after treatment in 239 cases, 65 of which were diseases of the heel tendon. 2/3 of the cases had no complaints after 2 weeks of treatment. Relief in almost all of the other cases. No success in only 5 out of 65 persons with calcifications of the tendons. The earlier the treatments starts, the better the results, especially before the onset of calcification. In acute cases of disease of the tendons subfebrile temperatures are present and some times a higher blood sedimentation rate. Positive results after ultrasonics-treatment can be seen within a shorter time than with X-ray, while the performance of the ultrasonics treatment is easier. Demonstration of good X-ray films.

Discussion:

LEHMANN: (concerning the lectures of DALICHO and SCHNEIDER) The vegetative influence is of marked importance in the formation of the periarthritides humeroscapularis. These manifestations following a neuritis are successfully treated with the sound application directed to the stellate ganglion. If the cause is myositis, topical application and the surrounding muscles have to be in the field of treatment.

HINTZELMANN: (concerning the lectures of DALICHO and SCHNEIDER): Reports, that barbitural drugs help the onset of periarthritides humeroscapularis. That means no barbiturate may be used in this treatment.

43. L. BARBE, Bordeaux, France

Les ultrasons en oto-rhinolaryngologie. (Ultrasonics in ENT.)

Studies about the action of ultrasound on the auditory organ in the field of physics, histo-physiology and therapy. (used frequ. 1 Megacycle). Description of a special apparatus. If ultrasound penetrates aqueous solutions or living tissue, luminescence occurs with wavelength from ultraviolet to 3500 A. In the physiologic test hyperfunction of the auditory organ can be found at 0.5 watt per sqcm. At 1.5 Watt per sqcm a primary functional loss of hearing is present which then becomes secondary and can be noticed at higher frequencies. At 0.3 W/sqcm, a hyperaemic state is present which becomes pronounced at 1.5 W/sqcm; necrotizing effect at 4.0 W/sqcm for the cell. In the therapy of otosclerosis 35% had 25 decibel gain, 26% had 10 decibel gain of hearing capacity, in 49% no effect was present. Moderate deafness in case of lesions of the inner ear: 42% had 20 decibel gain, 36% had 10 decibel, no reaction in 22%. Tinnitus in the diseases reported will be influenced in 80% of all cases.

44. K. ECKEL, Bad Ischl, Austria

Die Behandlung muskulärer Erkrankungen mit Ultraschall. (Treatment of Muscular Disease with Ultrasound.)

In considering muscular diseases, this group of sickness has been divided into 3 subgroups. Therapy possibilities were enhanced by the excellent trophic effects of ultrasound treatment of neural and spinal muscle atrophies, that is, in case of toxic-infective neuritis and of poliomyelitis. During treatment of these muscular atrophies most of the effect are achieved over vascular-vegetative innervation, because ultrasonics treatment of regional blood vessels, conveying blood toward the region, leads to full effect. There was shown in case of spastic paralysis that best effect was achieved by ultrasonics treatment of the affected muscles themselves. By no means in case of spastic paralyzes by ultrasonics treatment of the vertebral column a special tonus loosening effect comes about. In some case of transverse lesion of the spinal cord only the impression has

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been that improvement of conductivity itself comes about for the nervous tracts in the spinal cord, for instance in case of myelitis arachnoiditis, and hematomyelitis. Rather frequently, visceral functions of bladder and intestines only improve, without improvement of mobility. In sum, the tonus loosing effect of ultrasound, however, must be regarded in case of transverse lesions as practically little effective. Results are better for more proximal spinal localization than for lumbar. But because also contractions show improvement in case of local ultrasonics treatment, nevertheless ultrasound shall be used as peripheral muscular treatment for transversal paralyzed patients. Best results and practically most important ones were achieved by ultrasonics treatment of Little's disease. Motility and spasticity improve by it and permanent success is achieved by loosing of contractures. Considerable improvement can be shown for a third group of diseases of nervous system; in case of progressive mytonia atrophica, dystrophic muscles sometimes show some gain in strength but mostly it does not persist. Amyotrophic lateral sclerosis and spastic paralysis of spine were treated with little success.

Discussion

STUHLFAUTH: Confirms the great importance of ultrasonics treatment in vegetative vascular regions. It is important for knowledge about spastic processes that tonus loosing effects come out at direct ultrasonics treatment of muscles. Vegetative reaction is shown also by decrease of eosymophil blood cells which we have found to be especially large at ultrasonics treatment of vascular system.

ZACH: The effects on the autonomic vascular system have been very often observed, when no other therapeutic effects are obtained; in 4 of 6 cases improvement of bladder or visceral function were achieved, whereby motility remained unchanged.

MAYR: Indications and questions whether ultrasonics treatment of heart and stellate ganglion in cardiac region brings about complication.

ZACH: No injury was done to myocardium by ultrasonics treatment. Well conditioned hearts do not show any disturbance even in case of excessive treatment with ultrasound.

STUHLFAUTH: In case of injuries to myocardium and coronary sclerosis a series of damages might lead to anginous attacks of heart. This is by no means a consequence restricted to ultrasonics treatment only; it can also be brought about by a hot hand bath. If the heart is in proper condition, effective disturbances never occur: Experiments of some authors on themselves showed that only in case of extremal doses, cardiac sensations could be excited. (Static ultrasonics treatment with 2.5 W/sqcm.

PAVELKA: Does not find any danger from circulatory system at many ultrasonics treatments of stellate ganglion, if the patient is treated with caution and by slowly increasing doses. Regulative effects to heart come out, but there was never shown any serious complication.

ECKEL: (Conclusion): Agrees to last discussions, in which there was established that generally little reaction comes from ultrasonics treatment of vegetative nerves along vascular system, if the vascular system of the patients is sound and if doses applied are small ones. The danger of ultrasonics treatment of cervical sympathetic system at endangeitic processes and apoplectic states cannot be overemphasized. There was reported additionally that cardiac phenomena are without doubt appearing too, if for instance largely extended parts of muscles are treated ultrasonically with large intensities. Perhaps humoral substances acting on vascular system must be considered, formed during ultrasonics treatment of big areas.

45. K. HENKEL, Garmisch-Partenkirchen, Germany

Mikrodosen (Microdoses).

Practical work with small intensities of sound proves, that sensitivity and reactive stage of the patient influences to a very large degree the effect. Small doses, thoroughly confirmed the opinion about neural mechanism of the effect. Own experiences confirmed that improvement by the therapeutic effect is the same if there is used a maximum of 0.6 W/sqcm instead of 3-4 W/sqcm, it is rather better at small intensities. Ultrasonics treatment is regarded as stimulating treatment.

Discussion

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ZACH: The smallest doses in a case of bronchial asthma with clinical effect proved by electrodermatography was 0.1 W/sqcm, at a pulse to pause ration of 1:13 at 1.2 mc, so that the average total intensity was 0.08 watts.

ECKEL: We have long ago found by neurologic application that, with regard to the neural mechanism of the effect, small doses are sufficient to achieve optimal effects. The calculation of an average value concerning time in the remark above should be rejected because otherwise physical data taken for determining the applied energy, being complicated enough in themselves, would become yet more confusing. This averaging includes already the assumption of pure thermal effects, even if it has not been explicitly said. In case of pulsed sound, amplitudes remain unchanged for different pulse to pause ratio, in ZACH's example, they always correspond to 0.1 W/sqcm. In pauses at pulsed sound peaks of temperature become equalized but there is no mechanical action then.

46. K. WOLLMANN, Berlin, Germany

Lokale oder segmentale Beschallung? (Shall ultrasonics treatment be local or segmental?)

The author, who has made experiences with more than 10.000 ultrasonics treatments proves at 39 cases that treatment of ulcera cruris, scapulchumeral periartthritis, arthrosis deformans of knee and hip joint, ischialgia, epicondylitis leads to far better and earlier improvement if besides local ultrasonics treatment also segments were treated. If only segments were treated or only local treatment would be used, no such successes could be achieved.

47. G. WILLIAM, Linz, Austria

Erfahrungen über die praktische Arbeit an 300 Ultraschall-Therapiestellen. (Experiences in Practice at 300 Ultrasonics Therapy Stations.)

Survey on practice and efficiency of ultrasonics treatment. After the judgement of 85% of physicians, active in therapeutic practice, the result of ultrasonics treatments are very good, further 9% regard it as useful. Only 6% come to negative judgement about it. Dosing and coupling closely connected with it are essential factors. In practice best results were achieved by slowly raising the intensity up to the final successful dose, because the reactive stage of

inflammatory processes as infiltrates, hydrarthrosis, paronychia, lymphomas, chronic osteomyelitis, thrombophlebitis and similar. Also phlegmons, endangeitic or diabetic gangrenes sinusitis and catarrh of Eustachian tubes, suppuration in middle ear are indications for successful treatment. In practice, results are not so good at chronic inflammation of joints, because then universal treatment is important.

Discussion

ZACH: Reports about a panaritium which has been healed after 2 ultrasonics treatments with pulsed sound 1.2 mc at 0.1 W/sacm.

MAYR: Warns of treatment of suppuric processes because of growing number of progressive inflammation, as has been shown by experiments.

WEDNESDAY, September 10, 1952 Afternoon Session

Presiding: F. SEIDL - F. LETTOWSKY

48. J.J.WILD, J.M. REID, Minneapolis, USA

Fifteen Megacycle Pulsed Ultrasonic Reflection Studies on Biological Tissues.

An ultrasonic beam of 15 mc pulsed ultrasound of 0.5 microseconds duration at a frequency of 600-4000 pulses per second was applied on tissue. Peak intensity on the crystal was less than 644 W/sqcm. Thickness of ultrasonic beam was 3 mm. The emitted pulses were received with the same quartz as emitted. The most important result is that malignant tumors show distinct differences in received intensity against normal tissue, and also against benign ones. There were 19 cases of tumors of the female breast clinically established as all of them being malignant ones, that is 11 tumors correctly were recognized. Hypothetically there has been assumed, that suppression of echo at malignant tumors was caused by stronger concentration of cell nuclei in malignant tissue.

49. R. H. BOLT and T.P.HUETER, Cambridge, USA

Some aspects of Transcranial Ultrasonic Transmission.

Although many ultrasonograms have shown a definite gestalt similarity to X-ray pictures obtained with air filled ventricles, we must also face the fact that two groups of investigators (at Erlangen and MIT) have obtained lateral ultrasonograms on water-filled

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skulls which show a characteristic gestalt likeness to the ventricles. Nevertheless, there have been obtained at MIT (using apparatus developed there) ultrasonograms in the A-P direction on two cases that showed abnormalities, in general agreement with operative findings which established the presence of a tumor. The A-P sonogram is easier to interpret than the lateral pictures obtained by DUSSIK because of its symmetry and because $\frac{1}{2}$ of ventricle is within access of the parallel portion of the transmitted signal. Some noise problems (electromagnetic noise, cross-talk, tube input noise, ground loops, acoustic transmission around head, reverberation in tank, relative motions of transmitter, receiver and head, variations in contact of coupling water with head, grease, hair, air bubbles) can be solved within the general limits on intensity, frequency and beam width of signals which can be safely generated and transmitted into the patient's head, but there are major noise problems, variations arising from scattering and refraction in brain tissue, non-homogenous folds, and especially the undesired skull information, influencing the acoustic signal (a) Thickness variation b) shape variation c) Internal structure) on which the entire method will stand or fall. Bone attenuation can be compensated by the following methods: (1) 2-frequency differentiation, (2) X-ray (3) Differentiating to show slopes at edges of ventricles (4) Radioactive absorption. Other possible kinds of signal processing are (a) Averaging over space and/or over frequency to smoothen out interferences. (Frequency modulation of noise band will help reduce fluctuations.) (b) Pulse-gating. (Signals not coming along minimum path are minimized) (c) Correlation and filtering methods. (d) Compression and expansion in presentation. First, one must try to see all the information, conveyed by any given type of transmitted signal. No amount of processing can add new information. The lecturer emphasizes that the desired signal is: "Normal" "Abnormal". Even X-rays have distortion. All information wanted may be obtained merely by a "pip" on the oscilloscope. Considering all recent advances in the processing of information to extract weak signals from noise, there cannot yet be said that, even with help of these techniques, the sonogram will become a reliable diagnostic tool for the neurosurgeon.

50. K.Th. DUSSIK, Boston, USA

Entwicklung und Aussichten der Ultraschall-diagnostik mittels Durchschallung (Hyper-

phonographie) (Development and Chances of Ultrasonics Diagnosis by Means of Sound Transmission (Hyperphonography))

The transmission method for achieving pictures of living human objects, especially the cranium, first has been brought before the ultrasonics congress in 1949 at Erlangen to be discussed. Since this method has been worked out at two places outside of Bad Ischl, and that by PAETZOLD, FIEDLER and GUETTNER in the laboratories of the "Siemens - Reininger Works" then by a research team of the General Hospital at Boston and of the Massachusetts Institute of Technology at Cambridge. The method has to meet with considerable experimental difficulties, as has already been emphasized at Erlangen, and as has become yet more clear in course of further testing and developing the method. The lecturer could not make use of any larger experimental possibilities, needed for answering and solving different questions. Therefore he can show only the hyperphonograms which were achieved until 1949 against the results from Erlangen and Boston - Cambridge. While the group at Erlangen in consequence of their measurements and conclusions has come to the result that this method would not make possible to get any pictures of true shape of the ventricles because of different disturbing effects, especially because the skull is varying in thickness. The American team too has established such effects, but they have sought possibilities to compensate them. In case of 2 tumors clinically serviceable results were achieved. The ultrasonic pictures, which have been obtained by means of the transmission method of the lecturer in anterior - posterior direction to the skull, could be verified by operation. The lecturer points out that some pictures obtained at Bad Ischl also have been verified clinically. Especially there was discussed about pictures before and after cranial operation, showing such differences that they could be regarded as full proof for the conclusion, that information obtained by ultrasonic pictures is in good agreement with internal cranial details. While in this case from the same cranium necessarily different results were obtained, there are otherwise ultrasonics pictures well reproducible, if they have been obtained at the same conditions. The author, however, has observed that distinct pictures were not obtained for every adjustment of the apparatus. Because adjustment of the apparatus in Bad Ischl is very subtle, intensity, frequency (in limited degree) and modulation being variable, and because in operating the apparatus in Bad Ischl the optimal contrast between the ventricular region and its environ always was establish-

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ed, the lecturer assumed until 1949 that failure of this method in the mentioned cases was due to not sufficient accuracy of adjustment. Results from Erlangen and from Boston-Cambridge, however, indicated that there were certain anatomical circumstances, leading sometimes to applicable results, but sometimes to non-applicable ones. Therefore practical serviceability of the method depends on compensation of the chief factor causing disturbances, that is of varying thickness of skull. The lecturer declares that such compensation could be reached by coupling the ultrasonic beam with a corresponding one of X-rays. Electroenceleography and radioisotopic techniques have been developed since 1937, when first the method was known, but they did not solve the problems inasmuch that concerning pathological values of elasticity and viscosity no further progress could be made in determining them, and so the lecturer believes that in spite of the objections of the Erlangen group further work in improving the transmission method, especially by means of compensating the disturbing factor that is the thickness of the skull bones stands a chance and will have success. Finally there is irrefutable clinical evidence, which cannot be explained by self deceiving, that at least a considerable amount of information, contained in ultrasound pictures, taken in Bad Ischl is not caused by bone attenuation, but is informing about essential internal details of the brain. Against the said arguments theoretical considerations and investigation on details are less convincing, especially in a field that is new and physically difficult. Also in case of other diagnostic methods, based on physics, first there had been told by therapists, that it were impossible to get any results from it (for instance electroencephalography, electron-microscopy a.a.), while nevertheless further development proved, that these methods are useful. Concerning the questioned ultrasound transmission method, the lecturer did not change his opinion, that there indeed were difficulties in developing the method, but that nevertheless a valuable enlargement of diagnostics will result from this method.

51. W. GÜTTNER, Erlangen, Germany

Betrachtungen zur Möglichkeit der Ultraschallabbildung am menschlichen Schädel.
(Considerations about the Possibility of Achieving Ultrasound Pictures of the Human Cranium.)

Careful considerations of DUSSIK's transcranial ultrasonic transmission method lead to a series of acoustical problems, which seem almost impossible to solve. Measure of propagation, speed, wave resistance and acoustical attenuation on liquor, brain and bones show that 1) Refraction of brain against liquor is of negligible amount, and sound transmission is practically without any reflection. 2) There are actually differences in attenuation between brain and liquor, but they are very small compared with attenuations caused by bones. 3) Transmission through bones depends on angle of incidence. Therefore it follows and can be experimentally proved, a) Refraction of sound caused by the external surface of the human cranium which approximately can be regarded as spherical, leads to distortion of pictures b) The skull bones, varying in thickness from point to point, cause already some very distinct structure in attenuation pictures, whereby the thickness of the bones remains unknown, so that additional decrease in attenuation, caused by the ventricles, can not be differentiated c) The attenuation picture does not show proportionality to length of path travelled by ultrasound. From these investigations it can be concluded, that ultrasound pictures were incomparably inferior as to true shape and precision to pictures obtained by X-ray methods.

Discussion

The lecture was followed by a very lively discussion whereby different views were exchanged, questions answered and details explained but there did not result any new aspects of the problem itself. In the discussion participated: DAUM, F. DUSSIK, ECKEL, v.GIERKE, LETTOWSKY, PAVELKA, FOHLMAN, SEIDL.

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