Computer-assisted method for compiling a blood group register

L. A. BELLCHAMBERS, M. G. RINSLER, AND A. G. SIGNY

From the Group Laboratory, St Stephen's Hospital, London

SYNOPSIS The compilation of the records of a serology department using a computer to produce alphabetically ordered files is described. This has proved to be an efficient and economical technique which may well be applied to other similar problems in a large clinical laboratory.

As more technical procedures tend to be automated and the flow of data increases, the problems of consolidating and extracting information in clinical laboratories are becoming more acute. Although considerable thought has been given to cumulative individual records (Whitby and Owen, 1965; Flynn and Vernon, 1965), little attention has been given to the working files of data within the laboratory.

The present filing system in this laboratory involves sorting by hand the NCR copies of reports in alphabetical order of patients' names, so leading to large, unwieldy files. The files require considerable clerical time to keep in order as cards are frequently lost or misfiled. Withdrawal and re-entry of records is time consuming. Because of these difficulties we have undertaken an experiment in the application of modern techniques in automated data handling to the problems in the clinical laboratory. We chose the records of the serological division of the haematology department as the most suitable for investigation. This file, which is separated from the main haematology file, contains the records of the transfusion work of the laboratory, antenatal serology, and general serology in relation to other haematological problems. Each year this file grows by 10,000 records. The type of test performed is limited in number and fairly uniformly applied to each specimen and includes ABO grouping, Rh grouping, and the detection of antibodies. This file is frequently referred to for checking current against previous data and accurate up-to-date information is essential. Our aim, therefore, has been to produce an alphabetically listed file which could be sorted and printed by computer, was convenient to handle, and occupied minimal space. Furthermore, since the cost of producing the file should be within reasonable

financial limits, we proposed to spend not more than the salary of a half-time clerical officer per annum on the system.

Our first problem was to decide what the information to be stored and printed should be, within the limits of the electric page printer. This information was divided into patient and sample identification data, clinical data, and laboratory data. The layout we adopted is shown in Table I. In all there were 114 characters, excluding spaces and tabulation, of which 49 were identification characters including name, hospital number, sample number, date, and location of the patient. The program for the production of the register was based on the flow chart presented in Fig. 1, and written by members of Elliott Medical Automation Ltd for the operation of the Elliott 4100 computer at the Computer Centre, Royal Postgraduate Medical School, Hammersmith.

Special laboratory worksheets were printed on NCR paper so that the identification data, working data, and results could be recorded on one line. After the entry of the working data and results the upper sheet was preserved in the laboratory for immediate reference. The copy of the work sheet is given to the typist whose task is to produce an accurate perforated paper tape in a format that the computer can use. This work is carried out on a page printer with a perforated paper punch. The printed page is checked visually for typographical errors and the paper tapes are ready to be fed into the computer. The unsorted file is read from the paper tape into the computer store and from there is written on to a magnetic tape. This unsorted file of about two weeks' work is then sorted alphabetically by program and added to the sorted file on magnetic tape. A perforated paper tape corresponding to two weeks' sorted file is produced by the computer and

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TABLE I
REPRODUCTION OF THE PRINT-OUT OF THE HAEMATOLOGY REGISTER

Date	Laboratory Number	Name	Hospital Number	Age	Sex	Ward	Hospital
18/08/67	07081	Smart, Judith		020	F	MT	SMA
19/05/67	04433	Smart, June		020	F	MT	SMA
06/04/67	03029	Smart, Patricia	139529	026	F	RH	SMA
01/04/67	02900	Smart, Rosemary		020	F	MT	SMA
14/09/67	07906	Smart, Rosemary		020	F	MT	SMA
24/10/67	09263	Smart, Rosemary		C		MT	SMA
03/05/67	03916	Smart, Vickie	A039710	020	F	MT	SSH
26/07/67	06442	Smith, Barbara	A023005	027	F	MT	SSH
23/08/67	07216	Smith, Christina	161630		F	RH	SMA
23/06/67	05471	Smith, Christine		026	F	MT	SMA
22/06/67	05451	Smith, Christophe		016	M		PUT
09/10/67	08733	Smith, Hilda	037619	068	F	5B	SSH
23/08/67	07195	Smith, Kathleen	A042308	028	F	MT	SSH
18/10/67	09009	Smith, Patricia	A043430	026	F	MT	SSH
29/05/67	04726	Smith, Phyllis	026232	064	F	6B	SSH
19/09/67	08045	Smith, Vera	A004041	029	F	5C	SSH
15/05/67	04284	Smith, Violet			F	5C	SSH
19/09/67	08047	Smythe, Alice		039	F	RH	SMA
23/06/67	05464	Smythe, Baby		C		MT	SMA
03/06/67	04870	Smythe, Gladys	005007	080	F	HN	PBH
12/10/67	08832	Snag, Florence	A042095	075	F	3C	SSH
15/07/67	06141	Snag, Nicola		023	F		PUT
04/08/67	06691	Sneath, Rita	132159	029	F	MT	SMA
13/09/67	07837	Sneath, Susan	A042612	018	F	MT	SSH
22/05/67	04509	Snell, David	005305	024	F	MT	PBH
12/05/67	04198	Snell, Peter		031	F	MT	SMA
27/07/67	06474	Snook, Edward		068	M	AC	SSH
31/07/67	06547	Snook, Sophie	A008107		F	7D	SSH
05/05/67	04046	Snow, L.			F		PUT
15/08/67	06968	Sober, Joan	A003692	026	F	5C	SSH
31/07/67	06592	Sofer, Amanda		N	F	VT	SMA
28/07/67	06502	Soft, Patrick		026	F	MT	SMA
19/05/67	04432	Sole, Mary		034	F	MT	SMA
23/10/67	09125	Solid, Baby		C	F	MT	SSH
31/08/67	07425	Solid, Sheila	A026885	033	F	MT	SSH
14/09/67	07897	Solid, Sheila	A026885	033	F	MT	SSH
12/10/67	08808	Solid, Sheila	A026885	033	F	MT	SSH
30/09/67	08317	Solid, Sheila	A026885	033	F	MT	SSH
17/05/67	04333	Solid, Sheila	A026885	033	F	MT	SSH
26/06/67	05538	Somers, Olive	004994	023	F	MT	PBH
27/07/67	06477	Soper, Marion		024	F	TE	SMA

this is printed off-line with a page printer. The sorted records on the magnetic tape file are now merged with the previously sorted records. At intervals of six months the entire file is printed either on a page printer from a perforated paper tape or directly by a line printer. Since each record occupies one line compared with a whole card there is a considerable saving of space. The records of each patient are accumulated on successive lines which facilitates reading and comparisons and there is no need to draw and replace filing cards.

CODING OF DIAGNOSTIC AND TRANSFUSION DATA

Must be one of the following:

T + number	} eg P4, P1/TO, P4/M2/T3	T = Transfusion	
P + number		P = Pregnancy	
M + number		M = Miscarriage	
Maximum number of characters is 8, including the obliques.			
S	= surgery	GI	= gastrointestinal bleeding
HA	= haemolytic anaemia	UC	= ulcerative colitis
PA	= pernicious anaemia	CDA	= coagulation defect due to drugs
LEU	= leukaemia		= gynaecology
AP	= aplastic anaemia	GY	= threatened abortion
SP	= splenectomy	TA	= miscellaneous
TH	= thalassaemia	AD	= obstetric bleeding
CD	= coagulation defect	OB	

TABLE I—continued

REPRODUCTION OF THE PRINT-OUT OF THE HAEMATOLOGY REGISTER

History	ABO	Rh Factor	Genotype	Antibodies	Direct Coombs	Antibody titre Saline	Alb	Coombs	Ig	VDRL	Bottle Numbers
P1	A	POS		NIL						NEG	
P1	A	POS		NIL						NEG	
	A	POS		NIL						NEG	
P1	O	NEG	LRLR	NIL						NEG	
	O	NEG		NIL						NEG	
	O	POS		NIL	NEG					NEG	
P1	O	NEG	LRLR	NIL						NEG	
P3	A	POS		NIL						NEG	
OB	B	NEG	LRLR	D		NIL	0008	0016	G	NEG	
P2	A	POS		NIL						NEG	
	A	POS		NIL						REP	
GY	B	POS		NIL						NEG	
P1	O	POS		NIL						NEG	
P7/M1	A	POS		NIL						NEG	
	A	POS		NIL						NEG	
S	O	POS		NIL						NEG	040658 040682N
	A	POS		NIL						REP	MM
TA	O	POS		NIL						NEG	
	A	POS		NIL	NEG					NEG	
S	O	POS		NIL						NEG	042242 043204—
S	O	POS		NIL						NEG	055201 058681
TA	A	POS		NIL						NEG	078258 078259—
P3/M1	O	POS		NIL						NEG	
P1	O	NEG	LRLR	NIL						NEG	
P1	B	POS		NIL						NEG	
P2	AB	POS		NIL						NEG	
CDA	O	NEG	LRLR	NIL						NEG	
AD	A	POS		NIL						NEG	005506—
	A	NEG	LRLR	NIL						NEG	017862 017864—
AD	A	POS		NIL						REP	008557 008620—
											008566—
	B	POS		NIL						REP	007114—
P1	B	POS		NIL						NEG	
P4	A	POS		NIL						NEG	
	O	POS		NIL	NEG					NEG	
	O	NEG		NIL						NEG	
	O	NEG		NIL						NEG	
	O	NEG		NIL						NEG	
	O	NEG		NIL						NEG	
P6	O	NEG	LRLR	NIL						NEG	
P1	O	POS		NIL						NEG	
S	A	POS		NIL						REP	000995 001016—
											077865N

CODING OF ANTIBODY DATA

Must be one of the following:

ND	= Not done	Le	= c	LEAB	Le ^a + Le ^b
NIL		LEC	= eC	LUA	= Lu ^a
C		M	= M	LUB	= Lu ^b
D		N		K	= K
E		S		LK	= k
CD		LS	= s	FYA	= Fy ^a
DE		Pi		FYB	= Fy ^b
LC	= c	LEA	= Le ^a	SC	= See card
LCE	= cE	LEB	= Le ^b	REP	= Repeat

CODING OF RH GROUP FACTORS

Must be POS, NEG, DU or REP

REP = Repeat

CODING OF ABO GROUPS

Must be one of the following:

A, A1, A2, A3, A4, AM
 AB, A1B, A2B, A3B
 B, O

RHESUS (G = GENOTYPE)

Must be any pair of the following:

R1, R2, RO, RZ, RC, RE, RY, LR
 RC = R¹
 RE = R¹¹
 LR = r

FIG. 1. *Reproduction of the flow chart of the haematology register.*

Since a full description of the information in each column would require very lengthy records, coding of information was performed as far as possible. We have endeavoured to devise a code which resembled conventional abbreviations, either local or national, to simplify interpretation of the print-out. Examples are shown below.

The main difficulties of the new system have been chiefly in the transfer of information from one document to another. Careful visual checks are applied to the completed worksheet and to the first printing of the unsorted data and all corrections entered on the perforated paper tape. After the first run through the computer, records which are not accepted are corrected and entered again. Typical time is about 50 to 60 records an hour to which correction time must be added. To speed the time of printout, particularly of the six-monthly compilation, a line printer has been employed which cuts the printing time to about 5% of that of a page printer which types one character at a time.

With greater experience we would expect to produce a more compact, efficient program and extend the program so that certain types of data can be extracted by the computer: for example, the list of primiparous patients who are D negative is now being produced manually in order to forecast the immunoglobulin requirements for the patients. Such applications will greatly increase the usefulness of the classified information.

REFERENCES

- Flynn, F. V., and Vernon, J. (1965). *J. clin. Path.*, **18**, 678.
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