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Processing haematological data on a network environment

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Abstract

A system for computerising full blood picture reporting developed in-house using dBASE IV on IBM-compatible microcomputers in a local area network environment is described. The software package has a user-friendly interface which consists of a horizontal main menu bar with associated pull-down submenus. The package captures data directly from an automatic blood cell counter and provides options to modify or delete records, search for records, print interim, final or cumulative reports, record differential counts with an emulator, facilitate house-keeping activities which include backing-up databases and repairing corrupted indices. The implementation of this system has helped to improve the efficiency of reporting full blood picture in the haematology laboratory.

Key words: Database management, software, dBASE, Novell, local area network, haematology records, microcomputers.

INTRODUCTION

In our haematology laboratories, when a sample for full blood picture study arrives at the reception counter, the particulars of the patient in the accompanying request slip are recorded and the sample is given a registration number. The sample is then diverted to the blood counter section for analysis. Routine analysis includes making of a blood film and staining it with Wright's stain, and automatic analysis of the blood with a Coulter JR blood cell counter (Coulter Electronics, U.S.A.). After analysis, a triplicate printout is made by the counter. The first page of the printout is sent out to the consumer as an interim report after validation by the machine operator who is a qualified medical technologist. Meanwhile, the master card which contains previous reports of the patient is traced. If it is a first encounter, a new master card is created. Together with the stained blood film and the remaining printout, the master card is sent to the film report section. Here, the medical technologist would carry out a differential count and report on the blood film. These details are written direct on the printout. These findings are then checked by the duty haematologists. Additional information or correction is done direct on the printout. After final validation by the haematologist, page 2 of the printout is sent out as the final report, while page 3 of the printout is retained and pasted to the master card which is then filed away in a cabinet according to the national registration identity card number. If any enquiry is made of such sample, the same master card has to be traced again.

We have earlier, in 1990, computerised the histopathology reports.[1] We turned our attention to the haematology laboratories in 1992. There are various systems reported in the literature about using microcomputers to handle haematological data.[2,3,4] In this report, we describe our experience in computerising the above work procedures.

METHOD

Hardware and software

The Department, for service purposes, is served by a 386-microcomputer acting as file server (called PK) and running Novell Netware 3.11 (Novell Incorporated, U.S.A.). There are 30 microcomputers mainly XT models attached to this local area network using low cost arcnet card in each computer and coaxial cables in star distribution connected by active or passive hubs. The connection is illustrated in Fig. 1. This network was first organised and supervised by one of the authors (CSK) in 1990.

The Coulter JR with its data terminal is attached via its RS232 serial port to its equivalent in an independant XT microcomputer with a hard disk. This XT is connected to the PK file server via an active hub. Unidirectional transmission of data in ASCII form is done from the data terminal to the XT, 40 reports at a time.

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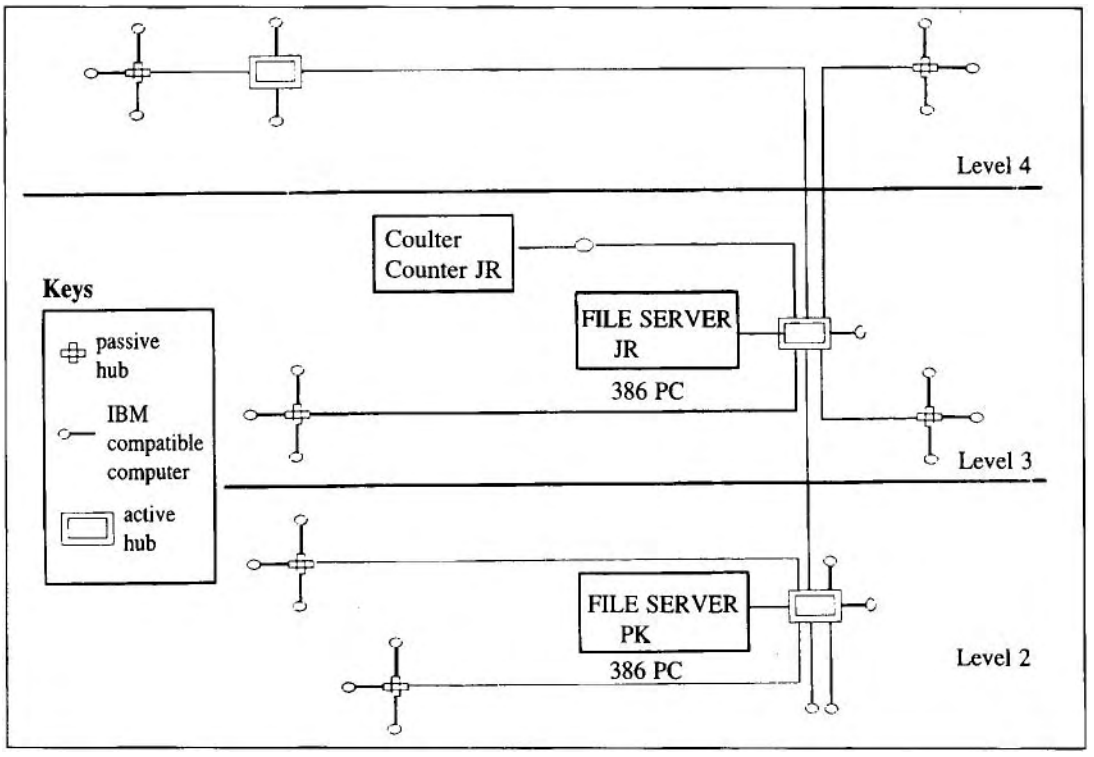

FIG. 1: The organisation of Local Area Network (LAN) of Microcomputers in the Department of Pathology, UKM.

A data capture program written in C language is used to capture these transmitted data, once the data stored in the data terminal are validated.

The program proper is an in-house program written by one of us (ZAG) using dBASE 4 version 1.1 (Borland International, U.S.A.). It is network enabled so that multiple users logged into the network can access the same database simultaneously.

Application development

The database was created and named JR.dbf. Each record comprised 48 items. These included Laboratory number (Labno), Patient's name (Nama), Identity card No (Nokp), Registration number (Nodaftar), Sex (Jantina), Ethnic group (Bangsa), Age (Umur), Clinic (Klinik), Date (Tarikh), Clinical diagnosis (Diagnosa), White blood cell count (Wbc), Red blood cell count (Rbc), Haemoglobin (Hgb), Hematocrit (Hct), Mean cell colume (Mcv), Mean cell haemoglobin concentration (Mchc), Red cell distribution width (Rdw), Platelet count (Plt), Mean platelet volume (Mpv), Neutrophils (Neu), Eosinophils (Eos), Lymphocytes (Lymphs), Monocytes (Mono), Basophils (Basos), Atypical Lymphocytes (Atyp_lymph), Immature granulocytes (Imm_gran), Blast cells (Blast), Other cells (Others), Absolute neutrophils (ANeu), Absolute eosinophils (AEos), Absolute lymphocytes (ALymphs), Absolute monocytes (AMono), Absolute basophils (ABaso), Absolute atypical lymphocytes (AAtyp_lymp), Absolute immature granulocytes (AImm_gran), Absolute blast cells (ABlast), Absolute other cells (AOthers), Platelet appearance (Plat_app), Red cell size (Rcsize), Red cell colour (Rccolour), Red cell shape (Rcshape), Nucleated red blood cell (Nrbc), Reticulocytes (Retic), Other cells (Othercell), Comments (Komenl, Komen2) and Pathologist's signature (Pathologist). Names in brackets were used as field names in the database.

When the program is activated, a banner will appear. The banner announces the laboratory using the program, the authors, and the version of the program. The horizontal menu bar on top of the banner allows user to select four functions, namely Record, Report, Utility and Quit (Fig. 2).

The Record function

When this function is selected, a pull-down submenu with five further selections appears, namely Add and Edit Record, Delete Record,

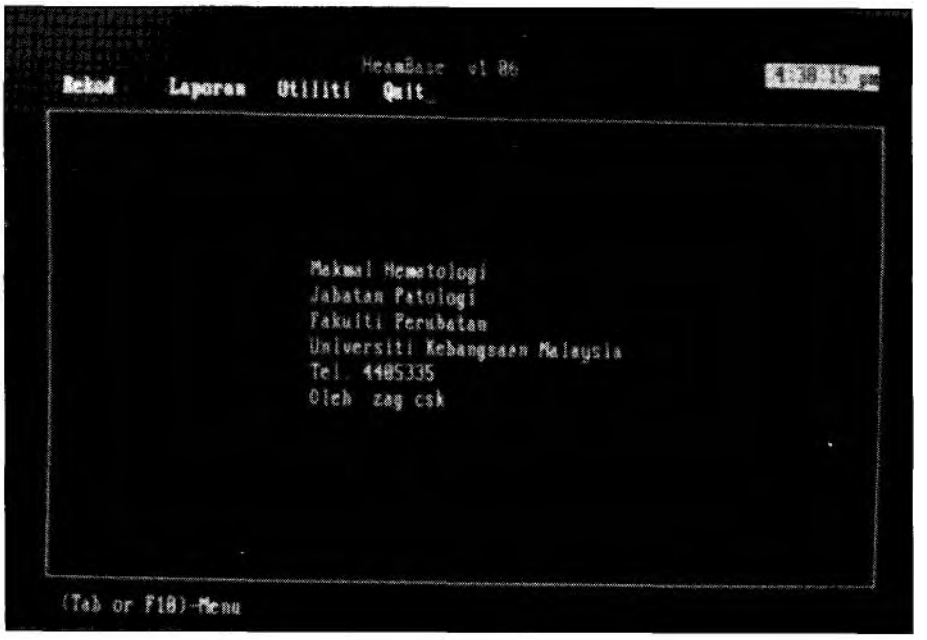

FIG. 2: The opening display of the software package. The horizontal menu bar is on top of the banner. Activation of an item in the menu bar produces further pull-down submenu.

Search Record, Browse and Import from JR. The Add and Edit Record allows adding of new records or modification of existing records (Fig. **3).** Checking mechanism is built-in to avoid record duplication. Search Record allows user to search an existing record through laboratory number, patient's name or patient's identity card number. Records located can be viewed as a cumulative report and printed. The Browse option allows the user to look at all the records in full but no modification is permitted.

Import from JR is an option that activates a program written in C to capture data direct from the data terminal of Coulter JR. The data are

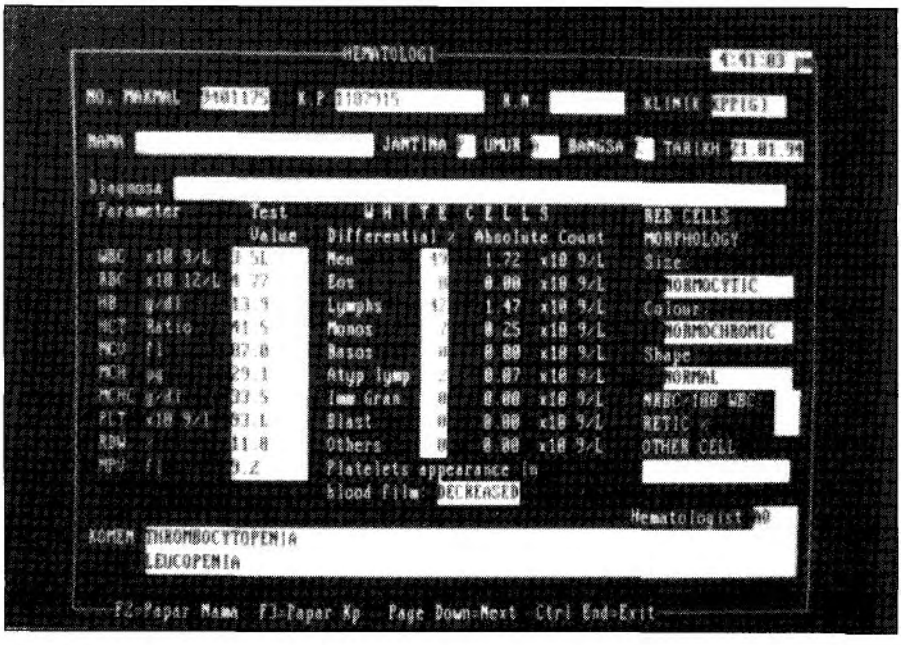

FIG. 3: The data form displaying patient's particulars and the full blood picture data.

then matched for the laboratory number assigned and imported into the database JR.dbf. Once the data have been incorporated into JR.dbf, they are now accessible by other authorised users of the network.

The Report function

This function consists of five options. The first option allows the user to modify the record, specifically the differential count. Coulter JR provides a three-part differential. We replaced it with a manual differential count to supply the users with absolute counts of a five part differential. When this option is activated, the user can make use of a function key to activate a pop-up window that emulates the manual differential counter (Fig. 4). Once the differential count is done through the keyboard, the percentage distribution and the absolute counts, which are calculated automatically based on the total white cell count, are then incorported into the database.

Other options allow the user to print an interim report for immediate despatch, print a final report after validation by the duty haematologist for later despatch to the doctors, print a cumulative report for a particular patient if requested, and print a hardcopy of daily reports of all cases for reference and filing.

The Utility function

The Utility function are for housekeeping purposes. These include provision to reindex databases if the index is damaged, find out other users logged onto the network, send messages to other terminals and backup databases into a hard disk. The last option is carried out in a workstation which has a hard disk designated for the purpose. This backup is done daily to secure data in case of a file server failure.

The Quit function

The Quit function when activated returns the user to the network menu. The network menu provides an option to backup database into tape. This is done weekly to guard against both hard disk and file server failures. It also provide a means to archive yearly data on tape.

DISCUSSION

Computerisation of full blood picture reporting has improved the efficiency of this major function of the haematology laboratory. There is no longer a need to keep a registration book as all incoming samples are now registered directly and are traceable through the computer screen. As the terminal is switched on during office hours, a telephone enquiry can be satisfied in a shorter

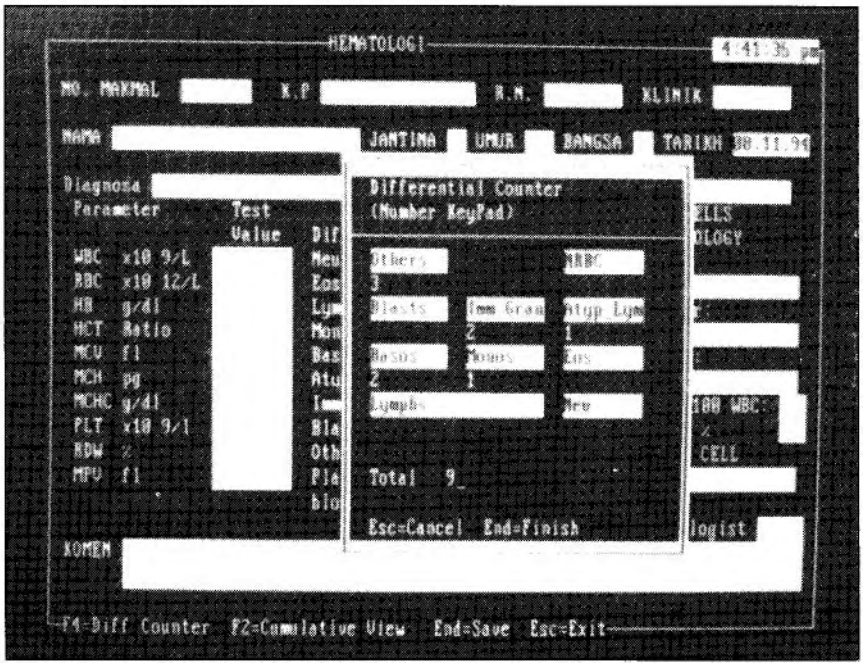

FIG. 4: The differential counter emulator appearing in a window superimposed on a data form display.

time by an electronic search. The steps that involve searching the registration book for the patient's particulars and tracing the master card for results have been made redundant. The laboratory manager no longer needs to worry about getting more and more cabinets to hold master cards before their eventual destruction.

The direct transmission of data from the counter to the computer network has negated the manual entry of data into the system. Manual entry of data is often a source of transcription error. This direct linkage has also made redundant the printing of results from the counter data terminal. Thus, the special multifold haematology printouts that are associated with the automatic blood cell counter and have characterised the haematology service for many years have suddenly become museum pieces. They are now replaced by plain paper computer printouts which are designed to suit the need. This has saved cost in maintaining the more expensive special printer and printouts.

In our laboratory, we still carry out the manual differential count using either a manual counter or an electronic counter. The latter is now emulated on the computer screen and the results automatically incorporated into the database. This has completely avoided any transcription error. Besides, it ensures that indeed 100 cells are counted for the differential rather than the not infrequent incomplete 99. When the five-part differential machines are available in the future, this function would then be obsolete.

The advantage of the old master card system is that all the previous results are attached for viewing and comparison. In the new system, the duty haematologist has to make a record search for that particular patient if previous results are required. The master card of a particular patient is often needed by other sections like haemoglobin analysis, coagulation screen and bone marrow. Searching a misplaced master card is often a source of conflict in the laboratory. This can now be avoided as the patient's data is now on the computer screen which can be accessed simultaneously from different terminals.

The current system deals only with the reporting of the full blood picture. Other functions of the laboratory remain to be computerised. It is hoped that at a later stage, these results could be added as separate databases. The final objective of the in-house computerisation effort is to merge all the services together so that an authorised user can enquire for the same patient any laboratory reports from the same computer terminal. The laboratory has benefited tremendously from automation in terms of efficiency and productivity. Computerisation of both automated and manual data processing has augmented these benefits further. We look forward to a fully automated and computerised laboratory in the future.

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