1 : 1,000, and even more; and, as such, were studied on intravenous injection in cats and rabbits. Intravenous injection of doses of 10 mg., and more, in cats produced a mild fall in blood pressure. Large doses, 50 mg., or more, depressed the respiration; and lethal doses (200 mg., and more) paralyzed the respiratory center. Even large doses of the drugs (200 mg. per kilo) *fed* to rabbits produced no appreciable impairment of either kidney or liver function. Because of their low toxicity, anesthetic properties, and antispasmodic effect on smooth muscle, carefully controlled clinical experiments with these compounds have been begun and are in progress.

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Prevention and Cure of Rickets in Rats and Antirachitic Activation of Ergosterol by Cold Quartz Mercury Lamp.*

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The cold quartz mercury lamp has certain definitely advantageous physical and mechanical features not possessed by other sources of ultraviolet rays.[1] One of the most striking is the fact that the heat radiation is very slight. The emission spectrum of the cold quartz mercury lamp has a limited range from about 185 mμ to about 436 mμ with its maximum intensity at about 254 mμ. By means of a balanced thermocouple and filter method of ultraviolet radiometry, Coblentz and collaborators[2, 3] measured the intensity of the radiations from a cold quartz mercury lamp. They found that the relative intensities of the cold quartz emission lines at 254 mμ, 297 mμ, and 313 mμ were 865, 14, and 45, respectively, and that over 95% of all wave lengths emitted, including the line at 313 mμ, was contained in the resonance emission line of mercury vapor at 254 mμ. By a less accurate method (a sodium photo-electric cell and filters) Hibben[1] studied the energy transmission of the grid type of cold

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[1] Hibben, J. S., *Arch. Phys. Therapy, X-Ray, Radium*, 1931, **12**, 645, 675.

[2] Coblentz, W. W., Stair, R., and Hogue, J. M., *Bureau of Standards J. Res.*, 1931, **7**, 723.

[3] Coblentz, W. W., Stair, R., and Hogue, J. M., *Bureau of Standards J. Res.*, 1932, **8**, 759.

quartz mercury lamp and found that 74.5% of it was emitted in the region from 200 to 254 mμ. This value is probably low. The greatest intensity of the radiations of the cold quartz mercury lamp is therefore in the range 200 to 254 mμ, not usually regarded as powerfully antirachitic, although such property has been attributed[4] to some of the longer rays within this range from other artificial sources of ultraviolet radiations. Up to the present there has been no report on the antirachitic properties of the rays from this type of lamp. It seemed of interest, therefore, especially in view of the physical and mechanical advantages of this type of lamp, to investigate at least one of its possible biological properties, the ability to prevent and cure rickets in animals and to effect the antirachitic activation of ergosterol.

Prevention and cure of rickets by direct exposure to Cold Quartz Mercury Lamp. Albino rats† were fixed in the prone position on a special holder[5] with head, limbs and tail covered by rubberized cloth impermeable to ultraviolet rays. The only part of the body that was exposed to the rays was the fur covered skin of the back from the level of about the fifth dorsal vertebra to that of the middle of the sacrum. The rats were fed on rickets-producing diet No. 2965 of Steenbock and Black.[6] Exposure to the rays of the lamp was made at a distance of 5 inches from the burner. In the preventive tests the exposure ranged from 1 second to 30 minutes, and the irradiation was begun when the animals were first put on the diet. In the curative tests the exposure was begun after the animals had been fed on diet No. 2965 for 3 weeks and showed severe rickets by roentgenogram. The curative tests were begun after the preventive tests had already given a definite indication of the antirachitic properties of the lamp. Therefore the exposures in these tests ranged only from 1 second to 2 minutes.

Table I shows that at a distance of 5 inches from the lamp, irradiation of a limited portion of the fur covered body surface for 3 seconds daily was the minimum exposure which afforded complete protection against the development of rickets to rats fed on a rickets-producing diet. Table I also shows that an exposure of 10 seconds induced advanced or complete healing in a period of 2 weeks while an exposure of 5 seconds gave variable results. The minimum

[4] Sonne, C., *Strahlentherapie*, 1927, **25**, 559.

† Wistar strain, bred at the Institute of Pathology, Western Reserve University.

[5] Shohl, A. T., PROC. SOC. EXP. BIOL. AND MED., 1931, **28**, 770.

[6] Steenbock, H., and Black, A., *J. Biol. Chem.*, 1925, **64**, 263.

TABLE I.

Antirachitic Effect of Direct Irradiation by a Cold Quartz Mercury Lamp.

Irradiation (seconds)	Preventive Tests Results	Curative Tests Results
1	Slight rickets	No healing
1	Very slight rickets	" "
1	" " "	——
2	" " "	No healing
2	" " "	" "
2	No rickets	——
3	" "	No healing
3	" "	" "
3	" "	——
4	" "	No healing
4	" "	" "
4	" "	——
5	" "	Very slight healing
5	" "	Slight healing
5	" "	Moderate healing
5	——	" "
10	No rickets	Healed
10	" "	"
10	——	"

curative daily irradiation to bring about complete healing in 2 weeks probably lies between 5 and 10 seconds.

In the preventive tests rats were also irradiated for 15, 20, 30, and 45 seconds, and 1, 2, 5, 10, 20, and 30 minutes (2 rats for every period) and all were completely protected. They showed no untoward effects due to the prolonged irradiation except a change in the color of the fur to a light yellow. This change did not occur in animals irradiated for less than 1 minute daily, and increased in severity with the increase in the length of the period of irradiation.

In the curative tests, rachitic rats were also irradiated for 15, 20, 30, 45, 60, and 120 seconds (2 rats for every period) and all showed complete healing at the end of 2 weeks. Advanced healing occurred in one week in rats irradiated daily for 45 seconds or longer.

Antirachitic activation of ergosterol by the radiations from a Cold Quartz Mercury Lamp. Five 10 cc. samples of a 0.2% solution of ergosterol (in olive oil) were exposed in open petri dishes 10 cm. in diameter to the radiations from a cold quartz mercury lamp at a distance of 5 inches from the burner for periods of 1, 5, 10, 20, and 30 minutes respectively. Every sample was irradiated separately and placed directly under the central portion of the burner. The solutions were exposed to the air during the irradiation. After the irradiation the solutions were diluted so that one drop (0.025 cc.) contained 0.002 mg. of irradiated ergosterol and 0.001 cc. of irradiated oil. Preventive and curative tests were then carried out on every sample. The results given in Table II show that all of the

TABLE II.
Antirachitic Activation of Ergosterol by Radiations from Cold Quartz Mercury Lamp.

Irradiation of ergosterol in oil‡ (min.)	Preventive Tests Results	Curative Tests Results
1	No rickets	Healed
1	" "	"
1	" "	"
5	" "	"
5	" "	"
5	" "	"
10	" "	"
10	" "	"
20	" "	"
20	" "	"
30	" "	"
30	" "	"
30	" "	"

‡ In both the preventive and the curative tests of the various solutions, the amount of irradiated material which every rat received daily was 0.002 mg. of irradiated ergosterol and 0.001 cc. of irradiated olive oil. The minimum protective and curative doses were not determined.

samples were active and that even of the sample that was irradiated for only 1 minute, 1 drop (0.025 cc.) daily, containing 0.002 mg. of irradiated ergosterol and 0.001 cc. of irradiated olive oil was sufficient to prevent and cure rickets in rats. The minimum preventive and curative dose of the various samples is being determined. The possible destructive effect on the vitamin D formed, due to prolonged irradiation in air and *in vacuo,* is also being investigated. A comparison of the biological properties of this lamp and of the ordinary mercury vapor quartz lamp will be reported later.

Conclusions. It has been shown that the radiations from the cold quartz mercury lamp are powerfully antirachitic. Direct irradiation for 3 seconds daily at a distance of 5 inches from the burner prevented the development of rickets in rats fed on a rickets-producing diet. Direct irradiation for 10 seconds daily for 2 weeks, at a distance of 5 inches from the burner, brought about complete healing of rickets in severely rachitic rats. Advanced healing occurred in one week in rats irradiated daily for 45 seconds or longer. Under the conditions mentioned in the text, exposure of ergosterol dissolved in olive oil to the radiations from a cold quartz mercury lamp for 1, 5, 10, 20, and 30 minutes at a distance of 5 inches from the burner resulted in the antirachitic activation of all of the solutions, of which 0.002 mg. of irradiated ergosterol and 0.001 cc. of irradiated olive oil together prevented and cured rickets in rats. The minimum protective and curative doses were not determined.