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METABOLIC CHANGES IN HUMANS FOLLOWING TOTAL-BODY IRRADIATION

REPORT PERIOD

February 1960 through April 30, 1966

Eugene L. Saenger, M. D.
Ben I. Friedman, M. D.
James G. Kereiakes, Ph. D.
Harold Perry, M. D.

Defense Atomic Support Agency
Washington, D. C. 20301

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University of Cincinnati College of Medicine
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Cincinnati, Ohio 45229

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FOREWORD

This report was prepared by the following members of the University of Cincinnati College of Medicine:

Eugene L. Saenger, M. D.

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Harold Perry, M. D.

The research was supported by the Medical Division, Defense Atomic Support Agency, Washington, D. C. The Project Officer for the contract is Cdr. George P. Douglas.

In conducting the research described in this report the investigators adhered to the "Principles of Laboratory Animal Care as established by the National Society for Medical Research"

ABSTRACT

This report summarizes the data accumulated from fifty patients who have been given total or partial body irradiation at the University of Cincinnati Medical Center from February 1960 through April 1966. Psychological, hematological, metabolic, immunological and chromosomal findings are statistically analyzed and some implications concerning reduction in combat effectiveness of military personnel exposed to ionizing radiation are drawn.

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INTRODUCTION:

This report presents data accumulated from February 1960 through April 1966. It reviews material obtained by studies on forty patients who received 25 rad to 200 rad midline absorbed tissue dose (40.8 r to 336 r midline air dose) of total body radiation (TBR) and ten patients who received 100 rad to 300 rad (150 r to 436 r) upper or lower partial body radiation (PBR). All patients were evaluated at the University of Cincinnati Medical Center.

Many of these data have been included in the previous reports of November 1961, April 1963 (DASA 1422), and February 1964 (DASA 1633). Because the initial report was not distributed through the usual DASA channels and because of the many changes in specific aspects of the program, this report summarizes certain previous segments of our work, some of which have been terminated, as well as presenting the more recent material.

AIMS OF THE PROJECT:

This program is designed to obtain new information regarding the metabolic, physiologic, psychologic, immunologic, hematologic, and biochemical effects of TBR and PBR in human beings. It will then be possible to understand better the influence of radiation on combat effectiveness of troops and to develop more suitable methods of diagnosis, prognosis, prophylaxis and treatment of radiation injuries. It is our belief that information concerning radiation effects in the human being can be determined as well or better in these subjects as in the laboratory animal even though the characteristic of cancer must be kept in mind in the evaluation of the data.

A major objective of these studies has been a search for a suitable biological indicator of radiation dose in human beings. Earlier work in this laboratory showed that amino-aciduria was non-specific for radiation, being present following stresses such as burn and trauma. At this time the urinary excretion of deoxycytidine seems to be promising as a biological indicator.

Hematological changes after TBR have followed those patterns well documented in the literature. Comparison of individuals receiving equal doses of PBR and TBR have shown far less hematological change in the former group. These findings demonstrate the importance of shielding in decreasing the deleterious effect of radiation. The design of this study provides a valuable baseline for the evaluation of a great variety of large area and volume exposures in the human being.

Computer analysis of hematological data has shown that using total white count data the computer could predict high or low dose (above or below 125 r) correctly in 13 of 15 patients tested. In this particular analysis 7 partial body patients were classified as "low dose".

Psychological and psychiatric testing has been started in 14 patients. This area of investigation is a new and difficult one. Tests to determine performance decrements in humans are not well developed. A variety of tests are being studied to determine those tests most suitable to indicate whether single doses of whole or partial body radiation produce any decrement in cognitive or other functions mediated through the central nervous system.

This approach will provide information on another important parameter of combat effectiveness of troops.

The continuing program envisions observations at increasing dose levels for whole and partial body radiation. Unilateral radiation and fractional radiation patterns will be studied. Intensive efforts will be devoted to studies of the metabolism of *DNA*, its precursors and catabolites. If these metabolic paths can be elucidated, basic injury and reparative patterns both at a cellular and organismic level can be better understood and methods of protection and therapy investigated.

DESIGN OF STUDY:

1. Selection of Subjects:

Patients with metastatic or incurable neoplasms are given whole or partial body radiation for palliative treatment of their disease. Patients for the studies described in this report are selected from the patients treated as described above providing that they satisfy the following criteria:

1. The patients have "solid" tumors. Patients with lymphoma are excluded.
2. Relatively good nutritional status (ability to maintain weight).
3. Normal renal function.
4. Stable hemogram in the control period.

TECHNIQUE OF STUDY:

The design of the study is such that each patient serves as his own control. A pre-irradiation control period of one to two weeks is utilized. The patients are followed as long as possible after the radiation exposure.

Usually five observations are made in the pre-irradiation period. Observations currently made are listed in Table 1. Post-irradiation specimens are then obtained at standard test times (see section on Data Collection).

Patients have been studied on the Tumor Ward and the Metabolic Ward of the General Hospital. One bed on the Metabolic Ward has been allotted for this study. During the pre-irradiation period, the patient's records are reviewed by the physicians to be certain that the contribution of the underlying disease can be evaluated. Several sham irradiations are given to permit accurate dosimetry and obtain cooperation of the patient. There is no discussion of possible subjective reactions resulting from the treatment with the patient. Other physicians, nurses, technicians and ward personnel are instructed not to discuss post-irradiation symptoms or reactions with the patient. This "isolation" is carried out carefully so as not to influence any subjective reactions of the patient which might be attributable to radiation.

DATA COLLECTION:

Collection of data continues essentially according to the plan of Thoma and Wald (J. Occup. Med. 1:420 - 447, 1959) and as described in Section 3 of "Medical Aspects of Radiation Accidents", E. L. Saenger, ed., U.S.

Government Printing Office, 1963 (Table I).

All data are recorded on score sheets and then transferred to IBM cards. Thus all information, together with the appropriate machine programs, is available for analysis by other centers or interested individuals.

We have used the profile scoring method of Wald and Thoma (ORNL-2748, Part B). This method provides a way of assigning rank scores for deviations from normality of certain blood values (Table II) and summing them to yield test scores which can be related to clinical degrees of injury.

In performing these calculations we calculated a disease mean daily test score (DMTS) based on the "net erythrocyte" scores (Table III). The DMTS is assumed to represent the daily contribution of the underlying disease to the total test score following radiation. Thus a mean disease score was subtracted from the total daily post-treatment score. To illustrate the calculations, a sample profile score sheet is appended with the derivation of each column (Table III). Table IV indicates the calculations on a representative patient.

DOSIMETRY:

1. *Total Body Radiation*

Cobalt - 60 :

The radiation is delivered by a Cobalt 60 Teletherapy Unit under the following exposure conditions:

The radiation beam is directed horizontally at a wall 338 cm. away with the patient midline at 282 cm. from the source. The beam area for the

50 percent isodose curve at the patient midline distance is a square approximately 67 cm. by 67 cm. The patient is placed in a sitting position with legs raised and head tilted slightly forward. The irradiation is given by delivering half the specified exposure laterally through one side of the patient. The patient is then turned and the other half exposure delivered laterally through the other side.

The variation of air dose with distance from the source was determined with a Victoreen 25r chamber. The results indicated no departure from the inverse square law relationship for distances used in the study. Therefore, no correction was required for a possible dose contribution to the patient due to backscatter from the wall.

Preliminary measurements were made in a masonite phantom using dosimeters placed on lateral surfaces and at the midline of the head, trunk and knee portions of the phantom. These results are shown in Figure 3. It is seen that if the midline doses to the trunk, head, and knees are compared, the maximum variation in these doses is about 16 percent.

The exposure to the patient was determined as follows. The percentage depth dose at different depths for a 400 cm^2 field area and a source-skin distance of 80 cm is given by H. E. Johns, "X-rays and Teliosotope Gamma-rays, Radiation Dosimetry. Edited by G. J. Hine and E. L. Brownell. Academic Press Inc., New York, p. 562. The depth dose at the greater source-skin distances used for the patients was found by multiplying the depth doses at 80 cm by the "F" factor postulated by Mayneord and Lamerton (Brit. J. Radiol. 14:255, 1941).

$$F = \frac{(D_d)^{f_2}}{(D_d)^{f_1}} = \frac{f_2}{f_1} \times \frac{f_1 + d}{f_2 + d}$$

where f_1 and f_2 are source - skin distances and d is the depth.

By using the corrected depth dose at the patient midline (one-half lateral dimension of the trunk) and a conversion factor of 0.97 rads per roentgen for Cobalt gamma radiation, the surface dose and midline air dose required to give a desired midline absorbed dose in rads was calculated.

A direct comparison of the calculated and measured (phantom) doses was made for one patient who had the same lateral trunk dimensions as the phantom. The relative depth dose for each lateral exposure to this patient is given in Figure 4. The doses indicated by crosses are measurements made in the phantom and compare quite well with the calculated doses. The combined dose of the two radiation fields is also given in this figure and shows a good homogeneous dose distribution through this patient. The maximum variation in lateral dose distribution was $\pm$ 13 percent for one patient having a lateral trunk dimension of 36 cm.

The dosimetry of the patients is given in Table V. Treatment time was 1/2 to 1 hour. Dose rates were 3 r/ min to 6 r/ min.

Partial Body Radiation:

In the individuals receiving partial body radiation, the teletherapy collimator is used to restrict the beam. The isodose curves for this latter case is shown in Figure 5. The relative dose for upper body radiation

is shown in Figure 6, that for the lower body is shown in Figure 7. These phantom measurements were determined with thermoluminescent dosimeters. For partial body radiation, the xiphoid was used as the boundary. This technique is similar to that described by Hansen, Michaelson, and Howland (The Biological Effects of Upper Body X-irradiation of Beagles UR 580, University of Rochester Atomic Energy Project, 1960).

CLINICAL OBSERVATIONS:

The clinical summaries of the forty patients who received TBR and ten patients who were given PBR are attached to this report as Appendix A.

One of the important questions in the acute radiation syndrome is whether an individual who has received previous radiation and/or chemotherapy shows an increased susceptibility to subsequent radiation. Specific symptoms are anorexia, lassitude, nausea and vomiting. The data are summarized in Table VI for patients receiving TBR. The incidence of symptoms is dose related. In our earlier reports it seemed that individuals receiving previous treatment were more likely to develop prodromal symptoms, but analyses of the results of 40 patients make this conclusion less tenable.

In the small group of ten patients receiving partial body irradiation, no prodromata were found at doses of 100 and 150 rad (2 patients). Two of five patients receiving 200 rad had transient nausea and vomiting. Both

patients receiving 300 rad to the lower body had nausea and vomiting. It is not yet possible to determine effects of prior therapy nor of the difference between upper and lower body radiation.

The latent period has lasted up to 21 days and is essentially asymptomatic. Several of the patients have had the manifest illness stage of the acute radiation syndrome associated with anemia, thrombocytopenia, leukopenia, and lymphopenia. Recovery from this stage has been gradual over several weeks. Ten of the patients died within thirty-seven days following treatment. Five of these patients had received radiation therapy shortly before or after TBR or PBR. Bone marrow infusion has been used in two cases and will be discussed in the section on Hematology. In one patient repopulation of the marrow space may have occurred.

Lassitude and anorexia persisted in some subjects for three to four months. It has paralleled somewhat the suppression of hematologic values.

PSYCHIATRIC EVALUATION:

One of the most difficult aspects of radiation injury requiring evaluation is that of performance decrement. This term is loosely used but in our laboratory it is defined as any decrease in ability to carry out assigned tasks. There are three ways in which these tasks or work can be defined. The first is physical work, e.g. ditch digging, driving a vehicle, heavy or light manual work of any sort. The second is repetitive mental work in which the nature of the task is somewhat repetitive but for which training can be given so that the number of decisions is somewhat limited-e.g. clerical, flying. The third is

cognitive in which command decisions affecting large numbers of people must be made either quickly or deliberately. The descriptions could perhaps be improved but it is thought that there are real differences between these three classes of activity.

With a sufficiently high dose there is serious physical incapacitation. The structure of our studies at present does not lend itself well to investigation of physical decrements since our patients are old, ill and may well have unknown metastases. Treadmill tests and similar ones which place a load on work capacity are not being pursued at this time.

The other two aspects of performance decrement, i.e. mental and/or emotional changes are more easily studied insofar as patient availability is concerned when the subjects are cooperative. The difficulty is that there have not been until recently well understood tests to measure changes of the type with which we should be concerned. There exists a large body of excellent radiobiological work on changes in the nervous system from radiation. This interest is to determine whether after whole or partial body radiation the individual immediately or at some time thereafter becomes less capable of making simple or complex decisions and doing something about them short of physical effort. In order to measure these functions it is desirable that the tests do not require training, e.g. punching buttons in rotation at a given speed for a reward, as tests of that type create a somewhat artificial situation for the problem being investigated.

New tests to evaluate performance decrement have been developed by Dr. Louis Gottschalk and Dr. Robert Kunkel of the Department of Psychiatry specifically for this study. They are the Gottschalk Clinical Depression Scale, the Hope Rating Scale and Denial Scale. Eleven patients have been studied, following the same protocol as for other tests with a control and post-radiation periods (Table VIII). The psychiatric evaluation of this group consists of three different, though related, collections of material: various rating scales, clinical impressions, and recorded verbal samples. The data are presented as mean score values and differences are statistically significant unless otherwise noted.

RATING SCALES:

Depression Rating Scales 1. Wechsler Depression Rating Scale (Wechsler, H., Grosser, G. H. and Busfield, B. L. Sr. The depression rating scale. A. M. A. arch. Gen. Psychiat. 9:334-343, 1963) and 2. the Gottschalk Clinical Depression Scale.

The depression rating scale reflects the presence or absence of depression and changes therein. As shown in Fig. 8 in these scales, there is the suggestion of a relation between degrees of depression and/or change in depression and change in physical state resulting from the radiation in that estimates of feeling increase during the period of manifest illness around the 28th day.

There is no striking increase in the patient's physical complaints at this time, however, as measured by separately examining and scoring this set of content items from the Depression Rating Scale (DRS). Since this

depression may result from symptoms associated with leukopenia, anemia, and other changes of the period of manifest illness without visible physical changes, these observations will require further investigation. Figure 9 shows the subgroup scores of the DRS, with the flattest curve over the entire course of psychiatric observations being the one reflecting the patient's physical complaints.

Hope Rating Scale

The Hope Scale is a 1 to 15 point scale, filled out by the psychiatrist. It rates the degree of hope that the patient has with respect to a favorable and optimistic attitude regardless of the patient's realization of the possibility of a fatal outcome of the disease. Two groups of patients were studied, one group composed of individuals who survived six weeks after radiation treatment and the other group made up of people who did not survive this period of time. The Hope Scale showed significantly higher scores among the longer survivors (using a Mann-Whitney one-tailed U test).

Significant levels of statistical difference were also found on the Wechsler Depression Rating Scale (DRS) for the group of patients who survived longer, this group having lower scores on the DRS.

Denial Scale

The Denial Scale is another clinical rating scale, measuring denial of illness and of pessimism. The group of longer survivors after radiation have higher scores on the Denial Scale reaching a significance level of 0.1.

Clinical Impressions

Clinical impression is obviously the most subjective method of evaluation. Only two patients have shown evidence of cognitive impairment, manifested by minor transient disorientation for time or place in the immediate post-radiation period (0-72 hours) (patients 058 and 059). Psychological tests during this period, however, did not show any significant change in intellectual or cognitive function during this time.

Recorded Verbal Samples (Gottschalk, L. A., Winget, C. M., Gleser, G. C. and Springer, K. J.:The measurement of emotional changes during a psychiatric interview. A working model toward quantifying the psycho-analytic concept of affect. In Gottschalk, L. A. and Overbach, A. H. eds. Methods of Research in Psychotherapy, New York: Appleton-Century-Crafts, 1966).

Various rating scales , as devised by Gottschalk, have been applied to the collected verbal samples. One of these scales, the "schizophrenic" scale, has been shown by other work to have application to brain syndromes in so far as patients demonstrating a brain syndrome will score in certain areas like schizophrenic patients. Figure 10 shows the results of scoring on the "schizophrenic" scale with a higher positive value indicating the presence of more schizophrenic-like material. The results show strikingly higher values after both sham and actual treatment. The lowest score was noted three days after actual radiation treatment. These low values may be related to the fact that at this point the majority of the patients were being discharged, which could be assumed to direct their attention to the reestablishment of relationships

outside which carried positive associations with them. An attempt is being made to single out from the schizophrenic scale those items which will more clearly separate patients with organic brain syndromes from those with schizophrenia or other functional psychiatric disorders.

Figure 10 also shows the results of applying a hope scale and a health-sickness scale to the verbal samples. The highest hope score was recorded three days after treatment, and may be related again to the fact of anticipated discharge from the hospital. since this fact usually conveys to the patient that the medical staff is satisfied with the progress thus far, giving the patient more hope. As with the schizophrenic scale, this kind of reasoning will have to be tested by comparing the scores of the patient group that were discharged then with the group that remained in the hospital.

Anxiety levels were highest immediately before both sham and actual treatment, with striking drops after both treatments; this difference in anxiety is statistically significant. This would seem to indicate that the anxiety is situation-related, and that the treatment does not increase the anxiety level. The upsurge in anxiety at the third day post-treatment is again thought to relate to anticipated discharge from the hospital.

Two objective scales of "hope" and of the capacity to involve oneself in satisfying human relations (the Human Relations Verbal Behavioral Scale), derived completely from the first five minute verbal sample obtained from the patients, showed definitely higher scores in the group of cancer patients who survived longer following body radiation. Further cases need to be collected to

determine whether the use of such an objective predictor holds up statistically.

Psychological Evaluation

The psychological evaluation has been carried out in tandem fashion with the psychiatric evaluation, each individual being evaluated on each occasion from both approaches. In the group, the age range is from42 to 80 years with a mean age of 59 years. Intellectually, the range of education has been from0 to 10 years with a mean of 5 years, while the mean IQ is 89, the range being 63 to 116. The computed Halstead Impairment Index (W. C. Halstead: Brain and Intelligence, Chicago: University of Chicago Press, 1947) from the extensive initial evaluation has ranged from 0.5 to 1.0, with a mean of 0.75. This index is considered quite sensitive to the organic state of the brain, based on a large number of tests, utilizing several sensory modalities, and ranging from complex abstract conditions to simple sensory-motor measures. The results thus far suggest that all patients in their base-line measures demonstrated cerebral organic deficit, normal range being 0 to 0.4.

The Psychological tests administered on all occasions after the initial evaluation consist of a battery selected from the initial group that seemed brief enough to be practical and yet pertinent to the overall design. They consist of a screening for aphasia, simple association and memory tasks, simple sensory-motor coordinations and speed, and the ability to conceptualize and perform verbal association under pressure of time. The data thus far gives

little evidence of directional trend over the various testing sessions.

None of the data thus far has been correlated with type of radiation (total or partial) or with dosage of radiation.

HEMATOLOGY:

Patients receiving whole body therapy showed a hematological response quite similar to those reported many times in the literature (Figure 11). Of particular interest in these studies is the comparison of hematological findings in those patients who received partial body radiation. A typical hemogram for upper body exposure (Figure 12) in a patient receiving 200 rad shows little change in total white count, platelet level or hematocrit. These observations were also noted in the two patients receiving 300 rad. Although if one had pretreatment counts, a downward trend could be noted, at no time did the total white count fall below 4500. If one had only 2 or 3 observations following this type of partial body radiation and no baseline values, it would be difficult to determine the presence of radiation.

In patients who received 200, 150, and 100 rad TBR, lymphopenia was not observed with the expected consistency in the first twenty-four hours. In four cases lymphocyte levels below 1000 were observed prior to radiation. However, if one followed the absolute lymphocyte count, one observes a marked and persistent lymphopenia ranging from 800 to 200, often remaining low for 40 to 60 days. In two of the partial body cases, the lymphocytes did not begin to fall for 48-72 hours after exposure. It would have been difficult to detect radiation by counts done at these early times. (These cases received 100 and 200 rad

respectively to the lower part of the body).

If one compares the hematological changes in TBR to those of PBR, one is struck by the paucity of change in the latter cases in total white count, platelets and hematocrit, particularly since 4 of the 5 patients receiving PBR doses of 200, 200, 300 and 300 rad had prodromal symptoms. The PBR dose which produces the degree of hematological change seen at 100-150 rad of TBR in the human being has not yet been established.

The method of profile scoring of the hematological data has been described under analysis of data. Scores of the cases are included in Table IX. Data accumulated by this method are cumbersome to obtain and add little additional information regarding the patient. Similar prognostic and diagnostic material is available from blood counts alone.

A mathematical approach to the hematologic data is included under computer analysis. This method has been of some value and may be helpful in predicting the exposure dose within certain worthwhile ranges.

Since severe hematologic depression was found in most patients who expired, autologous bone marrow storage was instituted in 1964. The method of Kurnick has been used (Transfusion 2:178-183, 1962). Marrow is removed from the posterior ilium, mixed with an Osgood-Glycerol media and stored at -80^0 C after programmed temperature reduction at 1° C/min.

Prior to infusion, dextrose is added during the warming period. The marrow is then infused intravenously without filtration at a rate of 50-60 drops per minute.

To date marrow storage has been performed for 13 patients. In only two patients has infusion been carried out. Figures 13 and 14 show the hematological courses of these individuals (cases # 51 and # 53). It is tempting to propose that Figure 13 illustrates the result of marrow repopulation. However, Figure 11 shows a similar course without marrow infusion.

The method is presently being refined so as to include filtration prior to infusion. Although we have not encountered morbidity following infusion, filtration appears to decrease the probability of incidence of pulmonary emboli.

COMPUTER ANALYSIS:

Studies of the type described in this report carried out in human beings are difficult to perform and it is desirable to record as much information on each patient as possible. It is this philosophy which has dictated the multi-faceted investigation carried out for each patient. These data consisting of clinical observations, measurements and test results were obtained at regular intervals during the pre and post radiation periods and recorded for IBM data analysis. Table X summarizes the variables which have been recorded. It is of interest to note that these data have not only been of value to us but have been used by other groups of investigators (see section on publications and reports).

To gain some insight into the trends of hematological changes that may possibly be contained in the data structure and for initial screening purposes,

high speed computer display techniques were utilized to prepare a large number of scattergrams in which each of the variables hemoglobin, platelets, and total white count was plotted against time (in days) to determine whether there were any consistent degradation/recovery trends which could be used for ultimate prediction. The data were condensed by dividing the patients into four groups: those exposed to lower level radiation (less than 125 rads) and those exposed to higher levels (greater than 125 rads); each exposure group was then subdivided into those patients who had experienced previous exposure and those who had not. A typical plot of a variable versus time for one of these groups is shown in Figure 15.

The degree of scatter evidenced in these figures was exhibited by virtually all of the variables for all of the categories studied. As a result of this initial scrutiny, it was possible to eliminate many of the biochemical variables from further study since it became clear that there was no tendency towards consistent behavior at the doses given. Although the scatter exhibited by the other variables was quite large in many cases, the presence of some trends could not be denied, and means had to be sought for reducing the amount of scatter so that meaningful equations could be derived. Since the raw data were available in machine compatible form, it was possible to explore a variety of transformation techniques. The transformation which produced the most effective reduction in scatter was one in which a particular reading was expressed as a ratio of the given value on any post treatment day to the average value of that variable for that patient during the pre-exposure period of scrutiny.

By referencing each set of readings for each subject to his control period in this manner, it was possible to compensate for the between-patient variation in level for a given variable. A representative graph of a group of transformed data is shown in Figure 16.

With the data available in this form, efforts were directed towards deriving a series of equations which would describe quantitatively the variation in time for each of the parameters. Based on the appearance of the transformed graphs and the nature of other biological time functions, attempts were made to fit the data to exponential equations of the general form

$$Y = Ae^{B^t} + C$$

where Y is the particular parameter under consideration, t is the time in days after exposure, e is the base of natural logarithms, and A, B, and C are arbitrary constants characteristic of the particular data. During this phase of the analysis, the curve fitting technique was applied to each of ten variables for the individual patients and for each of the four groupings. It was found that equations could not be derived for several of the variables due to the magnitude of the scatter that was still present. The results of this analysis are summarized in Table XI which shows a measure of the goodness of fit for each of the equations derived. It is seen, with only few exceptions, that the relationships were quite weak despite visual indications to the contrary on some of the graphs.

Since these attempts to fit a single, simple exponential equation to both the degradation and recovery phases of each time series was unsuccessful, techniques had to be devised for handling each part of the curve separately. This type of analysis was complicated by the fact that the transition

point at which degradation ceased and recovery began was not precisely known and could vary for each parameter. Consequently an iterative procedure was designed wherein a number of trial transition points were used to zero in on that point (day number) for a given variable which resulted in the pair of derived equations whose cumulative error was minimized. The criterion for error which was used in this analysis was the sum of the squared deviations around the derived curves. A summary of the results obtained with this technique is given in Table XII. When compared with the characteristics of the single exponential functions (Table XI) it is seen that for most of the variables considered, there was no appreciable improvement in correlation either because of the excessive scatter or because, in some cases, the number of days of data collection were not enough for the fitting procedure to work effectively. In the case of white blood count, platelet count, and hematocrit, however, the division of the data into two exponential functions resulted in dramatic improvements in correlations. Furthermore, there was a noticeable and consistent separation between those patients exposed to the lower dose (as defined above) and the higher dose group. The transition point for the low dose group occurred at 10-15 days after exposure for each of the variables examined, and the recovery portion of the curve had virtually no slope (i.e., the change in values during the recovery period was negligible). Transition points for the high dose group occurred at 25-30 days after exposure, and the recovery function at a positive slope, indicating that the degree of recovery was measurable by these criteria.

Whether a particular group had previous exposure or did not appear to influence the location of the transition point or the nature of the degradation and recovery curves.

Using the white blood count and platelet readings as the indicating variables, attempts are being made to establish a procedure for predicting the dose level for a given patient. It was seen that the time series of these readings, expressed as ratios to corresponding control readings for each individual, could be fitted to two exponential functions. The first of these extends over what might be termed the degradation, and the second fits the data for what might be considered the recovery period. Such equations were fitted to each of the 4 patient groups for each of the 2 variables by developing and using a program which tries combinations of equations for various time periods until it optimizes for that definition of degradation/recovery transition day for which the best fits are obtained for both positions.

It is seen that there is fairly good separation between high and low dose groups because both variables and transition days are different. It will be noticed, however, that the relationship for platelets for the low dose groups are quite weak (Table XIII).

From these results it was thought that it might be possible to combine all low dose patients into one group irrespective of their previous exposure history. This was also tried for the high dose group. The results are tabulated below. (See Table XIV).

From this table it is seen that we cannot combine all low-dose and all high-dose patients into an amalgamated group;the relationships deteriorate badly and cannot in any way be uses as predictors. Consequently, it appears that, at least for the present, we will have to continue to use the four original groups.

In an attempt to test the method based on earlier case analysis, the data from total white count and platelet count was presented to the computer analyst as unknowns. Because of the paucity of change in platelet and total white count values in patients receiving PBR, this group was included as "low dose" subjects. The results of this analysis are as follows:

Patient No.	Computer Dose Level Estimate*	Dose in Rad	Type of Exposure
43	low	100	PBR-lower body
44	low	100	TBR
45	high	150	TBR
47	low	150	PBR-lower body
49	low	200	PBR-lower body
50	low	200	PBR-upper body
51	high	150	TBR
52	low	200	PBR-lower body
53	high	200	TBR
55	low	200	PBR-upper body
56	low	100	PBR-upper body
57	** high	100	TBR
58	** high	50	TBR
59	high	150	TBR
60	high	150	TBR

*For this classification low refers to doses below 125 rad and high to doses above that value

** Cases in which the computer estimate was incorrect.

It is difficult to classify patients whose values do not show variation and those in whom a particular variable rises sharply from day zero before it begins to degrade.

DEOXYCYTIDINE AND RELATED DNA COMPOUNDS:

In 1963 we determined that aminoaciduria in the human being, particularly beta amino isobutyric acid and taurine, were non-specific indicators of stress (see below). In the search for other possible biological indicators, it was found that Parizek et al. (Nature 182:721-2, 1958) had reported elevation of urinary deoxycytidine (dct) in irradiated rats. They stated that this compound once formed is apparently not further metabolized and is excreted. The level of excretion was apparently directly related to dose. The method used by these workers was separation of the nucleoside by paper chromatography and determination of the level of dct by the Dische reaction.

Since the Dische reaction may be non-specific for a variety of nucleosides and related compounds, improved assay methods are desirable. The work in our laboratory has followed several lines of investigation as follows:

1. Improved assay methods
2. Studies of the metabolism of stable dct in the human being and in the rat
3. Studies of dct metabolism using labeled dct.

Our initial bioassay method was devised by Berry et. al. (Deoxycytidine in Urine of Humans after Whole-Body Irradiation; Berry, H.K., E.L. Saenger, H. Perry, B.I. Friedman, J.G. Kereiakes and C. Scheel. Science, Vol. 143, 396-398, Oct., 1963) and showed elevation of dct in two human beings with cancer following TBR. The method of assay was isolation and concentration of nucleic acid derivatives by absorption on charcoal and elution with pyridine. The material was then subjected to chromatography. The spots corresponding to dct and thymidine (t) were eluted into a nutrient medium with Lactobacillus Leishmania for assay since dct and t can substitute for B_{12}. The minimum detectable amount of dct in urine was about 4 μg/ml.

Subsequent assay studies have been directed toward attempts to develop simpler and more rapid methods. In the original method, excessive error and low recovery were introduced by variation in the quality of activated charcoal. According to W.S. Adams (Amer. J. Med. 28:726-734, 1960), by using the anion exchange method to separate the nucleic acid components, dct was the first component to come off the column followed closely by cytosine and cytidine. Seydel and Garrett (Anal. Chem. 37:271-274, 1965) found that incubation of deoxyribose at 80° C in 1 N HCl for 5-24 hours produced an ultra-violet chromophore giving a peak of 260 mu with the Beckman DU Spectrophotometer. Saslaw and Waravdekar (J. Organic Chem. 22:843, 1957) reported that 72 to 86% of free deoxyribose was found by hydrolysis of dct for 120 minutes in 0.01 N HCl in a boiling water bath. Thus the method

described below uses column-separation and acid-degradation with chromophore formation to quantitate dct.

The method is as follows: Sephadex anion exchange resin A-25, medium, is packed in columns 300 mm long and 10 mm in diameter using as the eluant a buffer of about equal amounts of NH_4OH (0.22 molar) and NH_4Cl (0.25 molar) adjusted to pH 10.4 with saturated NaOH. Urine specimens are treated with 1 ml of 5% urease to remove urea. One ml of the solution to be analyzed is introduced into the column followed by 50-100 ml of buffer and 10 fractions of 4.5 ml are collected using a Gibson Medical Electronics fraction collector.

The eluate is then processed in a number of ways as described below.

1. Comparison of readings of 2-deoxyribose and 2-deoxycytidine following incubation for 5-24 hours at 80°C in 1 N HCl.

The solutions were extracted with three fractions of 2 ml of Chloroform. The volumes were adjusted to 10 ml and centrifuged to remove suspended particles. The peak absorbance of deoxyribose and dct was at 261 mu (Figure 17). Figures 18 and 19 show the direct proportionalities between absorbance and concentrations of 2-deoxyribose and dct respectively at 261 mu. The slope of the 2-deoxyribose was 4.01×10^{-3} absorbance per microgram per ml of solution, that for dct 2.07×10^{-3}.

2. Table XV shows the absorbance of several combinations of cytosine, cytidine, dct, and 2-deoxyribose after having been passed through

the column. The column and the CCl_4 extraction are thus capable of separating both dct and 2-deoxyribose from cytosine and cytidine.

Table XVI shows the degree of hydrolysis of dct following the acid treatment. The minimal level was 83%. Table XVII shows that 0.25 - 0.5 ml of 12 N HCl is enough to hydrolyze each buffered fraction collected from the ion exchange column.

To this point column chromatography using the anion exchange resin appears encouraging as a rapid clinical method.

IMMUNOLOGY:

Serum from some of these patients has been stored and sent to Dr. Anthony J. Luzzio of the U.S. Army Medical Research Laboratory, Ft. Knox, Kentucky. The serum has been examined for radiation-altered serum gamma globulin by a quantitative precipitin test to detect antibodies stimulated by radiation altered HSGG (anti-XI-HSGG) which could detect specific antigens in the sera of patients treated with TBR. These data (Specific Proteins in Serum of Total-Body Irradiated Humans. Luzzio, A. J., B.I. Friedman, J.G. Kereiakes and E.L. Saenger. Jour. Immuno. 96:64, 1966) suggest an alteration in antigenicity of human serum gamma globulin as a result of in vivo irradiation.

Results and Conclusions:

The results show that in the quantitative precipitin reaction, anti XI-HSGG is precipitated in a unique pattern by human sera collected at

various times before and after irradiation.

The data are insufficient to determine whether the effects described are due to a direct effect on preformed proteins or an effect on the rate of synthesis of a pre-existing protein, or both.

In addition, other immunologic techniques have been used to study these patients. A slide test for thyroglobulin agglutination was negative before and after radiation.

The C Reactive Protein test was evaluated. Inconstant results were found with no trend noted.

Since the latex fixation test is easily available and indicative of immunologic reactivity, it was used as a screening test for immunologic response in ten patients who received TBR and three who received PBR. All studies were performed by a technician who had coded specimens. None of the patients who received PBR showed any change. Five of the ten patients given TBR had an increase in the Latex Fixation Test following therapy. However, two patients manifested decreasing titres. These results are inconclusive but should be evaluated further in additional patients. It does not appear that the latex test, as applied in these studies, is a suitable biological dosimeter.

Chromosome Studies:

Observation of peripheral blood chromosome cultures has continued. A finding of particular interest has been the observation of endoreduplication.

This phenomenon has been observed in eleven patients with cancer and in one control. It has been seen before and after irradiation. Four patients have been studied in detail (Table XVIII). In at least one patient, increased incidence of this occurrence seems to be a radiation effect. At this time it is not clear whether this observation is associated with irradiation or with the presence of malignancy. Additional studies are being carried on in controls and patients with malignancy to evaluate further the role of irradiation.

Terminated Studies:

a) Aminoaciduria:

In normal human beings receiving external gamma and neutron irradiation from radiation accidents, aminoacidura particularly of β aminoisobutyric acid and taurine has been described (Rubini et al. Proc. Soc. Exp. Biol. & Med. 100:130, 1959 and Gerber et al. Rad. Res. 15:31, 4, 1961). The excretion levels have exceeded values found in other normal population samples, but of course there was no opportunity to obtain pre-treatment control levels in these accident victims. Our cancer patients had a two-week control period and two episodes of sham irradiation. Quantitative two-dimensional chromatography of all urines were performed in most patients prior to 1963. Twenty amino acids were analyzed. There were no statistical differences in pre and post irradiation levels of individual or pooled urinary aminoacids. Several patients showed high spikes of certain aminoacids either just before or after sham irradiation (Figures 20, 21, 22).

In our clinic previous studies of children following surgery or infection showed increased aminoaciduria. Thus one is forced to conclude that aminoaciduria is non-specific and not solely characteristic of irradiation. It may be produced by different types of stresses including psychic stress. It is possible that the psychic stress was proportional to the radiation dose in the Oak Ridge patients. Possibly the neutron fraction of the radiation exposure in the accident victims was a factor by producing an increased RBE.

Creatinuria:

We were unable to demonstrate creatinuria. Subsequent reports of Gerber et al. (Rad. Res.15:307ff, 1961) have shown creatinuria both with whole and partial body irradiation. The method is not suitable for routine use in the laboratory.

Serum Electrophoresis and Immunoelectrophoresis:

Serum protein fractionation was performed by paper electrophoresis. No changes after TBR have been found. Therefore we have deleted this procedure.

Immunoelectrophoresis using a quantitative technique of West et al. (J. Lab. & Clin. Med. 58:137, 1961) was used to study possible changes of γA and γM globulines which appear to be related to the immune system. No changes were found and hence this technique has been abandoned. It does not now seem likely that changes will be found in constituents of plasma related to the immune mechanism (Hasek and Lengerove in Mechanism in Radiobiology

Vol. II, 207-229, 1960. Academic Press and Unesco Report on Effects of Atomic Radiation 164, 1962). Our findings are in accord with their conclusions.

SUMMARY:

This report summarizes the data and some conclusions accumulated from fifty patients who have been given total (TBR) or partial (PBR) body irradiation at the University of Cincinnati Medical Center from February 1960 through April 1966. Forty patients received 25 rad to 200 rad midline absorbed tissue dose (40.8 r to 336 r midline air dose of TBR). Ten patients were given either upper or lower body irradiation in doses varying from 100 rad to 300 rad (150 r to 436 r midline air dose).

All patients were studied for one to two weeks prior to radiation and for as long as possible after exposure. All patients received one or two episodes of sham irradiation. Radiation was delivered by a cobalt 60 teletherapy unit.

The incidence of prodromal nausea, vomiting, and anorexia rose with increasing dose in patients receiving TBR, being far more frequent above 125 rad. In the group of patients receiving PBR, prodromata were found when the dose was 200 rad or more. Psychological depression seemed to parallel the change in physical state following radiation. Anxiety was high prior to sham or actual treatment and dropped after both treatments.

The hematologic response in patients receiving TBR has been similar to that previously reported. The total white count falls to a low point 25 to 40 days after irradiation. There was a persistent lymphopenia which persisted for 40 to 60 days.

A comparison of the hematologic changes in PBR to those of TBR reveals a paucity of change in total white count, platelets, and hematocrit even when the patient had received more than 200 rad PBR. Lymphopenia did occur in patients given PBR but in two cases did not occur till 48-72 hours after exposure.

Profile scoring of hematologic data has been continued. It has not been of additional help in predicting which cases would have difficulty, nor useful as a "biological dosimeter." The method seems to add little additional information with considerable increase in work.

Infusion of stored autologous bone marrow has been completed in two patients. The marrow was infused intravenously without filtration. No significant morbidity was noted as a result of infusion. The response in one patient suggested marrow space repopulation.

In two patients the urinary excretion of the nucleoside deoxycytidine (dct) has been increased in the first 48 hours post TBR. Excretion has also been increased in the urine of rats given from 200 to 800 rad TBR. The charcoal absorption method previously reported by our group has been too time-consuming and laborious for the quantitative determination of dct in the urine. Therefore, a method of anion exchange column chromatographic separation and acid degradation chromophore formation is being evaluated.

In cooperation with A. J. Luzzio of the U. S. Army Medical Research Laboratory, Fort Knox, Kentucky, studies of serum from patients

given TBR have been performed. The data have shown that in a quantitative precipitin reaction antibodies to radiation altered human serum gamma globulin (anti-Xi-HSGG) are precipitated in a unique pattern by human sera obtained before and after irradiation. The data are insufficient to determine whether the observations are due to a direct effect on preformed proteins, an effect on the rate of synthesis of a protein, or both.

Other immunologic studies have revealed no specific post irradiation changes in the slide test for thyroglobulin agglutinations, nor the C-reactive protein. A suggestive change in the latex fixation warrants further investigation.

Endoreduplication has been seen with increased incidence in peripheral blood chromosome preparations. This observation may be associated with malignancy but was increased following TBR.

No significant trends in aminoaciduria, creatine excretion nor serum electrophoresis were found. Immunoelectrophetic studies for γA and γM globulins showed no changes following TBR. These studies were all discontinued, because of the negative findings.

The experimental design of this program has influenced the interpretation of the data because of the pre-irradiation observation. The effect of sham irradiation on urinary excretion of BAIBA in particular illustrates this point since in some patients BAIBA excretion was elevated more with sham than with radiation.

From the data which have been accumulated, it appears that combat effectiveness would be maintained relatively well with an exposure up to 150 rad TBR. A large number (up to 50%) of troops would manifest prodromata at or above this dose.

Partially shielded exposures are less easy to evaluate in terms of triage. Prodromata following large area PBR occurred at the 200 rad level, but subsequent hematologic change 25+ days later was minimal except for lymphopenia. Therefore, though early nausea and vomiting was temporarily debilitating, the manifest illness stage of the radiation syndrome was minimal.

Further study of partial versus total body exposure is important to clarify this difference.

PUBLICATIONS:

1. Metabolic Changes in Humans Following Total Body Irradiation. Report for February 1960 through October, 1961. DASA Contract No. DA-49-146-XZ-029, Defense Atomic Support Agency, Washington, D.C.

2. Metabolic Changes in Humans Following Total Body Irradiation. DASA 1422, Report for November 1, 1961 through April 30, 1963. DASA Contract No. DA-49-146-XZ-029, Defense Atomic Support Agency, Washington, D.C.

3. Deoxycytine in Urine of Humans after Whole-Body Irradiation. Berry, H.K., E.L. Saenger, H. Perry, B.I. Friedman, J.G. Kereiakes and C. Scheel. Science Vol. 143, pp. 396-398, October, 1963.

4. Metabolic Changes in Humans Following Total Body Irradiation. DASA 1633, Report for May 1, 1963 to February 29, 1964. DASA Contract No. DA-49-146-XZ-029, Defense Atomic Support Agency, Washington, D.C.

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*Abstract

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TABLE I

PRE AND POST IRRADIATION OBSERVATIONS

1. Complete history and physical examination
2. Temperature, pulse, and respiration
3. Body weight
4. Medications - fluids, antibiotics, steroids, narcotics
5. Urine
   a) volume
   b) routine urinalysis
   c) chromatography for deoxycytidine
6. Serum urea nitrogen
7. Quantitative precipitin test
8. Thyroglobulin agglutination
9. Latex fixation
10. C reactive protein
11. Chromosome studies
12. Blood cultures
13. Bone marrow aspiration
14. Autologous marrow storage
15. Psychological testing
16. Psychiatric evaluation of cognitive-intellectual functioning and emotional reactions

TABLE II

PROFILE VALUES ASSIGNED FOR VARIOUS RANGES OF ABNORMALITY

HEMATOLOGY--PERIPHERAL COUNTS

TEST	UNITS	NORMAL*	PROFILE VALUE							
			1	2	3	4	1	2	3	4
			(for increase above normal)				(for decrease below normal)			
Hemoglobin	gm. per cent	M-15.8	18	19	20	21	14	12	10	8
		F-13.9	16	17	18	19	11.5	10	8.5	7
Erythrocytes	Mill. /mm.^{3}	M- 5.4	6.0	7.0	8.0	9.0	4.5	3.5	2.5	1.5
		F- 4.8	5.5	6.5	7.5	8.5	4.0	3.0	2.0	1.0
Hematocrit	Volume per cent	M-47	54	56	58	60	40	35	30	25
		F-42	47	49	51	53	37	32	27	22
Leukocytes	1,000/mm.^{3}	7.4	12	18	24	30	4.0	3.0	2.0	1.0
Neutrophils	1,000/mm.^{3}	4.4	7.7	14	21	28.0	1.8	1.3	0.9	0.5
Lymphocytes	1,000/mm.^{3}	2.5	4.8	7.0	10	12.0	1.0	0.75	0.5	0.3
Platelets	1,000/mm.^{3}									
Rees-Ecker		405	545	700	850	1000	273	200	100	30
Brecher-Cronkite		257	440	600	750	900	140	100	50	30
Fonio		234	350	500	650	800	130	100	50	30
Dameshek		716	900	1000	1500	2000	500	350	100	30
Reticulocytes	per cent red blood cells	1.5	4	8	15	25	0.5	0		
Erythrocyte Sedimentation Rate	mm./hr.	M-5	10	20	30	40				
		F-10	20	30	40	50				

* Expressed as "universal mean" value. Taken from Standard Values in Blood: Being the First Fascicle of a Handbook of Biological Data. E.C. Albritton, Editor. W.B. Saunders Company, Philadelphia, 1952.

TABLE III

SAMPLE PROFILE SCORE SHEET

1	2	3		4		5		6		7		8		9		10		11		12		13	
STT	Day of Observ.	Hgb.		RBC		Hct.		Net RBC		WBC		Neutrophile		Lymph		Platelet		Disease Score		Radiation Score		Total Score	
		T	C	T	C	T	C	T	C	T	C	T	C	T	C	T	C	T	C	T	C	T	C

T = test score

C = cumulative score

Col 1 STT refers to standard test times (Thoma & Wald)

Col 2 Day of observation corresponding to standard test time

Col 3, 4, 5 Profile score based on observed Hgb, RBC, and Hct.

Col 6 Calculated "net erythrocyte" score, i.e., $T_6 = \frac{T_3 + T_4 + T_5}{3}$ $C_6 = \frac{C_3 + C_4 + C_5}{3}$

Col 7, 8, 9, 10 Profile score based on observed WBC, Neutrophile, Lymphocyte and Platelet Counts

Col 11 T_{11} = Calculated disease mean daily test score (DMTS) = $\frac{C_{11} \text{ (at end of pre Rx period)}}{\text{No. of observations prior to Rx}}$

In the post Rx period T_{11} = DMTS
In the post Rx period C_{11} = DMTS x number of observations in the post Rx period

Col 12 T_{12} (Radiation test score) = $T_{13} - T_{11}$
C_{12} (Radiation cumulative score) = $C_{13} - C_{11}$

Col 13 T_{13} (Total test score) = $T_6 + T_7 + T_8 + T_9 + T_{10}$
C_{13} (Total cumulative score) = $C_6 + C_7 + C_8 + C_9 + C_{10}$

TABLE IV

#007 JT, age 62, cm

PROFILE SCORE SHEET - TOTAL BODY RADIATION STUDY

1	2	3		4		5		6		7		8		9		10		11		12		13	
STT	Day of Observ.	Hgb.		RBC		Hct.		Net RBC		WBC		Neutrophile		Lymph		Platelet		Disease Score		Radiation Score		Total Score	
		T	C	T	C	T	C	T	C	T	C	T	C	T	C	T	C	T	C	T	C	T	C
Pre-Rx																							
	21	1	1	0	0	1	1	.66	.66	0	0	0	0	0	0	0	0	.66	.66				
	18	1	2	0	0	0	1	.33	.99	0	0	0	0	2	2	1	1	3.33	3.99				
	16	1	3	0	0	0	1	.33	1.32	0	0	0	0	0	2	0	1	.33	4.32				
	14	1	4	0	0	0	1	.33	1.65	0	0	0	0	0	2	0	1	.33	4.65				
	10	1	5	0	0	0	1	.33	1.98	0	0	0	0	0	2	0	1	.33	4.98				
	8	0	5	0	0	0	1	.00	1.98	0	0	0	0	0	2	1	2	1.00	5.98				
	2	1	6	0	0	0	1	.33	2.31	0	0	0	0	0	2	0	2	.33	6.31				
Calculated Disease Mean Daily Test Score (DMTS																		.9					
Post Rx																							
1	1	1	1	0	0	0	1	.33	.33	0	0	0	0	2	2	2	2					4.33	4.33
2	2	1	2	0	0	0	1	.33	.66	0	0	0	0	2	4	0	2					2.33	6.66
3	3	1	3	0	0	0	1	.33	.99	0	0	0	0	2	6	0	2					2.33	8.99
6	6	1	4	0	0	1	2	.66	1.65	0	0	0	0	4	10	0	2					4.66	13.65
9	9	1	5	1	1	1	3	1.00	2.65	2	2	1	1	4	14	1	3					9.00	22.65
12	12	2	7	1	2	1	4	1.33	3.98	2	4	1	2	4	18	1	4					7.33	29.98
15	14	2	9	0	2	1	5	1.00	4.98	1	5	0	2	4	22	1	5					7.00	36.98
18	17	2	11	0	2	1	6	1.00	5.98	1	6	0	2	4	26	2	7					8.00	44.98
21	20	1	12	1	3	1	7	1.00	6.98	3	9	1	3	4	30	2	9					11.66	56.64
24	24	2	14	2	5	1	8	1.66	8.64	3	12	2	5	4	34	3	12					13.66	70.30
27	28	2	16	2	7	1	9	1.66	10.30	3	15	2	7	4	38	3	15	.9	9.9	12.76	74.10	13.66	83.96

TABLE V

RADIATION DOSIMETRY *

Patient No.	Midline Air Dose Roentgens	Midline Absorbed Tissue Dose Rads
004	100	66
006	100	54
007	167.1	100
008	185	100
009	25	16
	25	16
010	157.4	100
011	170	100
013	85	50
	85	50
	85	50
015	166	100
017	149	100
018	313	200
020	294	200
021	322	200
022	248	150
023	336	200
024	322	200
025	226	150
026	155	100
027	238	150
029	257	150

TABLE V Page 2

Patient No.	Roentgens	Rads
030	149	100
031	155	100
033	152	100
035	227	150
036	153	100
037	231	150
038	41	25
040	152	100
041	77	50
042	216	150
043	150	100 (Lower)
044	149	100
045	250	150
047	233	150 (Lower)
049	304	200 (Lower)
050	348	200 (Upper)
051	212	150
052	296	200 (Lower)
053	316	200
055	341	200 (Upper)
056	151	100 (Upper)
057	175	100
058	81	50
059	238	150
060	231	150

TABLE V Page 3

Patient No.	Roentgens	Rads
061	76.4	50
062	231	150
063	436	300 (Lower)
064	444	300 (Lower)
065	310	200 (Lower)

* All cases not otherwise indicated received total body radiation.

TABLE VI

TOTAL BODY RADIATION

INCIDENCE OF PRODROMAL SYMPTOMATOLOGY

Dose		Pts. with symptoms / Total pts.		
Midline Air dose (Roentgens)	Midline absorbed Tissue dose (Rads)	No Previous Rx	Previous Rx	Totals
101	100	0/3	0/3	0/6
149 - 185	100	2/9	2/5	4/14
226 - 257	150	3/4	6/8	9/12
294 - 336	200	3/5	1/1	4/6
		8/21	9/17	17/38

* Patients #009 and #013 are ommitted because they received multiple doses of radiation.

TABLE VII

PARTIAL BODY RADIATION

INCIDENCE OF PRODROMAL SYMPTOMATOLOGY

Dose		Pts. with symptoms/ Total pts.	
Midline Air Dose (Roentgens)	Midline absorbed Tissue Dose (Rads)	No Previous Rx	Previous Rx
<100	<100	-	-
150-151	100	0/2	-
233	150	-	0/1
296-348	200	2/5	-
436-444	300	2/2	-
		4/9	0/1

TABLE VIII

PATIENTS FOR PSYCHIATRIC EVALUATION

Pt. No.	Age	Race & Sex	Marital Status	Type Cancer	Duration known tumor (in mos)	Years of school	I. Q.*	Halstead impairment
049	74	NM	D	rectum	2	10	116	1.00
050	80	WM	M	rectum, bladder	30	5	112	.875
051	66	WM	M	lung	18	7	99	.875
055	56	WF	W	rt. breast	6	2	72	.875
056	53	NM	Sep.	lung	3	0	89	.50
057	57	NF	W	ovary	3	7	79	.70
058	48	NF	M	cervix	12	8	84	.625
059	42	WM	M	kidney	4	8	99	.625
060	49	NF	M	rt. breast	10	3	87	.75
061	64	NF	W	metastatic ?	36	0	63	.67
062	60	NM	Sep.	colon	15	5	83	.75

* Bellevue Wechsler Adult Intelligence Scale

TABLE IX

PROFILE SCORING

PARTITION OF SCORES

BASED ON "NET ERYTHROCYTE" SCORE

Case No.	Dose (Rads)	Disease Score Test[A]	Disease Score Cumulative	Radiation Score Test	Radiation Score Cumulative	Total Score Test	Total Score Cumulative		Group
004	66	4.1	49.3	0	12.0	4.0	61.3	(30)	I
006	54	1.3	10.0	-	-	0.3	2.0	(18)	-
007	100	0.9	9.9	12.7	75.4	13.6	85.3	(27)	III
008	100	1.6	17.2	-	2.4	0.6	19.6	(27)	I
009[B]	16	1.3	7.8	3.0	14.2	4.3	22.0	(25)	II
010	100	1.2	12.7	3.4	11.3	4.6	24.0	(27)	I
011	100	2.3	8.0	-	10.3	0.3	38.3	(30)	I
013[B]	50	1.6	19.2	2.7	18.1	4.3	37.0	(30)	II
014	-	9.3	102.3	-	-	4.6	80.0	(27)	-
015	100	.5	6.6	7.1	37.4	7.6	44.0	(30)	II
016	-	3.1	37.2	2.5	19.8	5.6	57.0	(27)	II
017	100	0.0	0.0	7.3	47.3	7.3	47.3	(30)	II-III
018	200	1.4	16.8	12.6	47.2	14.0	65.0	(30)	III
020	200	1.7	22 5	4.2	98.2	6.0	120.7	(33)	III
021	200	3.8	49.4	12.2	64.2	16.0	113.6	(33)	II-III
022	150	3.8	19.0	4.2	8.0	8.0	27.0	(09)	I-II
023	200	0.4	4.8	7.9	63.8	8.2	68.0	(30)	III
		0.4	6.4	1.9	80.6	2.3	87.0	(44)	II
024	200	2.6	28.6	6.7	15.4	9.3	44.0	(30)	II
		2.6	39.9	12.3	52.7	15.0	92.6	(69)	II

TABLE IX
(continued)

PROFILE SCORING

PARTITION OF SCORES

BASED ON "NET ERYTHROCYTE" SCORE

Case No.	Dose (Rads)	Disease Score Test[A]	Disease Score Cumulative	Radiation Score Test	Radiation Score Cumulative	Total Score Test	Total Score Cumulative		Group
025	150	1.7	18.7	17.6	29.3	19.3	88.0	(27)	III
030	100	0.8	9.6	3.8	17.7	4.6	27.3	(30)	II
		0.8	11.2	0.5	23.9	1.3	47.3	(60)	I-II
		0.8	16.0	0.5	34.0	1.3	50.0	(90)	I-II
031	100	2.1	25.2	-	-	1.6	20.6	(30)	-
		2.1	37.8	-	4.5	1.3	42.3	(60)	I
		2.1	41.2	-	1.1	0.0	42.3	(90)	I
033	100	1.4	18.2	3.9	14.8	5.3	33.0	(30)	I
		1.4	25.2	1.2	27.1	2.6	52.3	(60)	I
035	150	0.0	0.0	10.6	38.3	10.6	38.3	(30)	II
		0.0	0.0	0.0	95.6	0.0	95.6	(60)	II
		0.0	0.0	0.0	96.6	0.0	96.6	(139)	II
036	100	1.4	16.8	8.9	61.5	10.3	78.3	(30)	II-III
		1.4	24.1	4.6	100.2	6.0	124.3	(47)	II-III
037	150	1.0	10.0	11.7	37.7	12.7	47.7	(26)	II
038	25	3.1	37.2	-	5.4	1.3	42.6	(30)	I
		3.1	55.8	1.5	21.5	4.6	77.3	(60)	I
		3.1	65.1	0.2	16.2	3.3	81.3	(105)	I
040	100	1.2	15.6	7.1	29.7	8.3	45.3	(30)	II
		1.2	21.6	0.8	50.0	2.0	71.6	(60)	II
		1.2	22.8	0.8	50.9	2.0	73.7	(75)	II
041	50	2.9	8.7	4.1	5.9	7.0	14.7	(03)	III
042	150	0.0	0.0	17.0	81.3	17.0	81.3	(30)	III
		0.0	0.0	2.0	139.0	2.0	139.0	(60)	III
		0.0	0.0	0.0	144.3	0.0	144.3	(105)	III

TABLE IX
(continued)

PROFILE SCORING

PARTITION OF SCORES

BASED ON "NET ERYTHROCYTE" SCORE

Case No.	Dose (Rads) *L - U	Disease Score Test[A]	Disease Score Cumulative	Radiation Score Test	Radiation Score Cumulative	Total Score Test	Total Score Cumulative		Group
043	100 (L)	4.8	33.6	0.8	12.0	5.6	45.6	(14)	II
044	100	0.0	0.0	3.3	20.3	3.3	20.3	(30)	II
		0.0	0.0	3.0	45.3	3.0	45.3	(60)	II
		0.0	0.0	0.0	61.0	0.0	61.0	(120)	II
045	150	0.0	0.0	15.0	49.3	15.0	49.3	(24)	III
047	150 (L)	4.8	57.6	-	-	2.3	51.3	(30)	-
		4.8	76.8	2.2	-	7.0	75.3	(44)	-
049	200 (L)	2.6	31.2	4.0	38.8	6.6	70.0	(30)	II
		2.6	46.8	2.7	57.2	5.3	104.0	(60)	II
050	200 (U)	0.8	9.6	-	13.4	0.6	23.0	(30)	I
		0.8	14.4	0.2	38.2	1.0	52.6	(60)	II
		0.8	17.6	7.2	52.7	8.0	70.3	(180)	II
051	150	5.6	67.2	4.7	22.1	10.3	89.3	(30)	II
		5.6	100.8	0.4	34.2	6.0	135.0	(60)	I
052	200 (L)	2.3	27.6	1.7	22.4	4.0	50.0	(30)	II
		2.3	41.4	2.3	39.2	4.6	80.6	(60)	II
		2.3	43.7	1.7	40.9	4.0	84.6	(75)	II
053	200	4.2	56.2	14.4	36.8	18.6	83.0	(27)	II
055	200 (U)	0.0	0.0	2.0	3.3	2.0	3.3	(30)	I
		0.0	0.0	4.6	25.6	4.6	25.6	(60)	I
		0.0	0.0	2.0	40.0	2.0	40.0	(129)	II
056	100 (U)	2.0	24.0	4.3	30.3	6.3	54.3	(30)	II
		2.0	28.0	5.6	41.3	7.6	69.3	(36)	II
057	100	0.7	8.4	6.3	40.2	7.0	48.6	(30)	II
		0.7	12.6	1.3	76.4	2.0	39.0	(60)	II
		0.7	15.4	6.9	95.9	7.6	11.3	(120)	II

* L= Lower
U= Upper

TABLE IX
(continued)

PROFILE SCORING

PARTITION OF SCORES

BASED ON "NET ERYTHROCYTE" SCORE

Case No.	Dose (Rads) *L	Disease Score Test[A]	Disease Score Cumulative	Radiation Score Test	Radiation Score Cumulative	Total Score Test	Total Score Cumulative		Group
058	50	5.1	61.2	-	11.4	4.6	72.6	(30)	I
		5.1	86.7	3.2	16.6	8.3	103.3	(48)	I
059	150	3.2	38.4	16.4	59.6	19.6	98.0	(30)	II
060	150	0.0	0.0	18.0	42.6	18.0	42.6	(30)	II
061	50	1.8	21.6	3.8	14.7	5.6	36.3	(30)	I
		1.8	28.8	0.2	24.5	2.0	53.3	(48)	I
062	150	2.1	25.2	3.2	2.8	5.3	28.0	(30)	I
		2.1	37.8	0.2	39.5	2.3	77.3	(60)	II
		2.1	46.2	0.9	47.4	3.0	83.6	(120)	II
063	300 (L)	4.0	48.0	-	-	1.6	35.6	(30)	-
		4.0	72.0	2.3	-	6.3	57.3	(60)	-
		4.0	80.0	1.0	-	5.0	65.0	(90)	-
064	300 (L)	1.6	19.2	2.0	15.4	3.6	34.6	(30)	I
		1.6	27.2	5.4	35.1	7.0	62.3	(48)	II
065	200 (L)	0.7	7.8	2.0	34.8	2.6	42.6	(30)	II
		0.7	9.8	2.9	43.8	3.6	53.6	(40)	II

[A] T (Disease) is Disease Mean Test Score.

[B] Patients #009 and #013 are placed in Group II because Cumulative score (Radiation) is greater than that for Group I though less than range for Group II. (Both received multiple Rx).

Patients #026, #027 and #029 were omitted because of technical problems.

( ) = Days post irradiation.

*L= Lower

TABLE X

VARIABLES FOR COMPUTER ANALYSIS

Physical

Body Weight, kg.

Fluid intake, ml x 10^2

Fluid output, ml x 10^2

Specific fluid intake, ml x 10^2 - saline

Specific fluid intake, ml x 10^2 - saline and glucose

Special fluid intake, ml x 10^2 - Ringers

Specific fluid intake, ml x 10^2 - Hartman

Average daily temperature

Respiration rate

Pulse

Amino Acid

Amino acids, µg/mg creatinine-glutamic acid*

Amino serine *

Amino glycine *

Amino threonine *

Amino alamine *

Amino glutamine *

Amino valine *

Amino taurine *

Amino BAIB *

Amino lysine *

Amino tyrosine *

Amino leucine *

Amino phenylalamine *

Amino proline *

Amino histidine *

Amino aspartic acid *

Amino cystine *

Amount of creatinine in 1000 ml*

* *Corrected and uncorrected for creatinine*

Biochemical

Creatinine - mg/100 ml

Creatine - mg/100 ml

Desoxycytidine - mg/100 ml

Creatinine - mg/100 ml

Creatine - mg/100 ml

Albumin - gm percent

Total protein - gm percent

TABLE X (page 2)

Microscopic - Blood

Hemoglobin

Red Blood Count

White Blood Count, x 10^2

Lymphocytes, total %

Lymphocytes, % normal

Lymphocytes, % small

Lymphocytes, % large

Lymphocytes, % atypical

Lymphocytes, % abnormal

Lymphocytes, % lymphoblast

Neutrophils, total %

Neutrophils, % poly-

Neutrophils, % metamyelocyte

Neutrophils, % myelocyte C

Neutrophils, % myelocyte B

Neutrophils, % myelocyte A

Neutrophils, % myeloblast

Monocytes, total %

Monocytes, % normal

Monocytes, % monoblast

Eosinophile, %

Basophile, %

Other, %

Normoblasts

Reticulocytes

Hematocrit

Platelets x 10^3

Co_2, %

Cl, %

Blood Na, %

Blood K, %

Blood BUN

Microscopic - Urine

Blood and urine
both = 8, urine only = 9

Urine pH

Urine sp. gr., x 10^{-3} + 1.0

Urine glucose

Urine acetone

Urine white blood count
8 = yes, 9 = no

Urine red blood count
8 = yes, 9 = no

Urine casts, 8 = yes, 9 = no

Urine bacteria, 8 = yes, 9 = no

TABLE XI

EXPONENTIAL FITS

Group 1 - No previous radiation, dose less than 125
Group 2 - Previous radiation, dose less than 125
Group 3 - No previous radiation, dose greater than 125
Group 4 - Previous radiation, dose greater than 125

Group	Variable	B		R
1	Hemoglobin	-.071		.32
2	"		NO FIT*	
3	"		NO FIT*	
4	"		NO FIT*	
1	Red Blood Count		NO FIT*	
2	" " "	.031		.32
3	" " "		NO FIT*	
4	" " "		NO FIT*	
1	White Blood Count	-.151		.62
2	" " "	-.211		.34
3	" " "	.000		.20
4	" " "		NO FIT*	
1	Total Lymphocytes	.000		.17
2	" "	.000		.25
3	" "	.000		.04
4	" "		NO FIT*	
1	Normal Lymphocytes	.001		.20
2	" "	.000		.26
3	" "	.000		.13
4	" "		NO FIT*	
1	Total Neutrophils	.004		.22
2	" "	-.018		.24
3	" "		NO FIT*	
4	" "		NO FIT*	
1	Total Monocytes	.006		.25
2	" "	.041		.29
3	" "	.000		.22
4	" "	-.004		.45
1	Reticulocytes	.043		.47
2	"		NO FIT*	
3	"	.016		.20
4	"		NO FIT*	
1	Hematocrit		NO FIT*	
2	"	.048		.31
3	"		NO FIT*	
4	"		NO FIT*	
1	Platelets		NO FIT*	
2	"		NO FIT*	
3	"	.000		.09
4	"		NO FIT*	

*No fit could be obtained due to excess scatter or lack of data over a sufficient time period.

TABLE XII

LINEAR FIT ON TRANSFORMED DATA

Group 1 - No previous radiation, dose less than 125
Group 2 - Previous radiation, dose less than 125
Group 3 - No previous radiation, dose greater than 125
Group 4 - Previous radiation, dose greater than 125

Group	Variable	Transition Day	B_1	R_1	B_2	R_2
1	Hemoglobin	9	-.006	-.17	-.001	-.08
2	"	13	-.003	-.16	.001	.25
3	"	33	-.005	-.60	.001	.40
4	"	9	-.010	-.48	-.001	-.12
1	Red Blood Count	9	-.007	-.17	-.000	-.01
2	" " "	12	-.008	-.28	.002	.40
3	" " "	9	-.005	-.34	-.001	-.24
4	" " "	8	-.010	-.56	-.001	-.12
1	White Blood Count	12	-.054	-.69	.001	.05
2	" " "	10	-.037	-.56	-.001	-.04
3	" " "	26	-.023	-.76	.006	.52
4	" " "	30	-.012	-.50	.009	.46
1	Total Lymphocytes	11	.016	.12	.010	.14
2	" "	10	-.022	-.20	.003	.10
3	" "	10	.033	.35	-.000	-.00
4	" "	6	-.015	-.10	-.001	-.03
1	Normal Lymphocytes	18	.010	.10	.012	.15
2	" "	10	-.025	-.24	.004	.16
3	" "	9	.037	.34	.000	.01
4	" "	6	-.015	-.11	-.002	-.04
1	Total Neutrophils	11	-.001	-.04	-.004	-.26
2	" "	10	-.005	-.10	-.002	-.18
3	" "	6	-.008	-.19	.000	.00
4	" "	8	-.008	-.29	-.001	-.06
1	Total Monocytes	9	.018	.09	.017	.28
2	" "	9	.018	-.07	.005	.38
3	" "	8	.010	.06	.007	.18
4	" "	18	-.008	-.07	.022	.38
1	Reticulocytes	41	-.001	-.05	.025	.81
2	"	12	.117	.18	-.001	-.01
3	"	15	-.040	-.50	.010	.46
4	"	5	-.152	-.06	.010	.05
1	Hematocrit	9	-.002	-.05	-.002	-.17
2	"	13	-.008	-.37	.002	.34
3	"	32	-.008	-.62	.003	.54
4	"	40	-.009	-.72	.005	.77
1	Platelets	12	-.030	-.40	.003	.12
2	"	10	-.017	-.29	-.001	-.03
3	"	25	-.037	-.76	.010	.40
4	"	36	-.024	-.71	.045	.66

B_1 Exponent of equation for initial period
B_2 Exponent of equation for recovery period
R_1 Correlation for interval 1
R_2 Correlation for interval 2

TABLE XIII

SLOPES OF PATIENTS WBC AND PLATELETS -- 4 GROUPS*

Variable	Group	Transition Day	R^2	Slope	S.D. Slope	95% Limits on Slope
White Blood Count	1	12	.472	-.054	.009	-.036 → -.072
White Blood Count	2	10	.314	-.037	.008	-.021 → -.053
White Blood Count	3	26	.576	-.023	.002	-.019 → -.027
White Blood Count	4	30	.250	-.012	.003	-.006 → -.018
Platelets	1	12	.159	-.030	.012	-.006 → -.054
Platelets	2	10	.086	-.017	.010	-.037 → +.003
Platelets	3	25	.590	-.037	.004	-.029 → -.045
Platelets	4	36	.516	-.024	.005	-.014 → -.034

* Group 1 - No previous radiation, dose less than 125
Group 2 - Previous radiation, dose less than 125
Group 3 - No previous radiation, dose greater than 125
Group 4 - Previous radiation, dose greater than 125

TABLE XIV

SLOPES OF PATIENTS WBC AND PLATELETS - - HIGH AND LOW

Variable	Group	Transition Day	R^2	Slope	S.D. Slope	95% Limits on Slope
White Blood Count	low dose	18	.410	-.035	.005	-.025 → -.045
White Blood Count	high dose	27	.009	-.014	.033	-.080 → +.052
Platelets	low dose	12	.184	-.035	.012	-.059 → -.011
Platelets	high dose	27	.094	-.013	.005	-.003 → -.023

TABLE XV

ABSORBANCE OF 2-DEOXYRIBOSE AND 2-DEOXYCYTIDINE IN MIXTURES OF CYTOSINE AND CYTIDINE

Tube No.	HCl 1 N ml	Cytosine µg	Cytidine µg	2-Deoxy-cytidine µg	2-Deoxy-ribose µg	Absorbance (chloroform extraction)
1	5	-	-	-	-	0.015
2	2.5	250	-	-	-	0.015
3	2.5	-	250	-	-	0.015
4	2.5	-	-	250	-	0.105
5	-	-	-	-	250	0.365
6	-	250	-	250	-	0.112
7	-	-	250	250	-	0.105
8	-	250	-	-	250	0.350
9	-	-	250	-	250	0.362

TABLE XVI

PERCENTAGE OF HYDROLYSIS OF 2-DEOXYCYTIDINE IN 1 N HCl AT 80° C WATER BATH FOR 5 - 24 HOURS

Quantity of dct µg/ml	Absorbance	2-Deoxyribose µg/ml Measured	2-Deoxyribose µg/ml Theoretical	Hydrolysis %
200	0.415	80	95.7	83.6
100	0.210	40.25	47.85	83.5
80	0.170	33.00	38.29	86
40	0.090	17.00	19.145	95
20	0.050	10	9.572	103
10	0.030	4	4.782	83
5	0.015	2	2.343	85

TABLE XVII

ABSORBANCE OF THE DEGRADED DEOXYRIBOSE OF DEOXYCYTIDINE

(A constant amount of dct in buffer was hydrolyzed with different amounts of concentrated HCl (12N) incubated at 80° C for 5 to 24 hours prior to extraction with chloroform).

dct* in pH 10 ammonium buffer	dct* in 1 N HCl	Concentrated HCl	Absorbance
	164 μ g	0.0 ml	0.085
164 μg		0.0 ml	0.000
164 μg		0.05 ml	0.000
164 μg		0.10 ml	0.015
164 μg		0.15 ml	0.050
164 μg		0.20 ml	0.045
164 μg		0.25 ml	0.085
164 μg		0.30 ml	0.082
164 μg		0.35 ml	0.085
164 μg		0.40 ml	0.085
164 μg		0.45 ml	0.085
164 μg		0.50 ml	0.085
164 μg		0.55 ml	0.055

* 164 μgm dct in 4.10 ml of solution

TABLE XVIII

INCIDENCE OF ENDOREDUPLICATION
(Patients)

Chromosome Sampling Date	Cells Showing Endoreduplication	No. of Mitosing Cells Counted	Incidence %
S.H.			
11/15/63	0	2272	0.00
11/18/63	0	1874	0.00
11/22/63	0	3208	0.00
11/24/63 100 Rad Total-Body Irradiation			
11/24/63 2 hr post irradiation	0	2029	0.00
11/24/63 6 hr post irradiation	0	3920	0.00
11/25/63	8	1401	0.57
11/29/63	0	2180	0.00
12/6/63	0	1619	0.00
12/13/63	0	1522	0.00
12/20/63	0	2068	0.00
12/24/63	1	2015	0.05
M.R.			
10/18/63	0	1942	0.00
10/23/63	1	2500	0.04
10/25/63	0	1604	0.00
10/27/63 150 Rad Total Body Irradiation			
10/27/63 2 hr post irradiation	2	1862	0.11
10/27/63 6 hr post irradiation	1	563	0.18
10/28/63	1	1425	0.07

TABLE XVIII
(continued)

Chromosome Sampling Date	Cells Showing Endoreduplication	No. of Mitosing Cells Counted	Incidence %
M. R. (continued)			
11/1/63	0	1383	0.00
11/8/63	0	3873	0.00
11/15/63	0	1372	0.00
11/22/63	0	3073	0.00
11/26/63	0	3633	0.00
F. W.			
3/8/63	17	12743	0.13
3/11/63	0	1966	0.00
3/14/63 pre-irradiation	4	1993	0.20
3/14/63 150 Rad Total Body Irradiation			
3/14/63 post-irradiation	74	7979	0.93
3/15/63	1	59	1.69
3/20/63	0	48	0.00
3/26/63	0	556	0.00
4/1/63	3	1281	0.23
4/8/63	1	2810	0.04
4/15/63	0	55	0.00
M. L.			
6/4/63	8	18196	0.04
6/11/63	2	1254	0.16
6/14/63	3	2788	0.11

TABLE XVIII
(continued)

Chromosome Sampling Date		Cells Showing Endoreduplication	No. of Mitosing Cells Counted	Incidence σ_c
M. L. (continued)				
6/16/63 100 Rad Total Body Irradiation				
6/16/63	2 hr post-irradiation	1	83	1.20
6/16/63	6 hr post-irradiation	6	2928	0.20
6/17/63		11	3209	0.34
6/21/63		7	5115	0.14
6/28/63		0	1558	0.00
7/5/63		3	3260	0.09
7/11/63		2	2256	0.09
7/16/63		21	11774	0.18

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FIGURE 1

CONSENT FOR SPECIAL STUDY AND TREATMENT

I, _____, do hereby give my consent to the members of the professional staff of the Cincinnati General Hospital, University of Cincinnati College of Medicine, to administer to me whole or partial body irradiation on or about _____, 196____.

The nature and purpose of this therapy, possible alternative methods of treatment, the risks involved, the possibility of complications, and prognosis have been fully explained to me. The special study and research nature of this treatment has been discussed with me and is understood by me.

Consent is given for photographs and publication for the advancement of medical education.

_____
Signature

Relationship_____
(Patient or Guardian)

Date_____ AM PM_____
(Mo. Day Year)

Place_____
(Ward - Clinic - Unit)

Chart no._____

Witnesses to signature:

_____

_____

Original: to patient's chart
Copies: to Co-60 file
to TBR file

5/1/65

FIGURE 2

CONSENT FOR SPECIAL STUDY AND TREATMENT

I, _____, do hereby give my consent to the members of the professional staff of the Cincinnati General Hospital, University of Cincinnati College of Medicine, to perform a bone marrow aspiration and to story my bone marrow on or about _____, 196__.

The nature and purpose of this therapy, the risks involved, the possibility of complications, and prognosis have been fully explained to me. The special study and research nature of this treatment has been discussed with me and is understood by me.

Consent is also given for reinfusion (giving the marrow back to me) when the members of the professional staff recommend it.

Consent is given for photographs and publication for the advancement of medical education.

_____
Signature

Witnesses to signature.

_____

_____

Relationship_____
(Patient or Guardian)

Date_____ AM PM _____
(Mo. Day Yr.)

Place_____
(Ward-Clinic-Unit)

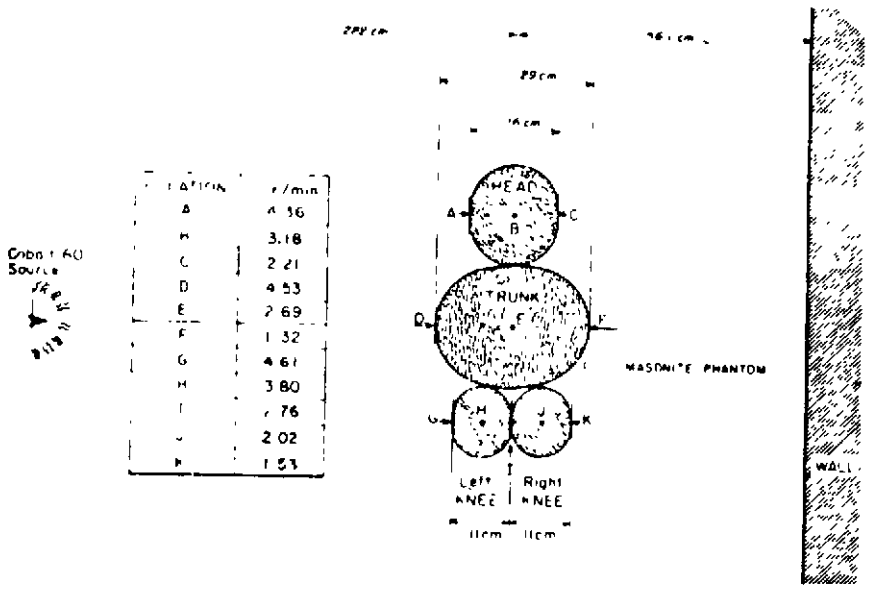
Chart No._____

Original: to patient's chart
Copies: to Co-60 file
to TBR file

5/1/65

FIGURE 3

DOSIMETER MEASUREMENTS IN A MASONITE PHANTOM



RELATIVE DEPTH DOSE FOR LATERAL EXPOSURES

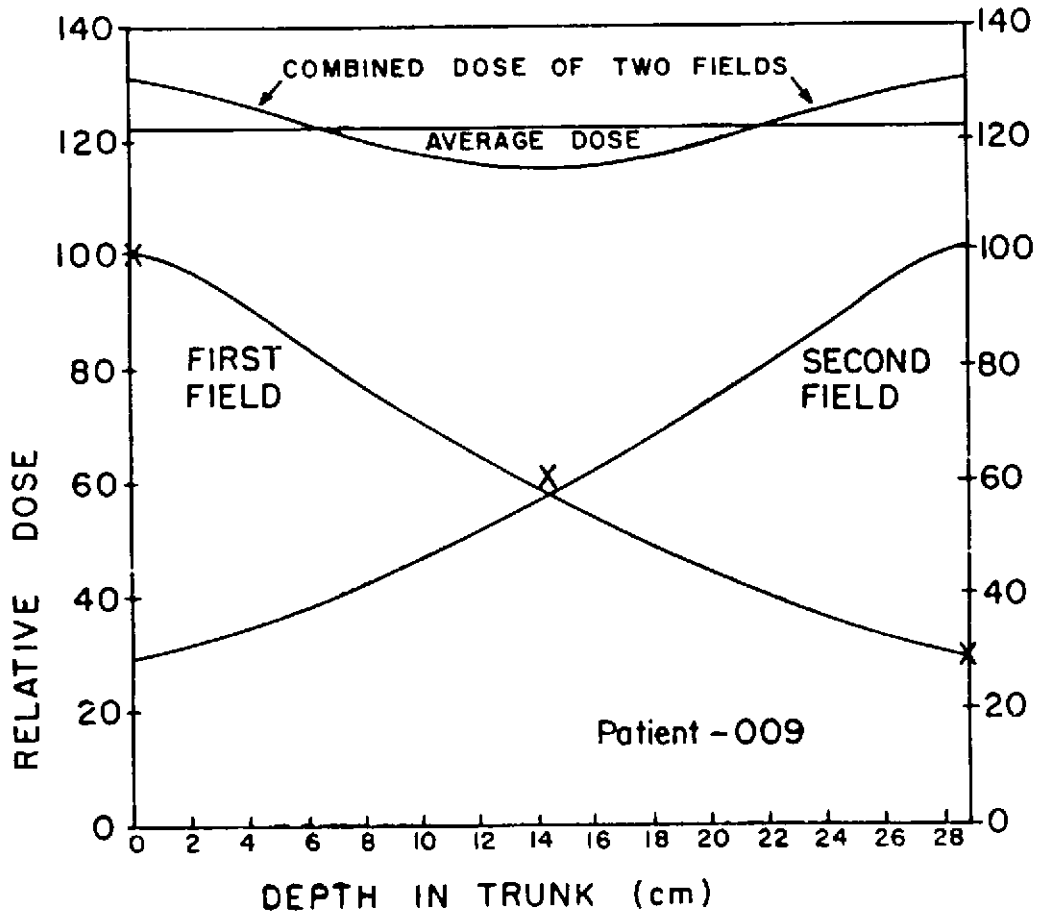


FIGURE 4

FIGURE 5

COBALT 60 FIELD FOR PARTIAL (HALF) BODY IRRADIATION

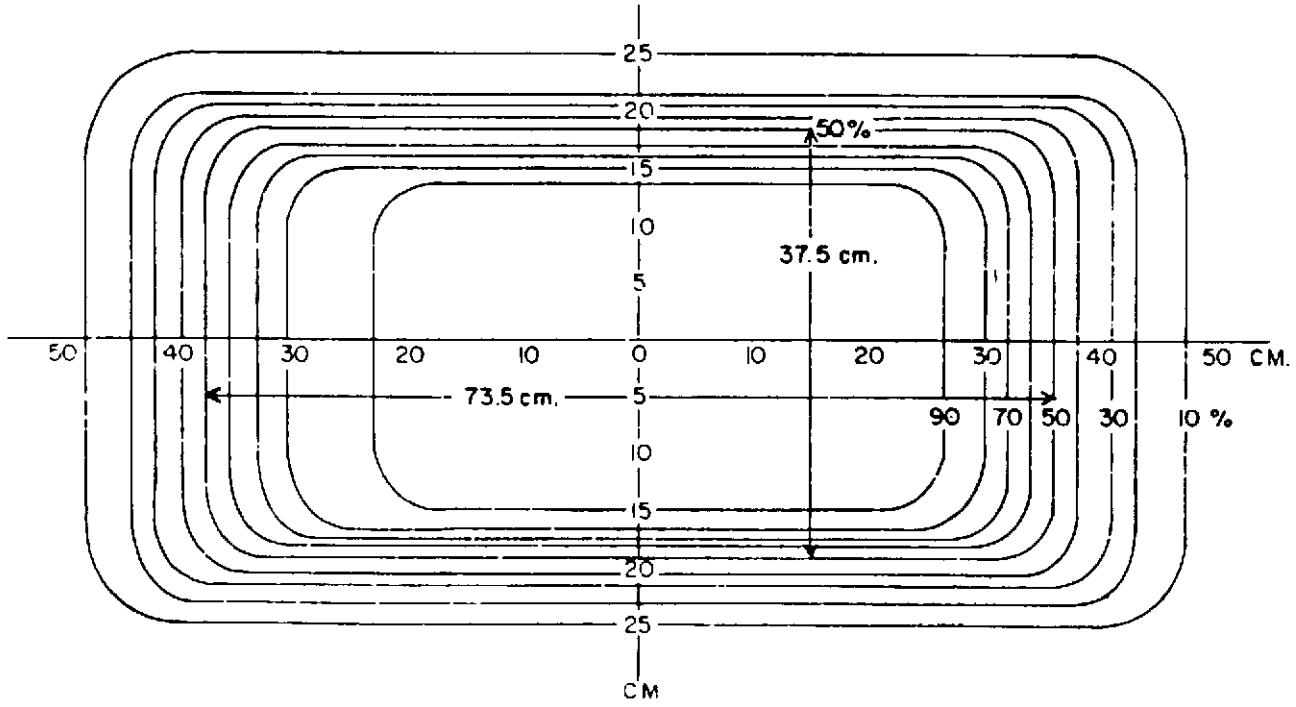


FIGURE 6

RELATIVE DOSES FOR ^{60}Co PARTIAL BODY (UPPER) IRRADIATION AS MEASURED WITH TL-100 POWDER AT CENTER OF RANDO PHANTOM LATERAL IRRADIATION

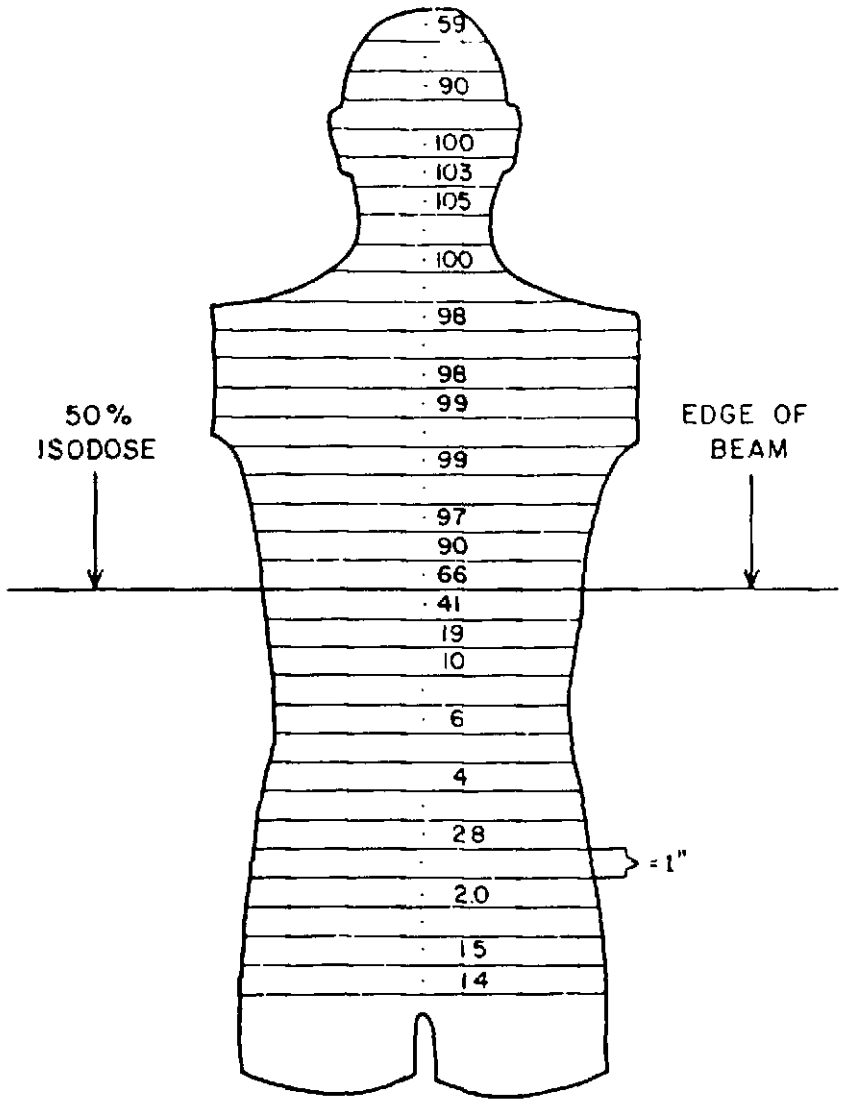


FIGURE 7

RELATIVE DOSES FOR ^{60}Co PARTIAL BODY (LOWER) IRRADIATION AS MEASURED WITH TL-100 POWDER AT CENTER OF RANDO PHANTOM LATERAL IRRADIATION

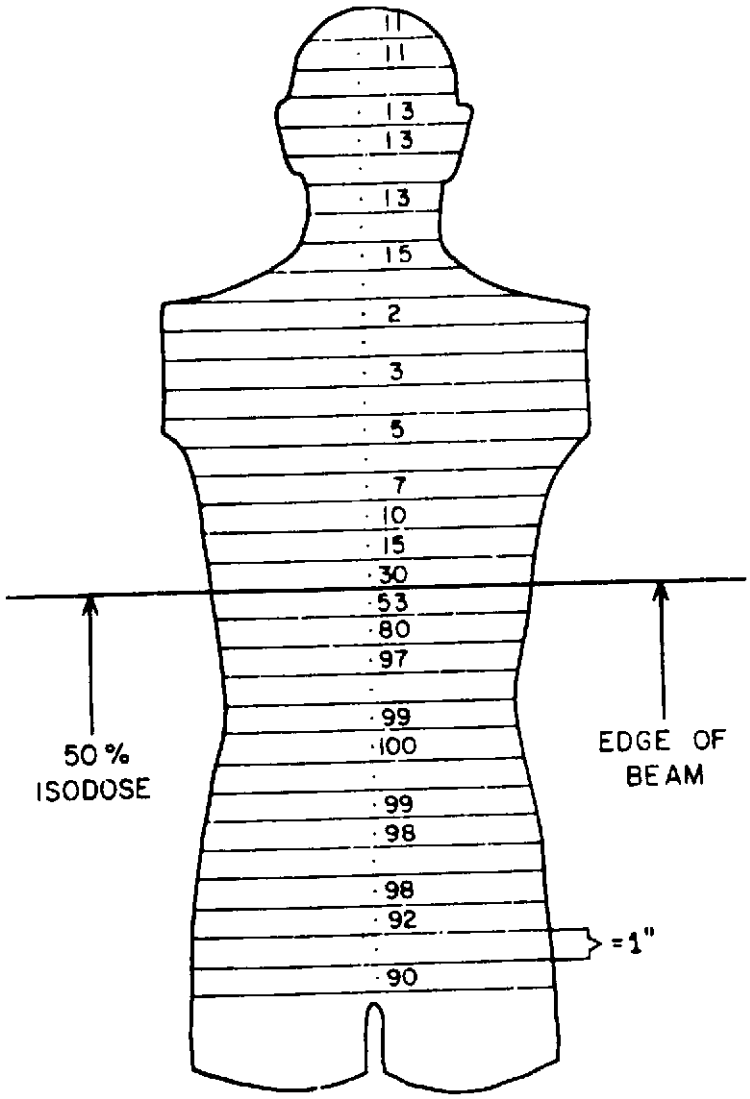


FIGURE 8

MEAN GROUP SCORES FOR WECHSLER DEPRESSION RATING SCALE AND FOR THE GOTTSCHALK CLINICAL DEPRESSION SCALE

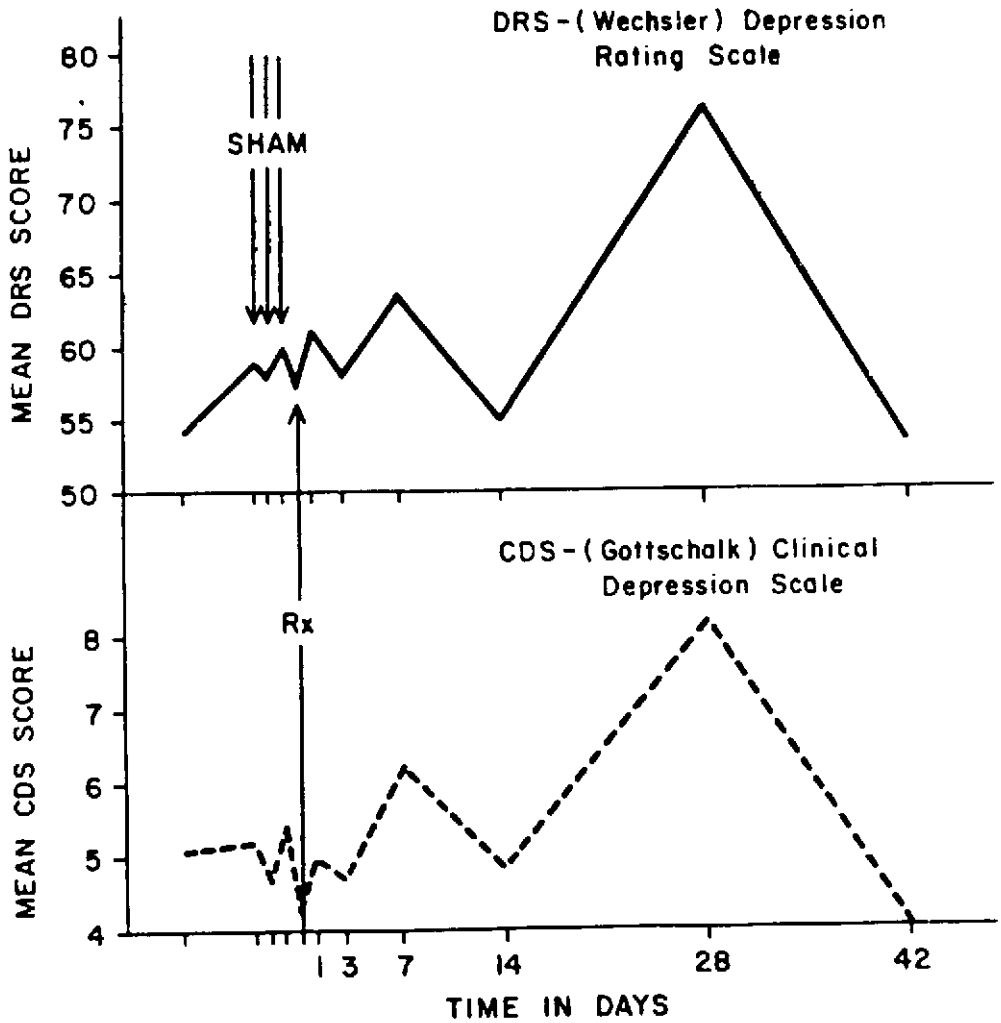


FIGURE 9

MEAN SUBGROUP SCORES OF THE DEPRESSION SCALES

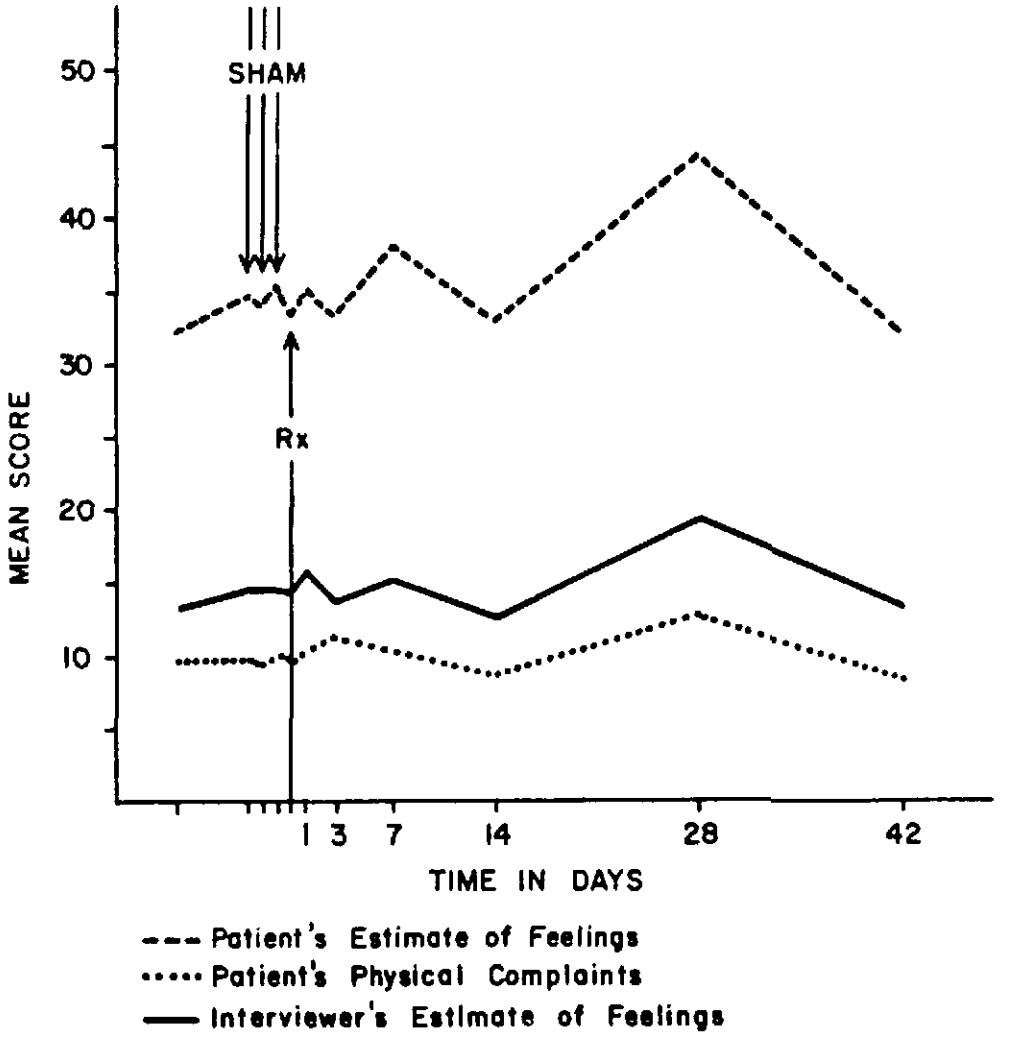


FIGURE 10

MEAN GROUP SCORES FOR THE SEVERAL TESTS FOR 11 SUBJECTS STUDIED

(See Table VIII)

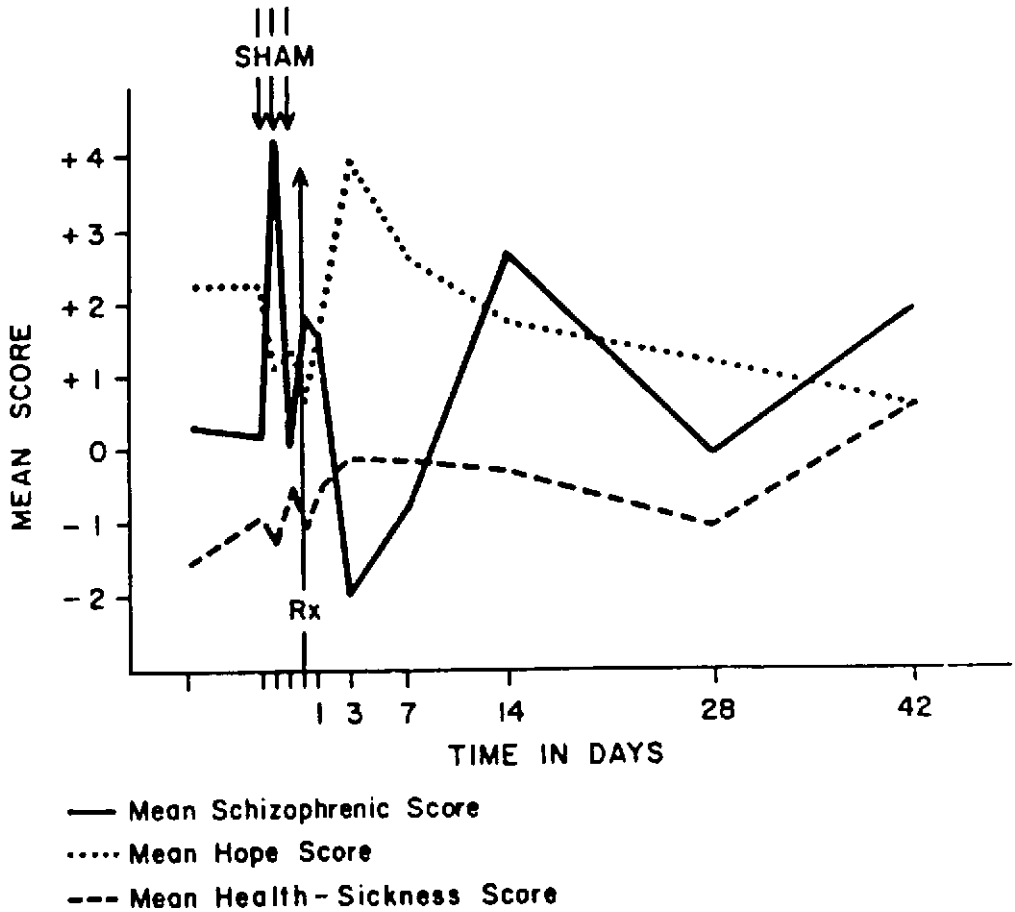


FIGURE 11

HEMOGRAM FOR TBR- CASE #023

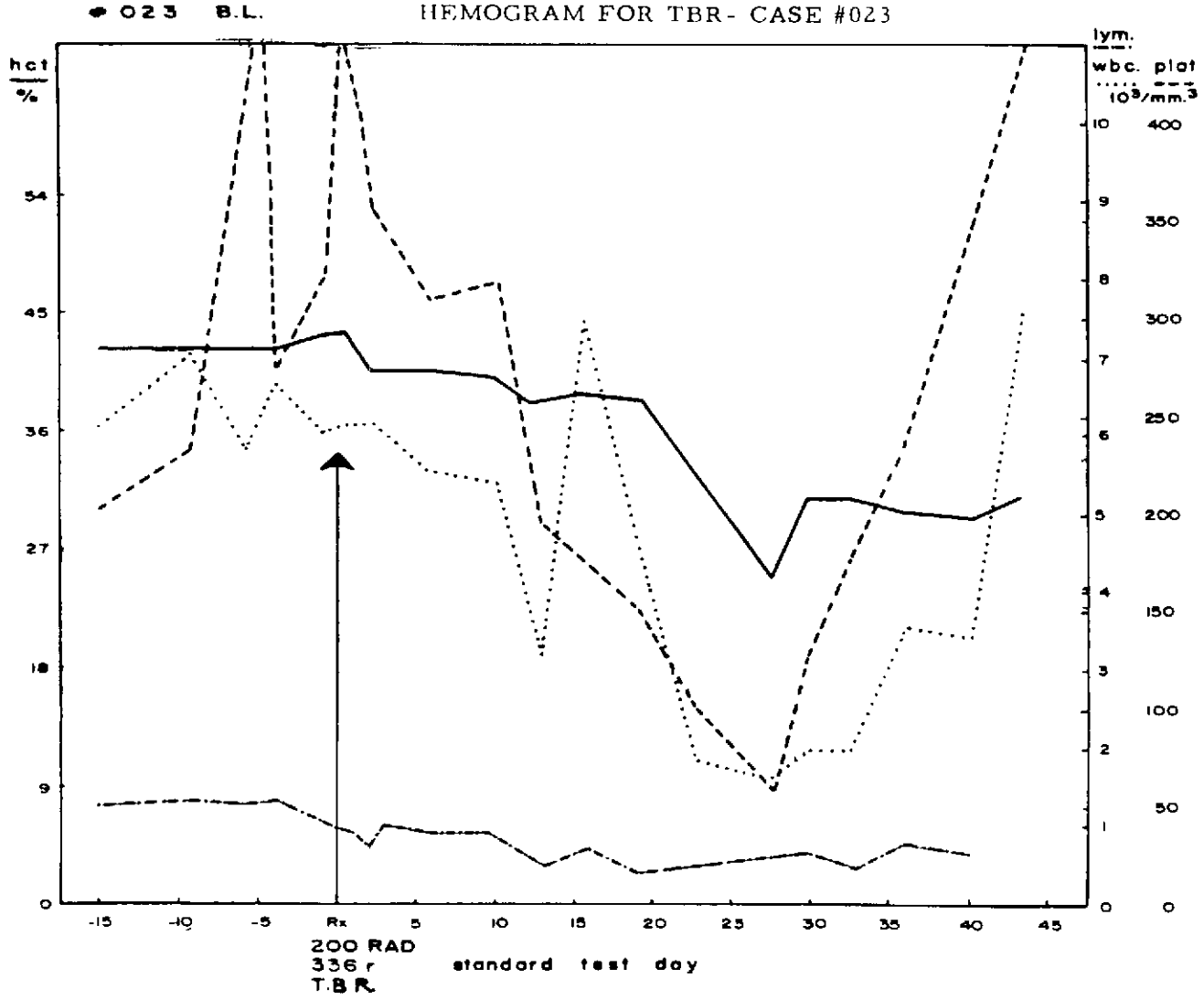
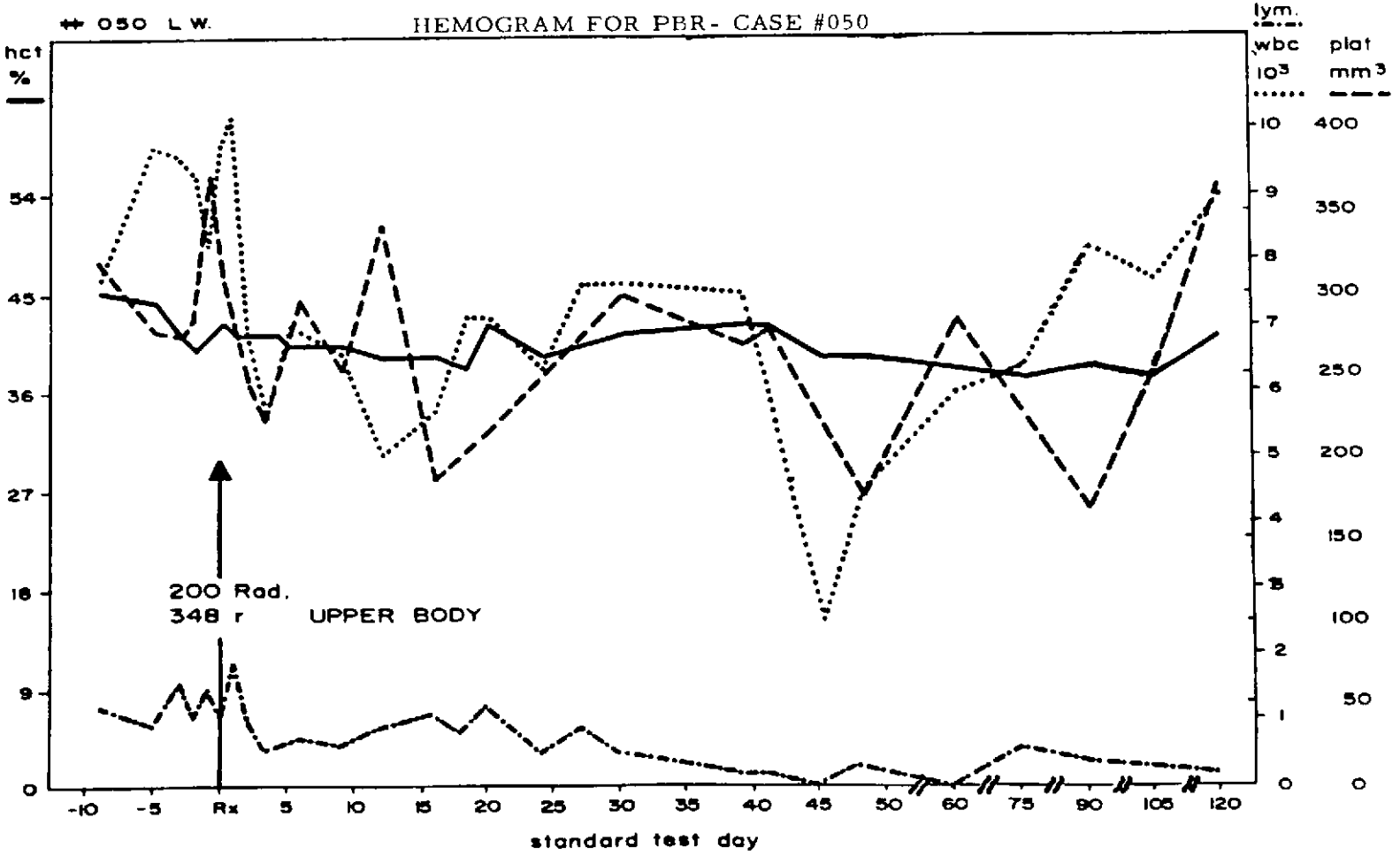
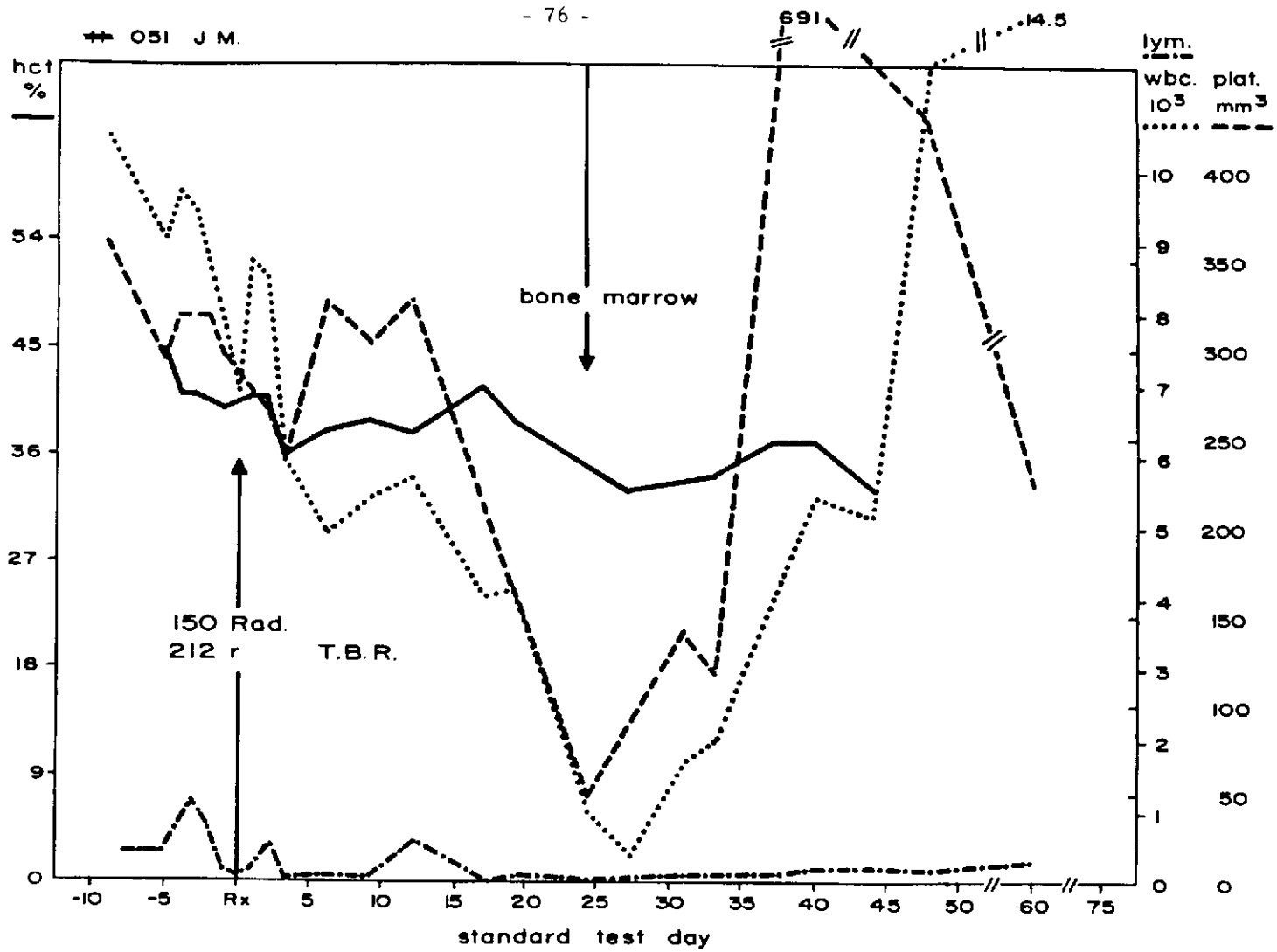


FIGURE 12


HEMOGRAM FOR PBR- CASE #050
050 L.W.
hct %
lym.
wbc 10^3
plat mm^3
200 Rad.
348 r
UPPER BODY
standard test day

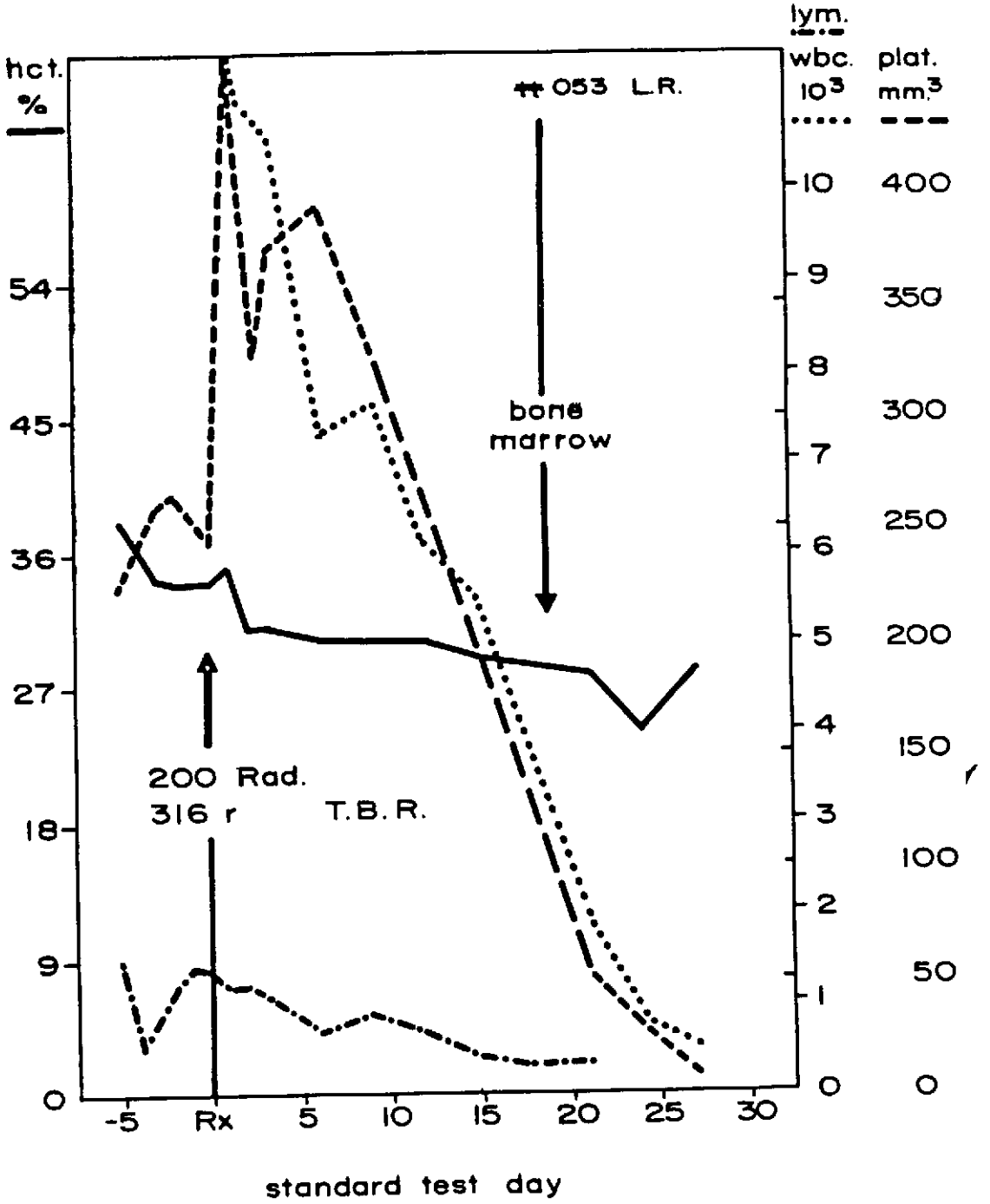


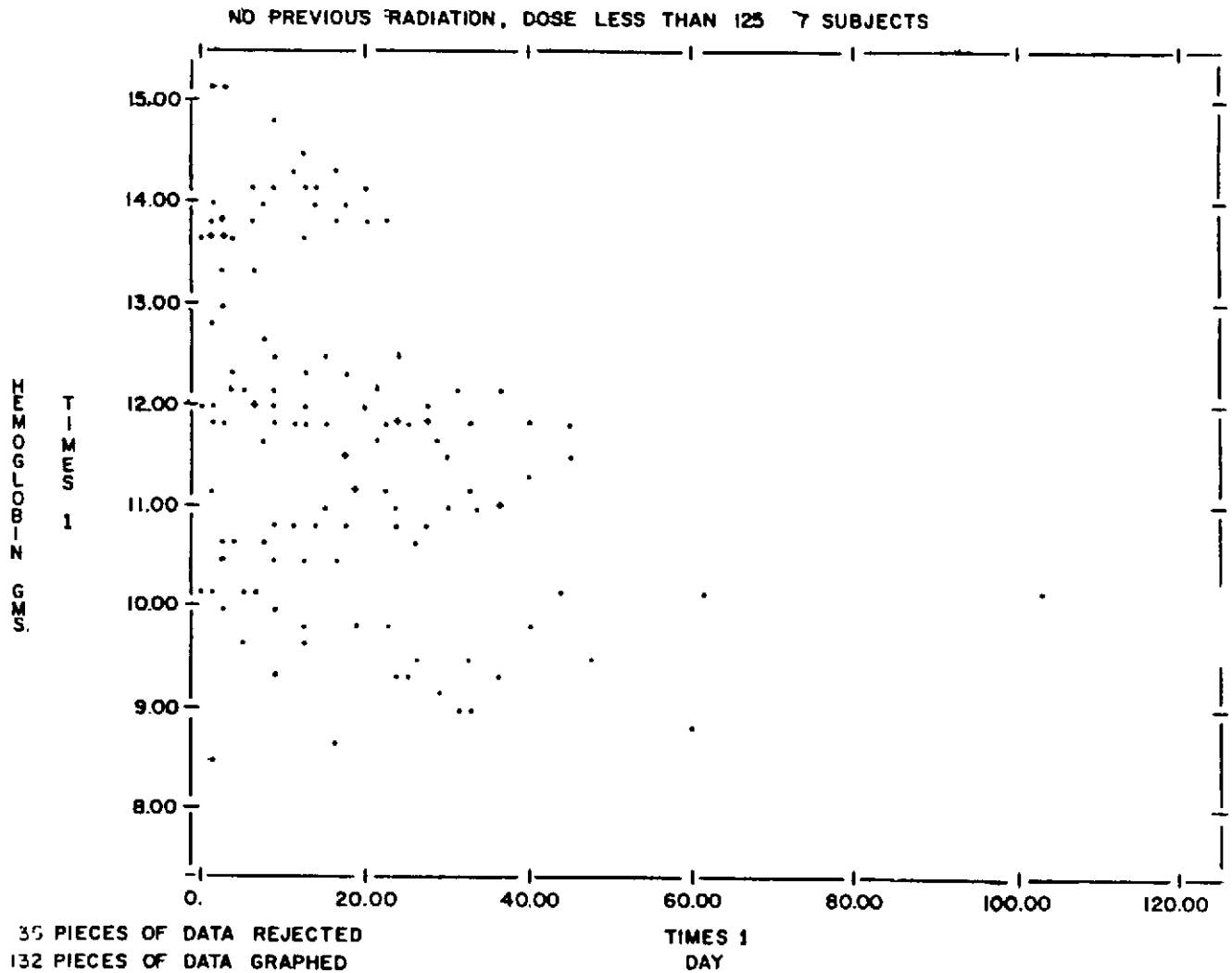
HEMOGRAM FOR TBR - CASE #051

FIGURE 13

FIGURE 14

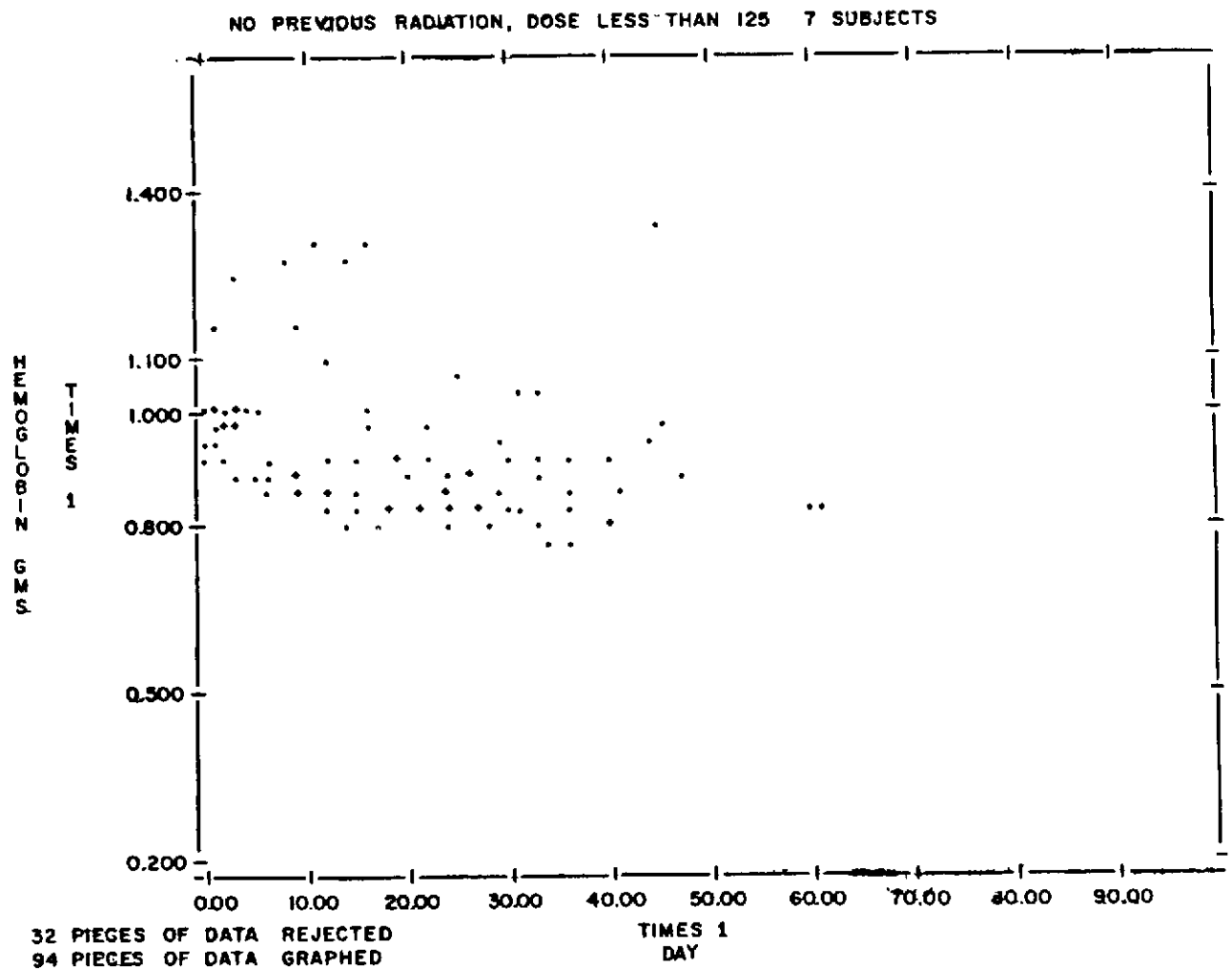
HEMOGRAM FOR TBR - CASE #053





SCATTERGRAM VS. TIME--GROUP

FIGURE 15



TRANSFORMED DATA

FIGURE 16

FIGURE 17

THE ABSORBANCE OF THE CHLOROFORM EXTRACTS OF THE DEGRADED 2-DEOXYRIBOSE AND 2-DEOXYCYTIDINE (5-24 hrs. at 80.0° C in 1 N HCl) AGAINST WAVE LENGTH.

A. READING OF THE DEGRADED 2- DEOXYRIBOSE PEAK: 258-261

B. READING OF THE DEGRADED 2-DEOXYCYTIDINE PEAK: 258-261

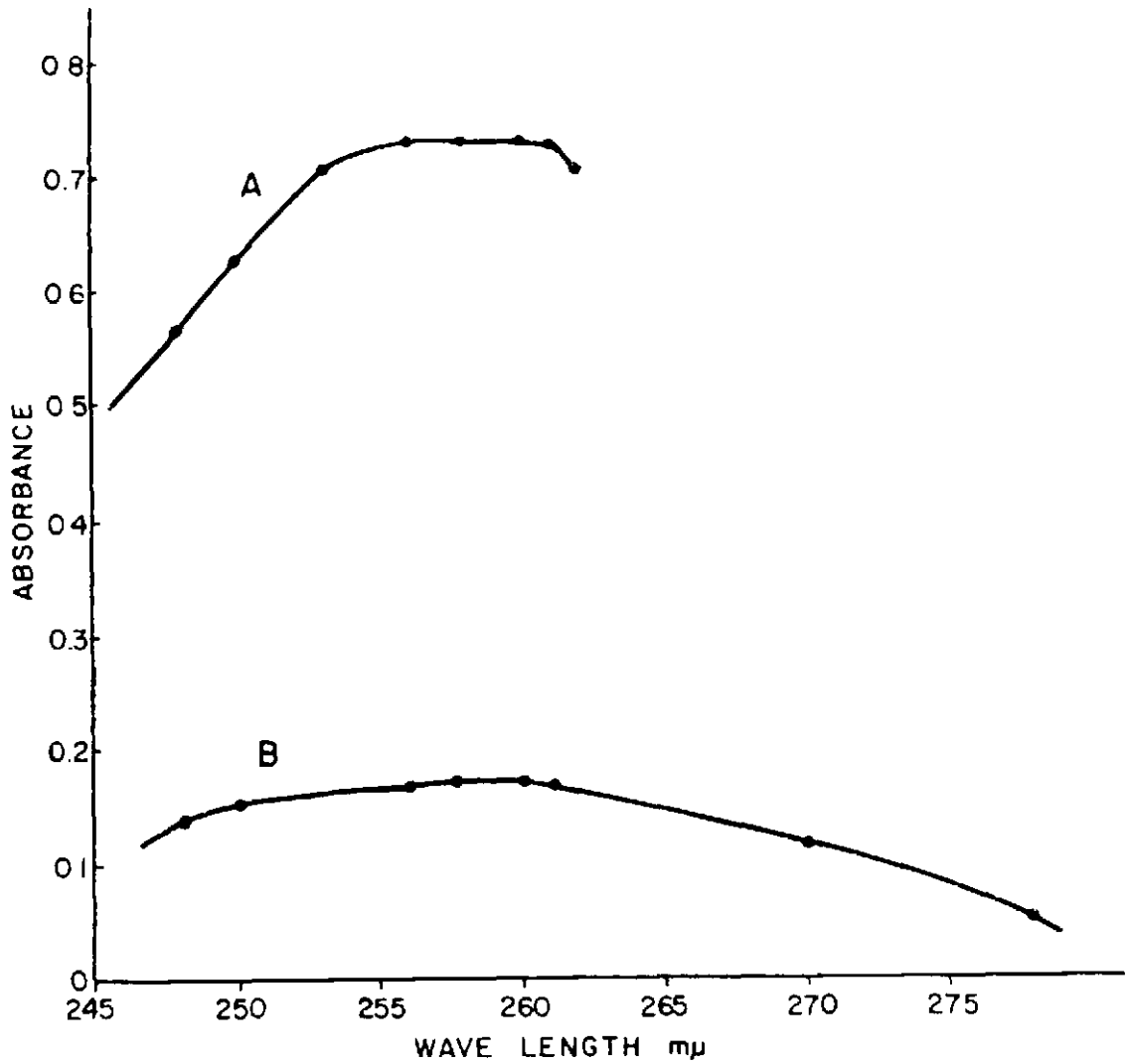


FIGURE 18

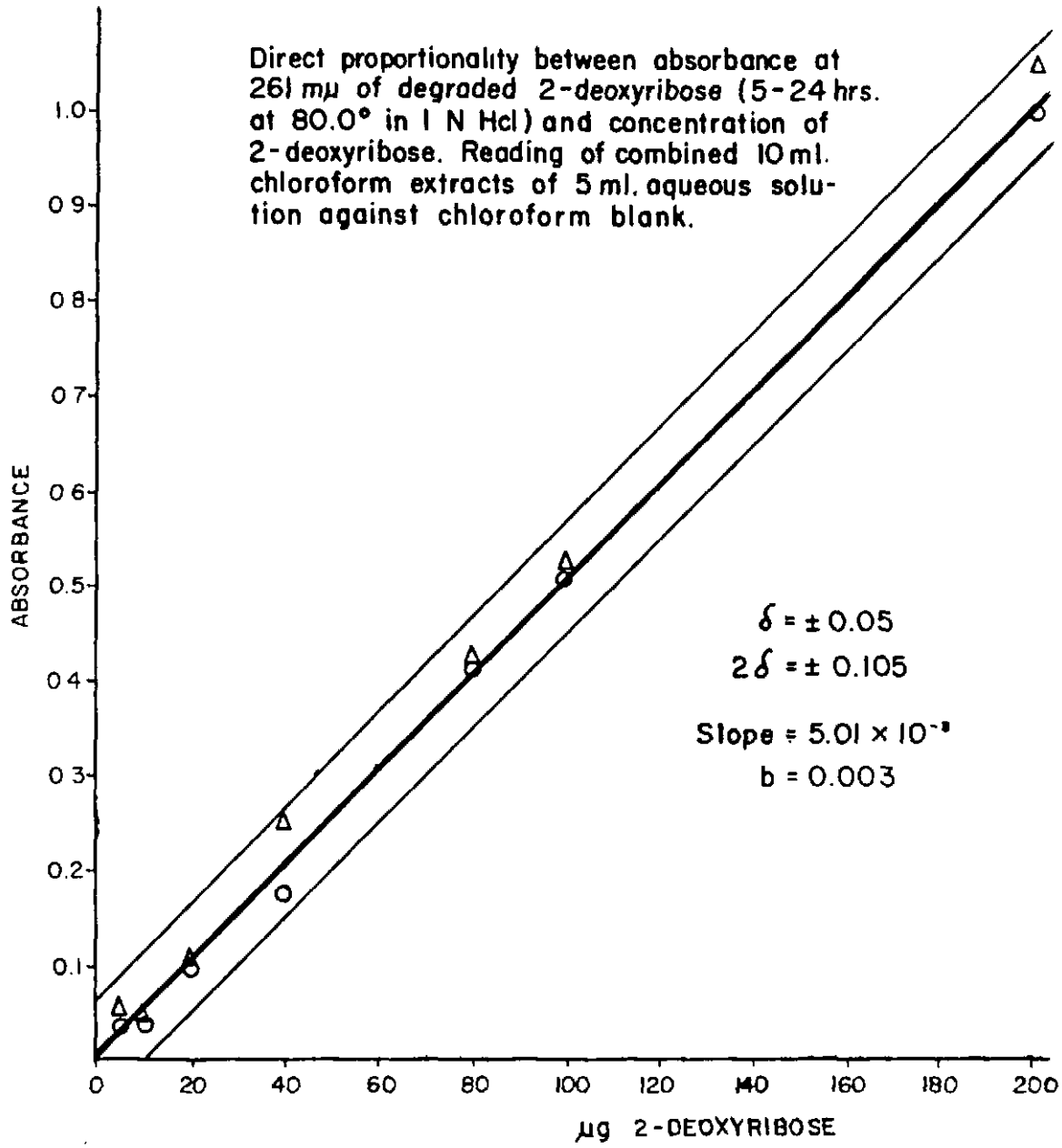

Direct proportionality between absorbance at 261 mμ of degraded 2-deoxyribose (5-24 hrs. at 80.0° in 1 N Hcl) and concentration of 2-deoxyribose. Reading of combined 10 ml. chloroform extracts of 5 ml. aqueous solution against chloroform blank.
δ = ± 0.05
2δ = ± 0.105
Slope = 5.01 × 10⁻³
b = 0.003
ABSORBANCE
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
20
40
60
80
100
120
140
160
180
200
μg 2-DEOXYRIBOSE

FIGURE 19

DIRECT PROPORTIONALITY BETWEEN ABSORBANCE AT 261 MU OF DEGRADED 2-DEOXYCYTIDINE (5-24 HRS AT 80.0° C in N HCl) AND CONCENTRATION OF 2-DEOXYCYTIDINE. READING OF COMBINED 10 ml CHLOROFORM EXTRACTS OF 5 ml AQUEOUS SOLUTION AGAINST CHLOROFORM BLANK.

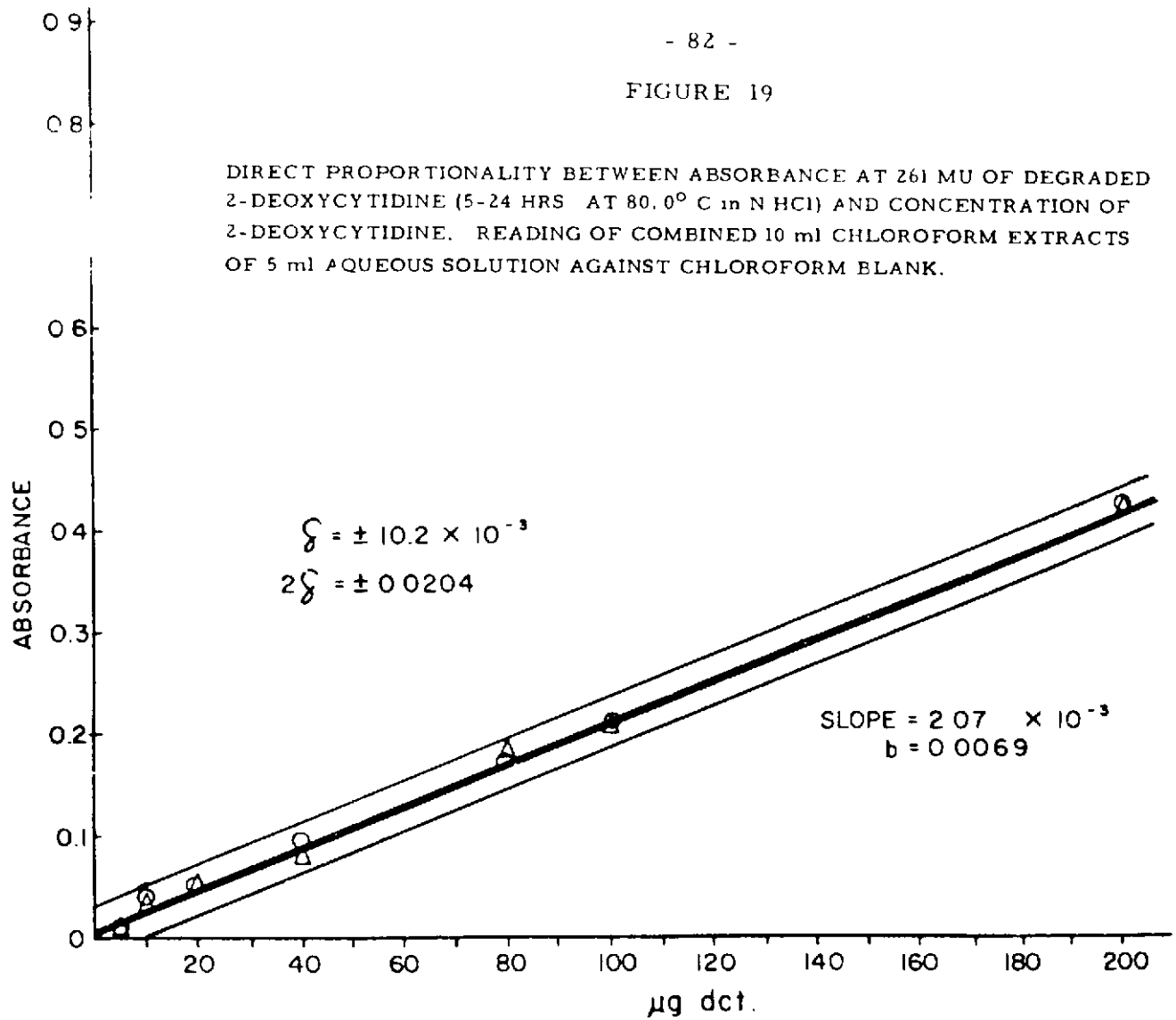


FIGURE 20

URINARY EXCRETION OF β AMINO ISOBUTYRIC ACID
BEFORE AND AFTER TOTAL BODY RADIATION

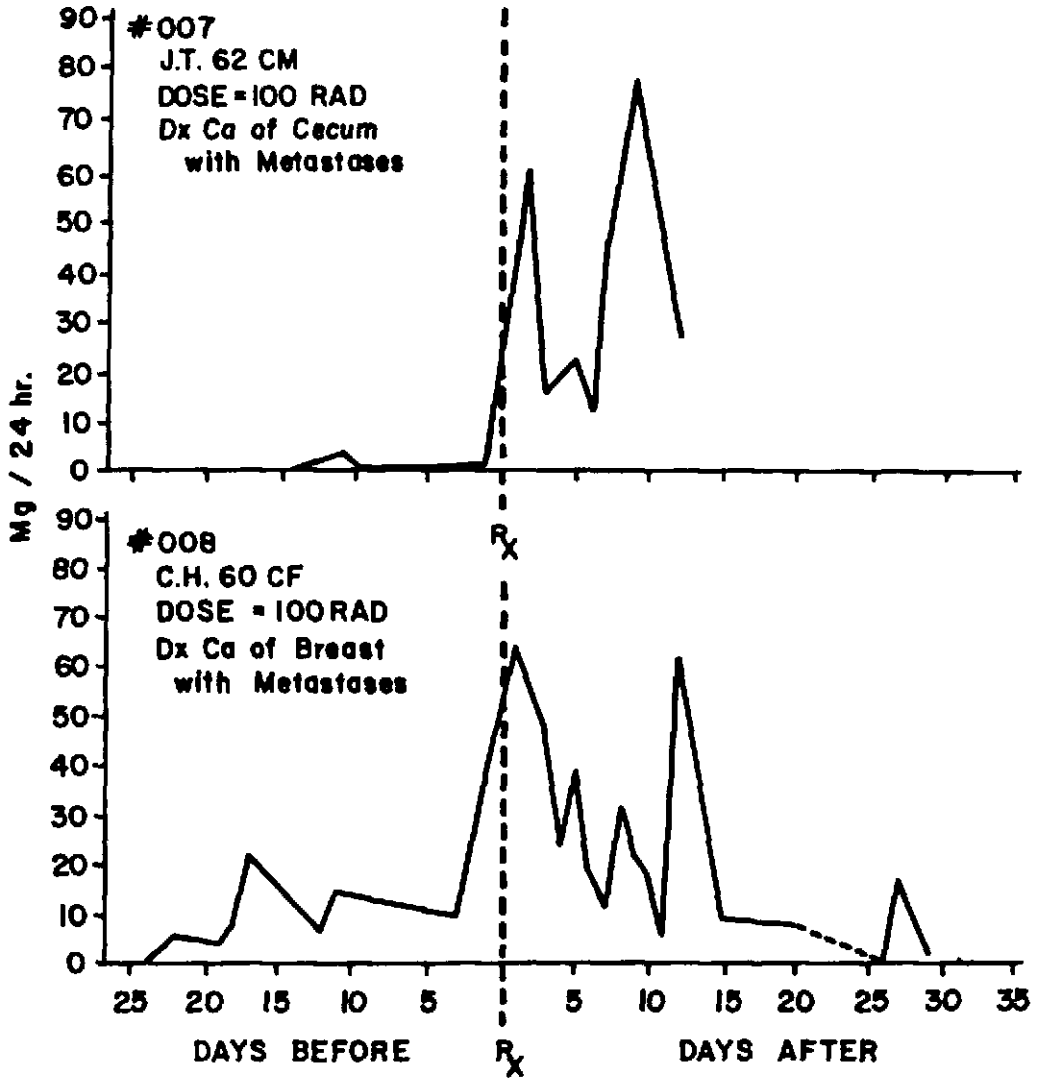


FIGURE 21

URINARY EXCRETION OF β AMINO ISOBUTYRIC ACID
BEFORE AND AFTER TOTAL BODY RADIATION

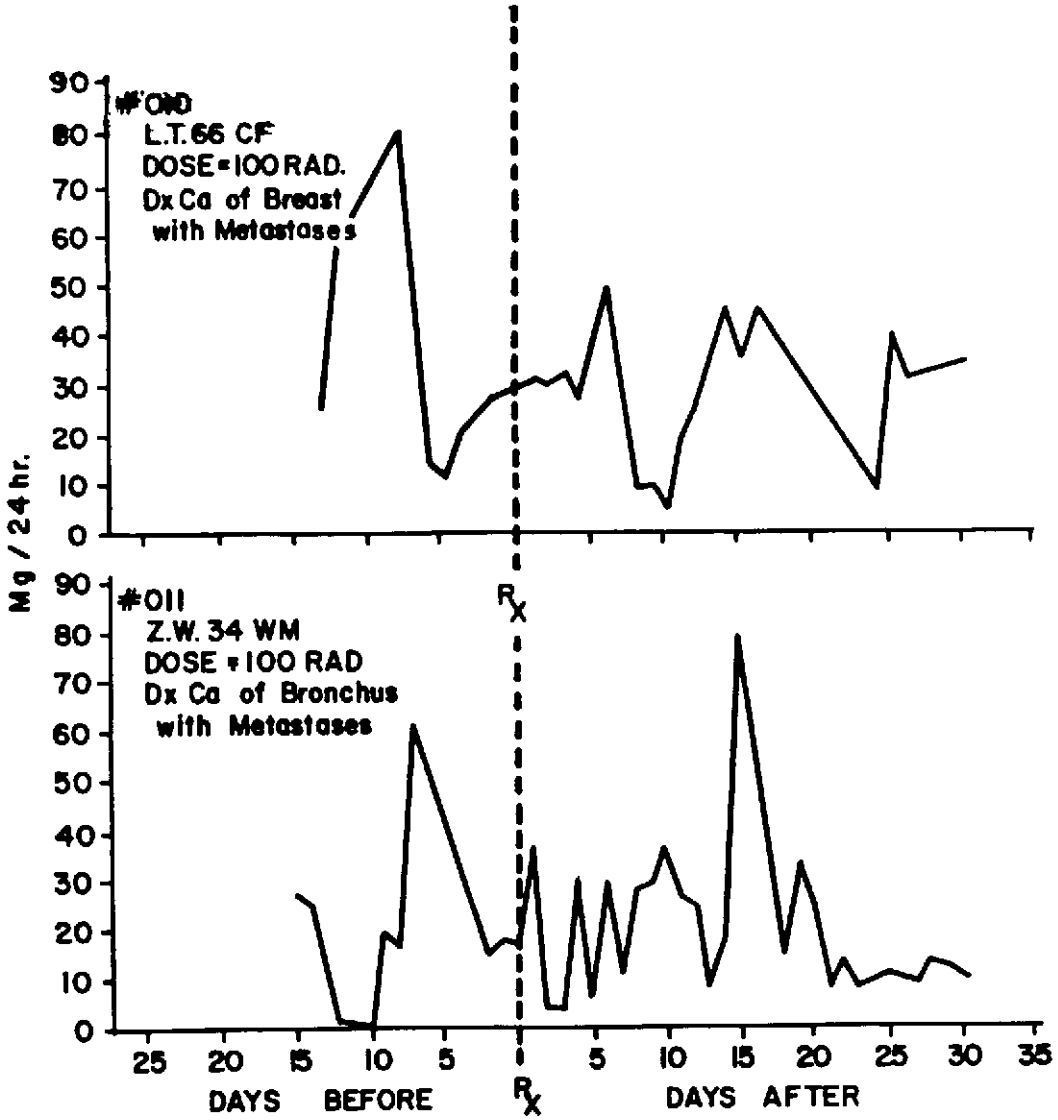
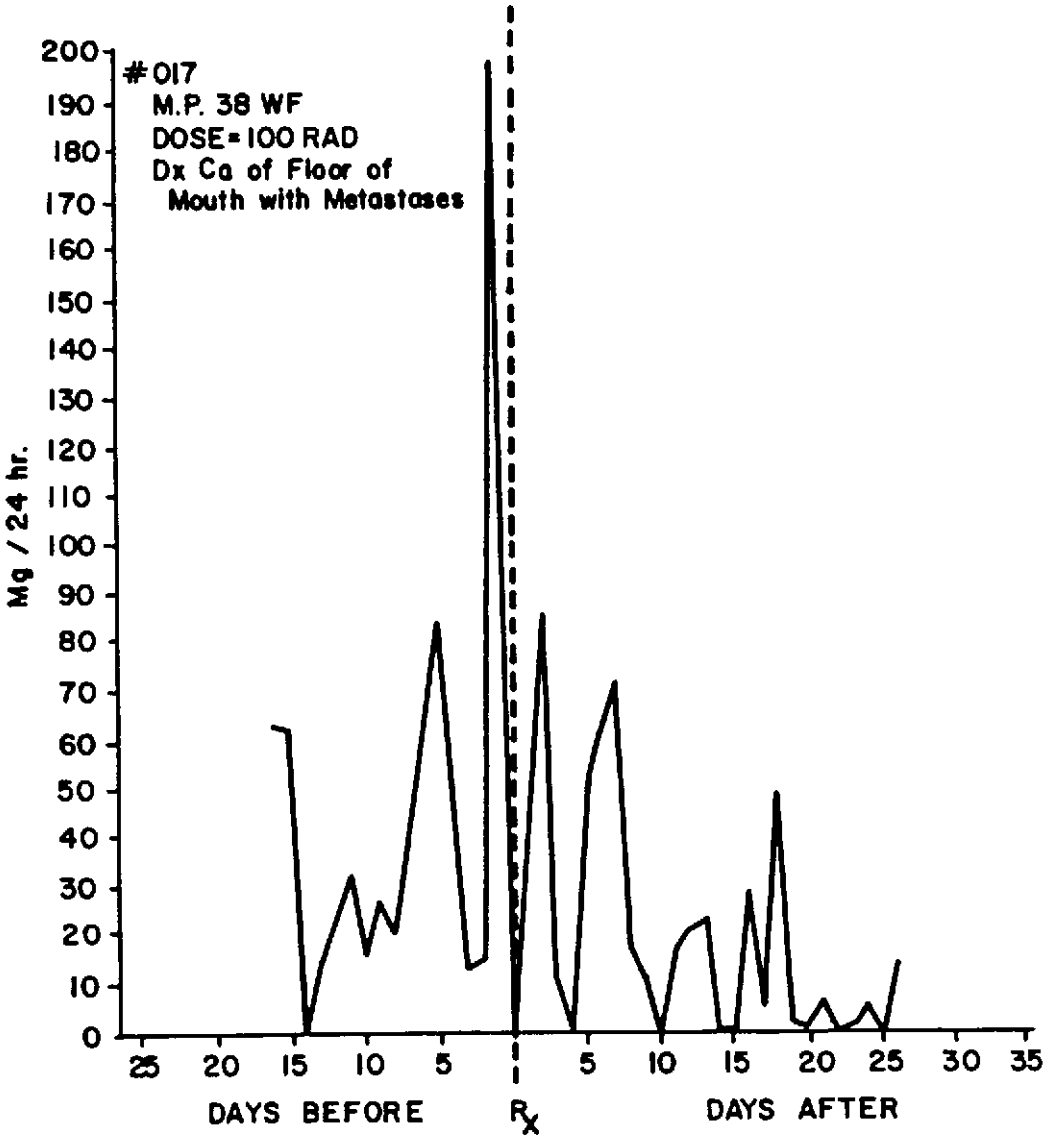


FIGURE 22

URINARY EXCRETION OF β AMINO ISOBUTYRIC ACID
BEFORE AND AFTER TOTAL BODY RADIATION



APPENDIX A

CLINICAL SUMMARIES

THE FOLLOWING POINTS HAVE BEEN CONSIDERED IN ALL CLINICAL SUMMARIES:

1) Original Symptoms

2) Date of Original Diagnosis

3) Date of Previous Treatment

4) Diagnosis of Metastases

5) Sham Radiation

6) Total Body Radiation - Dose Rate, Rad, Roentgen
or
Partial Body Radiation

7) Symptoms Post TBR or PBR

8) Hematology Post TBR or PBR

9) Subsequent Treatment

10) Date of Death - Days Post TBR or PBR

Study No. 004

Patient. J.W.

Chart No. 232557

The patient was a 67 year old Negro male who had radium therapy to a left cervical node for carcinoma of the left tonsilar area associated with enlarged left anterior cervical lymph nodes (SP 48-971) in 1948. His usual weight of 68 Kg. had fallen to 62 Kg. At that time the patient received 200 KV irradiation therapy through two lateral ports and one anterior port.

On March 30, 1950 seven (7) radon seeds of 1.02 millicuries were inserted into the tonsil and posterior aspect of the left tongue for microscopically proven residual or recurrent squamous cell carcinoma of the tonsilar fossa (SP 50-631).

The patient was followed in the Tumor Clinic until January, 1953. He was not seen again until he returned to the ENT clinic in October, 1959, complaining of dysphasia and hoarseness of several months duration. His weight was 53 Kg. There was an extensive lesion involving the entire soft palate, hard palate, and nasal pharynx. Biopsy revealed squamous cell carcinoma (SP 59-2625). A feeding gastrostomy was performed. A 3 cm. area of induration in the left neck just below the tip of the left mastoid process was palpated. On intra-oral examination a large granular lesion involving the entire soft palate, posterior aspect of the hard palate and both tonsilar areas was present. The uvula had been destroyed. Extension into the nasopharynx with complete occlusion of both naries as well as a large mass on the posterior and right lateral pharyngeal wall was noted. The patient received Co-60 teletherapy from

Continued: (004)

October 16 to November 20, 1959. The calculated tumor dose of 6000 r was administered in 37 days. There was 80 to 90% regression of the above described lesion. Residual tumor was noted in the right nasopharynx in the right tonsilar area. Supportive therapy consisted of Lipomul 600 ml. each day for twelve days and gastrostomy feedings. The hemoglobin was 8.7, WBC 2750 with normal differential count and were adequate platelets. At the time of discharge from the hospital on December 17, 1959, a gastrostomy tube was in place but clamped off. His weight remained at 53 Kg.

In spite of his ability to eat a soft diet well the patient lost 3.6 Kg. He was admitted on March 28, 1960 because of a right cervical lymph node metastasis and recurrent local tumor.

On April 6, 1960 a radium implant of a right cervical node, 3 x 4 cm., was performed and a dose of approximately 8000 r delivered to the treatment area. On May 24, 1960 the patient was given 66 rad midline absorbed tissue dose (100 r midline air dose) total body irradiation.

Following total body irradiation, the patient's course remained satisfactory and weight was maintained. (His WBC fluctuated between 2000 and 8000 before and after TBR, varying with local therapy). Palliative x-ray to 4 x 7 x 4 cm. left anterior cervical metastasis was started on June 21, 1960 (28 days post TBR). Total tumor dose was 2400 r in seventeen days. The cervical mass improved with x-ray, but patient's condition progressively deteriorated and he expired August 5, 1960 (73 days post TBR). An autopsy was performed.

Study No. 006

Patient. A. T.

Chart No. 380174

This 67 year old Caucasian male had an exploratory laparotomy on November 4, 1959 at the Duval Medical Center, Jacksonville, Florida which revealed a carcinoma of the rectum with metastasis to the liver. A colostomy was performed. He was admitted to the Cincinnati General Hospital on March 4, 1960, and discharged March 9, 1960.

He was readmitted on May 6, 1960 because of bleeding from the rectum and from the colostomy. System review prior to total body radiation was essentially negative. The patient was obese, elderly and in no acute distress with a midline double barrel colostomy. On sigmoidoscopy an annular mass with papillary edges was seen at 6 1/2 cm. Biopsy diagnosis was adenocarcinoma of the rectum (SP 60-1659).

On July 4, 1960 he received 54 rad midline absorbed tissue dose (100 r midline air dose) total body radiation. There were no symptoms following this exposure. During the time he remained in the hospital he had several rectal hemorrhages. Moderate anemia was noted.

The patient had an uncomplicated course and was finally discharged to Drake Hospital on August 12, 1960. He expired there July 14, 1962 (740 days post TBR).

Study No. 007

Patient. J. T.

Chart No. 351651

On December 16, 1957 this 62 yr. old Negro male had a right total colectomy with ileotransverse colostomy for adenocarcinoma of cecum. (SP 57-3607) In June, 1960, a routine chest film revealed multiple metastatic nodules in the lung while the patient continued asymptomatic. On October 6, 1960 patient was admitted to the CGH with a ten day history of weakness in his legs and repeated convulsions. Physical examination at this time was not remarkable except for weakness in his right lower extremity. The diagnosis was cerebral metastases. On October 28, 1960 the patient received total body irradiation with the dose of 100 rad midline absorbed tissue dose (167.1 r midline air dose). There were no symptoms attributable to this therapy, nor was there any symptomatic response.

In view of the patient's progressively deteriorating course of lethargy and paralysis, x-ray therapy to his head through two ports was instituted on November 7, 1960 (10 days post TBR) and continued until November 25, 1960. It was discontinued at the 2750 r in air because of patient's poor clinical condition. His course was one of continued progression of neurologic disease with quadraplegia, and he expired on November 29, 1960 (32 days post TBR).

An autopsy was performed.

Study No. 008

Patient. C. H.

Chart No. 261892

On March 18, 1958 this 60 year old Negro female had a left simple mastectomy followed by radiation through 5 ports of 1120 r in air which was completed in May, 1958. Pathological diagnosis was anaplastic inflammatory carcinoma of breast (SP 58-836). The patient did well until April, 1960 when a left pleural effusion necessitated thoracentesis on April 15, 1960. Two weeks later 30 mg. of nitrogen mustard was instilled in the left pleural space. Four weeks later there were nodules in her surgical scar. On July 2, 1960 biopsy diagnosis of a nodule was metastatic carcinoma, (SP 60-1708). There was gradual accumulation of right pleural fluid.

The patient received 100 rad midline absorbed tissue dose (185 r midline air dose) total body radiation November 8, 1960. This was followed by nausea and weakness beginning twelve hours post radiation therapy and lasting approximately 24 hours. The patient was subjectively improved, and there was softening and regression of the metastatic nodules on her chest wall. Her WBC fell to a low of 3100 13 days post TBR but recovered to 5200 by 20 days post TBR. A repeat thoracentesis was necessary on December 27, 1960. Her course was one of steady deterioriation due to multiple pulmonary infarctions and cor pulmonale. She expired February 7, 1961 (91 days post TBR). An autopsy was performed.

Study No. 009

Patient. B. B.

Chart No. 381031

This patient was a 67 year old Negro female who was seen at CGH in March, 1960 with generalized lymphadenopathy and hepatosplenomegaly. Node biopsies, peripheral bone marrow examinations and blood were non-diagnostic at that time.

She was readmitted on October 7, 1960 because of increasing dysphagia and orthopnea. Two lymph node biopsies on October 11, 1960, were interpreted as malignant lymphoma, follicular type (SP 60-2471 and 60-2483). At this time the diagnosis of chronic pyelonephritis was established with a slight elevation in the patient's BUN. On November 4, 1960 through November 7, 1960 patient received 350 r to her anterior mediastinum. This was followed on November 9, 1960 and November 11, 1960 by total body radiation; each dose being 16 rad midline absorbed tissue dose (25 r midline air dose). Several days before total body radiation the patient had developed nausea and vomiting which did not seem to be aggravated by radiation therapy. However, it became progressively more severe and when a rising BUN was noted, and the patient was given 900 r to her spleen from November 21, 1960 (10 days post TBR) to December 1, 1960. Associated with this Rx there was excellent control of her disease process. The nausea and vomiting subsided promptly when the intramuscular oxytetracycline therapy was discontinued. Her WBC fell to 4000 25 days post TBR; however, no further studies were obtained.

Continued: (009)

On January 24, 1961 patient was treated with chlorambucil because of enlarging lymph nodes and residual hepatomegaly. Some improvement was noted but on April 3, 1961 local x-ray therapy (1000 r in four days) to the inguinal nodes was started because of lymphedema. A course of 1000 r each was given to the right and left axilla in June, 1961. Because of the increasing size and number of nodes in the neck and supraclavicular area, 1200 r was given to these areas beginning June 8, 1961.

She was last seen in Hematology Clinic on July 13, 1961, feeling well. The patient expired at home January 23, 1962 (438 days post TBR).

Study No. 010

Patient. L. T.

Chart No. 261569

The patient was a 66 year old Negro female who noted a small lump in her right breast in July, 1953. On July 13, 1953, patient had a right radical mastectomy. The pathological diagnosis, (SP 53-1385) was carcinoma of breast with metastases to two of thirty-five lymph nodes. She received radiation of 10,700 r in air to four ports from August 8, 1953 to September 1, 1953. In October, 1954 she had a left radical mastectomy for carcinoma of the left breast. Histologically, this was read as medulary carcinoma of breast with lymphoid stroma involving two of fourteen nodes (SP 54-2358).

The patient did well until December, 1958, when she developed skin metastasis to the right chest wall. One of these was biopsied and the report (SP 58-3276) was metastatic meduallary carcinoma. She was placed on estrogen therapy. Beginning January 1, 1959 3200 r was given to the skin metastasis with some regression. At this time she developed a right pleural effusion and the first thoracentesis was followed by the installation of 85 millicuries of Au-198. One additional thoracentesis was necessary on February 24, 1959 but then she remained asymptomatic until October, 1959, when lenticular metastasis of left chest wall appeared.

Stilbesterol had been discontinued in May, 1959 because of vaginal bleeding. In November, 1960, the patient developed a left pleural effusion. She was started on Stilbesterol in January, 1960, but it was discontinued in June , 1960, patient was given 24 mg. of nitrogen mustard in the left pleural

Continued: (010)

space which was followed by a systemic reaction of nausea and vomiting, decrease in the size of lenticular metastasis and decrease in her WBC count.

On December 4, 1960 the patient received 100 rad midline absorbed tissue dose (157.4 midline air dose) total body radiation. No toxic symptoms or signs were noted.

Left pleural effusion recurred though the lenticular metastases improved. On January 1, 1961, she convulsed. Her WBC had fallen to 3400 and remained at this level. X-ray therapy to the skull was of no avail and was discontinued after 850 r. She was totally non-responsive and expired January 22, 1961 (49 days post TBR).

Study No. 011

Patient. Z. W.

Chart No. 387229

The patient was a 52 year old Caucasian male who had a proven carcinoma of the right upper lobe by lobectomy on September 14, 1959 at Good Samaritan Hospital. Following surgery he received local therapy of 2800 r to three ports. In 1960 he was placed on 5 flurouracil, chlorambucil and steroids. He continued to have pain in his right upper extremities and occipital region of his head. He received 2600 r tumor dose Cobalt 60 therapy in 16 days beginning December 5, 1960. There was some reduction in the size of the mass.

He received 100 rad midline absorbed tissue dose (170 r midline air dose) on February 9, 1961. Nausea and vomiting occured within two hours; anorexia and weakness lasted 24 hours. His WBC dropped from an average of 7000 before TBR to 2500 by 4800 days post TBR; it returned to 5400 by 63 days post TBR.

A cordotomy was necessary on July 31, 1961. In October, 1961 a barium swallow was performed and showed invasion of the esophagus. There was edema and swelling of the right upper extremity with evidence of nodes in the right supraclavicular area. Following 27 mgm. of nitrogen mustard on September 16, 1961 he continued to deteriorate with increased dysphagia. December, 1961 he developed left upper lobe pneumonia and expired December 29, 1961 (324 days post TBR).

Study No. 013

Patient. R. D.

Chart No. 312809

The patient was a 49 year old Negro male with Kaposi's sarcoma diagnosed July, 1960.

The lesion progressed rapidly and in January, 1961, he had massive edema of the legs and groin in addition to lesions on the nose and over the eye. SP 61-1674 and SP 61-232 were interpreted as revealing Kaposi's sarcoma. Fifty rad midline absorbed tissue dose(85 r midline air dose) of total body radiation were given on May 19, 1961, on May 24, 1961, and twelve days later, June 5, 1961 without symptoms. Minimal improvement in the skin lesions occurred.

The WBC reached a low level of 1000 37 days after his initial TBR. In spite of local x-ray therapy, the patient followed a progressively deteriorating course and expired on September 9, 1961 (121 days post first TBR).

Study No. 015

Patient. J.D.

Chart No. 163344

The patient was a 61 year old Negro male who had a combined abdomino-perineal resection for carcinoma of the rectum January 25, 1957 (SP 57-265). He was asymptomatic until April 26, 1961 when post prandial epigastric fullness, and constant RUQ pain occurred. Physical examination revealed an adequately nourished patient with the liver palpable to the umbilicus.

The patient received 100 rad midline absorbed tissue dose (166 r midline air dose) total body radiation on May 18, 1961. He had nausea and vomiting that night. Gas pains and anorexia associated with weakness lasted six days. No change in the abdominal mass occurred. His WBC fell to a low of 2000 30 days post TBR but recovered by 40 days. His platelet count remained within normal range throughout the follow-up.

In view of continued pain and deterioration with a large liver, he was given 3000 r cobalt-60 in 13 days to the liver in July, 1961. There was no reduction in size of the liver but his pain decreased considerably. He deteriorated rapidly and expired on September 16, 1961 (121 days post TBR).

An autopsy was obtained.

Study No. 017

Patient. M. P.

Chart No. 204753

This 39 year old Negro female in January, 1951, had a partial glossectomy and right radical neck dissection for mucoepidemoid carcinoma of the tongue. Hysterectomy for uterine fibroids was performed in 1955. From 1951 until December, 1960, the only complaints were of a chronic and recurrent sore throat. A small mass on the tongue was noted and repeatedly biopsied (SP 61-70, SP 61-202, and SP 61-955) revealing recurrent mucoepidermoid carcinoma.

Total body radiation 100 rad midline absorbed tissue dose (149 r midline air dose) was given May 18, 1961. Within three hours she had nausea, vomiting and diarrhea. Anorexia and weakness were present for four days and then cleared. Her WBC fell 30 days after TBR to 2200 from 5000 level before treatment. However, it recovered by 40 days.

On August 11, 1961 excision of the recurrent carcinoma was performed. Biopsy of questionable recurrence in the right submaxillary region on January 5, 1963 was negative. A submandibular lymph node removed July 1, 1964 revealed metastatic carcinoma (SP 64-1884).

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On November 9, 1965 a biopsy (SP 65-3660) was taken from the left side of the neck and was found to have a pattern similar to the previous specimen (SP 64-188) of metastatic carcinoma. A chest x-ray on October 12, 1965 revealed two pulmonary nodules. A recurrence was noted in the incision of the radical neck dissection in March, 1966. She was placed on the Surgical Chemotherapy Program March 10, 1966. Hexestral (1 gm B. I. D.) was given from March 16 to April 21, 1966. The tumor mass decreased slightly after completion of this agent; otherwise, her condition was unchanged (1838 days post TBR).

Study No. 0 18

Patient. H. G.

Chart No. 399452

The patient was a 67 year old Caucasian male who had an onset of hemoptysis eight weeks prior to admission to the Veterans Administration Hospital in October, 1961. Biopsies of the bronchus at the level of the carina and a tumor involving the esophagus 20 cm below incisors showed an undifferentiated carcinoma. Biopsy of a right scalene node revealed papillary adenocarcinoma (Cin. VAS 61-1257, 1279, and 1323). There had been no weight loss or previous therapy.

On November 5, 1961 he received 200 rad midline absorbed tissue dose (313 r midline air dose). Mild nausea occurred for one hour two hours after completion of therapy. Eleven days later he complained of increased fatigability. This progressed with increasing anemia, leukopenia and thrombocytopenia which were most severe 30 days after TBR. The WBC dropped to 1100 and platelets to 5,000. By 43 days post TBR these returned to pretreatment levels.

The patient's weakness persisted and no improvement in the tumor was noted. Local Co 60 therapy was administered to the esophagus from December 22, 1961 to (47 days post TBR) February 8, 1962, delivering 6000 r in 48 days. Esophagram showed definite regression of the large mass lesion and almost complete disappearance of the nodular and ulcerative lesion in the upper 1/3 of the esophagus. However, there was definite increase in the amount of hemoptysis.

Continued: (018)

In April, 1962 it was necessary to dilitate the esophagus. A metastasis was noted in the right supraclavicular area in May, 1962. Radiotherapy was begun on June 20 to the right supraclavicular area with a dose of 5000 r delivered in 23 days with very poor response. A mass was noted above the left eye upon completion of the above therapy; 2000 r was delivered to this area in ten treatments. Response to this therapy was also disappointing.

Vomiting increased, hemoptysis recurred and he was admitted to CGH on August 19, 1962 with right and left lower lobe staphylocaccal pneumonia. He expired August 30, 1962 (298 days post TBR).

Study No. 020

Patient. G.N.

Chart No. 403118

This patient was a 69 year old Negro female who 2-3 months prior to her admission to CGH on February 11, 1962, began having weakness, anorexia, general malaise and severe rectal pain. Biopsy obtained during a combined abdominoperineal resection (SP 62-491 and SP 62-563) on February 28, 1962, showed adenocarcinoma of the rectum invading the muscularis.

On April 22, 1962 she received 200 rad midline absorbed tissue dose (294 r midline air dose) total body radiation. She had no symptoms following radiation but developed leukopenia and thrombocytopenia ten days post therapy. These cleared by 60 days post TBR. Beginning on May 28, 1962 (36 days post TBR) she received Cobalt 60 2200 r to her pelvis in 18 days. Therapy was not completed because she failed to return. September 8, 1964, she returned with constant abdominal pain. The patient expired September 24, 1964 (885 days post TBR).

Study No. 021

Patient. J. W.

Chart No. 335593

This 73 year old Caucasian male was admitted to CGH in December, 1961 with weight loss, abdominal pain, bloating and constipation. Chest x-rays showed a large left upper lung field mass; small bowel studies showed a midabdominal mass. Resection of the mass on January 16, 1962 revealed anaplastic carcinoma of small bowel with incision of lymphatic and blood vessels (*SP* 62-132).

In April, 1962 he was seen because of left leg and hip pain, progression of the lung lesion and subcutaneous lesions. On April 28, 1962, he received 200 rad, midline absorbed tissue dose (322 r total midline air dose) total body radiation. Nausea and vomiting which were present prior to therapy did not change after TBR. His WBC dropped from an average of 10,000 prior to therapy to a low of 600 29 days post TBR. Platelets dropped to 50,000 on the same day and did not recover before his death. Chest x-rays showed infiltrate in the lungs which was diagnosed as either tumor or pneumonia. His course was progressively downhill, and he expired June 3, 1962 (36 days post TBR).

Study No. 022

Patient. E. J.

Chart No. 369118

This patient was a 48 year old Negro female who had a 4 to 5 cm. mass in the left breast and axillary lymph nodes in January, 1961. On February 2, 1961 a left radical mastectomy was performed. The biopsy diagnosis was poorly differentiated solid carcinoma with metastases to regional lymph nodes (SP 61-560).

At Christ Hospital she received 19 treatments (4032 r total tumor dose) over 24 days beginning March 6, 1961 through anterior and posterior chest ports. Chest x-rays in October, 1961, showed a nodular shelled out lesion of the right midlung field and films of the lumbar spine revealed a metastatic destructive lesion of L3 with consequent collapse. A repeat chest film showed a nodular lesion in the left upper lung field in addition to the one in the right lung.

Local therapy to the spine was initiated on October 18, 1961 with a total tumor dose of 1948 r completed in 15 days with marked subjective improvement. At the time of a bilateral oopherectomy and excision of uterine fibroids on December 6, 1961 (SP 61-3191), examination of the upper abdomen revealed several large hepatic nodules.

On April 14, 1962, local therapy was instituted because of increased pain in the right pelvis and hip. 2000 r was given to the right hemipelvis and upper femur, with considerable diminution of pain.

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May 11, 1962 the patient received 150 rad midline absorbed tissue dose (248 total midline air dose), total body radiation. She experienced anorexia, vomiting and nausea immediately following therapy but they cleared. She became very lethargic and increasingly weak with mental confusion and hallucinations. Her course was progressively downhill and she expired May 21, 1962 (10 days post TBR).

Study No. 023

Patient. B. L.

Chart No. 385615

The patient was a 49 year old Negro male who had the diagnosis of colloid adenocarcinoma of the hepatic flexure of the colon made in September, 1960 (CGH SP 60-2233). A right colectomy was performed. Hepatic enlargement was first noted in August, 1961. At the time of admission, April 30, 1962, his only complaint was of occasional cramping right upper quadrant pain. There was no significant weight loss (weight at 85.9 Kg.).

On May 15, 1962, he was given 200 rad midline absorbed tissue dose (336 r midline air dose) total body irradiation. Anorexia was present for five hours on the day of TBR. Decreased abdominal pain was noted. Four weeks post TBR he had pharyngitis, when his white count was 1500, which cleared quickly on penicillin therapy. He was discharged June 15, 1962, with decreased abdominal pain and treated with a tumor dose of 3000 r to liver over 24 days beginning July 6, 1962 (51 days post TBR) thru 20 x 20 cm anterior and posterior quadrant ports. When on this Rx, the WBC fell to 3900. On March 25, 1963 he continued with little pain and weight of 84 Kg. Blood counts had returned to normal. By January, 1964 he had massive ascites uncontrolled by abdominal paracentesis. He expired February 25, 1964 (649 days post TBR).

Study No. 024

Patient. E. C.

Chart No. 146412

The patient was a 39 year old Negro female who had a metastatic carcinoma from the cervix. She had been treated at Lima Hospital in Lima, Ohio, January 1961, with external radiation and intracavitary radium, 2200 r through 2 pelvic fields and 400 r through a transvaginal cone. Radium dose was 4500 mgm. hrs. In May, 1965 she was admitted to CGH because of enlarged supraclavicular nodes and severe pain into the legs. A left inguinal node biopsy was positive for metastatic squamous cell carcinoma (CGH SP 62-1227). There was metastatic carcinoma (CGH SP 62-1288) on needle biopsy of a neck mass. A nonfunctioning left renal system was noted on intravenous pyelography. Retrograde study revealed narrowing of the lower ureter with hydroureter and caliectasis above. Nodular metastases in the left lung field were seen.

On June 10, 1962 the patient received 200 rad midline absorbed tissue dose (322 r midline air dose) total body radiation. She experienced dizziness, nausea, and vomiting at the conclusion of therapy while in the therapy room. These symptoms cleared within three hours. Post TBR, pain was a major problem. Leukopenia and thrombocytopenia occurred six days after TBR, being most severe and associated with anemia at five weeks. Fever occurred but cleared with antibiotic therapy.

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By July, 1962 pain decreased and the patient's sense of well being returned to pretreatment level. Progression of metastatses was noted in both lung fields in July, 1962. She received intrathecal phenol on October 4, 1962 and intra-arterial nitrogen mustard to her pelvis on October 23, 1962 without improvement. She expired at home December 21, 1962 (194 days post TBR).

Study No. 025

Patient. J. W.

Chart No. 201454

This patient was a 64 year old Negro male who entered CGH in July, 1962 with chief complaint of severe chest pain of 2 months duration, anorexia, and weight loss. A right preauricular node biopsy on July 20, 1960, revealed metastatic colloid carcinoma (SP 62-1990).

On September 25, 1962, 150 rad midline absorbed tissue dose (226 r total midline air dose) total body radiation was administered. He experienced nausea for one day and vomited four hours after treatment. Subsequently, anorexia, lassitude and weight loss continued.

Beginning twenty-three days post TBR, October 18, 1962, he received 1100 r in four days to the rapidly enlarging periauricular node. Four weeks after TBR, hemoptysis occurred. This was associated with anemia, severe leucopenia (WBC 500) and thrombocytopenia (platelets 25,000). His course continued downhill and he expired October 28, 1962 (33 days post TBR). An autopsy was obtained.

Study No. 026

Patient. F. B.

Chart No. 413142

The patient was a 29 year old Caucasian male with the diagnosis of malignant lymphoma (Hodgkins type) made on January 31, 1963 (CGH SP 63-280 and 63-904). He had upper gastroenteric bleeding from an undetermined site. Lymphadenopathy and hepatosplenomegaly were present.

On February 9, 1963, he received 100 rad midline absorbed tissue dose (155 r midline air dose) total body radiation. No significant change in pre-existent nausea and vomiting followed his TBR. There was minimal change in the lymphadenopathy and hepatosplenomegaly, The left kidney was not visualized on IVP. Because of gastroenteric hemorrhage, intravenous nitrogen mustard (0.2 mgm/kg) was given March 28, (48 days post TBR) and March 29, 1963. A gastrostomy was performed on April 8, 1963, to control the bleeding from the stomach. Local x-ray was given to a large retroperitoneal mass in the region of the stomach: 1980 r tumor dose was administered in 25 days (April 22, 1963 to May 17, 1963). Vinblastine sulfate (8 mgm I. V.) was started on June 4, 1963 and given several times through October 14, 1963.

He did fairly well until June, 1964 when he had severe GI tract bleeding (hct. 10%). At that time he was placed on Cytoxan because of a severe pruritis. The patient was readmitted several times for hematemesis. His last admission was November 8, 1964 with hct. of 10%; blood was administered but he expired November 17, 1964 (646 days post TBR).

Study No. 027

Patient. D. J.

Chart No. 400383

The patient was a 17 year old Caucasian male with Ewing's sarcoma (CGH NP 61-144) diagnosed on a biopsy from a sacral tumor in December, 1961. A course of 4,700 r of cobalt-60 therapy to the sacrum was given through February, 1962. In January, 1963, metastases to the lung with pleural effusion were noted.

On February 23, 1963, he was given 150 rad midline absorbed tissue dose (238 r midline air dose) total body radiation. Severe nausea and vomiting began three hours after exposure. These symptoms persisted for 48 hours. Anorexia lasted for 72 hours. The patient's complaint of chest pain prior to therapy improved, as did the radiological findings, but recurred in four weeks. Four weeks following therapy, anemia, leukopenia, and thrombocytopenia with petechiae occurred. Weakness, anorexia, and depression were prominent.

Gradual improvement in the hematologic studies occurred so that local mediastinal cobalt-60 therapy in a dose of 4,000 r was given from April 30, to May 27, 1963 (65 days post TBR). His platelet count and white count were maintained in spite of this therapy, but the anemia persisted.

He did well until November, 1963 when he had recurrence of chest pain and was given 3,400 r to the left thoracic wall in 26 days. From December 6, 1963 to January 6, 1964 he received 3,300 r to the right cardiophrenic angle, and from December 31, 1963 to January 17, 1964, he received 1,230 r

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in 14 days to the left elbow. There was no relief of symptoms in the elbow. 4,000 r cobalt-60 was delivered to the left supraclavicular area in 29 days with considerable alleviation o f left chest pain.

In March, 1964, skull x-rays revealed several lytic lesions. A 7 cm. mass was removed which involved the right temporal parietal region and associated calvaria was removed on April 4, 1964. In April, 1964, 3,000 r in 20 days was given to the skull. He was treated with Methotrexate and 1,500 r of x-ray therapy in May, 1964. The patient expired October 8, 1964 at Drake Hospital (592 days *post* TBR).

Study No. 029

Patient. F. W.

Chart No. 109436

The patient was a 63 year old Caucasian female who had an adenocarcinoma of the left breast with metastases (CGHSP 61-3080) treated in November, 1961, with a radical mastectomy. All resected nodes were positive. In January, 1962, she completed 3980 r tumor dose in 29 days through an internal mammary port and 3840 r through a supraclavicular port. In November, 1962, recurrent carcinoma was present in subcutaneous tissue from the left anterior chest wall. On November 20, 1962, she was placed on Stilbesterol 5 mgm TID which was discontinued in January, 1963.

On March 14, 1963, the patient was given 150 rad midline absorbed tissue dose total body radiation (257 r midline air dose). No symptoms referrable to the therapy were noted. Anemia to 5.0 gm, hemoglobin, leukopenia to the 2500 range and thrombocytopenia were noted at four weeks. She was placed on testosterone propionate 100 mgm. three times per week and 200 mgm. I. M. three times per week. Studies two months after therapy revealed a normal white and platelet count with a hemoglobin of 12.4 gm. Progression of the tumor continued.

On July 9, 1963 she started a course of A-20968. There was increased bleeding from the chest wall and progressive ascites. Prednisone was started on July 22, 1963. She became clincially edematous jaundiced, deteriorated rapidly and died August 15, 1963 (151 days post TBR).

Study No. 030

Patient. J.D.

Chart No. 382572

The patient was a 54 year old Negro male who had a laparotomy performed on September 11, 1962 because of severe epigastric pain of three weeks duration. Inoperable carcinoma of the stomach with widespread metastasis to the celiac and middle pelvic nodes, the peritoneum and omentum was diagnosed (CGH SP 62-2445). A gastrojejunostomy was performed. Following surgery he had increased appetite and cessation of vomiting, but severe pain in the abdomen continued. He was discharged September 27, 1962.

On October 9, 1962 he was placed on A-8103, 40 mgm/day, as well as medication for control of pain and gastric spasm. The chemotherapy was discontinued in December, 1962. On May 17, 1963 the patient was admitted to CGH with complaints of nausea and vomiting of three weeks duration. A 10 cm. mass was present in the epigastrium.

The patient received 100 rad midline absorbed tissue dose (149 r midline air dose) total body radiation on June 6, 1963. He had no symptoms following treatment. The patient had nausea and vomiting which was not related to his radiation therapy, but was associated with a partial obstruction at the operative atoma. Thirty days after treatment he developed slight leukopenia (WBC 3700) and thrombocytopenia (platelets 90,000) with the leukocyte and platelet counts returning to pre-treatment levels by sixty days post irradiation. A mild anemia developed approximately one week after treatment persisting through out this follow-up (89 days post TBR). There was definite

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evidence during this time of progression of the epigastric mass.

He was admitted to CGH on October 4, 1963 (120 days post TBR) because of increased nausea, vomiting and constipation. Surgical chemotherapy (Oxytone 25 mg) was begun on November 7, 1963. Vomiting continued and he expired December 23, 1963 (200 days post TBR).

Study No. 031

Patient. M. L.

Chart No. 116158

The patient was an 81 year old Negro female who had the diagnosis of carcinoma of the right breast made in February, 1958. March 7, 1958 a right radical mastectomy was performed. (CGH SP 58-391).

On May 14, 1963 the patient was admitted to CGH with a mass in the left breast which had been slowly increasing in size for one year. There was also a mass over the liver. Biopsy of the breast on May 23, 1963 revealed carcinoma of the breast (CGH SP 63-1301) and on May 28, 1963 a simple mastectomy was performed. (CGH SP 63-1379).

The patient had radiation therapy for fibroids thiry-four years prior to the first breast amputation. She did not receive post-operative radiation therapy.

On June 16, 1963 the patient received 100 rad midline absorbed tissue dose (155 r midline air dose) total body radiation. She had no symptoms following treatment. Thirty days after treatment leukopenia and thrombocytopenia developed. The platelet count returned to pre-treatment levels by sixty days and the leukocyte count by seventy-five days post radiation. Prior to treatment the patient had a mild anemia with the hemoglobin averaging 10.5 gms., the hematocrit 35%. After treatment there was an improvement in the anemia: seventy-five days post TBR her hemoglobin was 11.9 gms., hematocrit 38%.

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The patient did well until January, 1964 when she noticed increasing anorexia, pain and tenderness over the liver area. Radiation therapy was started to the liver on January 7, 1964. She received 3700 r in 31 days. The response to therapy was excellent; liver size decreased from 10 cm below the right costal margin at beginning of therapy to 3-4 cm.

She did well until July 31, 1964 when she was admitted to CGH for evaluation of increasing ankle edema and ascites. Stilbesterol was started but she continued downhill and expired on September 5, 1964 (446 days post TBR).

Study No. 033

Patient. A. J.

Chart No. 363128

The patient was a 64 year old Negro male who had abdominal pain and cramping with a polypoid cecal mass on barium enema in March, 1959. The diagnosis of colloid adenocarcinoma of the colon was made on a biopsy obtained at a colectomy and ileo-transverse colostomy performed March 24, 1959 (CGH SP 59-980).

On May 28, 1963, the patient was seen in Medical Clinic with complaint of weight loss and upper abdominal pain of several months duration. At this time there was a large right upper quadrant mass. He had received no radiation therapy.

On July 7, 1963, he received 100 rad midline absorbed tissue dose (152 r midline air dose) total body radiation. There were no symptoms from radiation. Prior to treatment, the patient's major complaint was severe intermittent pain in the hepatic region. He had some relief from pain, and decrease in size of the hepatic mass. Twenty six days after treatment, the patient developed leukopenia (WBC 2600) and thrombocytopenia (platelets 91,000) with the leukocyte and platelet counts returning to pre-treatment levels by thirty-nine days post radiation.

On August 6, 1963, the patient was discharged, but on August 20, he was readmitted with complaint of severe anorexia, nausea, weakness, and abdominal pain. His WBC rose to 17,000 and chest x-ray revealed pneumonia. His course continued downhill and the patient expired on October 1, 1963 (85 days post TBR).

Study No. 035

Patient. M. R.

Chart No. 415556

The patient was a 53 year old Negro female who had the diagnosis of carcinoma of the right breast with metastases to the skin and supraclavicular nodes made in April, 1963 (SP 63-952). She also had a large abdominal mass, and on May 1, 1963, an abdominal hysterectomy for large uterine fibroids was performed (SP 63-1100).

On October 15, 1963 the patient was readmitted to CGH for evaluation for total body radiation. She had no previous radiation therapy or chemotherapy.

October 27, 1963, the patient received total body radiation of 150 rad midline absorbed tissue dose (227 r midline air dose). Approximately two hours after treatment she compalained of anorexia, nausea and vomiting, and feeling "lightheaded". The vomiting abated after approximately six hours, but anorexia and post prandial nausea persisted for 48 hours. She also complained of weakness and fatigue after treatment but had experienced these symptoms prior to treatment. Hematological studies before treatment revealed average values of: Hgb. 12.4, Hct 41%, RBC 5,100,000, WBC 8,400, platelets 250,000. Seventeen days post treatment the blood values fell to Hgb. 11.2, Hct. 36%, RBC 4,200,000, WBC 3,800, platelets 166,000.

November 20, 1963, 24 days post TBR, the patient's platelet count was 50,400. It continued to drop to a low of 36,560 thirty-six days post TBR. Between 28 and 47 days post TBR, guaiac positive stools and micro-hematuria were observed.

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By 54 days post TBR the platelet count had returned to pre-treatment levels and upon examination 61 days post TBR the stool was guaiac negative.

The WBC reached its lowest point, 1,100, 33 days post TBR. It remained between 1,100 and 2,500 until 47 days post TBR when it rose to 3,150. It continued to climb and 75 days post TBR the WBC was 7,450. In February, 1964, bone metastases were noted in the pelvis and upper femurs.

The patient began receiving testosterone, 100 mgm t.i.w. March 16, 1964. On October 9, 1964 when some increase in the metastatic disease of the chest wall was noted, 2,800 r was given in 20 days to the skin nodules in the right supraclavicular area and to the right chest wall. Regression of the tumor nodules was noted after therapy was completed. On February 15, 1965, 2,000 r x-ray was given in 14 days to the left femur (site of lytic metastases).

She returned to CGH on February 11, 1966 in acute respiratory distress. Three thoracenteses were performed and she did well until early March when she developed weakness, nausea and vomiting. She expired March 5, 1966 (830 days post TBR).

Study No. 036

Patient. S. H.

Chart No. 301648

The patient was a 64 year old Negro male who had a right colectomy performed November 23, 1954 for colloid adenocarcinoma of the colon (SP 54-2560). None of 20 lymph nodes were involved. On November 1, 1963 an exploratory laparotomy was performed which revealed unresectable sigmoid carcinoma. At the time of a loop colostomy, biopsy was obtained which revealed colloid carcinoma (SP 63-2704).

The patient had received no previous therapy. On November 24, 1963 100 rad midline absorbed tissue dose (153 r midline air dose) total body radiation was administered. He tolerated the procedure well and experienced no symptoms following radiation. Prior to TBR the patient's average hematology values were: Hb. 10.8 gm., Hct 37%, WBC 6400, Platelets 250,000, Retic 0.8%, Sed Rate 50.

The patient's blood count reached a low at 26 days post TBR: Hb 9.5, Hct 30%, RBC 3.7, WBC 2,000, Retic 0.5%, Platelet 64,000, with an increase in Sed Rate to 57. Forty-four days post TBR the count appeared to be rising, but had not yet returned to the pre-treatment levels.

The patient was last seen March 5, 1964 (102 days post TBR). His WBC had risen to 3700 and platelets were within normal values. He appeared to be steadily deteriorating. He continued a downhill course and expired July 20, 1964 (239 days post TBR).

Study No. 037

Patient. W. R.

Chart No. 424061

The patient was a 64 year old Negro male on whom the diagnosis of metastatic signet ring carcinoma was confirmed by esophagoscopy November 22, 1963, and left scalene biopsy November 23, 1963 (SP 63-2917). Due to the distant disease, the patient was immediately worked up for total body radiation. He had no previous therapy.

On December 15, 1963 the patient received 150 rad midline absorbed tissue dose (231 r midline air dose) total body radiation. He experienced no symptoms following radiation. Prior to treatment the patient's average hematology values were: Hb 12.3, Hct 37%, RBC 3.7, WBC 7,800, and Platelets 225,000, by twenty-three days post TBR the values had fallen to Hb. 11.4, Hct 34%, RBC 3.4, WBC 1,500, and Platelets 54,000.

He expired February 6, 1954 (54 days post TBR) continuing to refuse further evaluation.

Study No. 038

Patient. W. B.

Chart No. 343619

The patient was a 73 year old Negro male who had the diagnosis of squamous cell carcinoma of the right pyriform sinus with right cervical lymph node metastasis in May, 1963 (SP 63-1187). He refused surgical treatment. Radical radiation therapy was administered to the hypopharnyx from May 21, 1963 to July 3, 1963, delivering a minimal tumor dose of 6700 r in 42 days overall time. There was approximately 90% regression of the primary lesion at the conclusion of therapy. On July 7, 1963 radioactive Ir 192 was utilized for a single plane implant of the lymph node in the right cervical area. The estimated dose was 3000 r.

The patient was readmitted to CGH on March 16, 1964 for total body radiation. At that time the right neck node showed a definite increase in size. Hematology work-up revealed a decreased white blood cell count, and the pre-therapy bone marrow examination revealed marked reduction of the cell content with an increase of fat.

On March 22, 1964 the patient received 25 rad midline absorbed tissue dose total body irradiation (41 r midline air dose). He experienced no symptoms following treatment.

His WBC continued at pre-treatment low levels with some recovery 25 days post treatment. After that it began to drop and continued to remain between 2500 and 2000. His platelets fluctuated between 110,000 and 200,000 both before and after treatment (low of 110,000 reached 33 days post TBR).

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Examination on March 21, 1966 was negative with no evidence of tumor. He continues to do well (806 days post TBR).

Study No. 040

Patient. A. B. J.

Chart No. 425203

The patient was an 82 year old Negro female who was first admitted to CGH on March 25, 1964, with a diagnosis of carcinoma of the breast with right axillary and pulmonary metastases (SP 64-869). Stilbesterol therapy was initiated on April 6, 1964.

On April 24 and 25, 1964, the patient received sham irradiation of 5 minute duration. On April 26, 1964, 100 rad midline absorbed tissue dose (152 r midline air dose) total body radiation was administered.

The patient experienced no symptoms following therapy. Before treatment her hemogram was stable with average values of: Hb. 12.6, Hct. 41%, RBC 4.4, WBC 6,000, Retic. 2.2%, Plat. 160,000. The WBC fell to a low of 1,900 thirty days after treatment. The platelet count was 100,000. By seventy-five days after therapy the WBC and platelet counts had returned to pre-treatment levels. The patient developed a mild anemia which persisted through our follow-up (123 days post TBR).

Local x-ray therapy to the breast was initiated July 16, 1964, 81 days after total body irradiation. A tumor dose of 3000 r was delivered. She has been lost to follow-up.

Study No. 041

Patient. S. W.

Chart No. 425326

The patient was a 63 year old Negro male who was first admitted to CGH on April 3, 1964 with the diagnosis of far advanced carcinoma of the stomach. A liver biopsy performed on April 13, 1964 revealed metastatic carcinoma of gastric origin (Liver biopsy GE # 2020). He had received no previous therapy.

On April 26, 1964 the patient received 50 rad midline absorbed tissue dose (77 r midline air dose) total body irradiation.

Prior to therapy, the patient's condition appeared to be deteriorating. The WBC was rising and on the day of therapy was 13,600. A platelet count done on May 1, 1964 was 150,000. On May 4, 1964 his WBC was 23,250, and the hematocrit was 27%. The patient continued a downhill course, and on May 5, 1964 he expired (nine days post TBR).

Study No. 042

Patient. G.S.

Chart No. 416749

The patient was a 42 year old Caucasian female who was first admitted to CGH in May, 1963 with a diagnosis of carcinoma of the cervix, clinical stage I. Biopsy obtained on May 17, 1963 revealed squamous cell carcinoma, poorly differentiated (SP 63-1252). Between July 6, 1963 and August 20, 1963, she received a minimal tumor dose of 4200 r to the parametrial midplane in 45 days overall time. Intracavitary radium was inserted, 30 mgm in two ovoids in the vagina on August 7, 1963, and 30 mgm in a tandium into the uterine canal on August 14, 1963. The total exposure dose from the two implants was 7200 r.

On January 7, 1964 she had a small mass on the anterior aspect of the upper third of the right thigh excised. Histologic diagnosis was squamous cell carcinoma, metastatic (SP 64-44). Following surgery she received radiation therapy to the right anterior thigh. A minimal tumor dose of 4967 r was administered in 30 days overall time.

In April, 1964 the patient developed metastases to the left cervical lymph node (SP 64-994). Radiographs obtained March 26, 1964 revealed evidence of probable bony metastases in the lumbar spine and pelvis.

The patient received total body irradiation on May 4, 1964. The midline absorbed tissue dose was 150 rad (216 r midline air dose). Nausea and vomiting began approximately two hours after the completion of therapy, and abated within the first 24 hours. Anorexia continued for four days.

Continued: (042)

Prior to therapy, the hematology values were stable and averaged: Hemoglobin 13.8; Hematocrit 43%; WBC 6,300; RBC 4.22; Platelet 260,000. By thirty days post TBR, the blood counts reached their lowest levels. The WBC fell to 700, platelets to 20,000. The Hb., Hct., and RBC fell gradually to 9.3, 29%, and 2.89 by thirty-nine days post therapy. The profile score indicated a Grade III Acute Radiation Syndrome at 30 days post treatment. By fifty days after therapy, the WBC had returned to pre-treatment levels. The hemoglobin and hematocrit continued to rise and ninety-eight days post TBR the hemoglobin was 11.8, hematocrit 37%.

She had excellent results from total body radiation until October, 1964, when she developed pain in her left pelvis and leg.

On November 25, 1964 72 ml. of bone marrow was aspirated for storage. November 27, 1964 20 mg. of nitrogen mustard was injected and she was subsequently discharged.

December 11, 1964 a peripheral nerve block and alcohol injection gave only moderate relief of the pain. She was readmitted on January 4, 1965 because of edema in the lower extremity. Chest x-rays on January 8, 1965 revealed multiple pulmonary nodules and two collapsed lobes. The patient expired on January 21, 1965 (262 days post TBR).

Study No. 043

Patient. J. H.

Chart No. 119338

The patient was a 45 year old Caucasian male who was first admitted to CGH in April, 1959, with the diagnosis of alcoholism, pneumococcal lobar pneumonia, septicemia and thrombocytopenia secondary to the septicemia. Bone marrow examination revealed a fatty, hypocellular marrow consistent with liver disease.

At esophagoscopy and biopsy on April 16, 1964, the diagnosis of adenocarcinoma of the distal third of the esophagus was made (SP 64-1108). May 1, 1964, the patient had an esophagogastrectomy with intra-thoracic esophagogastrostomy. The post-operative diagnosis was poorly differentiated adenocarcinoma of the stomach (SP 64-1285). The superior resection site was infiltrated by tumor, and there were metastases to two of eight lymph nodes.

On October 14 and 15, 1964, the patient received sham irradiation. On October 16, a partial body irradiation dose of 100 rad midline absorbed tissue dose (150 r midline air dose) was administered to the lower body. There was no increase in pre-existent nausea and vomiting following PBR. Ten days post PBR the WBC fell from 13,000 to 6,000, only to climb again. He continued to deteriorate rapidly and on October 31, 1964, he expired (15 days post PBR).

Study No. 044

Patient. B. P.

Chart No. 84376

This 53 year old Negro female had bronchoscopy June 8, 1964 at Dunham Hospital. The biopsied lesion proved to be squamous cell carcinoma. Cobalt 60 teletherapy was instituted on July 7, 1964. The patient received a minimal tumor dose of 6047 r and a maximum tumor dose of 6152 r, through anterior straight portal, and oblique posterior portals in thirty days. Chest x-ray showed lung metastases and pneumonitis in October, 1964.

Sham irradiation with sound was administered on November 5, 1964 and November 6, 1964. The patient received 100 rad midline absorbed tissue dose (149 midline air dose) total body radiation on November 7, 1964. Hematology values were normal prior to treatment. The patient had no symptoms following TBR. Her WBC dropped to a low of 2300 thirty-seven days post TBR; platelets reached a low of 100,000 twenty-eight days post TBR. Both had recovered to normal values by 75 days post TBR.

On April 30, 1965 because of psychiatric symptoms, complaints of intermittent eye pains and difficulty in breathing she was admitted to CGH. Her weight had dropped from 50 kg to 30.4 kg on admission. She continued to have increased difficulty in breathing. The patient expired on May 23, 1965 (197 days post TBR).

Study No. 045

Patient. M. J.

Chart No. 428894

The patient was a 49 year old Caucasian female who was first admitted to CGH in July, 1964 for evaluation of a mass in the right breast. She had pain in the right hip, knee and lower back which began in December, 1963. A 6 x 5 cm mass was noted in the right breast with attachment to the underlying structures. On July 17, 1964, specimen on a needle biopsy was diagnosed carcinoma of the breast (SP 64-2009). There was metastatic bone disease involving the skull, right femur, right acetabulum, the pedicles and spinous processes of D12 and the sixth left rib.

Hexamethylmelamine was instituted on July 27, 1964. A course of this drug was completed on August 18, 1964.

With this medication, her primary tumor receded markedly, but her metastatic lesions continued growing. On November 11, 1964, the patient was readmitted to CGH. On November 7, 1964, total body irradiation was administered. The midline absorbed tissue dose was 150 rad (250 r midline air dose). At the termination of treatment, the patient had severe vomiting which continued throughout the next 24 hours in spite of intramuscular compazine.

Before treatment the patient had a normal hemogram, with average values of: Hb 13.4; Hct 43%; WBC 5,900; RBC 4.3; plat 370,000. Seven days post treatment the WBC began to fall. The platelet count began to fall approximately 14 days after treatment.

Continued: (045)

The patient continued to have pain, particularly in the right leg, intermittent vomiting, lethargy and weakness. Two weeks after treatment, there was increased dyspnea, cardiac gallop, and chest films showed a diffuse infiltrate in the left lower lung field and collapse of the right lower lung. She was digitalized, started on antibiotics, and on a course of heparin.

The WBC and platelet count continued to fall. Twenty-three days after treatment, the patient had "coffee ground" emesis. Her WBC was 1,000, platelet count 80,000. On the 24th post treatment day the WBC was 850, platelet count 38,000. The patient continued to deteriorate and expired December 2, 1964 (25 days post TBR).

Study No. 047

Patient. F. W.

Chart No. 435763

The patient was a 57 year old Caucasian male who had the diagnosis of adenocarcinoma of the rectosigmoid colon diagnosed by biopsy at sigmoidoscopy at Deaconess Hospital, December, 1963. A colostomy was performed on January 23, 1964. In June and July, 1964, the patient had intravenous nitrogen mustard via intra-arterial route, followed by 5 flourouracil, 750 mgm x 11.

The patient was admitted to CGH on February 15, 1965. Prior to therapy he had a slightly elevated white count and anemia. On February 17, 1965, 171 ml. of bone marrow was aspirated for storage without difficulty. On February 19, 1965, he received sham irradiation with no observed reaction. Partial body irradiation was administered to the lower body on February 20, 1965. The midline absorbed tissue dose was 150 rad (233 r midline air dose).

There was no leukopenia after irradiation. The patient was transferred to Drake Hospital and expired on July 17, 1965 (147 days post PBR).

Study No. 049

Patient. J.R.

Chart No. 424794

This patient was a 75 year old Negro male who had a 35 year history of chronic constipation. On March 11, 1965 anoscopy and a biopsy revealed a mass on the anterior wall of the rectum which was diagnosed as adenocarcinoma (SP 65-792). At exploratory laparotomy and sigmoid colostomy on March 31, 1965, carcinoma of the rectum with pelvic invasion was found. On April 20, 1965, a total of 180 ml. of bone marrow was aspirated and stored.

The patient received two sham irradiations prior to treatment without incident. On April 24, 1965, 200 rad midline absorbed tissue dose (304 r midline air dose) partial body irradiation was administered to the lower body.

Prior to treatment the patient was slightly anemic but otherwise had a normal hemogram. Three days post treatment his WBC rose to 15,000 due to an infection. Twenty-three days post treatment his WBC dropped to 9,000 and remained at that level.

The patient was discharged to a nursing home in Middletown, Ohio, on June 28, 1965 with no change in his condition. He expired on October 10, 1965 (169 days post PBR) at the nursing home with no further follow up.

Study No. 050

Patient. L. W.

Chart No. 210410

This patient was an 80 year old Caucasian male who had the diagnosis of adenocarcinoma of the rectum and recurrent transitional cell carcinoma of the urinary bladder with metastases to both lungs. The carcinoma of the rectum was biopsied in 1962 (SP 62-1373). At cystoscopy in June, 1962, papillary carcinoma of the bladder was diagnosed (SP 62-1500). On June 7, 1962 an abdominal perineal resection was performed (SP 62-1156). Nine lymph nodes were negative for metastases.

Cystoscopy on February 5, 1963 revealed recurrent papillary carcinoma (SP 63-333). A biopsy of the rectum (SP 63-1596) on June 24, 1963 showed chronic inflammation of the rectum.

Multiple pulmonary metastases were noted in April, 1965. On April 19, 1965 a total of 198 ml. of bone marrow was aspirated and stored without difficulty. The patient received three sham irradiations with no reaction. Partial body irradiation was administered on April 24, 1965 to the upper body. The midline absorbed tissue dose was 200 rad (the midline air dose was 348 r). No reaction was noted.

Prior to therapy the patient's hemogram was in the normal range (WBC average: 8900). Two days post-treatment the WBC dropped to 6850 and remained in the 6000 range.

Continued: (050)

From May 18, 1965 to June 7, 1965 the left chest was given 2000 r and the right chest 800 r x-ray therapy. He was admitted to CGH because of weakness, malaise, shortness of breath, chest pain, and anorexia with vomiting, and treated with penicillin and chlormycetin. The course of 1200 r to the right chest was completed by June 25, 1965 without regression of the pulmonary metastases. His WBC dropped to 2500 June 8, 1965 (45 days post PBR) but recovered after completion of therapy. On August 6, 1965 rib involvement on the under surface of the 6th, 7th and possibly 8th posterior righ ribs and increase in the larger pulmonary nodule on the right was noted on x-ray. There was questionable liver enlargement. On September 13, 1965 the liver was enlarged an palpated 8 cm. beneath the right inferior costal margin. No other masses were noted, but the patient complained of anorexia.

By November 1, 1965 he was very lethargic most of the time and eating poorly. He expired on November 7, 1965 (195 days post PBR).

Study No. 051

Patient. J. M.

Chart No. 421562

The patient was a 66 year old Caucasian male who had a diagnosis of undifferentiated oat cell carcinoma of the lung established from a bronchial biopsy (SP 63-2661) in October, 1963. Scalene node biopsy was negative. He received 5000 r to the right chest and 4800 r to the supraclavicular fossa. This was completed in thirty five days.

In February, 1965, he was seen with severe chest pain and dyspena diagnosed as pleurisy with underlying pneumonia. He again developed severe chest pain in April, 1965. At this time x-rays revealed two metastatic nodules in the left chest. It was then decided to administer total body radiation. Prior to treatment his hemogram was normal. On April 26, 1965 a total of 210 ml. bone marrow was aspirated for storage without difficulty. He received sham irradiation in the three days prior to treatment with no observed reaction.

On May 1, 1965, 150 rad midline absorbed tissue dose (212 r midline air dose) total body radiation was administered. After treatment the patient experienced mild nausea, anorexia and vomiting; however, it lasted just through that evening.

Seventeen days after treatment his WBC went from 5,700 to 4,000 and his platelet count began to decrease. Both continued to drop; at twenty-four days post TBR his WBC was 950 and platelet count 45,600. He was admitted to CGH and placed in reverse isolation. On May 25, 1965 he tolerated infusion of the autologous bone marrow well. Moderate hemoglobinuria occurred was because of the exessively rapid rate of infusion. Twenty-seven days post TBR his WBC reached a low of 0350; likewise his platelet count dropped to 36,400.

Continued: (051)

The following day his WBC rose to 0700; it continued to rise steadily until at thirty-eight days post TBR it was 5,150. His platelets rose very rapidly to 691,400.

On June 18, 1965, (Forty-eight days post TBR) the WBC was 11,850 and platelet count 431,200. His physical condition remained essentially the same as before except for pedal edema and cyanosis. Two thoracenteses were unsuccessful. The patient continued a downhill course and expired on July 14, 1965 (74 days post TBR).

Study No. 052

Patient. J.W.

Chart No. 436868

This patient was a 60 year old Caucasian male who had an exploratory laparotomy with omental biopsy and an ileo-transverse colostomy on April 2, 1965. Biopsy of the omental implant (SP 65-1100) was diagnosed as metastatic colloid adenocarcinoma.

The patient was seen on April 9, 1965 in Tumor Clinic. It was decided to administer partial body irradiation followed by local irradiation to the cecum. He was given three sham irradiations prior to treatment without difficulty. On April 21, 1965, a total of 227 ml bone marrow was aspirated for storage without difficulty. Partial body irradiation to the lower body was administered on May 1, 1965. The dose was 200 rad midline absorbed tissue dose (296 r midline air dose). Mild nausea, anorexia, vomiting and diarrhea following treatment lasted approximately nine hours.

He received 5000 r to three abdominal ports in thirty-nine days, May 17, 1965 to June 25, 1965. The patient's hemogram continued at normal level as it was prior to treatment. His condition was essentially the same as before. He continued a downhill course and expired on July 31, 1965 (91 days post PBR).

Study No. 053

Patient. L. R.

Chart No. 382011

This patient was a 66 year old Caucasian male who had a diagnosis of pulmonary and laryngeal tuberculosis established in 1960. He was treated at Dunham Hospital for one year. On April 6, 1965 he was admitted to CGH with a six month history of pain in the right shoulder, anorexia, and weight loss. A right supraclavicular lymph node biopsy on April 9, 1965 was diagnosed as metastatic squamous cell carcinoma (SP 65-1184). Bronchial aspirant revealed undifferentiated carcinoma (SP 65-1344).

Before treatment the patient's hemogram was normal except for a slightly elevated WBC (over 12,500). On May 4, 1965 a total of 217 ml. bone marrow was aspirated for storage without difficulty.

He tolerated three sham irradiations well. On May 8, 1965, total body radiation was administered. The patient received 200 rad midline absorbed tissue dose (316 r midline air dose). After treatment the patient vomited through the evening with nausea and anorexia persisting for three days.

His hemogram remained stationary until six days post TBR. At this time his WBC dropped to 7,250 and remained there through day twelve. He was placed on INH three days after irradiation. His condition did not change after TBR.

Continued: (053)

On the eighteenth day (May 25, 1965) after TBR, the WBC dropped from 5500 to 3250. On May 27, 1965 autologous bone marrow was infused without difficulty.

The platelet count and WBC continued to drop steadily until they reached a low (WBC 350; platelet 8,730) at twenty-six days post TBR. The WBC and platelet count remained at the same low level until he expired on June 5, 1965, 28 days post TBR.

Study No. 055

Patient. L. W.

Chart No. 441714

This patient was a 57 year old Negro female who was first admitted to CGH on August 23, 1965, because of a grapefruit-sized lump on her right breast present since six months prior to admission. Biopsy (SP 65-2847) on August 30, 1965 was diagnosed as carcinoma of the breast. Masses were also noted in the left breast retroareolar area and fullness in the right supraclavicular area. Prior to therapy the hemogram was normal. In the three days prior to therapy she received sham irradiation with no observed reaction.

On September 18, 1965, partial body irradiation, 200 rad midline absorbed tissue dose (341 r midline air dose), was administered to the upper body. She tolerated the treatment well and experienced no side effects (20 days post PBR).

Local x-ray therapy began on October 8, 1965. At this time the left breast mass was larger and the right breast was ulcerated. Large nodes were present in both axillary areas and right supraclavicular area. She received 2000 r in 53 days to her left and right chest through large anterior and posterior ports. Then on December 1, 1965, x-ray therapy was begun on the intermammary chain and to the anterior and posterior supraclavicular region. She received 4000 r in 40 days. Her WBC fell to a low of 2200 on December 3, 1965 (76 days post PBR) and her platelets reached their lowest (78,000) on the same date. The WBC and platelets had returned to normal levels by January 25, 1966 (129 days post PBR).

Continued: (055)

She was followed in x-ray therapy and did well until February 12, 1966 when she was admitted to CGH because of increased shortness of breath, fever, hemoptysis and cyanosis. A tracheotomy was accomplished but the patient expired (148 days *post* PBR).

Study No. 056

Patient. J. B.

Chart No. 332867

The patient was a 53 year old Negro male whose chest x-rays on July 12, 1965, showed large nodes present in the left supraclavicular area and a possible hilar mass. Biopsy of a supraclavicular lymph node (SP 65-2692) revealed metastatic carcinoma. On September 14, 1965, 205 ml. of autologous bone marrow was aspirated for storage without difficulty. Prior to treatment his hemogram was: WBC 9,900, Hct. 37%, Hb. 10.9 gms., RBC 4.0, platelets 350-500,000, retic., 0.0%.

On September 18, 1965, the patient received 100 rad midline absorbed tissue dose (151 r midline air dose) partial body irradiation to the upper body. There were no prodromal symptoms post PBR.

A course of local therapy was given to the left supraclavicular area from October 9, 1965 (17 days post PBR) to October 18, 1965 (1400 r in nine days), but it did not seem to alleviate the pain. The patient continued to lose weight. His WBC began rising 20 days post Rx to a high of 16,700. The Hb. and Hct. dropped in this same period of time (Hb. 9 gms., Hct. 29%) but his platelets remained fairly constant. He continued a downhill course and expired October 26, 1965 (38 days post PBR).

Study No. 057

Patient. C. J.

Chart No. 89831

The patient was a 55 year old Negro female who had an abdominal mass diagnosed as uterine fibroids. In January, 1958, she was admitted to CGH for a possible ovarian tumor but discharged without treatment.

Specimens from an abdominal hysterectomy on August 26, 1965 were diagnosed as bilateral papillary cystadenocarcinoma of the ovaries. She was discharged on September 17, 1965 to return in two weeks for radiation therapy. Prior to therapy hemogram was normal except for a 35% hematocrit and an 11 gm hemoglobin.

She received 100 rad midline absorbed tissue dose (175 r midline air dose) total body radiation on October 2, 1965. She tolerated the treatment well. She began cobalt-60 therapy on January 4, 1966 (95 days post TBR) and received 4000 r to her pelvis. She also received 4000 r to her upper abdomen during the same treatment period.

Her WBC dropped to a low of 1500 on November 4, 1965 (33 days post TBR); platelets dropped to a low of 35,000 on the same date. Her WBC continued at the 2000 level through 120 days post TBR due to the local therapy. She continues to do well (241 days post TBR).

Study No. 058

Patient. E. G.

Chart No. 24619

This patient was a 47 year old Negro female who noticed a vaginal discharge in November, 1964. A biopsy of the cervix (SP 64-3278) was performed on November 25, 1964 and showed squamous cell carcinoma (Stage III).

She received 4000 r external radiation therapy and was then admitted on January 11, 1965 for a radium insertion. The first insertion was on January 13, 1965 and the second on January 27, 1965. On January 30, 1965 definite flattening of the tumor was observed.

In September, 1965, she was referred to ENT clinic because of a mass which had appeared overnight in the right parotid area. A biopsy (SP 65-3210) of the right mandible on September 29, 1965 showed metastatic squamous cell carcinoma. On a laminogram of the right lung on September 27, 1965 a solitary pulmonary nodular lesion was observed.

Her blood count prior to TBR was: WBC 12,000, RBC 3.3, Hb. 8.0 gms, Hct. 10%, platelets 350-400,000, Retics 1-2%.

She received 50 rad midline absorbed tissue dose (81 r midline air dose) total body radiation on October 16, 1965. On November 3, 1965, her hemoglobin was 8.0 gms and hematocrit was 25%. Her temperature was constantly elevated and she had a left hemiperesis. Lumbar puncture was negative but a carotid angiogram showed an intracerebral mass lesion in the frontal region. By November 18, 1965 she was completely obtunded and being

Continued: (058)

fed intravenously. Co 60 therapy to the brain was given from November 11, 1965 to December 4, 1965, totaling 3000 r tumor dose, without improvement. She steadily deteriorated and expired January 4, 1966 (80 days post TBR).

Study No. 059

Patient. R. T.

Chart No. 441482

The patient was a 42 year old Caucasian male who had difficulty in voiding 24 hours before admission. X-rays of the lumbar spine revealed complete absence of the left third transverse process and indistinctness of the pedicle of L 3. An IVP on August 24, 1965 showed a large inferior renal mass with distortion and displacement of the calyces which was also seen on retrograde pyelography August 25, 1965.

A right nephrectomy was performed on August 26, 1965. Numerous nodules in the liver and multiple palpable periaortic nodes were found. Final diagnosis of the specimen (SP 65-2813) was malignant hemangiopericytoma.

He received a minimal tumor dose of 2000 r in fifteen days ending on September 16, 1965 with some relief of pain. The patient was to return in two to three weeks for further external radiation to the abdomen. Prior to treatment his hemogram was normal except for slight anemia (Hct. 32%, Hemoglobin 10 gms.). No bone marrow was stored because of the previous treatment to the posterior iliac area. The patient received sham irradiation one day prior to treatment followed by nausea and vomiting.

On October 16, 1965, 150 rad midline absorbed tissue dose (238 r midline air dose) total body radiation was administered. Vomiting, anorexia and nausea were present for approximately six hours after treatment. He had no further discomfort and was discharged on October 19, 1965. He received 1500 r tumor dose Cobalt 60 therapy to his pelvis from November 3, 1965 (18 days post TBR) to November 9, 1965. By November 9, 1965 (25 days post

Continued: (059)

TBR) his WBC had dropped from 4500 on November 3, 1965 to 1800. The platelet count also dropped from 138,000 to 24,400. There were ecchymoses, petechiae, and perioral bleeding.

The WBC dropped to 200 on November 15, 1965 (30 days post TBR) and platelets to 3,460. RBC was 1.7, Hgb- 5.6 gms., and his Hct.-17%. He expired on November 17, 1965 (32 days post TBR).

Study No. 060

Patient. C. B.

Chart No. 47455

This patient was a 49 year old Negro female who had a mastectomy performed at St. Mary's Hospital, Cincinnati, Ohio (S-11465) on January 25, 1965 with the biopsy diagnosis of carcinoma of the breast. On an October 7, 1965 chest x-ray there was a left pleural effusion or infiltrate into the left lower lobe and nodular densities in the right chest. She was admitted to CGH on October 23, 1965 for a persistent cough and shortness of breath. Prior to treatment her hemogram was normal.

On November 6, 1965, 150 rad midline absorbed tissue dose (231 r midline air dose) total body radiation was administered to the patient. The patient experienced nausea, vomiting, and anorexia until early afternoon of the day of treatment. On November 25, 1965 she was very short of breath and coughing frequently. Her WBC had dropped to 3200 by 16 days post TBR from 5100. It stayed at that level until it dropped to 0800 on the date of her death. Her platelet count fell to a low level of 48,000 on the same date. She rapidly deteriorated and expired on December 6, 1965 (30 days post TBR).

Study No. 061

Patient. M. L.

Chart No. 441059

This patient was a 64 year old Negro female who was seen at Baroness Erlanger Hospital, Chattanooga, Tennessee in January, 1965 with hepatomegaly. At this time an exploratory laparotomy was performed with a biopsy of the liver. The pathology report (#2899) was adenocarcinoma metastatic to the liver.

She was admitted to CGH on August 9, 1965 for persistent pain on her right side. Diagnosis of adenocarcinoma metastatic to the liver was confirmed. A liver scan on August 13, 1965 revealed gross hepatomegaly with multiple areas of decreased activity consistent with neoplasm. Her hemogram was normal except for a slightly elevated WBC. On November 11, 1965 approximately 90 ml of bone marrow was aspirated and stored.

November 20, 1965 she received 50 rad midline absorbed tissue dose (76.4 r midline air dose) total body radiation. She experienced no symptoms following the treatment.

Her condition was unchanged twenty days after therapy. Her WBC was within normal range but she developed a slight anemia (Hb 9.8 gms.). She was transferred on January 15, 1966 to Drake Hospital and expired there March 13, 1966 (113 days post TBR).

Study No. 062

Patient. C. D.

Chart No. 429905

This patient was a 60 year old Negro male who had noticed epigastric pain and weight loss since December, 1963. A diagnosis of adenocarcinoma of the colon (SP 64-2518) with extension to the small bowel and wall of the stomach with metastasis to one of 18 lymph nodes was made in August, 1964, at the time of resection of the splenic flexure, stomach, third portion of the duodenum and first portion of the jejunum.

In May, 1965, he had increased weakness and fatigue. There was moderate tenderness over the liver, which was enlarged and somewhat irregular. Biluria was observed in his urine at this time but he was not overly jaundiced. Local therapy to the liver was initiated on June 10, 1965. He received a minimal tumor dose of 3000 r in 34 days. Decreased tenderness was noted. In August, 1965, pedal edema and a node in the left supraclavicular area were present.

His hemogram was normal prior to therapy. No bone marrow was stored. The patient received 150 rad midline absorbed tissue dose (231 r midline air dose) on December 6, 1965. He experienced no discomfort during or following the treatment. The WBC dropped to a low of 1700 and platelets to 20,000 on January 6, 1966 (31 days post TBR). By forty-four days post TBR both had returned to normal. He continues to do well (176 days post TBR).

Study No. 063

Patient. J. Y.

Chart No. 212177

This patient was a 38 year old Caucasian male who was in good health until two years prior to admission on December 31, 1965. He noted the gradual onset of malaise, anorexia, weakness and weight loss. Two months prior to admission he developed intermittent episodes of cramping abdominal pains accompanied by anorexia, vomiting, diarrhea and melena. Two days before admission he became obstipated and developed pneumaturia and fecaluria.

His family history was remarkable in that his father died at age 37 with "locked bowels and cancer" and his sister had multiple polyposis and an extensive carcinoma of the rectum.

Sigmoidoscopy revealed multiple polyps, but the biopsy specimen was negative. Hypaque enema showed an obstruction in the recto-sigmoid colon. On January 1, 1966 a completely diverting right transverse colostomy was performed. A cystostomy was performed on January 8, 1966. Biopsy of small bowel and para-aortic lymph node revealed adenocarcinoma at the time of laparotomy and small bowel resection February 3, 1966.

Prior to therapy his WBC was elevated (average 15,000) and slight anemia was present. On February 22, 1966 a total of 140 ml of bone marrow was aspirated and stored.

On February 25, 1966, 300 rad midline absorbed tissue dose (436 r midline air dose) was administered to the lower body. Following therapy he had nausea, anorexia and vomiting. Vomiting subsided within 48 hours but nausea and anorexia persisted for 72 hours.

Continued: (063)

Two sham treatments were given ten and twelve days post PBR, but no symptoms were observed. There has been no change in his physical condition or hemoglobin, WBC, platelets. He continues to do well (97 days post PBR).

Study No. 064

Patient. R. H.

Chart No. 445221

This patient was a 54 year old Negro female who first came to CGH on December 27, 1965 with two days of vomiting, diffuse abdominal cramping and constipation.

On January 18, 1966, a double barrel colostomy and liver biopsy were performed. A large mass was felt in the left lower quadrant extending well past the midline. Biopsy report showed no diagnostic abnormalities of the liver, although it was felt at the time of surgery that liver disease was present. An exploratory laparotomy and biopsy of the tumor was performed on February 12, 1966. At that time the diagnosis of adenocarcinoma of the sigmoid colon was established (SP 66-471). A large mass was felt in the descending colon at the beginning of the sigmoid reflection. Tumor had invaded the peritoneum on both sides of the main mass and appeared to be 5 cm in length. Peri-aortic nodes extending up to and along the iliac artery to the aorta were also present, and there appeared to be tumor involvement within the mesentery.

Her blood count was normal except for a slight anemia (Hb. 10.0 gms). A total of 200 ml. of bone marrow was aspirated and stored before therapy.

She received 300 rad midline absorbed tissue dose (444 r midline air dose) partial body radiation to the lower body on April 2, 1966. Immediately following therapy she was nauseated and vomited. After that single occurrence she had no further symptoms. She has been lost to follow-up (60 days post PBR).

Study No. 065

Patient. L. A.

Chart No. 193718

This patient was an 84 year old Negro female who was admitted to CGH on June 4, 1965 because of icterus, decreased appetite, malaise, and weight loss of 22.7 Kg. in the 8 months prior to admission. Biopsy of the pancreas (SP 65-2177) taken at the time of choledochoduodenostomy and gastrectomy on June 29, 1965 revealed scirrhous adenocarcinoma. Upon examination February 8, 1966 a small mass was noted in the right upper quadrant. An upper G.I. series in April, 1966 showed compression of the duodenal loop.

The patient had received no previous therapy. On April 15, 1966 approximately 200 ml. bone marrow was stored without difficulty.

April 16, 1966, 200 rad midline absorbed tissue dose (310 r midline air dose) partial body radiation was administered to the lower body. Nausea persisted for two days but anorexia continued as before.

On May 18, 1966 she was placed on a diuretic because of ascites and peripheral edema. She underwent diuresis and continued to do well (48 days post PBR).

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This report summarizes the data accumulated from fifty patients who have been given total or partial body irradiation at the University of Cincinnati Medical Center from February 1960 through April 1966. Psychological, hematological, metabolic, immunological and chromosomal findings are statistically analyzed and some implications concerning reduction in combat effectiveness of military personnel exposed to ionizing radiation are drawn.

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