precipitation, agglomeration, and conglomeration of crystalloids from such a solution.

If the concentration of such protective colloids is insufficient, stone formation begins or is accelerated. In 680 subjects the incidence of stone was found to be almost inversely related to the degree of protective urinary colloids present.

Subcutaneous injection of hyaluronidase (mixed with saline) causes a pronounced increase in protective urinary colloids. The colloids may form a gel and thereby prevent crystallization of the electrolytes present. They act as excellent dispersing agents, preventing the formation of stones.

Hyaluronidase therapy has been effective in preventing the formation or recurrence of urinary calculi over a period of 11–15 months in 18 of 20 patients with a tendency to rapid stone formation.

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Multicurie Cobalt 60 Units for Radiation Therapy

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One of the fundamental objectives in the use of radiation in cancer therapy is to deliver a large dose of radiation to the tumor with a minimum dose to the healthy tissue. When the tumor is situated below the skin surface it is necessary to use radiation which gives a high-percentage depth dose. This percentage depth dose is defined as the ratio of the dose received at a depth below the surface to the maximum dose which occurs at or near the surface. Two important factors affect this percentage depth dose: (*a*) the distance from the source of radiation to the skin (SSD), and (*b*) the energy of the radiation. If the SSD is 10 cm, then the dose received at a point 10 cm below the surface of the skin cannot be greater than 25% in accordance with the inverse square law for a diverging beam. In practice, the percentage depth dose is even less than this, because of the absorption of the radiation. As the energy of the radiation is increased, the beam becomes more penetrating, and more radiation is delivered to the underlying layers of tissue.

When radiations of energy greater than 1 mev interact with matter, most of the electrons are projected in the forward direction, so that the energy absorbed in the superficial layers of the skin is less than that absorbed a few millimeters below the surface. For the radiation from Co^{60}, the maximum dose is delivered 5–6 mm below the surface. This is another advantage of high-energy radiation.

For many years large sources of radium (5–10 g) have found limited usefulness in the treatment of certain types of cancer. The dosage rate from these units is small, being about 10–12 r/min at a point 10 cm from the source. These units cannot be used at greater distances because of the low dosage rate, and so the percentage depth dose achieved is very small, being about equivalent to what can be obtained from a low-voltage x-ray machine. Nevertheless, because of the nature of the radiations, radium units have been used successfully in treating cancers where cartilage is involved. For these radiations, 1 g of fat will absorb about the same amount of energy as 1 g of bone, in contrast with the case of low-energy radiation where bone may absorb up to 10 times as much energy as the fat.

If a source of radium is made much larger than 10 g it becomes so thick that much of the radiation is lost by self-absorption within it. Aside from cost, this places an upper limit on the effective strength of such a unit. If the source is increased in area it is difficult to obtain a suitable beam of radiation.

In the Canadian reactor with its high neutron flux density, it is possible to produce sources of Co^{60} with specific activities of 20–60 curies/g in a reasonable length of time. One g of Co^{60} with an activity of 20 curies will give the same radiation output as 32 g of radium. It is therefore obvious that physically small sources with high activity are feasible using radioactive cobalt. With this higher activity, they may be used at larger SSD. The radiations from cobalt consist of 2 γ-ray lines of 1.17 mev and 1.33 mev, emitted in equal numbers as Co^{60} decays to Ni^{60}. The average energy of these is comparable to the energy of the radiations from radium sources.

In the summer of 1951 two sources of Co^{60}, each with an effective strength of 1000 curies, and having a specific activity of about 20 curies/g, were made available from the Canadian heavy water pile at Chalk River, for teletherapy units. One of these sources was installed in the University Hospital in Saskatoon, and the other in the Ontario Cancer

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Foundation, Victoria General Hospital, London. The sources are 1 in. in diameter and about 0.5 in. thick and were assembled from a number of thin disks. Both sources give an output of 33 r/min at a point 80 cm from the source. Details of the problem of activating and handling the cobalt will be found elsewhere (*1*).

Before the design of the teletherapy units was undertaken, discussions were held with many radiologists as to the essential requirements of such units in output, field sizes, treatment distances, and sharpness of collimation. Preliminary investigations were made, theoretically and with trial sources, to see how these requirements could best be met, and preliminary results with one trial source have been published (*2*). In these investigations there was close collaboration among Eldorado Mining and Refining (1944) Ltd., the University of Saskatchewan, and the National Research Council. With the same ultimate objectives, two units, quite different in mechanical construction, were designed and have now been tested.

The unit installed at the University Hospital in Saskatoon was designed by two of the authors (H. E. J. and L. M. B.), with the assistance and advice of T. A. Watson, director of Cancer Services, Saskatchewan Cancer Commission. This unit consists of a head, capable of rotation about a horizontal axis, between two arms of an inverted, U-shaped yoke. The yoke is attached to an overhead carriage by means of telescoping steel tubes. The carriage may be moved along horizontal rails mounted near the ceiling. The weight of the head is carried by steel cables which pass over a pulley system to counterweights behind a wall at one end of the room. The head is made of lead encased in a steel cylinder about 20 in. in diameter and 22 in. in length and weighs about 1 ton. It can be rotated through 120° in a vertical plane so that the direction of the beam varies from vertically downward to somewhat above the horizontal. The vertical movement of the head is about 50 in. and the horizontal travel is about 80 in. The unit may be turned "off" or "on" by the rotation of a steel wheel mounted centrally in the head. This wheel, made of lead and tungsten alloy encased in steel, carries the cobalt source at one end of a diameter. In the "on" position, the source is exposed through a tapered opening in the lead shield. Rotation of the wheel through 180° to the "off" position surrounds the source with 10 in. of lead or its equivalent of tungsten alloy. The wheel is rotated by means of an electric motor requiring about 5 sec to turn the unit "off" or "on." As a safety feature the wheel may also be rotated manually. Measurements outside the head, with the beam off, indicate that the stray radiation 1 ft from the head is everywhere less than 7 mr/hr.

Collimation of the beam and limitation of the field size are achieved by interchangeable lead diaphragms with various circular or square openings. These are mounted on the end of a telescoping cylindrical sleeve fastened to the head. The SSD can be varied from 80 to 50 cm. The unit will be used most of the time at an SSD of 80 cm. Each diaphragm is attached to a light, stainless steel cone, 15–20 cm in length. These serve to fix the treatment distances and to indicate the field sizes.

TABLE 1

COMPARISON OF DEPTH DOSE GIVEN BY Co^{60} WITH THAT GIVEN BY A 2.0-MEV X-RAY MACHINE (*3*)
(FILTER 9 MM PB)

Depth (cm)	Field size SSD	5 cm × 5 cm 100 cm	Field size SSD	10 cm × 10 cm 100 cm
	Cobalt	2-mev	Cobalt	2-mev
0.5	100	100	100	100
1.0	97	91	98	98
5.0	76	66	80	75
10.0	52	44	58	52
15.0	36	30	41	36
20.0	24	20	29	25

The other unit was designed by R. F. Errington and D. T. Green, of the Development Division of Eldorado Mining and Refining (1944) Ltd., and consists of a vertical pillar and base supporting a horizontal arm and yoke. The head is mounted in the yoke, on a horizontal axis, and can be rotated by a motor from about 5° above the horizontal downward to about 10° beyond the vertical. The horizontal arm can be moved vertically by a motor-driven screw, from about 27 in. above the base to about 84 in. above it.

The source is mounted near the horizontal axis of rotation, and the beam emerges through a conical opening. When the beam is shut off, this opening is completely filled with mercury. The switch that turns the beam on starts an air compressor mounted in the horizontal arm, and the air pressure forces the mercury into a reservoir outside the lead shielding, but enclosed in, the cover of the head. Turning the beam off releases a valve and allows the mercury to return under gravity, for all angulations of the head, into the conical opening. Failure of power automatically opens the same valve and shuts off the beam. The beam may be turned fully on or off in 5 sec. The stray radiation, with the beam turned off, is less than 6.25 mr/hr everywhere on the surface of the head.

The collimating system, attached to the head in front of the beam orifice, consists of 4 rectangular lead blocks, each with one end constrained to maintain contact with a side of the adjacent one while moving in a plane at right angles to the axis of the beam. The blocks can be separated, or brought together, by lever systems so that square or rectangular fields, with dimensions between 4 cm × 4 cm and 20 cm × 20 cm at 100-cm SSD, can be obtained. The shutter system can be retracted along the beam axis for treatment at any distance between 100 and 70 cm. With a 70-cm treatment distance, the end of the shutter system is about 13 cm from the patient. This separation is necessary to reduce the intensity of the electrons scattered from the collimating blocks.

Field localization is obtained by means of a light beam originating at the same distance from the pa-

tient as the radiation, and defined by the diaphragm system just as the γ-ray beam is.

Measurements were carried out by the group in Ottawa and by the group in Saskatoon. Depth dose measurements were made and isodose distributions determined for a variety of field sizes and source-to-skin distances. The results obtained by the two groups are in excellent agreement. A description of the methods and the details of the results will be published elsewhere (*1*). A summary of the results is given in Table 1 in which cobalt radiation is compared with that obtainable from a 2-mev Van de Graaff generator (*3*). In the first two columns, results are for a 5 cm × 5 cm field at an SSD of 100 cm, and in the last two columns results are given for a 10 cm × 10 cm field. In both cases the percentage depth dose obtainable with the cobalt is considerably greater than that reported for the 2-mev x-ray machine. In fact, the distributions of radiation are more nearly comparable with 3-mev x-rays (*4*).

The units should require less service and be more flexible in use than x-ray machines. The cobalt offers an alternative to x-ray machines in the 2–4-mev range.

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Absorption of DDT in Houseflies over an Extended Period[1]

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Studies on absorption of DDT by houseflies (*Musca domestica* L.) are usually based on an analysis of the extract of the flies 24 or 48 hr after treatment of the insect. Sternburg and Kearns (*1*), Perry and Hoskins (*2*), and Lindquist *et al.* (*3*) have reported on results obtained on this basis. Recent work in this laboratory has shown that the timing of the analyses in experiments of this type is very important. Considerable differences in the external and internal distribution of DDT may result if attention is not paid to this point.

In studies on absorption the writers radioassayed Orlando resistant flies that had been treated individually with acetone solutions of radioactive DDT about one year previously. Each fly had received 15 μg of DDT on the thorax, and the flies had been stored in pillboxes in the laboratory. They were prepared for radioassay by relaxing them in a high-humidity chamber and rinsing them in 5 ml of acetone for 30 sec to remove the DDT on the exterior of the body. The flies or dissected parts were then macerated in the presence of acetone. When the material was dry, the radioactivity was determined in a windowless gas-flow counter attached to a scaler. Measured amounts of the insecticide solution applied to counting plates with a microsyringe showed that 1 μg of DDT produced 165–180 cpm with this equipment. These figures were used in computing the micrograms of DDT or metabolites found in the extracts of the fly tissues.

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TABLE 1

DISTRIBUTION OF DDT OR DDT METABOLITES IN FLIES 385 DAYS AFTER DEATH. ONE μG RADIOACTIVE DDT WAS EQUIVALENT TO 165 CPM

Dissected parts	DDT or metabolite absorbed per fly	
	μg	Percentage of total
Internal organs, muscle, body fluids, gut, etc.	3.50	53
Cuticle-hypoderm:		
Top of thorax	0.56	9
Abdominal	.68	10
Remainder of thorax, legs, and wings	1.15	18
Entire head	0.64	10
Total	6.53	100

Radioactivity measurements indicated that an average of 5.8 μg DDT/fly had penetrated the integument of the flies surviving the DDT application, and that 3.3 μg remained on the exterior. Similarly, flies succumbing to the applied DDT showed a penetration of 7.5 μg each and a surface retention of 3.3 μg. This is in marked contrast to the 2.0 or 2.6 μg absorbed when the radioassay was performed 24–48 hr after the flies were treated (*3*).

In order to determine the morphological distribution of the DDT or metabolites, 10 of the flies were dissected. Table 1 shows that 3.50 μg of DDT or metabolites were in the internal organs. Previously, Lindquist, Roth, Hoffman, and Butts (*4*) made dissections of flies 24–48 hr after treatment and found an average of 0.271 μg, or 26–34% of the amount absorbed, in the internal organs; the remainder was in the cuticle-

TABLE 2

ABSORPTION OF DDT OR DDT METABOLITES IN FLIES AT INTERVALS AFTER TREATMENT (5.9 μG RADIOACTIVE DDT APPLIED PER FLY). ONE μG WAS EQUIVALENT TO 180 CPM

Days after treatment	Surviving flies		Dead flies	
	External wash (μg)	Extract of fly (μg)	External wash (μg)	Extract of fly (μg)
1	3.8	0.39	4.5	0.41
5	2.9	.71	3.9	.74
7	2.2	.88		
9	1.5	1.26	2.9	1.09