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By

LEWIS GREGORY COLE, M.D.

Professor of Roentgenology to Cornell University Medical College, New York

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Preliminary Report on the Therapeutic Possibilities of the Coolidge Tube

Lewis Gregory Cole, M.D., New York
Professor of Roentgenology to Cornell University Medical College

The advent of the Roentgen ray tube designed by Dr. Coolidge marks a new era in Roentgenology, and especially in Roentgenotherapeutics. Dr. Coolidge's investigations have culminated at a most auspicious time, as the reaction against Roentgenotherapy is now at a low ebb, while attention is being focussed upon the therapeutic value of radium. Such opposition as has been raised against treatment by the X-ray is the natural result of unreasonable claims made by certain men, whose work has been termed unscientific, to say the very least. The value of Roentgenotherapy for superficial epithelioma, certain types of sarcoma and the post operative conditions of cancer of the breast has already been thoroly established by men of unquestionable reputation—Pusey, Pfahler, Johnson, Van Allen, and many others, who have had the hearty coöperation of the surgeon, particularly in the post operative treatment of cancer of the breast. The results obtained by these men have been accomplished under great disadvantages, owing to the inadequacy of the ordinary type of Roentgen ray tube. It has been difficult to obtain a sufficient amount of highly penetrating rays, and furthermore impossible to determine definitely that the desired or supposed penetration was being sustained during an exposure. This uncertainty was due to the instability of the vacuum of the tube. Exposures sufficiently prolonged to produce a quantity of highly penetrating rays entailed dangerous exposure to intermediate tissue. It was Pfahler who first suggested the use of filters to absorb the soft rays and prevent surface burning. His method of protection was adopted and the filters increased in thickness by Albers-Schoenberg and Haenisch, and Kroenig and Gauss for the deep therapy of myomata. Even the long exposure thus made feasible by eliminating the soft rays have failed to produce hard rays in sufficient quantity for satisfactory results on deep lesions. Radium has been effective in the treatment of certain types of cancer. But here also long exposures are required; and moreover so little radium is available that it is beyond the reach of the great mass of patients.

The tube designed by Dr. Coolidge removes many of the limitations that have encumbered the development of Roentgenotherapy. The rays emanating from this tube far excel all former possibilities of penetration. The tube may be operated continuously without any fluctuation at a penetration which is beyond the scale of either the Walter pentrometer or the Bauer quantimeter. So great is the potentiality now available, that a full erethyma dose may be administered to the sur-

face without a filter in 30 seconds, with a 3 m.m. filter in 1 minute, and with a 10 m.m filter in 3 minutes.

Accordingly it is evident that if the soft and medium rays be filtered out by using different thicknesses of aluminum, a penetration desirable for a lesion of any depth may be obtained, especially by the cross-fire method, using several ports of entry thru the skin.

In order to demonstrate the superiority of the Coolidge tube to all other tubes, and to prove that with the Coolidge tube a full erethyma dose may be administered to a tumor 3 inches below the surface without endangering the skin itself or intervening tissues, the following experiments are submitted, showing—

1. That most of the rays from the ordinary tube, operated at its greatest penetration with a standard exciting apparatus, are absorbed in the first inch of the tissue, if no filter be interposed.

2. That with the ordinary tube, operated to its fullest capacity on such an apparatus, no filter being interposed, 11½ minutes are required for a full dose 3 inches below the surface, and that 16 times an erethyma dose is meanwhile administered to the skin.

3. That with the Coolidge tube a full erethyma dose can be administered to the surface in 30 seconds, if no filter be interposed.

4. That with the Coolidge tube a full erethyma dose can be applied to the surface in 1 minute, thru 3 m.m. aluminum.

5. That with the Coolidge tube a full dose 3 inches below the surface can be obtained in 6 minutes thru 6 ports of entry, using a 3 m.m. filter.

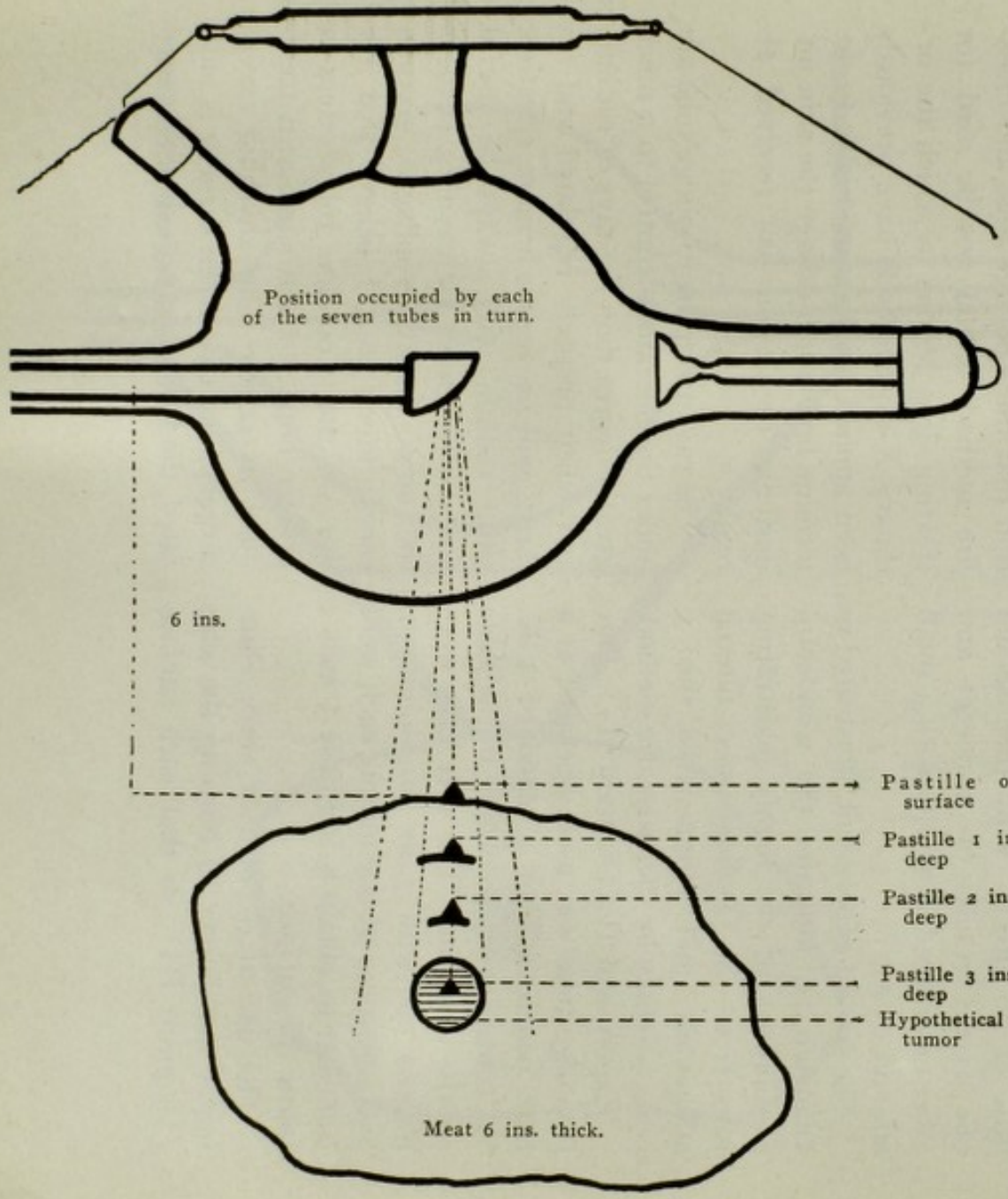
The experiments undertaken in proof of these tenets consisted of the Roentgenization of an area three inches below the surface of a piece of meat 6 inches thick, a depth of tissue calling for a penetration about equal to that required for treating a cancer of the pylorus. The surface of the meat was 6 inches from the focal point. The doses were measured by Hampson pastilles, one placed on the surface of the meat, a second imbedded one inch deep, a third located 2 inches from the surface, and a fourth 3 inches from the surface.*

The first experiment, illustrated in Diagram I, shows the inefficiency of the X-ray treatment of deep lesions by the ordinary Roentgen ray tubes, when neither filters nor the cross-fire method is employed.

Experiment I: The area 3 inches from the surface of the meat was exposed to rays from 7 ordinary tubes, excited to their greatest capacity by a standard transformer with a parallel gap ranging from 7 to 4 inches, according to the table given on the diagram. Eleven and one-half minutes were required to obtain a full dose at the fourth pastille, the supposed depth from the surface of a cancer of the pylorus. The surface pastille received coincidentally 16 times an erethyma dose, an exposure which of course would have burned a patient beyond recovery.

If not more than an erethyma dose

* While I am not a sponsor for the accuracy of the Hampson pastille in measuring an erethyma dose, it is undoubtedly a fair guide forcomparing dosage administered on the surface with that received one, two or three inchesbelow the surface.



Tube No.	Parallel Spark Gap: Began at	Dropped to	Milliamperage	Exposure (in minutes)
1	6	3	10—20	½
2	7 —6 —5 —4 —4½		10—15	2
3	7½—6 —5 —4 —4½—5		10—15	2
4	5½—5 —4 —4½—5		12—18	2
5	8 —5½—4½—4 —3½		10—15—18	2
6	4 —4½—4 —3½		15—15—16	1
7	4½—5 —5¾—6 —5¾		12—10	2
			14 Average	11½ Total

Average Milliampere Minutes :161

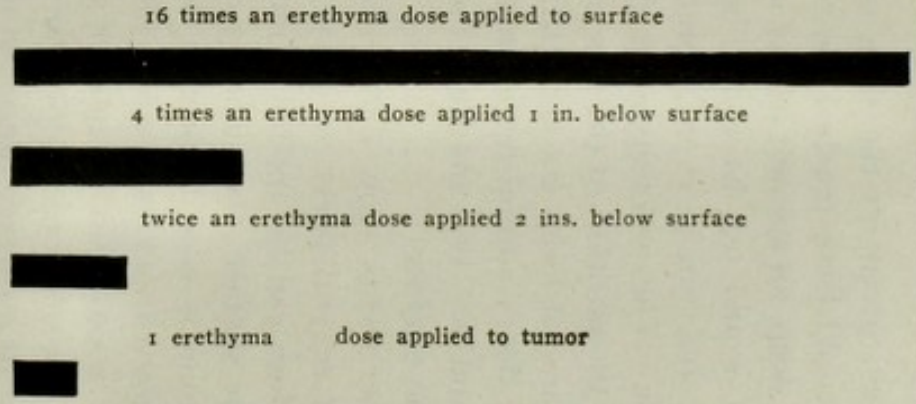


Diagram 1.

had been given on the skin, only 1/16 dose would have reached the tumor 3 inches deep, an amount of ray so small that it would not have any beneficial effect, and might even stimulate the growth. The accompanying diagram shows the position of the tube and pastilles, and includes a comparative table of the doses administered on the surface, and one, two and three inches below the surface.

Experiments show that without the use of several ports of entry only 1/6 of a dose can be applied 3 inches below the surface, even when 3 m.m. of aluminum is used to protect the skin; and that without the use of a filter only 1/16 of a dose can be applied 3 inches below the surface. 1/16 or even 1/6 dose applied to a surface cancer would have little or no effect. Why then should one expect results on a deeper and more extensive lesion with such a small amount of ray?

The second experiment, illustrated in Diagram II, indicates the wonderful possibilities of the highly penetrating rays from the Coolidge tube, filtered adequately, and administered thru 6 ports of entry by the cross-fire method.

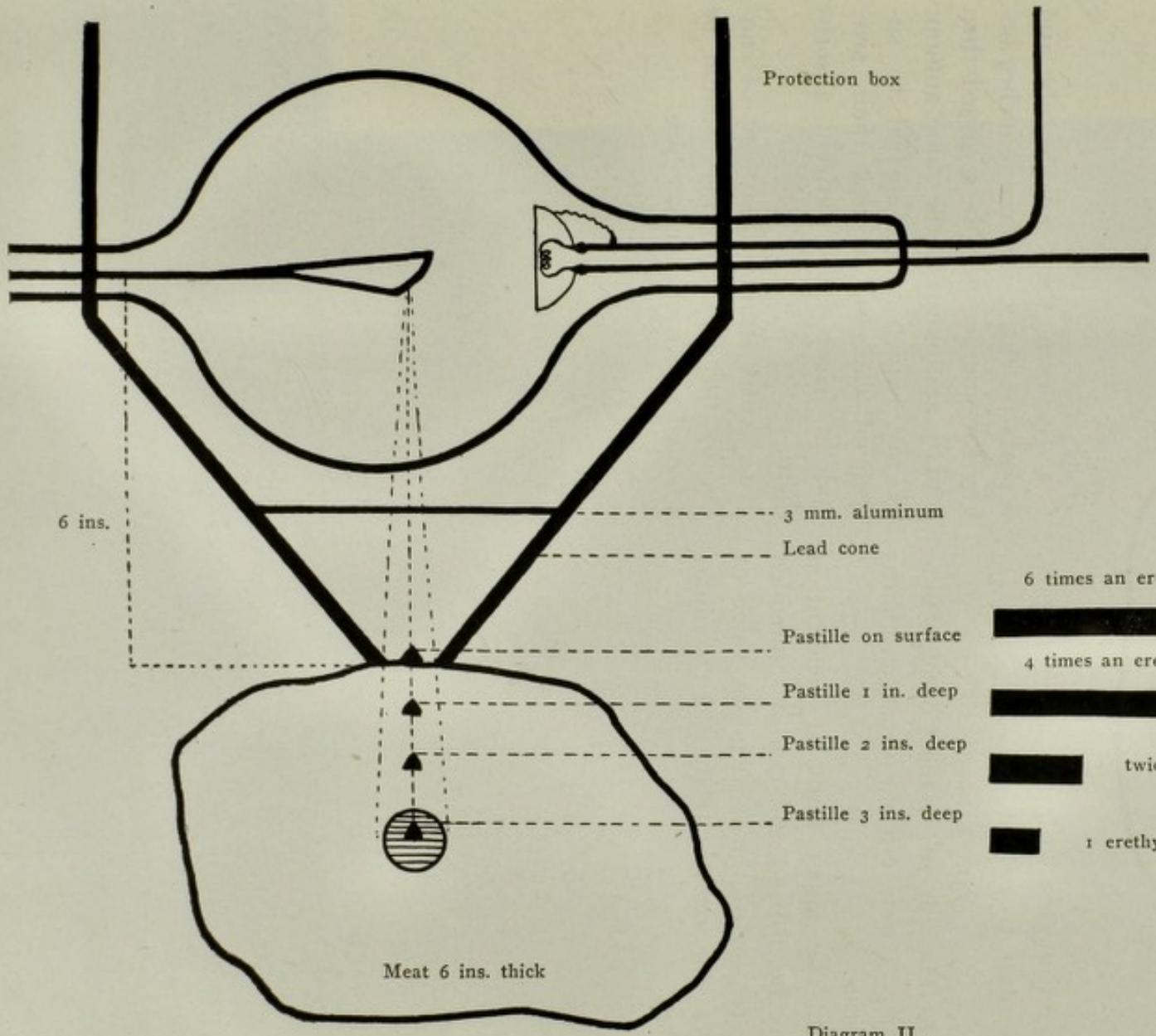
Experiment II (Diagram II): One Coolidge tube was used, operated at a high penetration by a standard 4 K W. transformer, according to the table on the diagram. The soft rays were filtered out with 3 m. m. aluminum. Six exposures of one minute each were sufficient to obtain a full dose 3 inches below the surface.

The use of 6 ports of entry eliminates the danger of burning the skin (Diagram III), so that each surface area receives only one erethyma dose. As our experiment was made on a piece of meat, this precaution was uncalled for.

The experiment just described was repeated thru 10 m.m. aluminum. Fourteen minutes were required for a full dose 3 inches below the surface, using 10 m.a. current, or 140 m.a. minutes. This exposure is more than twice as long as that required thru 3 m.m. aluminum, and yet the curve of absorption of the rays, after passing thru the filter, is practically the same. Therefore, if the therapeutic efficiency is in proportion to the rays absorbed, as we have suspected, the greatest value will be derived from rays of about this penetration.

It may be added by way of precaution that the Coolidge tube and cross-fire method should not be used for treating deep lesions to which the ordinary X-ray methods have previously been applied, as it is impossible to determine how much dosage the skin underlying the lesion has received already.

The rays from the Coolidge tube are under the operator's control to a much greater degree than the rays of radium, and when properly regulated and filtered, will prove much more effective, altho radium will always be useful for the treatment of cavities, such as the nose, throat, esophagus, rectum, cervix uteri, etc. I believe that the use of the Coolidge tube offers a greater hope for the successful treatment of cancer than anything except surgery, and that when surgery is indicated, the Roentgen rays should be used



Parallel Spark Gap	Milliamperage	Exposure (minutes)	Hampson Reading
8	10	1	Surface: 4
8	10	1	" : 8
8	10	1	" : 12
8	10	1	" : 16
8	9	1	" : 20
8	10	1	(1 in. deep: 15
			(2 ins. " : 8
		Total 6	(3 ins. " : 4

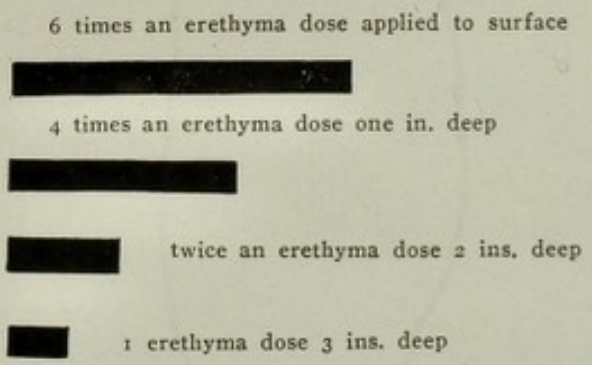
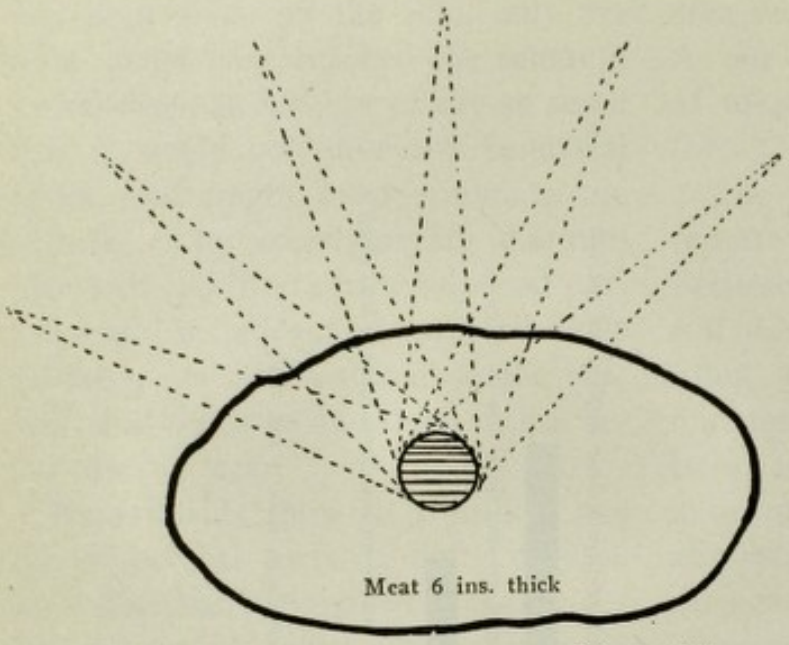


Diagram II.



Cross-fire method, using 6 ports of entry:
A series of 6 exposures of 1 min. each, made with the tube at 6 different angles, 6 ins. distant from the skin.
Result: Surface area as well as tumor receives approximately only 1 erethyma dose.

Diagram III.

in conjunction with it as a routine post operative treatment.

CONCLUSIONS.

1. The advent of the Coolidge tube marks a new era in Roentgenotherapeutics.

2. The upper limit of penetration may be utilized and readily controlled by reason of the tremendous value of rays obtainable from the Coolidge tube.

3. By using the Coolidge tube and 6 ports of entry, an area 3 inches below the surface may be exposed thru 3 m.m. aluminum to the same amount of ray, which when applied to superficial cancers, reduces their size, and in many cases entirely absorbs them.

4. Post operative treatment of cancer by the Roentgen rays should be adopted as a routine procedure.