tremity fat, as shown in Table 1. Correlations with weight were also higher than those for the central fat sites.

Three fat sites emerged as exhibiting (i) the greatest degree of communality and (ii) the highest correlations with weight. These were the iliac spine (I_2), mid-trochanteric (Tr_2), and lower thoracic (Lt). The predictive rankings for all 12 sites are shown in Fig. 1.

While fat over the pelvis here appears to be the best single predictor of fat in general, as is also true of the older adult male (*4*), the lower thoracic site may prove to be of considerable practical use.

Table 1. Mean intercorrelations for each fat site, and correlations with weight.

Fat site	Correlations	
	Mean*	Weight
1. Lateral arm (La)	0.65	0.47
2. Medial arm (Ma)	0.55	0.36
3. Deltoid insertion (Di)	0.63	0.51
4. Lower thoracic (Lt)	0.68	0.50
5. Iliac crest (I_1)	0.66	0.50
6. Iliac-spine (I_2)	0.73	0.62
7. Trochanteric (Tr_1)	0.67	0.44
8. Mid-trochanteric (Tr_2)	0.72	0.58
9. Lateral leg (Ll)	0.57	0.38
10. Medial leg (Ml)	0.61	0.48
11. Anterior leg (Al)	0.53	0.47
12. Posterior leg (Pl)	0.53	0.35

* Mean of 11 correlations involving each site obtained from the mean Z-transform of r (*4*).

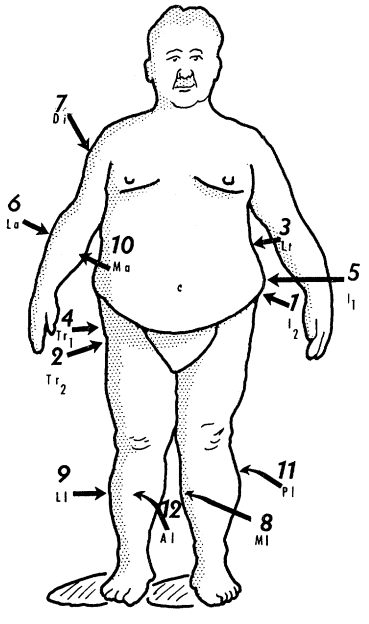

Fig. 1. Predictive efficiency of the 12 fat sites investigated in this study ranked in decreasing order of effectiveness. The lower thoracic site (Lt) can be measured on a routine chest x-ray plate.

The fat-plus-skin thickness at the mid-axillary line, at the level of the lowest rib, can be measured on full-size or miniature chest plates, thus extending the value of mass radiography to the assessment of obesity (*5*).

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References and Notes

1. S. M. Garn, *Science* 124, 178 (1956); S. M. Garn and E. L. Gorman, *Human Biol.* 28, 407 (1956).
2. This research was supported in part by the U.S. Air Force Office of Scientific Research, Air Research and Development Command, under contract No. AF 18 (600) 1566.
3. S. M. Garn, *Human Biol.* 26, 59 (1954).
4. R. A. Fisher. *Statistical Methods for Research Workers* (Oliver and Boyd, London, 1948).
5. Further details of this study, including improved estimates of the total weight of fat corresponding to a given thickness of superficial fat, are included in Technical Report AFOSR TR-S7-7.

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Differential Diagnosis of Hematologic Diseases Aided by Mechanical Correlation of Data

In recent years the increasingly large volume of technical information available in many fields of scientific work has led to difficulties in the efficient classification, correlation, and transmission of data. The position has been taken, by some, that methods which have led to efficient utilization of data in the past may no longer be adequate and should be supplemented by additional techniques (*1*). This concern has been voiced with regard to medical research and practice as well as to other fields (*2*). The present study was undertaken to evaluate the efficiency with which mechanical classification and correlation of data might assist in the utilization of data in the differential diagnosis of hematologic diseases.

Clinical and laboratory data characteristic of hematologic diseases were coded for application to marginal punched cards (*3*). The data included information from the case history, from physical examination, and from peripheral blood, bone marrow, and other laboratory examinations. They were chosen from a standard textbook of hematology (*4*). The data were classified on the punched cards by assigning them to 138 spaces, a single space representing the same information on all cards. For each of 27 hematologic diseases, a single master card was prepared, and the data characteristic of each disease were inserted on its card by wedge punching in the appropriate spaces. In addition, the most definitive diagnostic criteria of each disease were noted on the corresponding master card.

The records of 80 hematologic cases were then drawn from the files of a well-known university hospital. In each case the diagnosis had been established on widely accepted laboratory and clinical criteria and, in most cases, reflected the judgment of experienced hematologists. Each case was examined separately. With multiple insertions of data, the findings of a hospital case were correlated simultaneously with the data of the 27 diseases. Master cards containing data identical with the hospital case were separated from those not containing such data.

On the basis of the correlation procedure, the cases were grouped in three categories. The largest group consisted of 50 cases. The data of each of these cases were identical with data contained on one master card. The disease represented by the master card in each instance was identical with the diagnosis listed on the hospital record. In addition, it was noted that the code numbers of positive findings in the hospital case were identical with the code numbers of the definitive items needed to establish the diagnosis of the disease.

The second group consisted of 23 cases. The data of each of these cases were identical with data contained on several master cards and were therefore identical with the data of several diseases. By referring to the code numbers listed on each master card for the most definitive diagnostic criteria of the disease, it was possible to note that certain additional items of information from the hospital case were needed to establish the diagnosis of any of the diseases. When these items of information were obtained and entered in the correlation procedure, the data of each of the 23 cases were noted to be identical with the data contained on only one master card. Here, too, the disease represented by the card was, in each instance, the correct diagnosis for the corresponding hospital case.

The third group consisted of seven cases. The data of each of these cases were not identical with the data contained on any card. In each of these cases, more than one hematologic abnormality was present. These cases were examined, an additional procedure being used. A numerical value was assigned to each item of information previously coded in each of the 27 diseases. If the presence of an item of data contributed to the establishment of a diagnosis, the item was given a positive value in that disease. If its presence was not compatible with the diagnosis, it was given a negative value. If its presence would in no way affect the diagnosis, it was given the value of zero. Thus, each item might have a different weight in each disease. A hospital case was studied in

terms of each of the 27 diseases. In each instance the weighted average—that is, the ratio of the weight of the hospital data to the sum of weights of all data of the disease—was determined. The actual diseases present scored highest in terms of weighted averages, and the correct diagnoses could be confirmed by referral to the definitive diagnostic criteria. In addition, it was possible to identify diseases which closely resembled the diseases in the hospital case and to note similarities and differences. In one instance the set of diagnoses in the hospital record was incomplete, but mechanical correlation of data by the afore-described procedure resulted in presentation of a complete set of correct hematologic diagnoses.

Study of the methods of correlation of data described in this report revealed that these operations can be performed by electronic computing procedures available at the present time (*5*). Tabulation of the findings can also be made automatically. It is believed that further evaluation of the efficiency of these methods in correlating data of this type is indicated.

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References and Notes

1. I. Bowman, in *Report to the President on a Program for Postwar Scientific Research* (Government Printing Office, Washington, D.C., 1945).
2. V. Bush, *Med. Ann. Dist. Columbia* **22**, 11 (1953).
3. M. Lipkin and J. D. Hardy, *U.S. Naval Air Development Center* (*Report NADC-MA-5505,* Johnsville, Pa., 1955).
4. M. Wintrobe, *Clinical Hematology* (Lea and Febiger, Philadelphia, 1951).
5. V. K. Zworykin, personal communication.

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Radon Solubility in Rat Tissues

An estimation of the tissue radiation dose that arises from the inhalation of air containing radon can be made if, among other factors, the solubility of radon in various tissues is known. In the absence of such information, it has been customary to base estimates of the quantity of radon dissolved in the body on the following assumptions: (i) that radon solubility per gram of aqueous tissue is approximately equal to radon solubility per gram of water or physiological saline at body temperature; (ii) that radon solubility in the fatty tissues is comparable to the solubility of radon in some reference fatty substance such as olive oil.

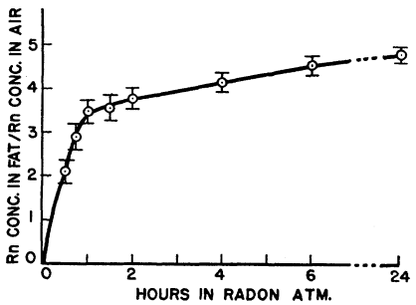

Fig. 1. Radon uptake by fat as a function of time of exposure. The vertical lines represent 95-percent confidence limits.

The values reported for the mean solubility of the entire soft tissue mass in man, based on such assumptions, range from 0.27 to 3.3 times that of the radon concentration in the inspired air (*1*).

The experiment reported here was undertaken to determine the solubility of radon in selected tissues of the rat and to study the rate at which radon is taken up by the fatty tissues that constitute the body's major reservoir of radon.

Adult Rochester Wistar rats were placed in a 14-lit Lucite inhalation chamber having separate cubicles for six rats. Expired carbon dioxide was absorbed on soda lime, and oxygen was continually supplied to maintain its initial concentration in the chamber air. A 30-minute trial period, to insure that the apparatus functioned properly, preceded the addition of radon to the chamber atmosphere. Except for radioactive decay and losses owing to inhalation, the radon concentration remained constant throughout a given experiment at levels ranging from about 0.5 to 5 μc/lit of air, as was determined from air samples withdrawn periodically from the chamber.

Exposure periods in the inhalation chamber ranged from 30 minutes to 48 hours, after which the rats were killed by the introduction of 1 lit of carbon monoxide into the chamber. Death occurred within 2 to 3 minutes. Rats were removed from the chamber, and specified tissues were dissected. Tissue samples (0.8 to 1.5 g) were rapidly placed in tared test tubes (50 by 12 mm) (control experiments in which tissue transfer was intentionally delayed indicated that the radon loss in the routine tissue transfer was equal to or less than 5 percent.) Close-fitting glass plungers were inserted into the test tubes until they came in contact with the tissue and were sealed to the test-tube walls with wax.

The relative gamma activity of the air and tissue samples was determined by counting in a well-type sodium iodide scintillation counter after allowing 4 hours for the build-up of radium C. Later recounts of the same samples showed no radon loss except that resulting from decay.

The distribution coefficient (radon concentration per milliliter of tissue/radon concentration per milliliter of air) at equilibrium was found to have the following mean values and standard errors: omental fat, 4.83 ± 0.07; venous blood, 0.405 ± 0.016; brain, 0.309 ± 0.008; liver, 0.306 ± 0.004; kidney, 0.285 ± 0.012; heart, 0.221 ± 0.013; testis, 0.184 ± 0.007; muscle, 0.154 ± 0.005. Experimental results indicate that the maximum, or equilibrium, value of radon concentration is attained much more slowly in fatty tissue than in any other tissue investigated. Tissues other than fat were essentially in equilibrium after 1 hour, and no consistent increase in radon concentration could be detected in any one of the other types of tissue by continuing the exposures for more than 1 hour.

The distribution coefficient shown for omental fat was determined by exposing rats to the radon atmosphere for 24 to 48 hours. The rate of build-up of the radon concentration in the fatty tissue can be observed in Fig. 1, which shows the increase of the distribution coefficient for omental fat with increasing periods of exposure. A half-equilibrium value is attained in about 30 minutes, and after 6 hours the value is at 95 percent of equilibrium. The curve presents data obtained from 90 rats, and the 95-percent confidence intervals are indicated for each value.

The information in Fig. 1 can be further evaluated by plotting it on semilogarithmic paper as follows: the value of the distribution coefficient at any time t is subtracted from the equilibrium value of the distribution coefficient, and this difference is plotted as a linear function of exposure time. If the curve shown in Fig. 1 represented a single exponential function, then the semilogarithmic plot would yield a straight line. On the contrary, the plot shows a sharp break in the semilogarithmic curve at an exposure period of about 1 hour. Such a plot appears to represent a process having two components with different time constants. The half-time for the fast component is 21 minutes; that for the slow component is 138 minutes. Such bimodality in gas uptake by adipose tissue has been suggested by H. B. Jones (*2*) on the basis of nonuniformity of blood perfusion within a tissue. Very few studies have been conducted on the uptake and loss of inert gases in single tissues.

By applying to man the values for the solubility of radon in various tissues of the rat, Black (*3*) has calculated that the mean solubility of the entire soft tissue mass in man is 0.89 as compared with earlier estimates ranging from 0.27 to 3.3 (*4*).

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