Automation of a flocculation test for syphilis on Groupamatic Equipment

M. GARRETTA*, A. PARIS-HAMELIN*, J. GENER*, A. MULLER*, C. MATTE*, and A. VAISMAN†
From the Centre National de Transfusion Sanguine*, Lille, and the Institut Alfred Fournier†, Centre International de Référence de l’Organisation Mondiale de la Santé pour les Tréponématoses Endémiques, Paris

The widespread utilization of Groupamatic Equipment for routine immunohaematological tests has increased the demand for serological procedures that can be performed with this machine. We now use two Groupamatic 360 GC machines on which we process each year more than 250,000 blood samples (Garretta, Gener, Muller, Matte, and Moullac, 1974a). These considerations make it apparent that automation of routine syphilis tests should be investigated.

In the serology of syphilis, the continuous-flow auto-analyser system has been applied to complement-fixation techniques. In 1968, the Venereal Disease Research Laboratory, in cooperation with Technicon Corporation, developed an automated flocculation test for syphilis (McGrew, Ducros, Stout, and Falcone, 1968a; Stout, McGrew, and Falcone, 1968b). Originally designed for a single-channel continuous-flow system, it has been adapted to a multichannel system (Schroeter, Taswell, Kierland, and Sweatt, 1971). In both, the sensitivity and specificity appeared to be greater than in the manual VDRL test (McGrew, Stout, and Falcone, 1968b; Stevens and Stroebel, 1970). Until the beginning of 1974, the routine screening at the Centre National de Transfusion Sanguine (CNTS) was effected on two single-channel continuous-flow systems using a cardiolipid antigen coated on inert particles. The reactive samples were checked by a modified rapid plasma reagin (RPR) slide test (read microscopically), and then sent for verification to the Alfred Fournier Institute. Under these conditions, we found in 1973 a positive rate of 0.8% and a false positive rate of 2%.

This paper describes the test method which was developed at the CNTS. We use a lipoidal antigen made up at the CNTS from the commercial K-antigen of Lille. Preliminary investigations (Garretta, Paris-Hamelin, Gener, Muller, Matte, Vaisman, and Moullac, 1973b) showed that this technique could be applied to a serological test for syphilis and we have been able to use it routinely since January, 1974, for all blood donors. To evaluate the new automated procedure, the test was performed on more than 63,000 samples. For 5,212 of them, the results were compared with those of classical serology and with indirect immunofluorescence methods (FTA-200 and FTA-ABS) and with the Nelson and Mayer test (TP1). All the positive results were confirmed, but in the Tables only the results concerning classical serological screening methods are shown.

Material and methods

EQUIPMENT
We use two Groupamatic 360 GC machines on which we process each year more than 250,000 blood samples to be analysed per hour in twelve separate channels including an electromechanical unit and an electronic unit. The former is used for agglutination reactions and identification of the samples. The latter, with a software programme, processes the data and prints them out. We use up to five successive runs, the 4th and 5th only concerning our most regular donors. The first and second runs are made in programme P1, and the tests performed are ABO group, with determination of A1, A2, B, O, A1B and A2B; Rh factor with determination of D and d; detection of Rh' and Rh"; detection of irregular alloantibodies; detection of immune antibodies anti-A and anti-B; screening test for syphilis. The third run uses the P2 programme for identification of detected alloantibodies. The fourth and fifth runs are used with programme P3 for erythrocyte phenotypings: K, C, c, D, D*, e, E, e, C, Le (a), P1, M and N.

Received for publication October 11, 1974
Address for reprints: Dr. M. Garretta, 6, rue Alexandre Cabanel, 75015 Paris, France

†K antigène—Centre Régional de Transfusion Sanguine de Lille, 21, rue Camille Guérin—59000 Lille, France

§Roche Bioélectronique B.P. 40—92212 Saint Cloud, France
One important point is the photometric reading of the reactions. The liquid mass contained within each cuvette is submitted to two measurements of opacity: a central reading and a peripheral annular reading. Each central measurement is classed as positive or negative by comparison with a threshold level. Each peripheral measurement is classed as negative, positive, or weakly positive by comparison with two threshold levels, a low and a high. The central and peripheral measurements are compared, and a negative response is characterized by absence of any variation in light intensity. On the contrary, a normal positive response includes some variation in opposite directions.

The detection of syphilis is made in programme P1 in channel 10. The grouping data give rise to a black printing of digits from 0 to 9, which are a function of the absence or presence of agglutination. The results are now printed out on self-adhesive labels and simultaneously on an 80-column punched card through the IBM card punch machine. The central threshold is adjusted at 3, the low peripheral threshold at 2, and the high peripheral threshold at 3. The central calibration is identical with that used for haemagglutination. The peripheral calibration is made in two steps on a real test: on a negative reaction for the peripheral zero, and on a one plus positive reaction for the peripheral maximum. Lastly, simultaneously with the acquisition and print-out of the characteristics of the reactions, an electromechanical reader records the identification number of the corresponding sample. The results are, in this way, attributed to the tested sample with no possibility of error.

**REAGENT**

We use a reagent developed in the CNTS laboratories, the GAST from the K antigen prepared by M. G. Chateau at the Regional Blood Transfusion Centre in Lille. Antigen for this test is an alcoholic solution containing cardiolipin, cholesterol, and colloidal benzoin gum. It is coloured by amido black and this stabilized suspension is calibrated to about 2 μ. The antigen–coated inert particles are placed in a special medium permitting collection of possible agglutinates. This reagent is now produced commercially in Lille and each lot of antigen is serologically standardized by proper comparison with an antigen of known reactivity. It is kept at +4°C, but must be used at room temperature (+18°C to +23°C), either by rewarming it in a water-bath for 20 min. at +37°C, or by leaving it at least 4 hrs at laboratory temperature. The reaction works in one step; one aliquot of 0-1 ml of plasma is mixed in the cuvette with one aliquot of 0-1 ml of GAST.

**SAMPLES TESTED**

63,848 specimens were classified into two categories: known samples already tested by all methods and screened samples (Fig. 2).

The known samples came from the Alfred Fournier Institute and had been stored frozen at —20°C. at the CNTS. They were accidentally frozen and thawed and we were compelled to use as a reference the modified RPR slide test. The first part (A) contained 2,500 samples of sera, 752 of which were positive; the second part (B) comprised 2,712 samples of plasma, 894 of which were positive.

The 58,636 screened samples were all obtained from volunteer blood donors (C). As in the case of the other plasma samples, they were collected in Vacutainers.

*Groupamatic automated syphilis test

†Becton Dickinson France—1, Place Gustave Eiffel Cedex L 222—94533 Rungis, France
will be briefly discussed at the end of this report. All the specimens of Series C were also tested on single-channel continuous flow systems, with checking of positives by the RPR test. Here, also, the positive results were confirmed by fluorescent antibody and treponemal tests.

Results

After preparation, the reactions may appear as follows (Fig. 3):

(1) Normal negative reaction: slightly bluish turbid and homogeneous liquid mass.

(2) Doubtful positive reaction ±: a little central opaque spot surrounded by a first peripheral area relatively opaque and a second turbid peripheral area.

(3) Positive reaction +: central spot of about 4 mm., very opaque, surrounded by a less transparent area.

(4) Positive reaction ++: central spot of about 8 mm., very opaque, surrounded by a very transparent area.

SERIES A. KNOWN SERUM SAMPLES TESTED BY ALL METHODS (Table I)

(1) 555 positive specimens were at least ++ in modified RPR slide test

The agreement of the GAST and RPR tests on the 555 specimens in this study was 99.8 per cent. Only one positive sample was not detected, but it has not been possible to test it again.

(2) 134 positive samples were + to ± in modified RPR slide test

Seven specimens (5.2 per cent.) were not detected, mainly corresponding to the weaker doubtful reactions in the modified RPR test.

(3) 63 positive samples were + to ± in modified RPR slide test, but were sometimes negative in traditional screening tests

The percentage of false negatives was 4.8 per cent. (three samples out of 63). These three specimens also gave weak doubtful reactions in the modified RPR test.
TABLE I  Series A  Tests performed on serum samples

<table>
<thead>
<tr>
<th>Number of samples</th>
<th>Tests performed on fresh serum</th>
<th>Tests performed on serum after freezing-thawing (once)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reiter</td>
<td>Kolmer</td>
</tr>
<tr>
<td>555</td>
<td>NT</td>
<td>+ + +</td>
</tr>
<tr>
<td>(Doubtful reactions)</td>
<td>NT</td>
<td>+ + +</td>
</tr>
<tr>
<td>63</td>
<td>NT</td>
<td>+ + +</td>
</tr>
<tr>
<td>1,748</td>
<td>NT</td>
<td>- - -</td>
</tr>
</tbody>
</table>

NT = Not tested

(4) 1,748 negative specimens

45 samples (2-6 pe cent.) were found to be falsely positive. Some of them were only spotted by visual control, the automatic reading being negative.

SERIES B. KNOWN PLASMA SAMPLES TESTED BY ALL METHODS (Table II)

It was in this series that the samples had been accidentally frozen and thawed, and the difference in results between the tests performed on fresh serum at the Alfred Fournier Institute and those performed on plasma at the CNTS were sometimes fairly large. This is why we used the modified RPR slide test as a reference test.

1) 389 positive samples were ≥+ in modified RPR slide test

384 specimens out of 389 were detected; the per-

TABLE II  Series B  Tests performed on plasma samples

<table>
<thead>
<tr>
<th>Number of samples</th>
<th>Tests performed on fresh serum</th>
<th>Tests performed on plasma after freezing-thawing (several times)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reiter</td>
<td>Kolmer</td>
</tr>
<tr>
<td>389</td>
<td>+ + +</td>
<td>+ + +</td>
</tr>
<tr>
<td>(Doubtful reactions)</td>
<td>+ + +</td>
<td>+ + +</td>
</tr>
<tr>
<td>30</td>
<td>+ + +</td>
<td>+ + +</td>
</tr>
<tr>
<td>(Dissociated reactions)</td>
<td>+ + +</td>
<td>+ + +</td>
</tr>
<tr>
<td>228</td>
<td>+ + +</td>
<td>+ + +</td>
</tr>
<tr>
<td>(Dissociated reactions)</td>
<td>+ + +</td>
<td>+ + +</td>
</tr>
<tr>
<td>15</td>
<td>AC</td>
<td>AC</td>
</tr>
<tr>
<td>(Doubtful reactions)</td>
<td>- - -</td>
<td>- - -</td>
</tr>
<tr>
<td>1,615</td>
<td>- - -</td>
<td>- - -</td>
</tr>
<tr>
<td>69</td>
<td>AC</td>
<td>AC</td>
</tr>
<tr>
<td>194</td>
<td>+ + +</td>
<td>+ + +</td>
</tr>
</tbody>
</table>

NT = Not tested

AC = Anticomplementary
centage of false negatives was 1.3. Here again, it was impossible to re-test these samples.

(2) 232 positive samples were \( \pm \) to — in modified RPR slide test

We noticed that the majority of these samples gave doubtful Kline and Kahn reactions on fresh serum. Out of 232 positive samples, only the 134 (57.8 per cent.) RPR positive samples can be considered as positive for the purposes of our comparison. Only 71 were detected with the GAST, which represents 30.6 per cent. of the total number, or 52.9 per cent. of the number of RPR positive samples.

(3) 30 positive samples were \( \geq + \) in modified RPR slide test but were negative in one or several traditional tests

The percentage of false negatives was 16.7 per cent. (five samples out of thirty); all gave negative reactions in both Kline and Kahn tests.

(4) 228 positive samples were \( \pm \) to — in modified RPR slide test, but were negative in one or several traditional tests

Only the 111 samples detected with the modified RPR can be considered as positive (48.7 per cent. of all the specimens). We detected only 49 samples with the GAST, i.e. 44.1 per cent. (21.5 per cent. of all the specimens).

(5) 15 positive samples, all of which were anti-complementary in haemolysis reactions on fresh serum

Eleven out of fifteen were detected (73.3 per cent.) The four false negative samples all gave doubtful reactions in traditional flocculation tests.

(6) 1,615 negative specimens

72 samples were considered as falsely positive (4.5 per cent.). More than half of them were spotted only by visual control and not by the machine.

(7) 69 negative specimens, all of which were anti-complementary in haemolysis reactions on fresh serum

The percentage of false positives was 2.9 per cent. (two samples out of 69).

(8) 194 negative specimens, but all giving false positive results in haemolysis reactions on fresh serum

Six samples out of 194 were detected, i.e. 3.1 per cent. of false positives with the GAST.

**SERIES C. SCREENED SAMPLES (Fig. 4)**

58,636 samples were tested. 65 (1.1 per 1,000) were detected and found positive in the FTA and TPI. Only one of them was \( < + \) on the Groupamatic machine, the 64 others being \( \geq + \). We checked 2,852 samples which were not completely negative on the Groupamatic, but were detected by the automatic reading or visually. All these samples were negative with the modified RPR manual test, as well as the TPI and the FTA. Among these, only 856 were considered to be true false positives, i.e. 1.4 per cent.

**FIG. 4 Series C—Results of screened samples**

of all the plasmas tested. The others were all \( < + \) on the machine and most of these readings were caused by electromechanical unit problems, in particular stopping of the conveyor belt. This point is very important for the automatic reading of the reaction: there is no problem at all for the photometer to detect a reaction \( \geq + \) with the GAST. We noticed that all the positives were in fact \( \geq + \).

**REPRODUCIBILITY OF THE GAST**

Evidence for the reproducibility of the GAST is presented in Fig. 5. In these experiments, forty selected specimens were tested each time we processed the GAST. Except for one doubtful result, complete agreement was obtained in all cases.

**FIG. 5 Reproducibility of GAST on forty selected specimens tested repeatedly**

**RELATION BETWEEN THE GROUPAMATIC AUTOMATIC READING AND THE VISUAL INTERPRETATION (Fig. 6)**

We selected a sample giving \( +++ \) with the modified RPR slide test and performed nine dilutions from 1/10 to 9/10. There is a close relationship between the two kinds of readings. There is no problem for the Groupamatic machine except for the doubtful
RPR reaction. This one lies just below the threshold, and this is the limit of the automated reading in routine work.

![Diagram showing modified RPR microscopic reading](image)

**FIG. 6 Automatic reading of reactions. Comparison between Groupamatic results and modified RPR (microscopic reading) results**

**Discussion**

It is obvious that the aim of a syphilis screening technique is to detect in the blood antibodies denoting the infection. Their time of appearance and evolution are now well known (Faure, 1958; Aho, 1967; Lassus, Mustakallio, Aho, and Putkonen, 1967). The earliest appear 30 to 40 days after infection, about 2 weeks after the appearance of the primary lesion. Antibodies detected by immunofluorescence reactions are the earliest closely followed by those detected by passive haemagglutination (TPHA) (Vaisman, Paris-Hamelin, and Fustec-Ibarboure 1974), then reagents and anti-Reiter protein (group) antibodies appear simultaneously. Antibodies detected by the TPI test are the last to appear. In the absence of any treatment titres of these antibodies increase and reach their maximum during the secondary stage of the disease. They stay at the same level for years and can then decrease progressively. The earlier the treatment, the sooner antibodies disappear, beginning with reagins and anti-Reiter protein antibodies. The others persist longer and may even remain despite proper treatment.

Requirements of serological tests for syphilis have always been two, namely specificity and sensitivity (Moline and Paris-Hamelin, 1974). In a Blood Transfusion Centre, the technique used should be simple, cheap, and quick. This is why the TPI, FTA, and TPHA have not hitherto been used for screening purposes. At first, reactions detecting anti-Reiter protein antibodies (more specifically using complement fixation) were strongly advised (Bekker, 1959). Results were excellent: 95.3 per cent. agreement with the TPI. The RPCF test is now less used, because of the relatively high number of false positives (Forström, Lassus, and Jokinä, 1969). This leaves reactions using reagins for which many manual methods are or have been used: the haemolysis test of Wassermann (Wassermann, Neisser, and Bruck, 1906) with the variants of Debains, Demanche, and Kolmer (Kolmer, 1942); flocculation tests including the Kahn (1928), Kline (1946), VDRL (Harris, Rosenberg, and Riedel, 1946; Harris, Rosenberg, and Del Vecchio, 1948), and the Rapid Plasma Reagin card test (Portnoy, Brewer, and Harris, 1962; Portnoy, 1963; Walker, 1971). Among these reactions, the RPR appears superior, being accurate, simple, easily readable, sensitive, and reproducible.

The initial trend of automation of routine techniques concerned these anti-lipoidal reactions, especially flocculation reactions on Technicon continuous-flow devices. We have been using this technique at the CNTS and will discuss it. A mixed technique using flocculation and complement fixation has been described by Lockyer (1970); Glenn and Turnbull (1971) used another analyser to automate the Wassermann reaction; Coffey, Jue, Thomas, Bradford, and Wood (1970) described an automation of the immunofluorescence technique. All the results seem satisfactory for screening purposes with a minimum concordance of 90 per cent. with the reference reactions. Our aim is not to compare here the GAST reagent with all types of syphilis screening or diagnostic techniques. We wish to see how this automatic screening test for reagins can replace other flocculation tests. We do not expect the test to be used diagnostically and a positive reaction should indicate the use of the more specific tests.

Our goal has been to obtain an automatic flocculation test having specificity and sensitivity compatible with the routine work of a Blood Centre. Our reference test has been the modified RPR slide test performed on samples processed by the CNTS (Series A and B). These samples had been frozen and thawed and thus their initial reactivity was often decreased. Tests performed at the Alfred Fournier Institute (RPCF, Kolmer CF, Kline, Kahn, TPI, FTA-200, FTA-ABS, TPHA) were all made with fresh serum and we should have found discrepancies not imputable to the GAST reagent. This phenomenon is well known in basic immunology, and one can recall the experiment of Price as described by Girond (1957), where positive syphilitic samples underwent long transportation. Either a decrease or an increase in the reagent concentration was found. Furthermore, the appearance of non anti-treponemal antibodies resulted in an increase of false positive reactions.

Samples of Series A (all were sera) underwent only one normal process of freezing/thawing and one can establish a steady decrease in reaction intensity without any discrepancy. Some samples with a doubtful positive RPR were found positive when the initial flocculation tests were negative. As far as positive samples (whatever the technique used) are concerned,
the percentage of Groupomatic false negatives was 0·18 per cent., which represents actually only one
discrepancy in a sample which could not be tested
again. Thus the results are excellent for this set of
samples. As far as weak and doubtful reactions
are concerned, the percentages of false negative
samples with the Groupomatic were respectively 5·22
and 4·76 per cent. which is quite reasonable for an
automatic screening test.

As far as Series B is concerned, all samples tested
at the CNTS were of plasma collected with EDTA-
K3. They underwent several freezing/thawing pro-
cesses and clear discrepancies appear between the
RPR performed on these plasma samples and
floculation reactions initially performed on fresh
sera. Detection of weak, moderate, and strong
positive samples on the Groupomatic did not raise
any problem: the percentage of false positives was
estimated at 1·3. As far as very weakly positive or
doubtful samples are concerned, we find the same
problems as before, the percentages of false negatives
being respectively 47, 16-7, 55-8, and 0 per cent.
(see Table II). The significance of these samples is
a matter of opinion in relation to transfusion, but one
should take into consideration the inferior sensitivity
of the GAST reagent for samples giving dissociated
or doubtful reactions with the four usual screening
techniques.

The percentage of false positives found in Series A
was 2·6 per cent. and in the three groups of Series B
4·5, 2·9, and 3·1 per cent. respectively. It should
be mentioned that we have considered as false positive
all reactions which were not strictly and homogene-
ously negative, which explains this relatively high
number of false positives. On the other hand, we
have been able to make a detailed study of 2,852
false positive results found among 58,636 samples
tested in Series C. Only 856 of them (1·4 per cent.)
were true false positives. This is very reasonable for
a screening procedure, since these samples are
tested again by manual techniques.

It seems to us that this automated screening
technique on Groupomatic systems, using a cardio-
lipid antigen, meets the needs of a Blood Transfusion
Centre. Sensitivity is very good for strong reactions
(more than +) but low for samples with doubtful
or dissociated reactions. Reproducibility among
batches was tested on forty samples of different
reactivity and appeared to be excellent (see Fig. 5).
Automatic reading of reactions is fair. The relations,
for different dilutions of a positive plasma, between
the reactivity examined by the charcoal RPR tech-
nique read under the microscope and the automatic
reading by the Groupomatic are given in Fig. 6. No
problem appeared except for a doubtful sample, the
reading of which was below the threshold of the
photometer. This confirms that a quick visual check
of every disc is worthwhile, as is done by us for
immunohaematological reactions. It would be pos-
able to detect these samples automatically, by
decreasing the low threshold of the photometer, but
this would not be acceptable, since micro-strings of
fibrin appear even when collection is by Vacutainer.
Prints-out up to 2 can then appear, which is not
compatible with routine work (Garretta, Muller,
André, Moulec, and Matte, 1973b).

All of these results demonstrate the very clear
advantages of the Groupomatic over the continu-
ous-flow techniques. They bear most of all on the absence
of contamination between samples, the automatic
reading and printing-out of results, and the rapidity
of the reactions in that 340 tests are performed per hr.
In our preliminary report (Garretta and others,
1973a), we compared the results of the mono-channel
Technicon and the Groupomatic, and found for the
former a percentage of false positives of 3 to 4 per
cent. The GAST sensitivity for strongly positive
samples was already excellent, which was not always
the case with our single-channel autoanalyzers, as
the size of the clump did not allow it to pass through
the appropriate tubing; this problem had already
been raised by other workers, notably by Schroeter
and others (1971). Finally, we had the same diffi-
culties with the weak samples no matter what the
technique. When the final results for the auto-
analyzers were reviewed, they proved to be much
worse than we had imagined in certain series, es-
pecially as regards the false negatives. In Series A,
the number of false negatives was 18, 62, and 65
per cent.; in Series B, this figure varied between 17
and 63 per cent. depending on the sample groups.
The number of false positives in Series A was 3·4 per
cent.; and that in Series B varied between 8·6 and
12·3 per cent.

The results obtained with our autoanalyzers, under
conditions quite similar to those of the GAST
evaluation, and assessed blindly, were much inferior.
These results relate to 5,212 samples of which 1,646
were positive. What explanation is there? The first
possibility concerns the way the machines are used;
it appears, however, that their use is sufficiently
simple for our staff so that their operation should
be error-free. Again, the explanation does not seem
to lie with the antigen; the GAST includes, as basic
antigen, the same antigen used in the continuous-flow
autoanalyzer, but with much better results. Finally,
the tested samples were identical with the two auto-
matic techniques. We can but state these results and
bring to mind what some of us have found recently
(Paris-Hamelin, Vaisman, and Fustec-Ibarboure,
1974) regarding the basic antigen used in the RPR
card test and the ART (automatic reagin test); this
antigen used manually on plasma, or on serum gave
excellent results; the use of a continuous-flow auto-
analyzer was so disappointing that it had to be given
up. The ART antigen was not at fault, but rather the
modified technique for this type of automatic equipment.

Bessemans and Derom (1946) showed that blood, serum, and plasma were capable, even in small amounts, of transmitting syphilis. They insisted on the now obvious fact that apparent health and negative serology did not guarantee the safety of the blood. Mollison (1972) stated that 35 per cent. of cases of primary syphilis are serologically negative. One of us (Vaisman, 1958) estimated that the phases during which blood is most infectious are the incubation phase, the primary phase, and the secondary phase. There is therefore no serological safety net during the incubation phase and for part of the primary stage. The data concerning the survival time of T. pallidum under conditions of blood transfusion are contradictory, and we are now working on this subject. Furthermore, an investigation involving dermatologists, neurologists, and cardiologists is planned, in which recipients who have been exposed to risk of infection will be followed-up.

Summary

A flocculation reaction employing a cardiolipid antigen was used for syphilis screening on Groupamat equipment in parallel with conventional screening reactions: Kolmer CF, RPCF, Kahn, Kline, and RPR. The positive samples were confirmed by FTA-200, FTA-ABS, TPI, and in some cases by TPHA.

There were 5,212 known samples which had already been tested by all methods and of which 1,648 were positive, and 58,636 screened samples including 65 positives. Half of the samples in the first series were taken without anticoagulant; the remainder were collected in potassium EDTA.

The percentage of false positives with the Groupamat was about 1.4 per cent. The percentage of false negatives among positive (≥ +) samples varied from 0.18 to 1.3 per cent.; on the other hand the sensitivity was less good for samples giving doubtful and/or dissociated reactions in conventional screening reactions.

The specificity and sensitivity of this technique are acceptable for a blood transfusion centre. The reproducibility is excellent and the automatic reading of results accurate. Additional advantages are rapidity (340 samples processed per hour); simultaneous performance of eleven other immunohaematological reactions; no contamination between samples; automatic reading, interpretation, and print-out of results; and saving of time because samples are not filed sequentially and are automatically identified when the results are obtained.

Although the importance of syphilis in blood transfusion seems small, estimates of the risk are difficult and further investigations are planned.

We wish to extend our grateful appreciation to our technicians, I. de Jerphanion, H. Cohen, S. Beauissant, D. Breuil, and S. Fustec-Ibarboure.

References

FAURE, M. (1958) Transfusion (Paris), 1, 107
GIRRONE, J. (1957) Sem. méd., 33, 449
KLINE, B. S. (1946) Amer. J. clin. Path., 16, 68
KOLMER, J. A. (1942) Ibid., 12, 109
STOUT, G. W., and FALCON, V. H. (1968b) Amer. J. med. Technol., 34, 634
VAISMAN, A. (1958) Transfusion (Paris), 1, 88