UNITED STATES ATOMIC ENERGY COMMISSION

CHANGES IN MEAN BLOOD LEVELS OF METALLURGICAL LABORATORY EMPLOYEES
DURING THE FIRST YEAR OF EMPLOYMENT, AS RELATED TO WORKING
CONDITIONS

by

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Hugh Kinsler
Authorizing Official
Date: 5/28/09

Date of Manuscript: June, 1946
Date Declassified: June 3, 1948

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ABSTRACT

Mean levels of several blood elements were investigated for a control group and for groups exposed to radiation and uranium toxicity hazards in the Metallurgical Laboratory at six months and one year after employment. No significant decrease in mean level was found for any blood element. Lymphocytes of the groups exposed to radiation hazards and those of the metal-working groups increased significantly after employment. The increase of lymphocyte count in hazard groups in excess of a slight increase in the control group is on the borderline of significance ($p = 0.05$). Thus it is possible that working in the presence of radiation or metal hazards somehow bring about slight lymphocytosis. Individual daily monitoring indicates that the average measured exposure is less than 0.1 r per day for all individuals in these groups.

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1. Introduction

Routine blood counts on persons working for the Metallurgical Laboratory constitute the only body of data which can give any measure of the effectiveness of control of the penetrating radiation hazard. An analysis of the blood elements of three groups of white males, who had been classified according to the type and amount of radioactivity handled in the course of their work is presented in Tables 1 and 2. Group H-1 was composed of employees in those groups working with high levels of radioactivity. Daily monitoring of these workers indicates that the average level of exposure was considerably less than 0.1 r/day in all groups, so that we may only say that for members of this group there existed a possibility of exposure to radiations. Group H-4 was composed of members of groups which were handling uranium metal, etc. Group H-7 consisted of administrative personnel who did not work in the vicinity of ionizing radiations, and for our purposes were considered to be a control group. This classification of groups according to the nature of hazard was made by the Health Physics Group of the Medical Division.

The data were collected from mid-1943 through 1945. The blood characteristics considered are the lymphocyte and neutrophil counts in cells per cu mm, the erythrocyte count in million cells per cu mm, and the hemoglobin concentration in grams per 100 cc. The counts which were used (in order to assemble groups which would be as large as possible) were the control count, taken soon after employment, and the counts taken closest to six and twelve months thereafter. Each individual was represented by one count at each counting interval. For the red cell count and hemoglobin

Table 1

Comparison Within Exposure Groups

A: Lymphocytes (cells/cu mm)

Group: Time of 2nd Count:	MW-H1				MW-H4				MW-H7			
	6 mo.		12 mo.		6 mo.		12 mo.		6 mo.		12 mo.	
	N	M	N	M	N	M	N	M	N	M	N	M
Control Count	287	2363	140	2308	166	2437	65	2383	176	2560	79	2530
Subsequent Count	287	2577	140	2530	166	2587	65	2663	176	2594	79	2682
Difference	+214		+222		+150		+280		+34		+152	
Y: Control 2nd	0.40		0.42		0.50		0.61		0.29		0.35	
P of observed D if true D = 0	.001*		.001*		.007*		.002*		.660		.129	

B: Polymorphs (cells/cu mm)

Group: Time of 2nd Count:	MW-H1				MW-H4				MW-H7			
	6 mo.		12 mo.		6 mo.		12 mo.		6 mo.		12 mo.	
	N	M	N	M	N	M	N	M	N	M	N	M
Control Count	287	4058	141	3871	167	4506	64	4320	173	4764	77	4633
Subsequent Count	287	3980	141	3906	167	4370	64	4570	173	4611	77	4529
Difference	-78		35		-136		250		-153		-104	
Y: Control-2nd	0.37		0.36		0.53		0.45		0.49		0.39	
P of observed D if true D = 0	.327		.769		.222		.085		.219		.555	

C: Erythrocytes (10^6 cells/cu mm) and Hemoglobin Concentration (gm/ 10^2 cc)

Group: Measurement:	MW-H1				MW-H4				MW-H7			
	Red Cells		Hemoglobin		Red Cells		Hemoglobin		Red Cells		Hemoglobin	
	N	M	N	M	N	M	N	M	N	M	N	M
Control Count	179	4.951	234	15.120	115	4.745	152	14.795	156	4.708	164	14.830
Six-Month Count	179	4.920	234	15.095	115	4.802	152	14.640	156	4.753	164	14.865
Difference	-.031		-.025		.057		-.155		.046		.035	
Y: Control 6 mo	0.19		0.29		0.37		0.44		0.34		0.39	
P of observed D if true D = 0	.490		.826		.144		.139		.190		.764	

Table 2

Comparisons Between Exposure Group Means

		(cells/cu mm)			(cells/cu mm)			(10 ⁶ cells/cu mm)			(gm/10 ² cc)		
Measurement:		<u>Lymphocytes</u>			<u>Neutrophils</u>			<u>Red Cells</u>			<u>Hemoglobin</u>		
Groups Compared:		H1-H7	H4-H7	H1-H4	H1-H7	H4-H7	H1-H4	H1-H7	H4-H7	H1-H4	H1-H7	H4-H7	H1-H4
Comparison Interval													
6 mo.	D	180	116	64	75	17	58	-.077	.011	-.088	-.060	-.190	.130
	P	.050	.146	.418	.610	.920	.682	.177	.834	.142	.704	.208	.300
12 mo	D	70	128	-58	139	354	-215						
	P	.549	.342	.596	.509	.126	.238						

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concentration, not enough counts were available at the twelve-month interval, so this was omitted for these characteristics.

2. Analyses

Two kinds of analyses can be made of the data available. In Table 1, we compare the control count of each characteristic with the counts taken six and twelve months later, and thus determine the extent to which the counts vary with time. In Table 2, the changes found in Table 1 are compared between groups, so that we can assess the differences between hazard groups. Table 1 is divided into three parts: The lymphocyte counts are treated in A; the neutrophils, in B; and the red cell counts and hemoglobin concentrations, in C. Each of the parts is further subdivided by hazard group and time comparison interval. In Parts A and B there are thus two control means given for each group, since only those individuals for whom twelve-month counts were available were included in the "12 month" columns. It can be seen that these control means are in most cases almost identical. The fourth line of each part of the Table gives the correlation coefficient of the control count with subsequent count appropriate to the column in which it is entered. It can be seen that these correlations are remarkably constant for all comparisons made; they do not depend on time of measurement nor even on the blood characteristic sampled. The mean correlation coefficient is 0.41, and only 5 of the 18 are as far from the mean as 0.10. The relatively large size of the correlations means that an individual's count may be predicted as being high or low with better than chance success, even a year after the original count.

The third line in each of the parts of Table 1 gives the net change in the characteristic measured relative to the control mean; it is the control mean subtracted from the subsequent mean. The last line, labeled "P", gives the probability of finding a deviation as large as that recorded in line 3, if the sample had been taken from a single universe with a true deviation

of zero. A value of P smaller than 0.01 is taken to mean that the deviation difference in the population is significantly different from zero; for a value of P as small as this or smaller there are ten or less changes in 1000 that the true population deviation is zero. Significant values of P are marked with an asterisk. It can thus be seen from Table 1A that there are significant increases in mean level of lymphocyte count in both exposed groups, but not in the control group. None of the changes observed in the other blood characteristics are significant.

In Table 2, the changes in each interval for every group are compared with the changes in the same interval for each of the other groups. This is done for each of the four blood characteristics, and with each net change D is given the probability P , as defined in the preceding paragraph, of the difference being due to chance. For instance, the entry in the "D" line at six months line for the lymph count mean of Group H-1 compared with that of Group H-7 is 180; this is the net change in the lymph mean of Group H-1 in the first six months after the control count, 214, minus the change in the mean of Group H-7 in the same period, 34. It will be observed that the P -value for this difference is only .05, which is on the borderline of significance. Hence, while the mean of the lymph counts for the hazard Group H-1 after six months' employment is significantly higher than that taken soon after employment, it is barely likely that this increase is related to the presence of hazard, for the control group moved in the same direction to some extent. All the other significant deviations seen in Table 1A drop below the level of significance when compared with deviations found in other hazard groups.

It should be pointed out that the differences were in all likelihood not due to seasonal variation in the counts, since the distribution in time of the counts was the same as that of hiring, and there is no marked seasonal weighting in the latter factor.