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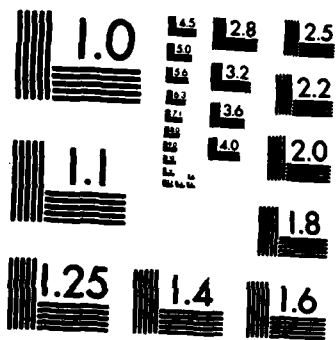
A COMPARISON OF TOTAL WHITE BLOOD CELL COUNTS ON THE
TECHNICON H6000 AND (U) NAVAL HEALTH RESEARCH CENTER
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A COMPARISON OF TOTAL WHITE BLOOD CELL COUNTS ON THE TECHNICON
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SUMMARY

White blood cell (WBC) counts obtained using a Technicon H6000 in a large occupational health program were compared with counts obtained on identical samples using a Coulter Counter Model ZBI. To assure quality control and to assess the comparability of results obtained on the two machines, a 25% systematic sample (N = 586) of analyses performed on the Technicon were independently and blindly performed on the Coulter Counter. The Pearson product-moment-correlation between WBC counts from the two machines was $r = .94$ ($p \leq .0001$). The mean WBC count was 6,664 cells/mm³ for the Technicon and 6,790 cells/mm³ for the Coulter Counter. The estimated prevalence of leukopenia (WBC counts $\leq 4,500$ cells/mm³) was 10.6% using the Technicon and 9.7% using the Coulter Counter. The results demonstrate that the two machines provide results which can be directly compared without corrections.



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A Technicon H6000 Automated Blood Cell Analyzer is currently being used for hematological monitoring in a large occupational health program at a predominantly civilian Naval facility. This large-scale monitoring program of total white blood cell (WBC) counts in an apparently healthy working population has as one of its objectives a comparison of the hematologic profile of the population under study with that of various reference groups. In particular, comparisons with the findings reported by the National Health and Nutrition Examination Survey (HANES)(11) of WBC counts in a random sample of the U.S. population were of interest, and a measure of correlation between the Technicon H6000 and Coulter Counter brand instrumentation used in the HANES was desired. The HANES performed WBC counts on a Coulter Counter Model Fn.

In order to assess the degree of comparability of results obtained on the Technicon H6000, a 25% sample of blood analyses were blindly repeated on a Coulter Counter Model ZBI, a machine very similar to the Coulter Counter Model Fn. This retesting procedure also served as an effective means of assuring quality control throughout the blood collection phase of the study.

Estimates of precision of WBC counts have been determined by repeated measurements on the same samples of blood for predecessors to the Technicon H6000 (2,8,9,13). Lappin, et al., reported a slight but statistically significantly lower mean WBC count on the Technicon SMA-4 (5,970 cells/mm³) when compared to a Coulter Counter Model A (6,140 cells/mm³), but agreement between these machines was reported as high ($r = 0.990$, $df = 98$, $p < .001$)(9).

The Technicon gives a differential white blood cell count, which is a far more complete picture of leukocyte population dynamics than a total WBC count. For our purpose, however, total WBC count was the measure of primary concern, as it can serve as an indicator of occupational exposures affecting bone marrow function (3,6,7,10).

This report assesses the degree of comparability of total WBC counts performed on the two machines.

Background of WBC Count Study

The Naval Health Research Center, San Diego, in collaboration with the Naval Regional Medical Center, Long Beach, and the Naval Weapons Center (NWC), China Lake, California, introduced a large-scale hematological monitoring project as a major component of the Occupational Health Program at the Naval Weapons Center. This project was begun in response to recommendations resulting from preliminary studies by the Center for Disease Control (CDC) of cases of leukopenia in employees of the NWC (15,16). The CDC studies were based on review of medical records of employees who received routine blood analyses as part of an existing occupational health program. From these data, however, it was not possible to estimate the prevalence of leukopenia for the entire Center workforce since most employees had not been tested. The CDC recommended the initiation of a Center-wide hematological monitoring program.

In response, a program was designed which would meet a number of objectives. These included the identification of individuals with leukopenia ($WBC \leq 4,500$ cells/mm³), the prevalence of leukopenia in the entire workforce, and an evaluation of the health importance of the observed prevalence. All procedures followed were in accord with procedures to protect human subjects prescribed by the Under Secretary of Navy Instructions.

Materials and Methods

A Technicon H6000 was installed at the Branch Medical Clinic at the Naval Weapons Center during November 1981. Comparison studies of the Technicon and Coulter Counter were carried out over an 11-month period from January 1, 1982, to November 30, 1982. Every blood sample drawn for occupational monitoring (N = 2,344) was tested on the Technicon H6000. A systematic sample consisting of every fourth blood sample drawn was also tested on the Coulter Counter (N = 586).

Data Collection

An occupational health nurse, two blood drawers, and a clerk visited work locations and drew blood samples in the field. Samples were collected using 20 gauge needles and vacutainers which contained 0.07 ml of EDTA anticoagulant. All samples were collected between 8:30 a.m. and 11:00 a.m., and with few exceptions were analyzed within 8 hours of being drawn.

The procedure for processing samples was as follows:

- (1) Every fourth blood sample drawn was noted and "flagged";
- (2) The "flagged" sample was split into two samples for analysis;
- (3) One sample was analyzed on the Technicon;
- (4) The other sample was analyzed on the Coulter Counter.
- (5) The results from each machine were entered by a different technician onto forms that had no information concerning the results obtained on the other machine.

Before each daily operation, quality control measures were performed for each instrument according to the manufacturer's recommendations (4,17). Checks on instrument function and electronic components and background counts were performed daily prior to routine operation. When counts on the Coulter Counter exceed 10,000 cell/mm³, the likelihood increases that two or more cells may pass through the aperture together as a single mass, and be counted as a single cell. The results from the Coulter Counter have been statistically corrected for this possibility using a standard algorithm(4).

Agreement between the two machines was assessed using a Pearson product-moment correlation(1). Difference in total mean WBC counts was tested for significance using a paired t-test (14). Correlation analyses and paired t-tests were performed with the Statistical Package for the Social Sciences (12). Confidence intervals on prevalence of leukopenia were calculated using the binomial distribution (5).

Results

A plot of the correlation between white blood cell counts as determined on the Technicon and the Coulter Counter is shown in the Figure. However, as shown in Table 1, the Technicon provided a mean white blood cell count which was 126 cells lower than that of the Coulter Counter. While this was a difference of minor clinical importance, it was statistically significant and affected the estimated prevalence of white blood cell counts which were below the level chosen as our definition of leukopenia ($\leq 4,500$ cells/mm³)(Table 2). The estimated prevalence of leukopenia was 10.6% using the Technicon, and 9.7% using the Coulter Counter, this difference was not significant.

Coefficients of variation were determined for the Technicon H6000 and Coulter Counter at high (10,000 - 11,000 cells/mm³) and low (3,500 - 4,500 cells/mm³) white blood cell counts. The coefficients for the Technicon were 1.8% for high white blood cell counts and 4.0% for low white blood cell counts; those for the Coulter Counter were 2.4% and 3.5%, respectively. Each coefficient was based on analysis of 25 duplicate samples. The results show that both devices produced results with reasonably high precision, making it unlikely that the observed low white blood cell counts were artifacts of instrument variability. Since the coefficients of variability were greater for low white blood cell counts than for high, however, the calculated confidence intervals shown in the table may be slightly narrower than appropriate for this isolated part of the distribution.

A measure of clinical importance is the proportion of counts on identical samples tested on the Technicon that fell within a specified range on the Coulter Counter. About 68% of the samples tested on the two machines fell within ± 500 cells (Table 3), but 2.5% of the samples were markedly different, i.e., outside of the $\pm 2,000$ cell range.

Discussion

The demand for a large number of WBC counts in a timely manner was met by the use of the Technicon H6000 automated blood cell analyzer. It was found that the Technicon provided WBC counts that are comparable to those reported by other large-scale research projects which used Coulter Counter brand instrumentation. These results provide reassurance that epidemiologic studies using the two models tested can be compared without introducing significant biases, and they provide a basis for acceptance of the Technicon H6000 as a useful tool in clinical pathology.

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Table 1

Comparison of Mean White Blood Cell Counts of
Identical Samples Tested on the Two Machines

<u>Machine</u>	<u>Mean white blood cell count (cells/mm³)</u>	<u>Standard deviation (cells/mm³)</u>
Coulter Counter	6,790	2,173
Technicon	6,664	2,101

t_{paired} = 4.09
df = 585
p < .0001

Table 2

Differences in Estimates of the Prevalence of Leukopenia
(White Blood Cell Counts $\leq 4,500$ Cells/mm³) Using
Identical Samples Tested on the Two Machines

<u>Machine</u>	<u>Estimated prevalence of leuko- penia (percent)</u>	<u>95% Confidence interval (percent)</u>
Coulter Counter	9.7	7.3 -- 12.1
Technicon	10.6	8.1 -- 13.1

Table 3

Differences in Total White Blood Cell Counts of
Identical Samples Tested on the Two Machines

Difference (No. of cells/mm ³)	No. of samples	Percent in this interval	Cumulative percent
+ 0 - 100	113	19.3	19.3
+ 101 - 200	80	13.6	32.9
+ 201 - 300	78	13.3	46.3
+ 301 - 400	67	11.4	57.6
+ 401 - 500	60	10.2	67.8
+ 501 - 1,000	127	21.7	89.5
+ 1,001 - 2,000	47	8.0	97.5
+ 2,001 +	14	2.4	100.0

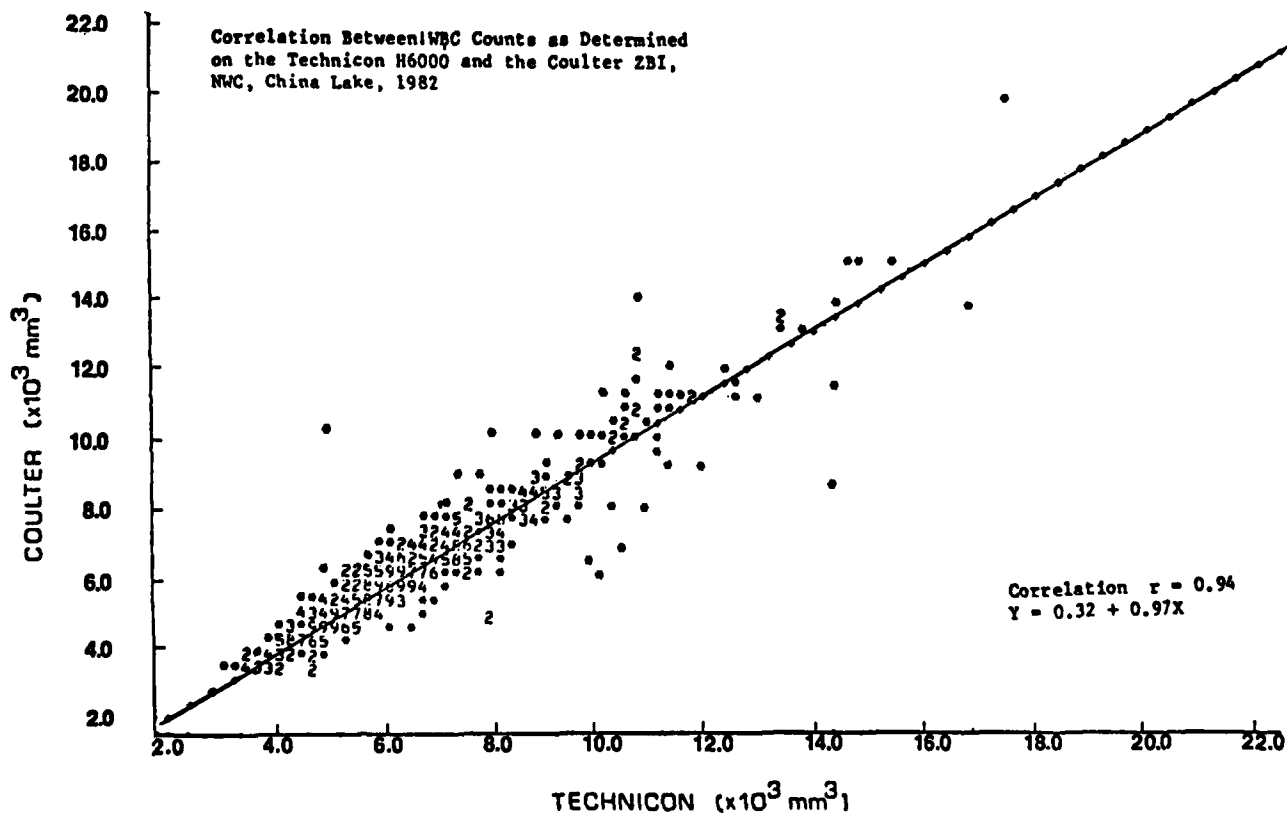


Figure Scatter diagram of 586 Coulter Counter and Technicon results showing the line of equality between the two methods.

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