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TECHNIC AND DOSIMETRY FOR WHOLE-BODY X-IRRADIATION OF PATIENTS

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STATEMENT OF PROBLEM

There is no general agreement as to the most desirable quantity to specify as the "dose" when whole-body radiation is delivered under a variety of conditions. Consequently, there is a good deal of uncertainty as to whether or not a specified dose in one institution is the same as that given in another institution. The air dose measured at a given point where human or animal bodies may be placed is a definite quantity, but the integral dose to the animal or human will vary according to the shape and weight of the body. It is evident that we cannot accurately compare the effects produced in animals and humans, or even in different human beings, by means of either the air dose or the integral dose estimated under such circumstances. We would not, for instance, consider that a very large man placed at a point where 200 r might be measured in air experiences a much greater effect because the integral dose to his body is much greater than that of a man only half his weight. Ideally, for specification purposes we would like to arrange the exposure circumstances so that every cell in the body would receive the same dose. By suitable experimental design it is possible to do this with many whole-body animal studies and it is possible to approach it with human irradiation. Since it represents the integral dose divided by the weight of the animal, the resulting dose could be called the *specific integral dose*, or simply the *average dose* or *mean dose*. The specific integral dose or average dose would be measured in gram rads per gram or simply in rads. It seems to me that the term *average dose* is simple and adequate and consequently that term will be used throughout this text.

We could plan both animal and human whole-body radiation studies on the basis of average dose. To obtain such a dose it is necessary to know the air dose that must be delivered at a certain point and to know the manner in which the subject should be irradiated when placed at that point. This could be accomplished by Mayneord's procedure for estimating the integral dose as a function of the weight and shape of the human body. The concept of average dose, however, has no general acceptance with regard to exposures to which human beings may be liable. In many practical circumstances in extended radiation fields, for example, the dose that is most conveniently specified is that dose which would be measured by an ionization chamber at a point where the human being might be placed—that is, *the air dose*. For instance, if the dose rate at a given point in the field around a nuclear bomb was 200 r/hour as measured with an ionization chamber, a person placed at that point for one hour would receive an exposure of 200 r. In actual fact, under most circumstances, the average dose would be perhaps a little more than half of this value.

Thus, we should distinguish clearly between *whole-body exposure*, meaning air dose (in roentgens) at the point, and *whole-body dose*, meaning average dose (in rads).

The question now arises as to the manner in which the mean lethal dose for human beings, or for animals for that matter, is specified. There is a good deal of confusion on this point. I am uncertain as to the basis for the present human mean lethal dose, but it seems likely that it was derived from the dose that a person might have received at Hiroshima or Nagasaki at a particular point in a radiation field. This corresponds to the *air dose* at that point. At the present time, therefore, it probably would be more useful to specify the whole-body exposure in terms of the air dose measured at the midline point of the human patient. From this value we could compute the average dose which would allow us to compare the radiation effects induced in one patient with those occurring in other human beings—even in persons of

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substantially different size—and in animals. It should be recognized that the average dose appears to offer the only satisfactory correlation between one species and another. Perhaps some of the confusion surrounding LD_{50} values, particularly in larger animals, will disappear when the average dose is specified for each of the circumstances.

Relation between whole-body exposure and whole-body dose

Suppose we have irradiation circumstances in which the radiation field varies only very slowly in intensity, so slowly that the variation over the dimensions of the human body is negligible (in effect, infinite focal skin distance). The air dose or whole-body exposure can be measured with an ionization chamber at a given point *P* at which the midline of the patient will subsequently be placed. However, if the dose in the medium is nonvarying, the position of P is quite uncritical and the air dose at the midline is the same as the air dose at the surface of the body. Consequently, the skin dose at the surface is the measured air dose multiplied by the backscatter factor. Alternatively, in some circumstances the skin dose might be measured directly under appropriate backscatter conditions. The average dose in the body may be found by multiplying the air dose at the point by the backscatter factor and then by Mayneord's estimate of the average dose factor for the body (1, 2, 3). The integral dose may be estimated from this by multiplying by weight in grams.

If the field is varying, for example, according to the inverse square law (in circumstances where the focal to point distance *f* in an x-ray irradiation is not infinite), then the whole-body exposure (air dose) is measured at P and the patient placed so that P is at the midline of the patient. The skin dose at a point *A* closer to the tube than P by half the lateral dimension of the patient, *a*, is obtained by the air dose at P multiplied by $(\frac{f}{f-a})^2$ times the backscatter factor. When this skin dose is multiplied by Mayneord's mean dose factor and by the FSD[1] correction to the mean dose factor, the average dose is obtained. Again the integral dose may be obtained by multiplying by the weight in grams.

[1]Focal skin distance.

Mayneord's mean dose factor varies, of course, with the dimensions of the patient, but for a given set of circumstances the value of f will usually be constant and the relationship between the average dose and the measured air dose at P can be set down in tables or graphs. To determine the average dose, then, the only measurement required would be the air dose at P.

Effect of wall of treatment room

In any practical circumstance in which x-ray whole-body irradiation is used, there will generally be a wall close to the patient since it is usually necessary for f to be large in order to provide a large enough field. This wall will complicate the situation (1) because it provides a backscattering contribution to the measured air dose at P, and (2) because the backscattered radiation from the wall may provide a small contribution to the average dose in the patient. The more serious error will probably occur in the measurement of the air dose at P. It may be desirable in some instances to measure the skin dose at the surface point by using a phantom of wax with a chamber mounted on it, but this measurement of the skin dose will not be independent of the backscattered radiation from the wall unless maximum backscatter already occurs at the point of measurement. This may be the case for AP irradiation, but is not the case for lateral irradiation; consequently, it is preferable to determine the relation between air dose at f and the skin dose at the surface experimentally for each set of irradiation circumstances. In most cases any contribution from the wall during the actual irradiation will be negligible if the patient fills most of the field area.

WHOLE-BODY X-IRRADIATION AT THE M. D. ANDERSON HOSPITAL

The procedure followed at the M. D. Anderson Hospital has been to measure the air dose rate at a particular point P where the midline of the patient will be placed. In specifying the air dose, the backscatter contribution from the wall is ignored initially but considered later. The irradiation is given by delivering half the specified exposure (based on air dose rate at P) laterally through one side of the patient. The patient is then turned over and the other half exposure delivered laterally through the other side.

Measurement of skin dose

During these exposures, condenser chambers are placed in the mid-axillary line of the arms, measuring on one side the entrance dose and on the other side the exit dose. In general the exposure has been given in a series of steps (three to each half) so that the chamber measurements can be made. The chambers give fairly reliable comparative results between one another, but their calibration and sensitivity with respect to Victoreens may change with time. The sensitivity is checked from time to time

TABLE I

Dosimetry data of 35 patients who received a nominal dose of 200 r whole-body x-irradiation

Exposure was performed under the following conditions: General Electric Maxitron, 250 kv., 3 mm. Cu HVL, 30 ma. maximum; approximate dose rate at 205 cm., 3.5 – 4 r/min; FSD, approximately 190 cm; midline of patient, 205 cm; mean average dose of the 35 patients, 130.1 ± 4.8 rads; mean integral dose, 8.06 ± 1.23 megagram rads.

Patient	Lateral dimension diameter (cm.)	Body weight (kg.)	Average dose (rads)	Variation (percent)	Integral dose	
					Megagram rads	Megagram r (condenser chamber)
1	34.5	53.5	125.8	± 21	6.73	6.03
2	34.5	59.0	125.8	± 21	7.42	6.80
3	30.5	62.5	132.2	± 15	8.27	7.66
4	31	56.5	131.4	± 16	7.44	6.77
5	34	55.7	126.6	± 20	7.05	6.45
6	33	61.2	128.0	± 19	7.83	7.08
7	32	57.5	129.6	± 17	7.45	6.67
8	31	71.3	131.4	± 16	9.37	8.41
9	31	46.0	131.4	± 16	6.05	5.57
10	33	69.0	128.0	± 19	8.83	7.43
11	35	91.0	125.2	± 22	11.40	10.40
12	32	67.0	129.6	± 17	8.68	7.88
13	31	57.4	131.4	± 16	7.55	6.71
14	32	54.1	129.6	± 17	7.01	6.44
15	34	72.0	126.6	± 20	9.11	7.55
16	30	63.2	133.2	± 14	8.44	7.44
17	28	52.3	136.8	± 11	7.15	6.46
18	33.5	62.8	127.2	± 19	8.00	7.19
19	30	63.3	133.2	± 14	8.44	7.59
20	32	58.8	129.6	± 17	7.62	6.77
21	30	49.8	133.2	± 14	6.64	5.90
22	23.5	44.2	146.0	± 6	6.45	6.58
23	30	66.7	133.2	± 14	8.90	7.75
24	33.5	71.5	127.2	± 19	9.10	8.45
25	27	55.4	138.8	± 10	7.68	7.11
26	40	88.8	118.4	± 32	10.52	9.08
27	32.5	62.2	128.8	± 18	7.99	7.05
28	35.5	64.9	124.4	± 23	8.08	7.35
29	35	65.4	125.2	± 22	8.19	7.70
30	32	77.4	129.6	± 17	10.01	9.45
31	31	53.3	131.4	± 16	7.01	5.59
32	32	50.8	129.6	± 17	6.59	5.55
33	28	51.3	136.8	± 11	7.02	6.91
34	29.5	76.8	134.0	± 14	10.28	9.36
35	36	66.2	123.6	± 24	8.18	7.59

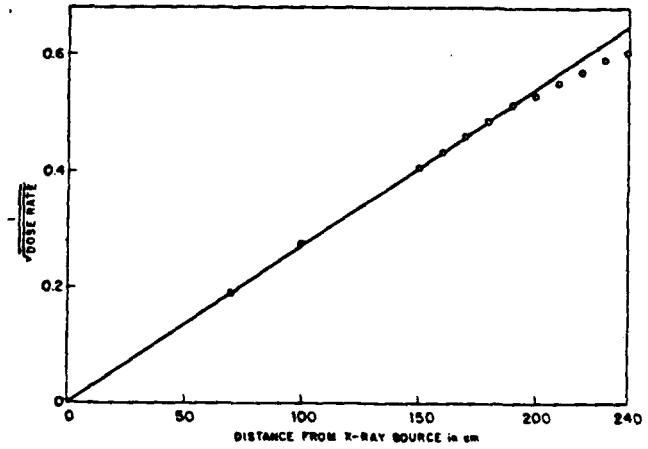

FIGURE 1

Effect of backscatter, caused by a wall at 240 cm. distance from the x-ray source, on the inverse square relationship between dose rate and target distance. The straight line represents the inverse square law, while the open circles denote measured values. Increasing deviation of the experimental values from the law occurs as the scattering wall is approached.

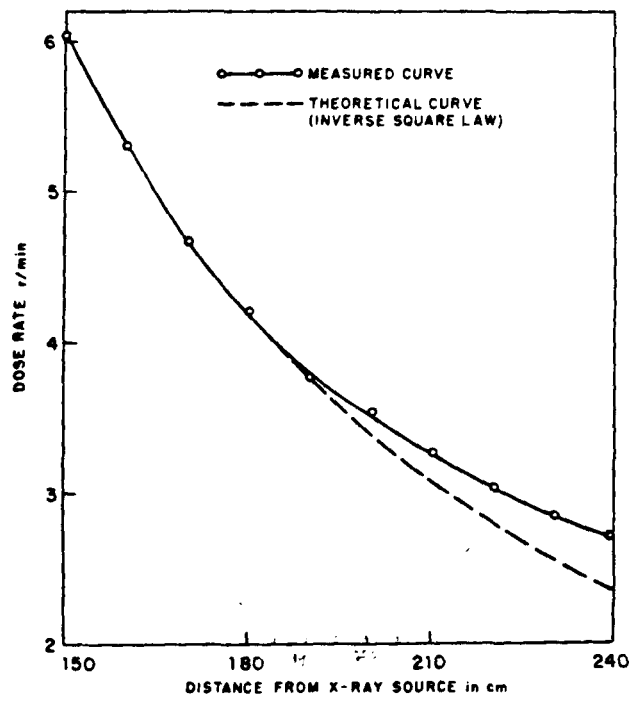

FIGURE 2

Relationship between dose rate and target distance; the backscattering wall is located at 240 cm.

and some variations have been shown. The average dose and the integral dose may be estimated using the forward skin dose as the sum of both entrance doses determined by these chamber measurements. The exit dose is ignored in the calculation and served only as a check that the wall backscatter is very small since the exit dose agrees rather well with the expected depth dose. The skin dose is then used with the mean dose factor and the FSD correction to estimate the integral dose in gram roentgens (3). This means that the average dose and integral dose are determined independently of the air dose measurement. Subsequent experiments indicated that it would be preferable to base the average dose and integral dose determinations on the air dose at P and to use the condenser chambers only as a check. This procedure is followed in the final dose specification.

Positioning and irradiation of patient

The unit used for these irradiations is a G. E. Maxitron operated at 250 kv. with a Thoraeus III filter providing an HVL of about 3.0 mm. of copper. The tube was used without a diaphragm and the beam aimed horizontally at a wall 240 cm. away. The area of the beam at the wall was a circle of approximately 120 cm. diameter. The patient was placed in a sitting position within the beam, slumped over so that the individual occupied about half of the beam area. The midline of the patient was at approximately 205 cm. and all air dose measurements were made at approximately 205 cm.

The variation of air dose with distance from the tube in this arrangement was subsequently determined using a 25 r Victoreen chamber normally used for calibration purposes (all chambers used throughout the calibration procedures are based on NBS calibrations). The curve in figure 1 indicates the departure from inverse square law as the chamber approaches the wall and backscatter from the wall becomes a contributing factor to the measurement. It is clear that at 205 cm. there is an error of approximately 5.5 percent in the air dose determination due to backscatter from the wall. If it can be assumed that the patient subsequently shields the wall from the beam, then the true air dose at the midline of the patient is actually the nominally specified value less 5.5 percent; thus, a nominal dose of 100 r is actually 94.5 r and

one of 200 r is 189 r. Furthermore, it is possible to obtain from figure 2 the air dose at the surface distance for any given value of a, the half-lateral dimension. For values of a of 15 cm. or more, the contribution of the wall backscatter to the air dose is negligible. To obtain the skin dose, the value for the air dose at the correct distance is taken from the graph (fig. 2) and multiplied by the backscatter factor.

Measurement of the backscatter factor

The cross-sectional area of the trunk is approximately 1,200 cm.^{2} According to Johns (4, p. 89), the backscatter factor for 3 mm. Cu HVL and an area of 400 cm.^{2} is 1.315. If the various factors for 3 mm. Cu HVL are plotted against area, the backscatter is found to increase to a value of about 1.36 at 1,200 cm.^{2} Measurements made with the Bomke ionization chamber very close to the surface of a water phantom and in air yield a backscatter factor of 1.36. Measurements at the surface of a flat wax phantom of approximately 1,200 cm.^{2} with the chamber embedded in the wax phantom were made with both the Victoreen 25 r chamber and condenser chambers, and yielded backscatter factors between 1.33 and 1.35. In the Bomke measurements no increase above the 1,200 cm.^{2} was observed. Consequently, a backscatter factor of about 1.35 to 1.36 is about maximum for this quality of radiation. However, in the lateral irradiation, the backscatter factor may well be less because of the curved nature of the surface exposed to the beam and because the 1,200 cm.^{2} is actually the effective area of the field at the midline, but not at the surface. Measurements were therefore undertaken, using condenser chambers at the curved surface of a Masonite phantom made in the shape of a chest and approximately under the conditions of a normal lateral irradiation. These yielded backscatter of 20 percent rather than 35 percent. Consequently, the skin dose at any given value of a, the half-lateral dimensions, can be found by taking the air dose value from figure 2 and multiplying by the curved surface backscatter factor, 1.20. This factor may vary a little with the size of chest and the shape of the lateral wall, but an average value of 1.20 has been used throughout. The condenser chamber, in the practical irradiation, was rarely in the position of maximum backscatter and consequently might be expected to read low values. In figure 3 the resultant values of skin dose per 100 r (nominal) delivered in air at midline are plotted against lateral dimensions of the patient.

Measurement of depth dose distribution

Depth dose measurements were made with a Bomke dosimeter in a maximum backscatter phantom; the phantom had an area of approximately 1,200 cm.^{2} and was filled with water. This yielded the depth dose curve shown in figure 4. The measurements were taken with the phantom replacing the patient close to the wall, but even at the greater depths no influence of the wall was noticed in the measurements. Consequently this factor can be ignored in the actual irradiation of the patient. This depth dose curve will, however, not represent the actual situation in the patient close to the front surface exposed to the beam, because there the skin dose is about 11 percent less, as we have already seen. At appreciable depths in the patient's trunk, the depth dose will be substantially the same as that indicated here. Unfortunately this actual situation could not be measured directly at this time because no chest phantom in water, through which the chamber could be moved, was available. However, the depth dose is required, at this point, only to check the approximate value of μ to be used for this quality of radiation. Mayneord's graph

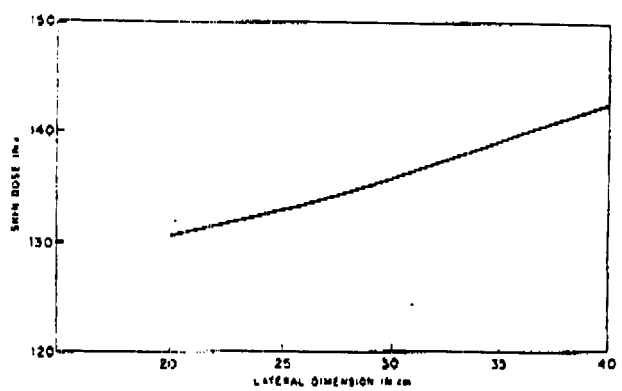

FIGURE 3

Relation between skin dose, r per 100 r nominal air dose delivered to the midline, and lateral dimensions of the patient. The values of skin dose are found by assuming that the midline of all patients is at 205 cm. The lateral dimensions will therefore determine the distance of the surface from the x-ray source and consequently determine the air dose at that point. Application of the backscatter factor thus establishes the value of the skin dose.

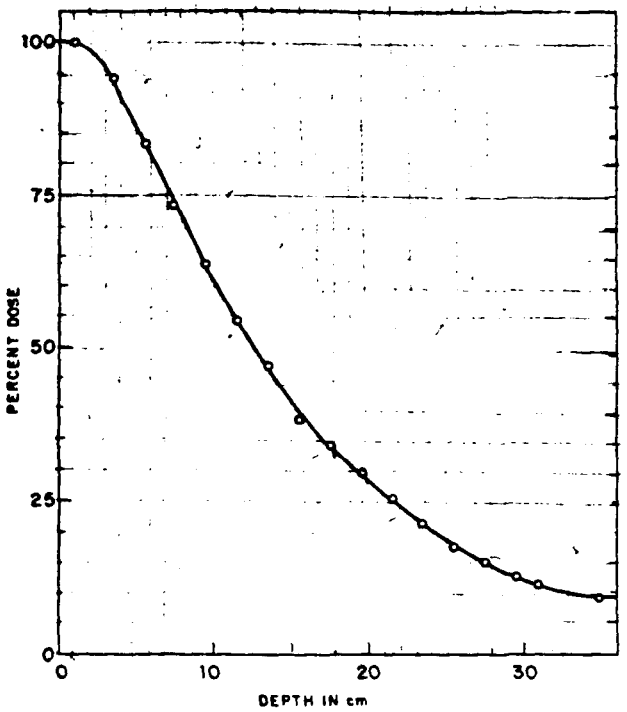

FIGURE 4

Percentage depth dose caused by x-radiation of 250 kv., 3 mm. Cu HVL, 190 cm. FSD, and a field of approximately 1,200 cm.² Measurements were made with a small ionization chamber probe (Bomke) and a water phantom.

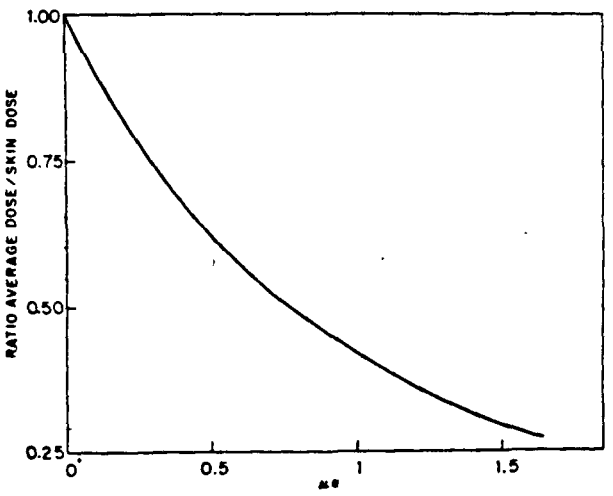

FIGURE 5

Average dose per unit skin dose as a function of μa the product of the linear absorption coefficient (μ) and the half-lateral dimension (a). Mayneord has derived the values from the formula for the average dose for an ellipse as quoted in the text. This graph has been plotted from Mayneord's calculations (3, p. 362, table 2).

(3, fig. 6) yields a value of μ of 0.053 cm.$^{-1}$ for 3 mm. Cu HVL. The value from the depth dose curve of figure 4 corrected for distance, is 0.063 cm.$^{-1}$ If the backscatter at the surface is lower, as we anticipate, the value should actually be less. Mayneord's values were determined under better conditions in this respect. Consequently a value of 0.055 cm.$^{-1}$ for μ has been assumed throughout.

Application of Mayneord's concepts

Mayneord (3) presents most of the material used in this analysis. The integral dose in an ellipse (3, p. 362) is equal to $\pi abD_0\,[1.000 - \mu a + 0.625(\mu a)^2 - 0.292(\mu a)^3 + 0.109(\mu a)^4 - 0.0343(\mu a)^5 + \ldots]$. The bracketed quantity is the average dose and Mayneord gives values (3, p. 362, table 2) for the average dose against μa. For convenience this has been plotted in figure 5.

If we now take the value of μ, equal to 0.055, as proposed above, the value of average dose for different values of lateral dimensions (2*a*) can be plotted as shown in figure 6. These values are for the trunk only. This graph has to be carried on to about 40 cm. because the lateral dimensions are greater than the anterior-posterior (AP) dimensions for which Mayneord did most of his work. It may be noted that his formula (3, p. 362) applies equally well to lateral irradiation, provided that the proper major-minor axes are used and that there is exponential decrease

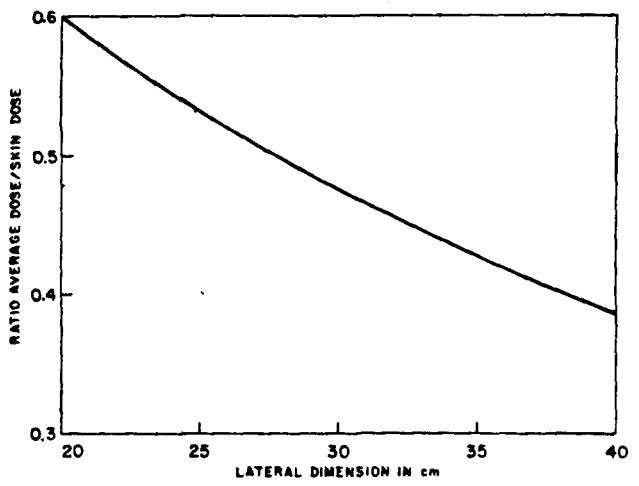

FIGURE 6

Relation between average dose per unit skin dose and lateral dimensions (trunk). This curve is derived from that of figure 5 using the values $\mu = 0.055$ cm^{-1} (see text). The curve will apply to the trunk only

of dose with depth. This is approximately true, as we have already seen. The values for the trunk must now be compounded with the values for the limbs in order to obtain the final average dose. In Mayneord's work the limbs have been taken on the average, as $^7/_{10}$ of the AP dimensions, but the lateral is about $^4/_3$ times larger than the AP dimensions. Therefore the limbs should be taken as $^{21}/_{40}$ of the lateral, or just about half. Consequently we can plot the average dose for the limbs by taking $^{21}/_{40}$ of the lateral dimensions and using Mayneord's values (3, p. 363, table 4). See figure 7. In order to get the whole body average dose we now take $^4/_7$ of the trunk value, $^3/_7$ of the limb value, for a particular lateral dimension, and draw a new graph (fig. 8) for the average dose for the whole body against the lateral dimensions. These values are for an infinite focal skin distance as determined from Mayneord's data. For the average focal skin distance used in these measurements, 190 cm., they should be modified by a factor provided by Mayneord (3, p. 364, fig. 4), yielding for 190 cm. a factor of 0.91. This correction is indicated also in figure 8. Combining this graph with figure 3, indicating the skin dose for 100 r delivered at 205 cm., yields a final graph (fig. 9) of the average dose per nominal 100 r in air at 205 cm. Using the factor, 0.97 rads per

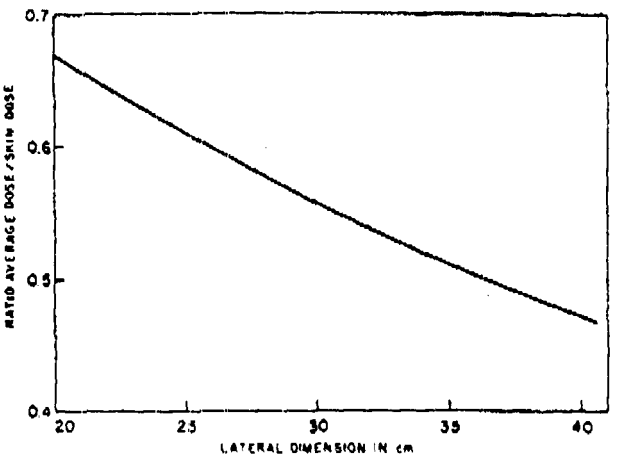

FIGURE 8

Relation between average dose per unit skin dose and lateral dimensions (whole body). Using the data of figure 6 and figure 7 and the fact that the trunk represents $^4/_7$ and the limbs $^3/_7$ of the total body weight, this curve is derived for the whole body. The values represented in figures 6 and 7 are strictly correct for infinite focal skin distance only; for a distance of 190 cm. a factor of 0.91 should be applied throughout. This has been done for the values represented in figure 8.

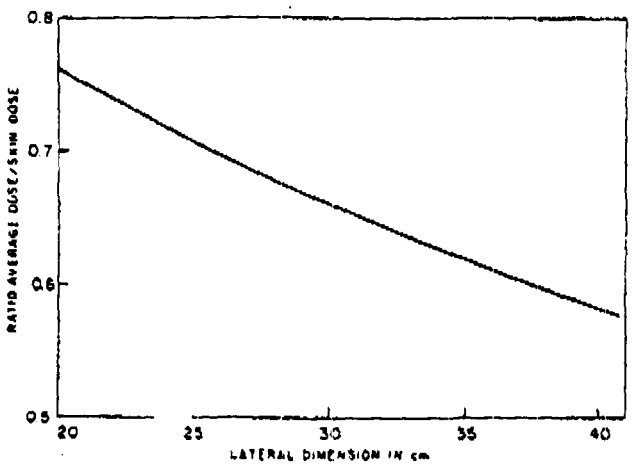

FIGURE 7

Relation between average dose per unit skin dose and lateral dimensions (limbs). This curve is derived from that of figure 5 using the fact that the limbs are about $^7/_{10}$ of the AP dimension and the AP dimensions are about $^3/_4$ of the lateral dimensions. Thus the dimensions of the limbs are about $^{21}/_{40}$ of the lateral dimensions.

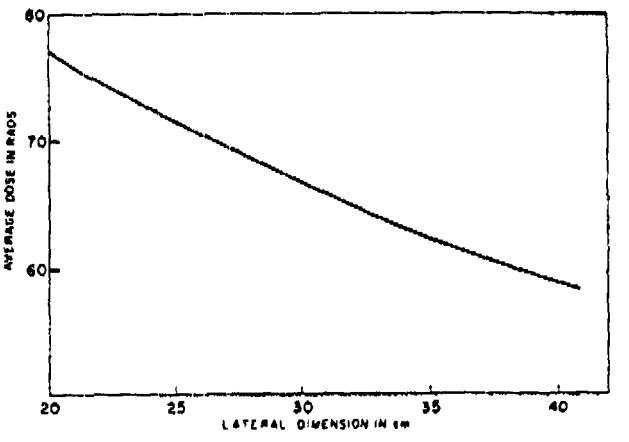

FIGURE 9

Graph showing the average dose in rads as a function of the lateral dimensions. Combination of the results of figure 3 with those of figure 8 enables the average dose in roentgens to be expressed as a function of lateral dimensions. Application of the factor 0.97 rads per 1.0 r for this quality of radiation enables the values in figure 9 to be expressed in rads.

roentgen for this quality, we are able to show in figure 9 also the average dose in rads as a function of the lateral diameter. The final integral dose can be obtained directly, knowing the patient's lateral diameter, by taking the average dose from figure 9 and multiplying by the weight in grams, giving the answer in gram-rads.

Variation in average dose

It would be desirable to have some estimate of the variation of dose throughout the body. This could be expressed as a percentage variation of the average dose or alternatively in the form of $\frac{\text{maximum}}{\text{average}}$ or $\frac{\text{minimum}}{\text{average}}$ dose. The former is the more convenient. If we take a typical example, with 2a = 32.5 cm., two parallel opposing depth dose curves (fig. 4) will yield the central axes distribution shown in figure 10. This graph probably represents a greater variation than would be found with a depth dose for the actual situation in the body which has a smaller value of μ. The variation of the maximum and minimum doses above and below the average is of the order of 18 to 20 percent. Plotting other such distributions for other values of 2a yields the curve of figure 11, showing percentage variation in the average dose as a function of 2a. Even with the largest patients it is seen that the variation does not exceed ±30 percent and for most patients the variation is only about 15 to 20 percent.

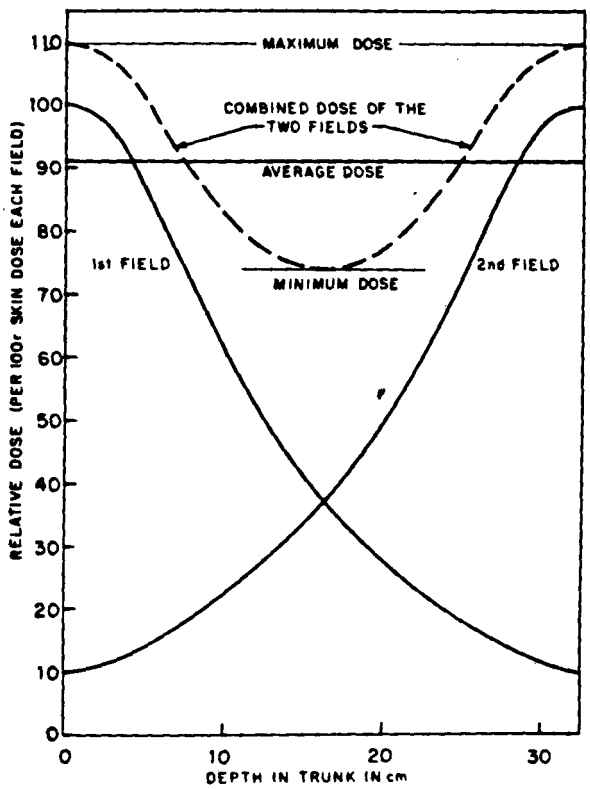

FIGURE 10

Graph showing the variation in dose across the trunk. The effect of delivering half the irradiation through each of two parallel opposing lateral fields is shown. The maximum and the minimum doses are about 20 percent above and below the average dose. This variation is greater for larger lateral dimensions and less for smaller lateral dimensions.

Comparison of measured and calculated skin doses

The condenser chamber measurements of entrance dose yield values which (even when corrected for an earlier error in calibration) are a small percent lower than expected from the air dose determinations and the estimate of skin dose. The difference is due (1) to possible higher temperature conditions on the skin of the patient, (2) to the fact that the chamber is rarely at the position of maximum backscatter, and (3) to the fact that the midline of the patient may be slightly farther away from the tube than the point of air measurement, 205 cm. An error of more than 5 cm. in the positioning is considered unlikely, however, and this will give rise

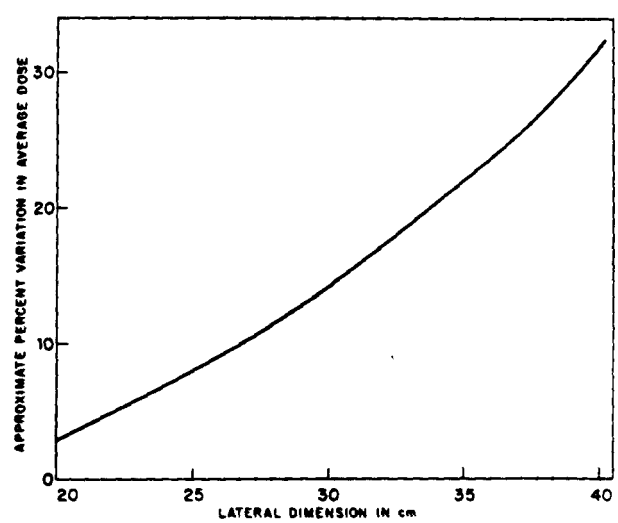

FIGURE 11

Graph showing the percentage variation in average dose as a function of the lateral dimensions. The variation in the dose becomes greater as the lateral dimensions increase (see legend to figure 10).

to an error of no more than 3 percent in the true air dose to the midline. Furthermore, the variations and general unreliability of this type of condenser chamber, as compared with the steadiness of the exposure measurements with the Victoreen chamber and the consistency of the backscatter determinations with a variety of measuring instruments, support the desirability of basing all subsequent estimates on the air dose determination. Therefore, while the condenser chamber determinations of integral dose are included for comparison, they are regarded as acting only as a useful experimental check on the air-dose determination.

SUMMARY

A prescribed air dose has been delivered to each individual and a record of his lateral diameter and weight kept. This nominal air dose is modified by a factor of 0.945 to exclude the wall backscatter from the measurement and yield the actual air dose. The average dose in rads is determined from the final graph (fig. 9) of average dose per nominal 100 r at 205 cm. The integral dose is then this average dose multiplied by the weight of the individual. The variation in average dose is taken from figure 11. This procedure has been followed in making up the table on the dosimetry of all patients irradiated at a nominal air dose of 200 r.

REFERENCES

1. Mayneord, W. V., and J. R. Clarkson. Energy Absorption II, Part I. Integral dose when the whole body is irradiated. Brit. J. Radiol. 17:151 (1944).

2. Mayneord, W. V., and J. R. Clarkson. Energy Absorption II, Part II. Integral dose when the whole body is irradiated. Brit. J. Radiol. 17:177 (1944).

3. Mayneord, W. V. Energy absorption III. The mathematical theory of integral dose and its applications in practice. Brit. J. Radiol. 17:359 (1944).

4. Johns, H. E. Physics of radiation therapy. Springfield, Ill.: Charles C Thomas, 1953.

School of Aviation Medicine, USAF, Report No. 57-70.

Technic and dosimetry for whole-body x-irradiation of patients.

W. K. Sinclair and A. Cole, Houston, Tex. Mar. 1957. 9 pp.

The dosimetry of whole-body x-irradiation when patient is irradiated laterally with two parallel opposing fields of x-rays at 250 kv., 3 mm. Cu HVL, at a dose rate of about 3.8 r minute is discussed. The difference between whole-body exposure and whole-body dose is explained.

Experimental work has shown that for a nominal exposure (or air dose) of 200 r at the midline, the actual dose is only 189 r. The skin dose varies with the lateral dimensions of the patient but usually amounts to about 135 r at each side of the patient. The theoretical and experimental studies of Mayneord are used to derive the average dose (or specific integral dose) and the integral dose, as a function of patient dimensions.

For a series of 35 patients irradiated laterally the mean of the average dose for each patient was found to be 130.1 ± 4.8 rads for a nominal 200 r at the midline. The variation in the average dose throughout each patient is about ± 20 percent. The mean integral dose was found to be 8.06 ± 1.23 megagram rads.

Condenser chambers were used at the surface of each patient during irradiation to act as a check on the skin dose. Most of the results were lower than the values estimated from the air dose but the average difference did not exceed 10 percent.

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