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Evaluation of an automated algorithm for interpretation of lupus anticoagulant testing

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Abstract

Introduction: Lupus anticoagulant (LAC) testing is a multistep procedure including screening, mixing, and confirmation tests. STA Coag Expert is a software module for STA R Max and STA Compact Max analyzers which includes an on-demand LAC algorithm, based on ISTH guidelines, for automatic interpretation, calculation, and launch of assays in LAC interpretation ("Stago coag algorithm").

Materials and methods: One hundred ninety four patient samples were analyzed in parallel and interpreted manually and automatically by LAC algorithms. LAC algorithms use identical flowcharts and cutoff values as in daily practice. Differently, it only uses index of circulating anticoagulant (ICA), whereas in routine also normalized ratios were assessed for interpretation of mixing tests. Interpretation of dRVVT and aPTT pathways and final conclusions were compared between both approaches.

Results: Compared to routine interpretation, LAC algorithm showed a sensitivity of 94% and a specificity of 100% for LAC detection, when discrepancies due to measured clotting times between both analyzers were excluded. Three false negatives were due to different interpretation of dRVVT mixing test. Discrepancies in interpretation of the aPTT mixing test (n = 11) did not result in discrepant final LAC result, all having negative confirmation tests. No false positives were observed. With LAC algorithm, hands-on time reduced from 200 to 80 minutes.

Conclusion: The LAC algorithm of the STA Coag Expert shows good comparability to the manual interpretation of LAC and may be used to assist laboratories in automatic launching of additional tests and in interpretation of LAC according to ISTH guidelines. This way the STA Coag Expert LAC algorithm may improve interlaboratory and STA comparability of LAC results.

KEYWORDS

evaluation, lupus anticoagulant, lupus anticoagulant algorithm, rules engine, STA R Max

1 | INTRODUCTION

The antiphospholipid syndrome (APS) is defined in a patient if at least one clinical and one laboratory criterion are fulfilled. The clinical criterion is characterized by the manifestation of recurrent vascular thrombosis and/or pregnancy morbidity. For the presence of the laboratory criterion, antiphospholipid antibodies (APA) must be demonstrable in patient's plasma on two or more occasions at least 12 weeks apart. As the incidence of the clinical symptoms is high and symptoms may be attributable to many other underlying factors, diagnosis of the APS relies mainly on the laboratory criterion. The laboratory detection of aPL consists of phospholipid-dependent coagulation tests for the detection of lupus anticoagulant (LAC) and immunoassays for the measurement of anti-cardiolipin antibodies

and anti-beta-2 glycoprotein I antibodies.[1] Detection of LAC in the laboratory is subject to some difficulties in standardization: The spectrum of aPL is heterogeneous and variable, the assay consists of a multistep testing procedure with a screening, mixing, and confirmation step, and many different assay principles and reagents are available, possible interference of anticoagulant medication and lack of a gold standard.[2,3] In 2009, the Scientific and Standardization Committee (SSC) of the International Society on Thrombosis and Haemostasis (ISTH) published recommendations for LAC detection, specifying who, when, and how to test for LAC, thereby aiming to improve the harmonization of the assay.[4]

Despite these recommendations, performance and interpretation of LAC tests remain a challenge.[3,5] Besides inadequate standardization of assays, differences in local working conditions and difficulties in correct interpretation of the results may lead to false results. Interpretation of the different steps in the LAC test procedure is based on exceeding the local cutoff values expressed as normalized ratio to normal pool plasma. Except for the mixing step, the ISTH guideline also allows the interpretation through the Rosner index (index of circulating anticoagulant) as an alternative for the measured clotting time.[4] The presence of anticoagulant medication impedes correct interpretation, since vitamin K antagonists may give false-negative results in the mixing step and direct oral anticoagulant therapy may cause false-positive results.[6] Standardized interpretation according to the in-house established cutoff values of all three steps benefits harmonization and reproducibility of the final LAC results. Also, generating comments on the result, especially in anticoagulated patients, and a global final conclusion help the clinician in the interpretation of the result.[4]

An automated algorithm with launch of the mixing step and confirmation step based on predefined cutoff values and calculations without need for intervention from the laboratory technician may benefit a uniform method of LAC detection and a standardized interpretation reducing the intralaboratory and interlaboratory variation. STA Coag Expert is a software module for Stago STA R Max & STA Compact Max analyzers including an on-demand LAC algorithm. We evaluated this algorithm and compared it with the manual LAC interpretation.

2 | MATERIALS AND METHODS

2.1 | Patient samples

One hundred ninety four samples with LAC request, due to a diagnostic work-up of hypercoagulability, pregnancy complications, autoimmune disease, or a prolonged activated partial thromboplastin time (aPTT), were analyzed at the Ghent University Hospital. Patients treated with anti-vitamin K therapy (VKA), direct oral anticoagulant therapy (DOAC), unfractionated heparin (UFH), or low molecular weight heparin (LMWH) were included. Samples were drawn and prepared according to the guidelines.[4] Samples were stored at −20°C for a maximum of one week until analysis in batch. This study was approved by the ethical committee of the Ghent University Hospital.

2.2 | Lupus anticoagulant testing

Lupus anticoagulant testing was performed in our routine practice according to the ISTH guidelines on STA-R Evolution (Stago, Asnières, France) and in parallel with the automated LAC algorithm, only available on STA R Max (Stago).[4]

In routine practice, LAC screening tests were carried out in two systems with an aPTT (PTT-LA®, Stago) and a dilute Russell's viper venom time (dRVVT) (STA-Staclot® dRVV Screen, Stago). For mixing tests, patient plasma was diluted 1:1 with pooled normal plasma (NPP), prepared in-house by mixing citrated plasma from 75 healthy volunteers. Confirmation tests were performed in aPTT with hexagonal phase phospholipids (Staclot® LA, Stago) and in dRVVT with a phospholipid-rich dRVVT reagent (STA-Staclot® DRVV confirm, Stago).[4] The Staclot® LA aPTT confirmation test was performed only on STA-R Evolution and was not repeated on STA R Max, since this is a partly manual assay (incubation of patient's plasma with and without hexagonal phase phosphatidylethanolamine occurs outside the analyzer, samples are only placed onboard after incubation for measurement of aPTT). For each batch analysis of 30 patient samples, a NPP sample was analyzed to be used for normalization of the clotting times to achieve clotting time ratio's for screening, mixing, and confirm assays.[4] Local cutoffs for screen, mixing, and confirm tests were calculated by the 99th percentile on 120 healthy donors and were similarly applied in the software program and with the manual interpretation. A quality control sample preceded every run of patient samples. In routine practice, mixing tests were performed if calculated normalized clotting time ratio's (NCR) for aPTT and/or dRVVT exceeded the normalized cutoff ratios. The confirmation step for prolonged dRVVT was performed independent of the result of the mixing test. A confirmation test for prolonged aPTT was performed if the NCR or index of circulating anticoagulant (ICA) of the mixing test for aPTT exceeded the cutoffs. LAC was considered positive if (a) the screening step was prolonged, (b) the mixing test ratio (either NCR and/or ICA) was prolonged, and (c) the confirmation step was exceeded the normalized reference ratio.[4] With the LAC algorithm on STA R Max, the same procedures were applied, except that the algorithm only uses ICA for interpretation of the mixing step and not the normalized ratio. LAC algorithm on STA R Max was compared to routine analysis of LAC on STA-R Evolution in terms of interpretation, reagent consumption, and hands-on time on the analyzer.

2.3 | STA Coag Expert

STA Coag Expert is a software module for Stago STA R Max and STA Compact Max analyzers (Stago, Asnières, France) that includes a LAC algorithm, specific mathematical rules for automatic launching of screening, mixing, and confirm assays without need for intervention from the laboratory technician. Local cutoffs are user-defined parameters within the software, that are configured when the software is installed. Test results are calculated and interpreted by the algorithm and recommendations for actions for the different results

are proposed. LAC algorithm was developed by Stago in collaboration with an expert group, following ISTH guidelines.[4]

Applying other guidelines (for instance from the Clinical and Laboratory Standards Institute (CLSI)[7]) would have affected the structure of the algorithm since guidelines differ at some points. The main issues that would have been different are as follows: order of screening, mixing, confirmation step, the choice of assays, and normalization of results.[7]

According to the ISTH guidelines, the order of the multistep procedure is screening, mixing, confirmation, also for paired tests, to avoid false-positive results.[3,8,9] The CLSI guideline advises for paired tests (dRVVT) to perform the mixing step if the confirmation step is negative, so the order of screening, mixing, and confirmation step differs between both guidelines.[7] To reduce the number of false positives and to obtain more harmonization in LAC testing, the ISTH guidelines recommend aPTT and dRVVT tests, and do not recommend other assays to be included. CLSI guidelines prefer also aPTT and dRVVT, but do not exclude other assays. In the evaluated algorithm, only aPTT and dRVVT are included. The interpretation of results is determined by the cutoff values and plays a major role in classifying a sample as LAC positive or negative. The software allows to use the local cutoff values. Although calculation of cutoffs differs between the guidelines, this will not hamper using the algorithm since the user can configure the software with own cutoff values. In the ISTH guidelines, normalization of results is performed by applying the value of a normal pooled plasma performed in each run. CSLI allows the use of a reference mean for each batch of reagent. Using a fixed value to normalize results is not possible in the algorithm the way it is now configured.

The algorithm is illustrated in Figure 1.

3 | RESULTS

3.1 | Lupus anticoagulant interpretation of dRVVT system

Tables 1 and 2 show the results of dRVVT pathway, aPTT pathway, and final LAC interpretation on both Stago instruments. Out of 194 samples, 37 were positive in dRVVT system (positive screening, mixing, and confirmation test) for both routine interpretation and with LAC algorithm and 143 were negative with both systems, yielding a sensitivity of 76% and a specificity of 99% for LAC algorithm on STA R Max, as compared to the results obtained without the algorithm on STA-R Evolution. Two false-positive results were observed on STA R Max, due to differences in measured seconds in screening test between both analyzers, and not due to differences in LAC interpretation (routine interpretation vs LAC algorithm). Twelve false-negative results were observed on STA R Max: nine false negatives were due

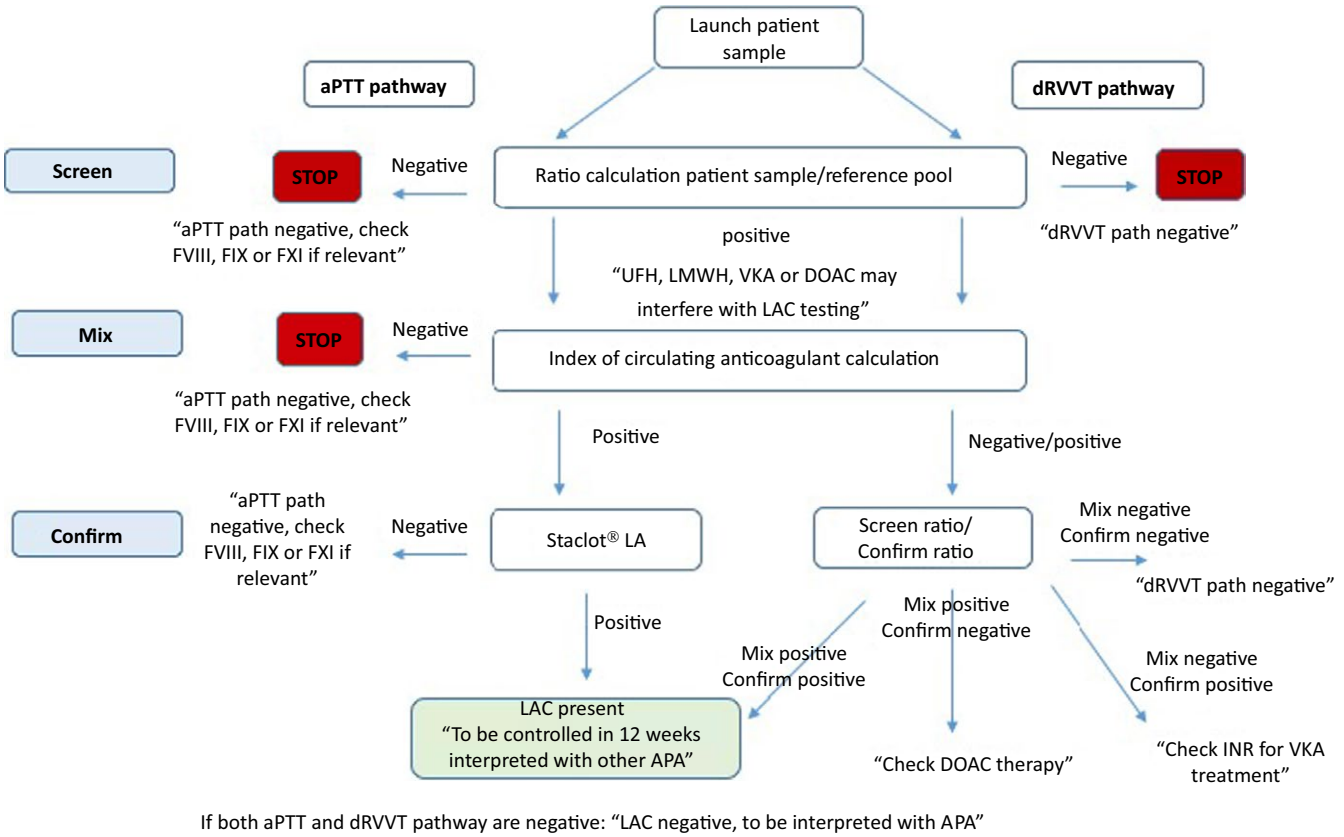

FIGURE 1 Flowchart of the lupus anticoagulant algorithm as applied by the STA Coag Expert software of Stago. "…" depict comments proposed by the software. APA, antiphospholipid antibodies (anti-cardiolipin and anti-β2 glycoprotein I antibodies) [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 1 2 x 2 contingency table for screen, mixing step, confirmation, and conclusion of dRVVT pathway (A) and aPTT pathway (B)

LAC algorithm on STA R Max	Routine LAC interpretation on STA-R evolution			
		Positive	Negative	Total
(A) dRVVT				
Screen	Positive	65	3	68
	Negative	2	124	126
	Total	67	127	194
Mix	Positive	49	0	49
	Negative	10	8	18
	Total	59	8	67
Confirm	Positive	51	1	52
	Negative	3	12	15
	Total	54	13	67
Conclusion	Positive	37	2	39
	Negative	12	143	155
	Total	49	145	194
(B) aPTT				
Screen	Positive	60	1	61
	Negative	5	128	133
	Total	65	129	194
Mix	Positive	31	0	31
	Negative	20	14	34
	Total	51	14	65
Confirm	Positive	20	0	20
	Negative	0	31	31
	Total	20	31	51
Conclusion	Positive	16	2	18
	Negative	3	173	176
	Total	19	175	194

LAC algorithm on STA R Max was compared to routine LAC interpretation on STA-R Evolution

TABLE 2 Number of positive and negative results for final conclusion of lupus anticoagulant applied by LAC algorithm on STA R Max, compared to routine LAC interpretation on STA-R Evolution

LAC algorithm on STA R Max	Routine LAC interpretation on STA-R Evolution		
	Positive	Negative	Total
LAC conclusion			
Positive	43	0	43
Negative	11	140	151
Total	54	140	194

to discrepancies in measured clotting times and three false-negative results were caused by differences in interpretation of dRVVT mixing test. For these three samples, the NCR was positive and the ICA was negative in routine practice,[10,11] which resulted together with a positive screening and confirmation test in a positive LAC result, whereas ICA was negative on STA R Max, causing a negative LAC interpretation. In conclusion, of 194 analyzed samples, 14 discrepancies were observed in dRVVT test between both platforms, but only 3/14 discrepancies were due to different interpretation of LAC.

3.2 | Lupus anticoagulant interpretation of aPTT system

In the aPTT system, 16 samples were positive on both platforms and 173 samples were mutually negative, yielding a sensitivity and specificity of the LAC algorithm on STA R Max of, respectively, 84% and 99%. Five discrepant results were observed: two false positives and three false negatives, all due to differences in measured clotting times. Four out of five discrepancies did not result in a discrepancy in final LAC interpretation since dRVVT system was positive on both platforms for those samples. Twenty discrepancies occurred in aPTT mixing test, nine due to differences in clotting times and 11 due to a positive NCR but a negative ICA.[10,11] However, the 20 false-negative aPTT mixing tests with LAC algorithm on STA R Max did not result in a difference in LAC interpretation since the aPTT confirmation tests were negative.

3.3 | Final LAC conclusion

For final LAC conclusion, there were no false-positive results of LAC algorithm on STA R Max compared to routine interpretation on STA R Evolution, since the false positives in the dRVTT system (n = 2) were positive on both platforms in the aPTT system, and vice versa the false positives in the aPTT system (n = 2) were positive on both platforms in the dRVVT system, resulting in a specificity of 100% compared to routine interpretation.

Eleven false-negative results were observed (10 in dRVVT system and one in aPTT system), yielding a sensitivity of 80%. Three out of 11 discrepancies were due to the different interpretation of dRVVT mixing test, the other eight discrepancies were caused by differences in measured seconds on both platforms. Excluding these eight samples, sensitivity of LAC algorithm for detection of lupus anticoagulant increased to 94%, and specificity remained at 100%.

3.4 | Comments on results

The STA Coag Expert software appended comments to the results of aPTT and dRVVT screen, mixing, and confirmation steps (Figure 1). When aPTT screen, mix, and/or confirm were negative, a comment was generated to check for clinically relevant intrinsic factor deficiencies of factor VIII, IX, or XI, which may also prolong the aPTT and can cause bleeding tendency. Alternatively, when aPTT and/or dRVVT screen were positive, an automated comment warned that unfractionated heparin (UFH), LMWH, VKA, or DOAC may cause interference with LAC testing. A prolonged dRVVT confirm ratio may be provoked by VKA or DOAC therapy, and thus, the comment

"check VKA or DOAC therapy" was added by the software in this situation. Different comments were possible for the interpretation of the dRVVT pathway, depending on the combination of the results of the mixing and confirmation step. A negative mixing step but a positive confirmation step may be due to VKA therapy, so the software proposed to check international normalized ratio (INR).[8,9] Conversely, when mixing step was positive but confirmation step was negative, the STA Coag Expert software advised to check DOAC therapy. Meanwhile, experience with DOAC has learned, depending on the type of DOAC, the level of DOAC, and the reagent used, that DOAC can influence all clotting tests in LAC measurement, mainly affecting the dRVVT test system. A warning for DOAC at each level of a positive dRVVT test should be more appropriate.[12] A final conclusion was given for every sample, depending on results of aPTT and dRVVT pathway. If positive, it was advised by the software to confirm LAC in 12 weeks and to interpret results together with the other APA (anti-cardiolipin antibodies and anti-beta-2 glycoprotein I antibodies).

3.5 | Reagent consumption and hands-on time

All LAC tests, except the aPTT confirmation test (Staclot® LA), were run automatically on the STA R Max analyzer, and consequently, all reagents needed to be placed in sufficient quantity onboard prelaunching the LAC assays. Therefore, both methods did not differ in reagent consumption, except for the Staclot® LA aPTT confirmation test. With LAC algorithm on STA R Max, 10% (20/194) less Staclot® LA tests needed to be performed without differences in LAC interpretation (20 aPTT mixing tests negative with LAC algorithm and positive with the routine method, but all with negative Staclot® results). For every run of 30 samples, in our working conditions, hands-on time for the technician on STA R Max decreased by 60% from 200 to 80 minutes since the laboratory technician did not need to supervise and interpret the multistep test procedure once samples were placed onboard.

4 | DISCUSSION

Lupus anticoagulant analysis is complex, including the three steps that are necessary to evaluate the presence of LAC.[4] Many pitfalls in interpretation of LAC may influence the results: The LAC antibodies are heterogeneous, reagents are not standardized, and there is no gold standard.[3] The multistep methodology might be a source of interlaboratory variation based on different interpretation of results. An automated algorithm may contribute to more harmonized performance of the multistep procedure and to more standardized interpretation. In-house developed algorithm or commercially available software modules can contribute to this goal. To facilitate LAC analysis and to increase between-laboratory standardization of LAC interpretation, an automated algorithm launching tests based on defined cutoff values and calculating results was developed by Stago based on expert's recommendations. This algorithm is executed through the STA Coag Expert software module. In this study, 194 patient samples were run on STA-R Evolution with routine interpretation of LAC assays and compared to the automated LAC interpretation with LAC algorithm on STA R Max. LAC algorithm uses the same flowchart and cutoff values for screen, mixing, and confirm assays for dRVVT and aPTT pathways as applied in routine practice. Both routine interpretation of results and LAC algorithm follow the ISTH-SSC recommendations.[4] In the current version of the LAC algorithm, only ICA was implemented for interpretation of mixing tests, whereas in daily practice also NCR was assessed. Although guidelines are not yet adapted on the interpretation of mixing tests, recent studies have shown that the NCR is more sensitive compared to ICA.[10,11]

Differences in LAC results between both methods were mainly due to minor differences in measured clotting times between both analyzers. Only a minority of discrepancies (three out of 194 samples) were due to differences in interpretation between both platforms, all occurring in the mixing assays: For those samples, the NCR of the dRVVT mixing step was positive and ICA negative, resulting together with a positive dRVVT confirmation in a positive LAC result in routine practice, whereas the negative ICA did not result in the launch of a confirmation assay with the LAC algorithm. Eleven comparable discrepancies in the aPTT mixing test did not end in a difference in LAC result since aPTT confirmation tests were negative for these samples. Adapting the algorithm by adding the NCR might solve this problem, but this would require additional evaluation studies. The more that we know that NCR is more sensitive in detecting LAC compared to ICA.[10,13]

Knowledge of an interference due to anticoagulant therapy in a given sample may influence the manual interpretation of LAC and may lead to a different conclusion than when guidelines would be strictly followed. LAC algorithm is in this way less flexible since interfering medication cannot be taken into account. However, the LAC algorithm applies different comments, depending on the results of screening, mixing, or confirmation step (Figure 1) and thereby warns the operator of possible anticoagulant therapy. This way the software aids the laboratory staff in the interpretation of LAC tests and in the launching of additional tests (possible testing for factor deficiencies or interfering anticoagulant therapy). These comments may also be implemented on the laboratory report and thus inform that results for LAC may be unreliable in case of the presence of anticoagulant medication. However, the final conclusion is always revised by the laboratory supervisor who does the clinical validation of the result before the result finally leaves the laboratory. An algorithm will never take over totally the end conclusion.

Since all reagents, except aPTT confirmation tests, needed to be placed onboard before launching the LAC assays on STA R Max, reagent consumption was similar on both analyzers. There was a negligible reduction of 6% of Staclot® LA confirmation tests. Technician's hands-on time on the analyzer was strongly reduced from 200 to 80 minutes, making it possible for the technician to perform other tasks in the laboratory.

Although the Stago LAC algorithm aids in the standardization of LAC interpretation, it is still necessary for each laboratory to

calculate their own cutoffs for screening, mixing, and confirmation tests or at least verify the cutoffs proposed by the manufacturer. In-house cutoff values have to be applied in the algorithm. When necessary due to reagent lot changes, programmed cutoff values can be adapted in the LAC algorithm software.

A limiting factor of this study is that the automated LAC algorithm was compared to the manual method using two different analyzers. Since the LAC algorithm is only available on Stago STA R Max analyzers, it was not possible to compare both approaches on the same analyzer.

Furthermore, the LAC algorithm has been evaluated using Stago reagents. Applying different LAC reagents would require additional evaluation of the algorithm.

The LAC algorithm was designed following ISTH guidelines. Other guidelines (CLSI, British Society for Hematology[7,14]) exist and differ in some ways from the ISTH guidelines.[15] Therefore, the LAC algorithm would not be applicable in laboratories following other guidelines than the ISTH. The rules used in the algorithm cannot be adapted and are fixed.

This study evaluated the diagnostic performance of a first version of a LAC algorithm on the current STA Coag Expert software. When a software update occurs or LAC algorithm is changed, LAC algorithm should be re-evaluated to ensure its performance.

5 | CONCLUSION

We conclude that the lupus anticoagulant algorithm of the STA Coag Expert shows good comparability to the manual interpretation of LAC. LAC algorithm may be applied to assist laboratories in automatic launching of additional tests in interpretation of LAC according to ISTH guidelines and in reducing technician hands-on time. This way, the STA Coag Expert LAC algorithm benefits in the harmonization of LAC interpretation and hence may improve interlaboratory comparability of LAC results.

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CONFLICT OF INTERESTS

The authors have no competing interests.

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REFERENCES

1. Miyakis S, Lockshin MD, Atsumi T, et al. International consensus statement on an update of the classification criteria for definite antiphospholipid syndrome (APS). *J Thromb Haemost*. 2006;4(2):295-306.
2. Devreese K, Hoylaerts MF. Challenges in the diagnosis of the antiphospholipid syndrome. *Clin Chem*. 2010;56(6):930-940.
3. Devreese KM. Antiphospholipid antibody testing and standardization. *Int J Lab Hem*. 2014;36(3):352-363.
4. Pengo V, Tripodi A, Reber G et al. Update of the guidelines for lupus anticoagulant detection. Subcommittee on Lupus Anticoagulant/Antiphospholipid Antibody of the Scientific and Standardisation Committee of the International Society on Thrombosis and Haemostasis. *J Thromb Haemost*, 2009. 7(10):1737–1740.
5. Devreese KM. Standardization of antiphospholipid antibody assays. Where do we stand? *Lupus*. 2012;21(7):718-721.
6. Moore GW. Current controversies in lupus anticoagulant detection. *Antibodies*. 2016;22(5):1-15.
7. Laboratory Clinical. Standards Institute. CLSI H60-A Laboratory Testing for the Lupus Anticoagulant. Approved guideline. 2014.
8. Devreese K. No more mixing tests required for integrated assay systems in the laboratory diagnosis of lupus anticoagulants? *J Thromb Haemost*. 2010;8:1120-1122.
9. Devreese KM, de Laat B. Mixing studies in lupus anticoagulant testing are required at least in some type of samples? *J Thromb Haemost*. 2015;13(8):1475-1478.
10. Depreter B, Devreese KM. Differences in lupus anticoagulant final conclusion through clotting time or Rosner index for mixing test interpretation. *Clin Chem Lab Med*. 2016;54(9):1511-1516.
11. Kumano O, Moore GW. Lupus anticoagulant mixing tests for multiple reagents are more sensitive if interpreted with a mixing test-specific cut-off than index of circulating anticoagulant. *Res Pract Thromb Haemost*. 2018;2(1):105-113.
12. Oxha A, Banzato A, Ruffatti A, Pengo V. Detection of lupus anticoagulant in the era of direct oral anticoagulants. *Autoimmun Rev*. 2017;16:173-178.
13. Moore GW, Culhane AP, Daw CR, Noronha CP, Kumano O. Mixing test specific cut-off is more sensitive at detecting lupus anticoagulants than index of circulating anticoagulant. *Thromb Res*. 2016;139:98-101.
14. Keeling D, Mackie I, Moore GW, Greer IA, Greaves M. Guidelines on the investigation and management of antiphospholipid syndrome. *Br J Haematol*. 2012;157:47-58.
15. Moore GW. Commonalities and contrasts in recent guidelines for lupus anticoagulant detection. *Int J Lab Hem*. 2014;36(3):364-373.

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