Computerization of a large antenatal serology service

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SYNOPSIS A computer scheme for a large antenatal serology service is described. A primary request form (for mother, father or child) has been developed. Standard reports are produced by the computer and are issued with a tear-off slip which should accompany subsequent specimens. Complicated reports are made by special letter. An instruction booklet is issued to all users. Information on patients with clinically significant antibodies is held in a special computer file and is regularly updated. The system provides an efficient and reliable day-to-day service and readily accessible data for retrospective research. A brief note on the computer elements of the system is provided.

The West Midlands Regional Blood Transfusion Service, Birmingham is the Antenatal Serology Centre for the whole region (pop. about 5 000 000). A large number of specimens (400-500) are investigated each day. A substantial file of data (all Rhesus negative mothers, irrespective of whether they had made antibodies or not) had accumulated over the years. Since the physical task of manually searching and extracting information from this mammoth file became stretched to full capacity and threatened to render the scheme 'non-viable', the Antenatal Serology Service has now been computerized.

Design criteria

Early thoughts on design produced a system that held all Rhesus negative cases on computer file. However, it soon became apparent that the cost of computer processing was prohibitive and that we were merely automating the manual system at considerable expense. Further, it was felt that in a few years the computer system would be suffering from the same problems as beset the manual system. Consequently, in order to produce a cost effective system, a computer processing time of one hour a day was taken as a basic design criterion. Considerable work was also undertaken into the exact nature and extent of patient identification and serological data that needed to be kept in a form that would be: (a)

readily available for day-to-day use in a current pregnancy, and (b) available for longer term statistical manipulation. Furthermore, with the advent of machine blood grouping and antibody detection and measurement, it was of paramount importance to design a system that would be compatible with developments in this field.

Outline of system

For a first request the primary request form (fig 1) is completed by staff at hospitals, antenatal clinics, and general practitioners' surgeries, in all at about 700 different points in the five counties covered by the Blood Transfusion Service (BTS). The primary request, together with a blood specimen which is specially preserved for machine analysis, is then collected by BTS transport or sent by post to the Transfusion Centre.

At the BTS, requests and specimens are received and sorted into various categories. The ABO and Rhesus groups are then determined on a Technicon® 15 channel grouping machine, a screening test for antibodies being included in the program. Those patients whose screening tests have indicated the presence of antibodies are, of course, then fully investigated. In practice, most mothers do not have any clinically significant antibodies. For these mothers, details of the test results are entered on the request form, and after a thorough check for transcription errors by two experienced senior techni-

PUNCH COLS 1-10
AS BELOW

BTS USE WITHIN THICK LINES

BIRMINGHAM REGION

PRIMARY ANTENATAL SEROLOGY REQUEST

TRANSFUSION CENTRE
VINCENT DRIVE
EDGBASTON
BIRMINGHAM B15 2SG
TEL: 021-472 3111

**SUBSEQUENT REQUESTS
SHOULD BE MADE ON THE
REPEAT REQUEST FORM**

SPECIMEN FROM
(PLEASE TICK APPROPRIATE BOX)

MOTHER	FATHER	CHILD
☐ 1	☐ 2	☐ 3

SURNAME 13

FIRST FORENAME 36

ADDRESS 50

73

96

119

46

FIRST 3 LETTERS OF
SECOND FORENAME 47

72

95

118

129

POSTAL
CODE 130

136

35

49

86

115

142

PLEASE ENTER ALL DATES IN NUMERIC FORM

DATE OF BIRTH
OF SPECIMEN DONOR 137

ESTIMATED
DATE OF DELIVERY 143

DATE OF REQUEST 149

IF PRIMIPARA ENTER 'P'.....155

TOTAL NUMBER OF PREGNANCIES (UP TO 9).....156

TOTAL NUMBER OF MISCARRIAGES/ABORTIONS.....157

TOTAL NUMBER OF STILLBIRTHS.....158

TOTAL NUMBER OF INFANTS WITH
HAEMOLYTIC DISEASE.....159

IF PATIENT HAS EVER BEEN TRANSFUSED ENTER 'T'.....160

142

148

154

PUNCH COLS 1-10
AS BELOW

BTS USE WITHIN THICK LINES

ENTER ENCLOSED DETAILS ONLY IF SPECIMEN IS FROM FATHER OR CHILD

DATE OF
BIRTH OF MOTHER 12

MOTHERS SURNAME 18

FIRST FORENAME 41

51

FIRST 3 LETTERS OF
SECOND FORENAME 52

54

17

40

87

SOURCE CODE 1

5

ATTACH LAB REF. LABEL

10

ADDRESS REPORT
TO BE SENT TO

MEDICAL ATTENDANT

18

40

DATE OF RECEIPT

11

12

17

BGC

REPS

REPORT CODES

41

42

43

BTS USE BELOW THIS LINE

BIL

HB

DCT

EL 1

EL 2

CONDIR 1

CONDIR 2

CONDIR 3

119

124

ANTIBODY 1

SGTH

INT. UNITS

60

65

66

70

75

80

85

88

ANTIBODY 2

SGTH

INT. UNITS

103

108

109

113

118

ASD. 1

ANTIBODY
Z FILE REF. 125

130

SCREEN
INIT. CONF.

ABO GROUP

RHESUS

ANTI
SCREEN

IMMUNE
α β

131

136

141

Fig 1 Primary request form

FOR QUERIES PLEASE QUOTE LAB. REF. Z REF.

REPORT ON

REGION BIRMINGHAM

ANTENATAL SEROLOGY REPORT

TRANSFUSION CENTRE VINCENT DRIVE BIRMINGHAM B15 2SG TEL 021 472 3111

DATE OF REQUEST

DATE OF BIRTH

ESTIMATED DATE OF DELIVERY

DATE OF TEST

PHOTO TYPE C D E S D

ANTIBODY SYSTEM

GROUP RHEBUS

STRENGTH

SPECIFICITY

PHENOTYPE

FOR TABLES OF GENOTYPES AND INTERPRETATION OF ANTIBODY STRENGTH SEE B15 CIRCULAR ON ANTENATAL SEROLOGY

PUNCH CDS 119 AS BELOW

SPECIMEN FROM

REPEAT ANTENATAL SEROLOGY REQUEST

REGION BIRMINGHAM

TRANSFUSION CENTRE EDGEMONT ROAD BIRMINGHAM B15 2SG TEL 021 472 3111

PLEASE PRINT ANY CHANGE IN THIS INFORMATION PLEASE FULLY

12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000

Fig 2 Combined report and repeat request form

cians, the results are then punched on magnetic tape before being sent daily to the Regional Health Authority (RHA) Computer Centre, which is about two miles away. Those with clinically significant antibodies are tested more extensively before the data are sent to the Computer Centre.

Each day the computer produces for each request a combined report and repeat request form (fig 2), which goes back to the doctor who made the request. For subsequent tests the repeat request form is detached from the report and sent with the blood specimen to the Transfusion Centre. The repeat request provides information to the transfusion service on the results of the previous test(s) and tells whether or not the mother had detectable antibodies. If a subsequent specimen is not accompanied by this form but by a primary request form, the system does not automatically identify it as a repeat request. For this reason all patients with primary request forms are looked up in the small manual Z file held at the BTS. It is, however, appreciated by most users that the provision of the 'tear-off' repeat request form is not only convenient but also that it is in the interests of themselves and their patients to use it. The majority of users do in fact submit these forms with repeat requests for investigation. The computer also produces a label for attachment to the blood group card (fig 3) and an identical address label to be attached to the envelope containing the report and repeat request. Information on workload and other data is produced at intervals (fig 4). For instance, the computer provides an important facility by building a complete record of all mothers with significant anti-

bodies. This file is in fact an almost identical copy of a manual file (see below) held at the BTS. The computer file, however, is intended for research and development purposes, while the BTS manual file is for dealing with actual day-to-day processing of requests.

Patient identification

In a service processing so many specimens, it is essential to have specimens and requests uniquely identified. Each request is allocated a sequential number, in triplicate, which is printed on small self-adhesive labels. One number is attached to the request form, another to the specimen, and the third to an entry in a control book (fig 5). The purpose of the control book is to book specimens into and out of the Centre and also to indicate anything of significance, for example, broken specimens. It then becomes very simple to see which specimens have been in the Centre for more than, say, four days. In fact, after four days an enquiry form (fig 6) is produced and sent around to all reporting officers. The 2% or so of patients whose results are of some significance are allocated a further identification number. This number is termed the Z case number, and it is a permanent reference number allocated to a particular patient. The number is five digits long, including the prefix Z, and is a self-checking number using modulus 11. The computer does, in fact, produce a list of Z case numbers so that the clerical staff can allocate them to new Z case mothers. Also, for easier reference, an alphabetical list of all Z case patients is produced periodically.

National Blood Transfusion Service

The Director, Regional Transfusion Centre,
Vincent Drive, Edgbaston, Birmingham B15 2SG.

N.B.T.S. 3
(Rev. 1960)

Tel. No. 021-472 3111

GROUP
AB
Rh D Negative
cde/cde

JAMES JANET
12 MELBOROUGH ROAD
ACKINGTON
SHROPSHIRE

SAR

XY2 27P

DATE OF BIRTH 07/05/39
LAB. REF. 000098
DATE OF TEST 15/09/73
ANTIBODY Z REF. Z00183
A1B NEG
- - - + -

IMPORTANT: If this person should be in need of a blood transfusion, compatible Rh Negative blood (Group plasma or serum may be used instead.

ANTIBODY

G. W. G. BIRD, Director.

Please turn over

Fig 3 Blood group card with attached label

B T S ANTENATAL SEROLOGY

WORKLOAD STATISTICS SUMMARY

QUARTER ENDING 31/12/75

	PRIMARY REQUESTS	REPEAT REQUESTS	2 REQUESTS	MOTHER REQUESTS	FATHER REQUESTS	CHILD REQUESTS	TOTAL REQUESTS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000	1001	1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013	1014	1015	1016	1017	1018	1019	1020	1021	1022	1023	1024	1025	1026	1027	1028	1029	1030	1031	1032	1033	1034	1035	1036	1037	1038	1039	1040	1041	1042	1043	1044	1045	1046	1047	1048	1049	1050	1051	1052	1053	1054	1055	1056	1057	1058	1059	1060	1061	1062	1063	1064	1065	1066	1067	1068	1069	1070	1071	1072	1073	1074	1075	1076	1077	1078	1079	1080	1081	1082	1083	1084	1085	1086	1087	1088	1089	1090	1091	1092	1093	1094	1095	1096	1097	1098	1099	1100	1101	1102	1103	1104	1105	1106	1107	1108	1109	1110	1111	1112	1113	1114	1115	1116	1117	1118	1119	1120	1121	1122	1123	1124	1125	1126	1127	1128	1129	1130	1131	1132	1133	1134	1135	1136	1137	1138	1139	1140	1141	1142	1143	1144	1145	1146	1147	1148	1149	1150	1151	1152	1153	1154	1155	1156	1157	1158	1159	1160	1161	1162	1163	1164	1165	1166	1167	1168	1169	1170	1171	1172	1173	1174	1175	1176	1177	1178	1179	1180	1181	1182	1183	1184	1185	1186	1187	1188	1189	1190	1191	1192	1193	1194	1195	1196	1197	1198	1199	1200	1201	1202	1203	1204	1205	1206	1207	1208	1209	1210	1211	1212	1213	1214	1215	1216	1217	1218	1219	1220	1221	1222	1223	1224	1225	1226	1227	1228	1229	1230	1231	1232	1233	1234	1235	1236	1237	1238	1239	1240	1241	1242	1243	1244	1245	1246	1247	1248	1249	1250	1251	1252	1253	1254	1255	1256	1257	1258	1259	1260	1261	1262	1263	1264	1265	1266	1267	1268	1269	1270	1271	1272	1273	1274	1275	1276	1277	1278	1279	1280	1281	1282	1283	1284	1285	1286	1287	1288	1289	1290	1291	1292	1293	1294	1295	1296	1297	1298	1299	1300	1301	1302	1303	1304	1305	1306	1307	1308	1309	1310	1311	1312	1313	1314	1315	1316	1317	1318	1319	1320	1321	1322	1323	1324	1325	1326	1327	1328	1329	1330	1331	1332	1333	1334	1335	1336	1337	1338	1339	1340	1341	1342	1343	1344	1345	1346	1347	1348	1349	1350	1351	1352	1353	1354	1355	1356	1357	1358	1359	1360	1361	1362	1363	1364	1365	1366	1367	1368	1369	1370	1371	1372	1373	1374	1375	1376	1377	1378	1379	1380	1381	1382	1383	1384	1385	1386	1387	1388	1389	1390	1391	1392	1393	1394	1395	1396	1397	1398	1399	1400	1401	1402	1403	1404	1405	1406	1407	1408	1409	1410	1411	1412	1413	1414	1415	1416	1417	1418	1419	1420	1421	1422	1423	1424	1425	1426	1427	1428	1429	1430	1431	1432	1433	1434	1435	1436	1437	1438	1439	1440	1441	1442	1443	1444	1445	1446	1447	1448	1449	1450	1451	1452	1453	1454	1455	1456	1457	1458	1459	1460	1461	1462	1463	1464	1465	1466	1467	1468	1469	1470	1471	1472	1473
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Storage of information

At the feasibility stage 'an informed guess' suggested that, of all the work processed, only 5% would be of any significance and worth keeping. Experience of running the scheme suggests that even this figure was optimistic and that it is actually about 2.5%. In a year's full working this would mean that we would retain the results from about 2300 requests. The degree of significance of these 2300 blood specimen requests varies quite considerably, so that we have subdivided our Z cases as shown below:

- Condition code 01 — antibodies that may cause haemolytic disease of the newborn, eg, Rhesus, Kell, Duffy, Kidd
- 02 — antibodies that are unlikely to be of much clinical significance in this context, eg, ABO, I, P, Lewis
- 03 — rare forms of ABO, Rhesus or other groups
- 04 — discrepancies for further investigation
- 05 — cases found to be positive for HBsAg.

In practice, we find that many Z case mothers' results have no great significance. For example, the condition 02 cases which have anti-I antibody can be weeded out at the end of a pregnancy. The computer helps with this weeding out process by producing each week a list of Z case women who had been delivered during the previous month. The list is then used by the senior technical staff to decide which cases can be removed from the computer and manual files. About 1% of cases are recorded in permanent files. Data on the other cases are filed in date of processing order and then destroyed 12 months later. No pre-sorting or extracting is necessary; it is merely a matter of working chronologically along the filing shelves.

Manipulation of data

To have on-line computer capacity is very useful, though extremely expensive, and we suspect that further problems may be introduced by our having to depend so much on a machine. The fact remains, however, that in processing requests on a daily basis one *must* have daily recourse to records. We have resolved this problem, and still remained within the constraints of a cost-effective system, by having a Z case manual file held at the Centre for day-to-day reference, and a computer counterpart of this file for longer term statistical analysis. The manual file is built up by inserting in a heavy-duty envelope the lower

portion of the request form for each test. Thus the data pertaining to each specimen investigated during a pregnancy are preserved. The computer file has been structured in such a way that it consists of a series of 58 character records, many of which at the moment are not activated; they exist for future requirements that have not yet been defined.

All the information is held under the mother's Z case number. Typical record details now held are mothers' personal identification ABO, and Rhesus groups, phenotypes, antibodies detected, and their strengths and condition codes (these are a means whereby any condition can be coded, eg, significance of case, whether child is a twin or one of triplets, etc, and then used as the means for calling back that information from the computer file). Serological results are also held for fathers and children, but, to preserve confidentiality, names and addresses are not held, and the information printed out from the file is not readily interpreted by the untrained eye. The record layout is extremely flexible and accommodates many test results per pregnancy, multiple pregnancies, multiple births, and clinical details.

Reporting

The majority of serological reports do not need any written comment; ABO, Rhesus group, and an indication that no anomalous antibodies have been detected are sufficient. When comment is necessary, much of it is of a routine nature—so much so that over the years standard phrases have been used in making reports. When, for example, a broken specimen is received with a request form, a standard letter asking for a fresh specimen was produced. This concept has been expanded to include the actual reporting of serologically significant results.

What is in effect a dictionary of up to 99 phrases is held on a computer file; a few of the phrases are given in the appendix. A full list may be obtained from the Director of the Regional Blood Transfusion Service, Birmingham. Each sentence is referenced by a two-digit code; thus, by specifying up to five codes, quite elaborate letters can be produced, including such statements that the patient may be heterozygous for the named antigen c. For the more commonly occurring multiphrase messages, it is necessary to specify only one code. A computer program automatically links the various phrases together to produce the total report; an example is given (fig 7). There are occasions when the automatic facility will not produce the required message or, if it does, it is expressed in a stiff and obviously automatically produced way. In these circumstances, 'code 88' is used, which produces the message 'Please see attached letter' on the report. Of the 76 500 requests processed so

FOR QUERIES PLEASE QUOTE LAB. REF. Z REF.		BIRMINGHAM ANTENATAL			REGION SEROLOGY REPORT		TRANSFUSION CENTRE VINCENT DRIVE EDGBASTON BIRMINGHAM B15 2SG TEL: 021-472 3111	
REPORT ON		DATE OF REQUEST		DATE OF TEST				
L		DATE OF BIRTH						
		ESTIMATED DATE OF DELIVERY						
GROUP A1B RHESUS NEG		ANTIBODY SYSTEM	SPECIFICITY	STRENGTH	PHENOTYPE			
		1 RHESUS	ANTI C+D	FAIRLY HIGH	C	D	E	
		2			c	e	D'	
		3						
		A FURTHER SPECIMEN SHOULD BE SENT IN 4 WEEKS TIME A SPECIMEN FROM THE FATHER SHOULD BE SENT AT THE SAME TIME PLEASE INFORM US WHETHER OR NOT THE PATIENT HAS RECEIVED IMMUNOGLOBULIN ANTI-D AT ANY TIME A NEW BLOOD GROUP CARD IS ENCLOSED. PLEASE DESTROY ALL PREVIOUSLY ISSUED CARDS

Dr. G. W. G. BIRD

FOR TABLES OF GENOTYPES AND INTERPRETATION OF ANTIBODY STRENGTH SEE BTS CIRCULAR ON ANTENATAL SEROLOGY

Fig 7 Specimen of a completed report

far, the '88' facility has been used only 445 times. Whatever report codes are used are printed out on the extreme right-hand side of the repeat request form so that the staff dealing with a subsequent request know what was said previously.

Statistics

A range of statistics is produced each quarter. The workload statistics are produced for each user of the service showing how many requests have been made in the quarter for mother, father, and child specimens; how many requests are of the 'Z' category and how many are straightforward; how many are first time requests and how many are repeats. All this information is compared with the figures from the preceding four quarters. In addition, the use of report coding allows the use of certain report codes to be classified and totalled against users. The computer automatically produces a total of the number of

times this report code has had to be used for each user. This enables the Service to advise such users of any difficulties that may have arisen, for example, specimens broken on arrival or delay in despatch of specimens, or specimens which are clotted or too haemolysed for satisfactory investigation. In addition, an analysis of the use of each report code in the dictionary is given, so that the relatively small dictionary can be periodically edited to contain only those phrases that are in most frequent use.

Implementation

Implementation of any change to a system providing a service to such a wide range of users is always a problem. In the early stages of the project, principal users were consulted so that the final design would at least be acceptable to a majority of users. Also, since it was obviously not possible individually to explain the system to each user, a manual describing the

operational aspects was produced so that a copy could be sent to each doctor availing himself of the system. A hospital volunteered to be the pilot hospital and the scheme was successfully run for three months. The scheme has since expanded to cover the whole of the West Midlands Region.

Computer elements

A description of the computer elements of the system has deliberately been left until the end since it represents only a part, albeit an important part, of the entire system. The design philosophy adopted in all the BTS computer applications has been that the computer exists to serve the Transfusion Centre and not *vice versa*. The computer employed to run the system is the RHA System 4/40 with a core store of 128K bytes: just over half an hour per day, five days a week, processing time is required which, in fact, is well within the design criteria of the system. Data are prepared at the Transfusion Centre using Burroughs magnetic tape encoders. The input data tape is then transported physically each day to the RHA. There are 17 programs in the serology suite, of which five are run daily, two weekly, four quarterly, and six on an *ad hoc* basis. All the programs, with the exception of the combined validation/update program, are relatively simple; this program is, however, unavoidably complex and occupies some 79K bytes of core. The programs have been written in system 4/40 Cobol under the direction of Mrs. Susan Taylor, a senior programmer of the Management Services Department of the RHA. At the time of publication of this paper, many of the programs have been written in 1900 series Cobol in preparation for transfer to an ICL 1904S machine.

Conclusions

The scheme has greatly eased the burden imposed on medical, scientific, technical, and clerical staff of the West Midlands Regional Blood Transfusion Service. This scheme is part of a larger scheme for the automation/computerization of the West Midlands Regional Blood Transfusion Service (Bird, 1974). Schemes pertaining to the blood donor system, control of issue and distribution of blood and its components, and HLA serology and organ transplantation are in preparation.

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Reference

- Bird, G. W. G. (1974). Automation in blood transfusion laboratories. *Synopses of Scientific Papers, Institute of Medical Laboratory Technology Triennial Conference, Sheffield, 10-17 August, 1974*, p. 20.

Appendix

SELECTION OF REPORT CODES FROM THE DICTIONARY

- 08 We regret specimen was found clotted on arrival and was unsuitable for testing.
- 29 A further specimen should be sent as soon as possible.
- 59 Direct Coombs test positive—strong.
- 89 Please inform us whether or not the patient has received immunoglobulin anti-D at any time.