Blood Examinations in Industry: A Comparison of Blood Cell Counts from Ear Lobe and Thumb Pulp

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Blood examinations are often included in the routine medical supervision of workers exposed to hazards such as lead, benzol, and the ionizing radiations. It is obviously desirable that the method of securing the sample should cause as little inconvenience as possible. Two sites are commonly used, the ear lobe and the thumb or finger pulp; the latter has disadvantages because it involves puncture of a highly sensitive area through hard and thick skin. Furthermore, the hands are likely to need prolonged cleansing, especially among those in contact with radioactive material (Gregory, 1953). Many of the standards now accepted in industry have been based on the examination of blood obtained from the thumb or finger pulp, and before suggesting to industrial medical officers that it is both quicker and more convenient to take blood samples in industry from the ear lobe, it was thought wise to see whether values from the two sites differed. Previous work such as that of Humpherdinck (1938) and Sørensen (1941) compared repeated samples from each site under experimental conditions; the present work aimed specifically at comparing samples from the thumb pulp with that from the ear lobe when taken during routine working conditions.

Method

Every sixth person reporting for a routine blood count to the Medical Department of a United Kingdom Atomic Energy Authority's works was seen by one of two senior and experienced technicians. Samples of blood were taken from the ear lobe and thumb pulp. The first drop of blood was discarded. New B.S.S. pipettes were used and each was numbered for identification; the equipment was carefully inspected daily for damage. Each technician carried through all the processes of counting for all samples he had collected. In order to eliminate any differential effect of diurnal variation found by Shaw (1927) and Chamberlain and Turner (1952) blood was taken only between 9.45 and 11.45 a.m.

One pipette of blood was used for the red cell count and one for haemoglobin estimation, for which the M.R.C. Grey wedge photometer was used. For the white cell count two pipettes of blood were taken as suggested by Chamberlain and Turner (1952) whose method of counting was followed. For the differential count at least 200 cells were examined. Seventeen male patients were seen by one technician and 18 by the other.

Results

Total White Cell Count.—The difference between the total leucocyte count for the two sites for each patient was examined. The average difference of 50 per c.mm., tested by Fisher's t test, was not significantly different from zero and thus there was no evidence that the site made any difference to the total leucocyte count ($t = 0.34; d.f. = 34; 0.08 > P > 0.7$).

Chamberlain and Turner found that the coefficient of variation of white cell counts varied from 10% when the mean count was 4,000 to 8% when the mean was 10,000. It can be assumed that, once in 20 pairs of repeat readings from the same site, experimental error alone might cause a difference of twice this magnitude from the mean. Here, the counts from the two sites differed to such a degree in only two of the 35 cases, and so there was no evidence that the samples were of different blood.

Differential Count.—Similar tests were made for the differential counts and the average difference in readings from the two sites was not significantly different from zero for any of them.

<table>
<thead>
<tr>
<th>Cell Type</th>
<th>Mean Difference (per c.mm.)</th>
<th>t</th>
<th>d.f.</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutrophils</td>
<td>140</td>
<td>1.6</td>
<td>34</td>
<td>$P \sim 0.1$</td>
</tr>
<tr>
<td>Lymphocytes</td>
<td>94</td>
<td>1.2</td>
<td>34</td>
<td>$0.3 &gt; P &gt; 0.2$</td>
</tr>
<tr>
<td>Monocytes</td>
<td>11</td>
<td>0.55</td>
<td>34</td>
<td>$P \sim 0.6$</td>
</tr>
<tr>
<td>Eosinophils</td>
<td>12</td>
<td>0.74</td>
<td>34</td>
<td>$0.5 &gt; P &gt; 0.4$</td>
</tr>
<tr>
<td>Basophils</td>
<td>1</td>
<td>0.18</td>
<td>34</td>
<td>$0.9 &gt; P &gt; 0.8$</td>
</tr>
</tbody>
</table>

Here, Chamberlain and Turner found that the coefficient of variation of the absolute count (i.e., the product of two independent variables) ranged from 11.5% when the proportion of the individual white cell was a half of the total to 32% when the proportion was one-twentieth. The readings obtained from ear or thumb were again in accordance with this range.

Red Cell Count.—Berkson, Magath, and Hurn (1940) found the coefficient of variation of the R.B.C. count, using one pipette, one chamber, and counting 80 small squares, to be approximately 8% for a count of 5,000,000 R.B.C./c.mm. In the present study the magnitude of the readings from the two sites was consistent with this finding. When, however, the individual differences between the two sites are examined, the average difference of 157,600 per c.mm. is significant statistically from zero ($t = 2.6; d.f. = 33; 0.02 > P > 0.01$). Thus it appears that, although the counts for each patient from the two sites agree in magnitude within the limits of experimental error, there is a tendency for the ear counts to be slightly higher. In the 34* cases considered, the ear readings were higher in 26 and lower in eight cases, a bias which is unlikely to have arisen by chance ($x^2 = 9.5; P < 0.01$). Upon examination this difference was shown not to be due to any bias of technician or pipette.

* One of the 35 pairs of samples could not be used for red cell count or haemoglobin estimation.
Haemoglobin Estimation.—The average difference in the haemoglobin estimation (in g./100 ml.) for ears and thumbs was not significantly different from zero, hence there was no evidence that the site chosen made any real difference to the estimation (mean difference = 0·22; t = 1·2; d.f. = 33; P ≈ 0·2). The ear sample estimation was higher than that of the finger in 22 cases, equal in three, and lower in nine cases. Again, if it is assumed that there should be an equal chance of readings from one site being above or below those from the other site, the evidence is such that a bias is possible (χ² = 5·4; 0·05 > P > 0·01). This tendency would be consistent with the findings for the red blood cell counts.

Summary and Discussion
Samples of blood from two peripheral sites, the ear lobe and the thumb pulp, were taken in the course of routine examinations of workmen. They were compared in respect of total white cell count, differential count, R.B.C. count, and haemoglobin estimation. The total white cell and differential counts showed no statistically significant difference for the two sites. The red cell count showed that while the readings for the two sites, when considered for each case individually, did not differ more than was expected from experimental causes; the ear samples were consistently a little higher. The haemoglobin estimations showed a similar but insignificant tendency.

The difference, however, is so small that there appears to be no reason to forgo the practical advantages associated with using the ear lobe as a source of blood in industrial medical practice.

We are indebted to Professor R. E. Lane, who suggested this investigation, for his advice throughout. Our thanks are due to Mr. S. Taylor and Mr. K. W. Boyle who made the blood counts.

REFERENCES
Gregory, J. (1953). British Journal of Industrial Medicine, 10, 32.