Evaluation of the Honeywell ACS 1000 leucocyte differential counter

MARGARET CLOWES, C GILES, RM IBBOTSON, AND PH JOHNSON

From the Central Pathology Laboratory, North Staffordshire Health District, Hartshill Road, Stoke-on-Trent ST4 7PA, UK

SUMMARY The Honeywell ACS 1000 is a relatively inexpensive differential white cell counter, which is only partially automated. This instrument has been evaluated in a routine haematology laboratory.

The advent of automated blood cell counters during the past decade has generated a vast increase in the workload of haematology laboratories. Blood film screening with or without differential leucocyte counts now occupies a major part of the working day of the trained medical laboratory scientific officer (MLSO), and there are already several automated differential white cell counters on the market, one of them based on continuous-flow analysis, the remainder on computerised pattern recognition. All these instruments are extremely expensive, and very few laboratories can afford them. The Honeywell ACS 1000 is an attempt to reduce the capital cost by only partial automation and is intended for laboratories with an intermediate workload. The instrument is well established in the United States but has not so far been seen in this country.

An opportunity arose early in 1979 to evaluate the ACS 1000 after discussion with Messrs Honeywell Europe SA, Brussels, Belgium, and this paper presents an account of this evaluation, which was carried out in the Haematology Department of the North Staffordshire Hospital Centre, Stoke-on-Trent in March 1979.

Description of the instrument

The ACS 1000 is a computerised blood film scanner in which the location and focusing of white cells is automated, leaving the operator the task of identifying and recording individual cells. The instrument is compact in size, measuring 21 in high, 30 in wide, and 26 in deep (53 × 76 × 64 cm) with a weight of 300 lb (136 kg). It is readily accommodated on a normal laboratory bench.

At the centre of the instrument is a modified Bausch and Lomb Balplan microscope with a motorised stage which can be driven in the X- and Y-axes either manually or automatically. The microscope is provided with binocular eye pieces and three objectives. The microscopic image is split in the optical assembly between the TV monitor and the two pre-amplifiers which control the automatic cell finder and the automatic focusing device (Fig. 1).

The pre-amplifiers are fed into a computer, which controls the drive motors of the microscope stage. Manual control of the microscope stage is accomplished with a joy-stick device and manual focusing with a knurled wheel.

The vertical panel of the ACS 1000 covering the microscope carries a 5-inch colour television monitor which is parfocal with the microscope image, and above it a large display panel for showing the number of cells counted and the X- and Y-coordinates of the microscope stage. Also located on the panel are the printer, threshold control, light filter, and the selector switch for the number of leucocytes counted.

On the horizontal panel is the keyboard, the manual (joy-stick) control of the microscope stage, and the manual focusing wheel. The layout of the keyboard is shown in Fig. 2; cell identification keys are grouped on the left side, function, mode, and data input keys in the centre, and a numeric keyboard on the right.

OPERATION

A well-stained conventional (wedge) blood film is oiled and mounted in the microscope stage. Using the TV monitor or the binocular eye pieces, the operator manually focuses the blood film, selects a well-stained area, and ensures that the Y-coordinate as displayed on the electronic panel is within set
Fig. 1  Block diagram showing the general layout of the ACS 1000
Evaluation of the Honeywell ACS 1000 leucocyte differential counter

limits for automatic counting. The keys marked ‘automatic focus’ and ‘automatic cell find’ are depressed, and the first cell is presented for classification. The cell is classified by pressing the appropriate key, and the next cell appears. This method is relatively slow, and it is more usual to instruct the stage to move continuously stopping only momentarily on individual cells which are keyed in as the count progresses. The stage moves in a meandering path across the film; bands 72 μm wide are scanned, leaving ‘dead’ zones 26 μm wide between (Fig. 3). The speed of scanning is set on the numeric keyboard, No. 9 the slowest, No. 1 the fastest speed.

As the count progresses successive leucocytes appear on the TV screen and under the microscope, and the number of cells already classified is shown on the display panel. The count can be stopped and re-started at any time, and mis-classifications can be corrected. By noting the X- and Y-coordinates, a suspect cell can be readily located at a later stage.

The instrument stops automatically and emits an audible signal when the pre-set number of cells (100, 200, etc) has been counted. Red cell morphology and platelet estimates are then keyed in, a report form is entered into the printer, and a printed report is obtained. The layout of the printed form allows a Coulter S count to be printed on the same report. The ‘clear’ key is now depressed, the slide is removed from the microscope stage, and the next count can begin. Reticulocyte counts can be performed after pressing the appropriate key but using manual controls.

CALIBRATION
At the beginning of each working day the X- and Y-coordinates are calibrated using the special calibration slide provided. Colour calibration of the TV monitor is likewise advised each day.

EVALUATION
The evaluation was carried out in two stages: during the first five days the machine was operated by a Honeywell operator, who participated in the first two exercises and who instructed two members of the laboratory staff in the use of the instrument; during the remainder of the trial period several members of the staff were instructed in the use of the ACS 1000, and their performance and subjective reactions were noted.

Effect of sample size on correlation between counts performed manually and on the ACS 1000
Blood films from 25 individuals with normal blood counts were examined manually by one of us (MC) and on the ACS 1000 by the Honeywell operator. Each specimen was subjected to a 50, 100, 200, 300, and 500 cell count, and individual results obtained by the two methods were then compared and analysed. A random sample of 10 films was manually counted by one of the haematologists. In Fig. 4 the differences between 500 cell counts on the one hand and 50, 100, 200, and 300 cell counts on the other are plotted for neutrophils, lymphocytes, monocytes, and eosinophils in all the 25 blood counts. As expected, the scatter of results is greatest in 50 cell counts and diminishes as larger samples are counted. The distribution of the scatter is similar between manual and ACS 1000 counts. Using a two-sample t test, no significant difference (p > 0.05) was found between the two methods when 100 and 200 cell counts were analysed.

Comparison of manual and ACS 1000 counts using a sample of 100 routine blood films
Blood films from 100 patients, including both normal and abnormal specimens, were subjected to 100 cell differential white cell counts and assessment of red
results by the two methods, were also examined manually by a haematologist.

In 81 of the 100 specimens there was close agreement between the ACS 1000 and the conventional method; the remaining 19 yielded discrepant results, but in only four of these were the discrepancies sufficient to affect the overall interpretation of the results. The time taken by the manual operator was 4 hours 10 minutes compared to 4 hours 37 minutes by the Honeywell operator using the ACS 1000.

In blood samples with a total leucocyte count of less than 3 x 10^9/l the ACS 1000 was faster than the manual method, but in all other cases conventional counts were at least as fast as those on the instrument. It must, however, be admitted that the manual operator was a very experienced chief MLSO and also that the blood films were a random sample of the previous day’s work, and some of them, although adequate for manual counts, presented difficulties when viewed under the ACS 1000.

**Familiarisation**

Five members of the laboratory staff (4 MLSOs, 1 haematologist) were instructed in the use of the instrument; one used it for a whole week (MC), two others for one day each, and two for only 2- to 3-hour sessions.

The experience of all the participants was that the basic technical skill of operating the instrument was acquired very quickly (one hour or less). Familiarity with the keyboard took longer to acquire, and even MC, who used the instrument consistently for several days, could not count specimens as fast as

*The result of this exercise was not subjected to statistical analysis: this would have required a larger number of specimens for which time was not available.*

---

**Fig. 3** Scanning pattern of blood films by the automatic microscope stage.

**Fig. 4** Comparison between manual (○) and automated (●) differential counts showing the differences between 500 cell counts on the one hand and 50, 100, 200, and 300 cell counts on the other in 25 specimens.
Evaluation of the Honeywell ACS 1000 leucocyte differential counter

she could manually. The preliminary steps of inserting the slide, focusing, and adjusting the coordinates in preparation of the automatic counting took on average 40 seconds, eight times as long as it takes to insert and focus a film in a conventional microscope and twice as long as the time taken to insert a film into the Hematrak-240 for an automatic count.*

Quality of blood films
Although designed for films stained by Wright's stain, the instrument worked well with Leishman/Giemsa stained preparations, which are used in this laboratory. Thinner wedge films were required for the ACS 1000 than for manual counts, and scrupulous preparation of glass slides and blood films greatly facilitated automatic counting. The absence of a blood film 'spinner' precluded the use of spun films in this evaluation.

Correlation of manual and automatic counts by the same operator
Two batches of 20 random blood films were examined by the same operator in the ACS 1000 at speed No. 6 and re-examined manually under her own microscope. The correlation of results was very good but the time taken by the ACS 1000 was 6 and 4½ minutes longer respectively.

Fatigue
The same operator spent a whole day using the ACS 1000 for routine differential white cell counts, gradually increasing the speed of the machine from 8 (slow) to 6 or 5, depending on the quality of the film, and using the TV screen at its higher magnification (× 1000). Subjective fatigue appeared as quickly as with manual counts.

Reproducibility
Five replicate 100 cell counts were carried out on five different specimens first using the same X-Y coordinates, that is, the same area of the film, and then on different areas of the same blood film. The replicate counts, using the same area of film, were all identical, showing that the stage follows exactly the same path as before and presents the same cells for classification. Replicate counts on different areas of blood films showed only minor variations.

Use of ACS 1000 for scanning
By using the automatic mode at a fast speed (for example, No. 3 or 2) it is possible to scan blood or Buffy-coat films for individual cells. Megaloblasts were readily discovered in this way; LE cells were found to be more difficult. Search for abnormal white cells was easier by this method than by manual scanning, but the actual identification of cells required microscopic confirmation.

Reticulocyte counts
Using the recommended method, reticulocyte counting was more accurate but decidedly slower than conventional counts.

Teaching by ACS 1000
The use of the TV monitor for teaching purposes was found to be one of the most valuable functions of this instrument. With good colour calibration the screen gave excellent definition of normal and abnormal cells even at × 1000 magnification, which compared favourably with colour photographs in textbooks.

Conclusions
The ACS 1000 is a compact, relatively inexpensive instrument, which reduces the effort of scanning blood films, especially with low leucocyte counts.

The claim by the makers that differential leucocyte counts could be performed more rapidly by the machine than on manual examination was not borne out by our experience. A highly experienced chief MLSO was able to examine 100 routine blood films while a professional operator examined the same batch with the machine. Laboratory staff who had been recently introduced to the machine took appreciably longer to count specimens than was their wont.

Counting on a TV screen appeared to be no less fatiguing than the conventional method. Re-positioning of the screen on future models might lessen the fatigue element.

Apart from minor design faults the layout of the instrument is good. We found it difficult to clean the microscope objectives owing to lack of access; the use of the light filter when looking through the microscope and on inserting or removing slides was mandatory as the glare from the light source was considerable.

The quality of blood films used in the ACS 1000 must be consistently high, and mediocre films, which can be used for manual counting, are very troublesome and slow to scan in the machine.

The basic skill of operating the instrument is readily acquired; it takes longer to get used to the keyboard, and there is an irreducible delay at the beginning of each count taken up with insertion and
focusing of the film, the finding of a suitable starting point for the count, and the keying in of personal data.

Calibration time is short at the beginning of each day, and no special maintenance is required either at the beginning or at the end of a working session.

The instrument is eminently suitable for rapid scanning of blood films for, for example, megaloblasts. It is an excellent aid to teaching, and this may well commend it for use even in the larger laboratories.

We thank Mr P G Garforth and Mrs Mary-Joy Stead, of Honeywell, for teaching us to use the instrument and for participating in the exercise; Mr D F Whitford for the loan of the ACS 1000; the staff of the Haematology Department, especially Miss Rosemary Thompstone, FIMLS, and Mrs Susan Lane, AIMLS; and Mr W A Lawton for statistical analyses.

References


Requests for reprints to: Dr C Giles, Central Pathology Laboratory, North Staffordshire Health District, Hartshill Road, Stoke-on-Trent ST4 7PA, UK.