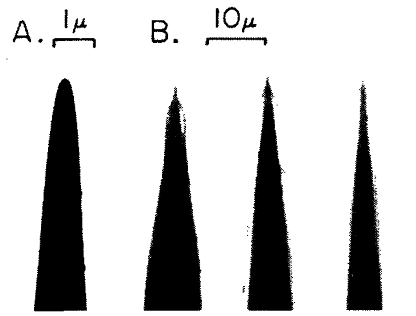

Fig. 1. (*A*) Electromicrograph of an uncoated, sharpened tungsten wire; (*B*) optical photomicrographs of coated electrodes immersed in water to show the coating.

emerges and lacquer runs up from the tip, the tip is quickly redipped up to the bead so formed, and this is repeated until the lacquer no longer runs up. The receptacle must be full and preferably small, and it must be used in a region where air is circulating to prevent thinner vapor from condensing on the tip and washing off the coating. The electrode is allowed to dry for 24 hours; it need not be baked.

Coarse testing is carried out by watching bubbling under the microscope when direct current is passed through the electrode in 0.9-percent NaCl solution using 6 to 12 v (electrode negative). This may be done for the shaft (at 10 diameters) and for the very tip (at 100 to 850 diameters). For electrodes to be used for intracellular work, the resistance may be measured as the electrode is immersed slowly in saline. Any abrupt changes after contact indicate flaws in the coating which may have failed detection in previous tests.

Fig. 1*B* shows several coated electrodes that were photographed under water with an optical microscope to show the coating, which is not otherwise visible and which usually extends well beyond where it can be seen by this method, as proved by the bubble tests.

Resistance measurements have been made using a Wheatstone bridge with rectangular pulses or short bursts of sine waves for a signal and a cathode-follower input stage as a detector (*4*). For small currents (of the order of 10^{-7} amp or less), resistance is fairly independent of direction and magnitude of current, and it varies widely from electrode to electrode, averaging perhaps 75 Mohm but ranging from 25 to 200 Mohm at low frequencies (100 cy/sec). At high frequencies (5 to 10 kcy/sec), the impedance drops to about 0.5 to 5 Mohm even when only the very tip is immersed. Measurements made while recording single-unit action potentials by shunting the electrode to ground with a variable resistance and calculating resistance from the drop in spike voltage have varied from 2.5 to 10 Mohm.

Direct-current stability of the electrode seems adequate to coarse measurements, as shown by the absence of any obvious instability over periods of 5 minutes, using 100-mv pulses with an inkwriter and direct-coupled amplifier with over-all sensitivity of 40 mv/cm. As might be expected, the electrode must be connected to a high-impedance input if the low frequency response is not to be severely limited, which means that a grid-leak resistor must not be used in the input stage. No evidence for polarization is seen if input current is kept low. It should be noted that excessive grid current may give rise to considerable noise.

Single-unit records from the nervous system have been obtained to date in cats from posterior root fibers, spinal cord, brain stem (reticular substance, dorsal cochlear nucleus, and superior olive), cerebral cortex, and olfactory bulb (Fig. 2). Spikes presumably recorded from outside the cell, averaging 5mv (0.5 to 10 mv), resemble in form those described by Rose and Mountcastle for the indium micropipette (*5*). Such spikes have also been obtained from cat's cerebral cortex after inserting the electrode through the unincised dura mater. Other spikes, presumably intracellularly recorded, may reach 40 mv with conventional cathode-follower input, and 70 to 80 mv when negative capacitive feedback is adjusted short of ringing. Such spikes have been observed for up to ½ hour with no loss of amplitude.

Finally, in fulfillment of the original objective, the electrode has been used for recording single units for periods of the order of 1 hour from cerebral cortex in chronic waking cats restrained only by a chest harness (*6*).

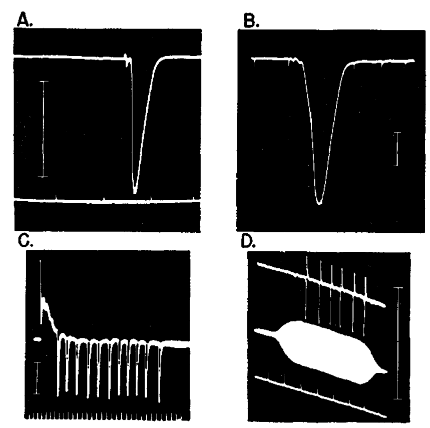

Fig. 2. Single-unit action potentials recorded from cat. (*A*) S_1 dorsal root, stimulation of same root. (*B*) Anterior horn cell, spinal cord, S_1. Stimulation of ventral root. (*C*) "Renshaw cell," spinal cord, S_1. Stimulation of ventral root. (*D*) Response in dorsal cochlear nucleus to a 4000-cy/sec tone. For all tracings, the amplitude is 5 mv, time is in milliseconds; positive deflections are downward.

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References and Notes

1. H. Grundfest *et al.*, *Rev. Sci. Instr.* 21, 360 (1950).
2. I wish to thank C. Henson for his technical assistance and Irvin Levin, Instrumentation Division, Walter Reed Army Institute of Research, for suggesting the electrolytic process as applied to tungsten.
3. For example, Insl-x, E-33, clear, made by Insl-x Co., Inc., Ossining, N.Y.; or clear vinyl lacquer, S-986s, made by Stoner-Mudge, Inc., Pittsburgh, Pa.
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6. A description of this technique is in preparation.

28 November 1956

Selection of Body Sites for Fat Measurement

With increasing interest in the problem of obesity, workers are turning from such indirect measures as overweight, relative weight, and percentage-of-standard weight to direct measurement of body fat. However, when the superficial fat layers are measured by pinch calipers or by means of roentgenograms (*1*), the problem arises as to which of many possible sites to employ.

In order to investigate the standardized soft tissue, teleroentgenograms were taken on 100 American-born white males aged 21.0 to 22.9 years (*2*). With suitable shielding, gonadal radiation was limited to approximately 0.02 r. In all, six regions of the body were x-rayed (forearm, deltoid, thoracic, iliac, trochanteric, and lower leg). From the series of six regions contained on a single 7- by 17-in. film, fat measurements were made at 12 sites. These included the medial and lateral arm, the "pocket" formed by the triceps and deltoid muscles, the lower thoracic site, the iliac crest and spine, the upper and middle trochanteric sites, and the four quadrants of the lower leg (*1, 3*).

The group studied had a mean stature of 180 cm and a mean weight of 72 kg: it was reasonably representative of young adult American males. All fat thicknesses were positively intercorrelated, with values of *r* ranging from 0.32 to 0.96. In general, deltoid, thoracic, iliac, and trochanteric fat (areas of "central" fat) showed considerably higher group intercorrelations than "peripheral" or extremity 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*).

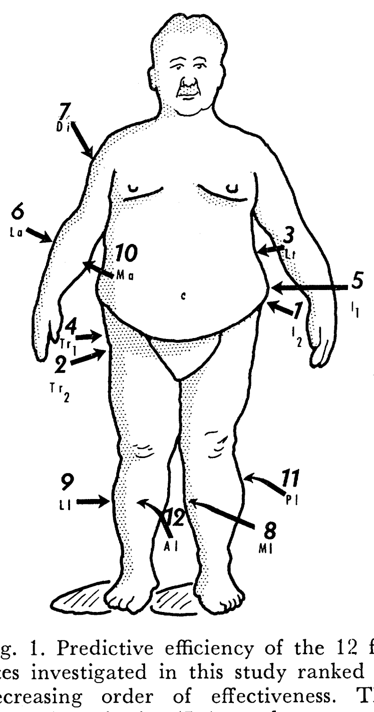

Fig. 1. Predictive efficiency of the 12 fat sites investigated in this study ranked in decreasing order of effectiveness. The lower thoracic site (Lt) can be measured on a routine chest x-ray plate.

The fat-plus-skin thickness at the midaxillary 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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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.

24 October 1956

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