COVID-19 IgM/IgG Antibody Test

Diagnostic Sensitivity and Specificity Study Report

Drafted by: Jun Zhang

Approved by: Jerry Zheng

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Management of the study: Artron Laboratories Inc.
R& D Department
Quality control departmen

Table of Contents

Study Summary

The purpose of this study was to obtain accurate information regarding the Diagnostic Sensitivity and Specificity of Artron COVID-19 IgM/IgG Antibody Test at three different evaluation sites from a total of 1162 samples, including 285 SARS-COV-2 positive cases confirmed by RT-PCR and 877 SARS-COV-2 negative samples.

The first evaluation was carried out at Affiliated Hospitals of Chongqing medical University, PRC. A total of 125 serum/plasma samples from COVID-19 infected patients were used: these included 6 asymptomatic infections, 8 patients with symptoms within 7 days, 49 patients with symptoms within 8-14 days, 62 patients with symptoms over 14 days. In addition to this, 123 non-COVID-19 infected sera/plasmas collected before November 2019 and stored in the third Affiliated Hospital, Chongqing medical University were also tested. Among all the chosen samples, Artron COVID-19 IgM/IgG Antibody identified 124 COVID-19 IgM&/or IgG positive samples including 108 IgM positive and 114 IgG positive from 125 COVID-19 infected patients samples.

The Second evaluation was conducted through Otogenetics Corporation in the US at 5 different clinic locations. A total of 780 samples were collected including 89 RT-PCR confirmed SARS-COV-2 positive samples and 691 SARS-COV-2 negative. Artron COVID-19 IgM/IgG Antibody identified a total of 83 COVID-19 IgM&/or IgG positive samples including 78 IgM positive and 80 IgG positive from 89 COIVD-19 infected patients samples.

The third evaluation was conducted by BC CDC. A total 134 samples from hospitalized patients included 71 RT-PCR confirmed SARS-COV-2 positive samples and 63 SARS-COV-2 negative samples were collected. Among all the chosen samples, Artron COVID-19 IgM/IgG Antibody identified 68 COVID-19 IgM&/or IgG positive cases including 67 IgM positive and 65 IgG positive from 71 COVID-19 infected patients samples.

Combine all the results from the three clinic centers: A total of 1162 samples including 285 of RT-PCR confirmed SARS-COV-2 positive sera/plasma/whole blood samples and 877 of RT-PCR confirmed SARS-COV-2 negative sera/plasma or clinic true sera/plasma (collected before Nov. 2019) were used to evaluate Artron COVID-19 IgM/IgG Antibody Test amongst all three clinical evaluations. Out of all the 285 positive samples, Artron COVID-19 IgM/IgG Antibody Test identified 269 of COVID-19 IgM&/or IgG positive cases including 253 of IgM positive; 259 of IgG positive. The diagnostic sensitivity for IgM test was 88.77%; for IgG was

90.88%; the combined sensitivity was 94.39%. The diagnostic specificity for IgM was 98.40%; for IgG was 99.77%; the combined specificity was 98.18%. The overall agreement for IgM and IgG was 96.04% and 97.59%, respectively. The combined overall agreement was 98.18%. The PPV for IgM and IgG was 94.76% and 99.23%, respectively. The combined IgM & IgG PPV was 94.39%. The NPV for IgM and IgG was 96.42% and 97.11%, respectively. The combined IgM & IgG PPV was 99.42%.

1. Purpose

To validate the diagnostic sensitivity and specificity of Artron COVID-19 IgM/IgG Antibody Test.

2. Reference and Compliance

- FDA, CE, CFDA，CMDR guidance for In vitro diagnostic medical device
- The present study conformed to all applicable laws and regulations.

3. Materials

- Positive Samples: Clinical samples collected and stored in local clinical laboratories. COVID-19 positive specimens were confirmed by RT-PCR with local government authorized tests
- Negative Samples: non-COVID-19 sera/plasma were collected before Nov. 2019 or samples from patients who have no exposure to SARS-COV-2 and no febrile, no respiratory symptoms and confirmed SARS-COV-2 negative by authorized RT-PCR tests.
- Local government authorized RT-PCR reagents
- Artron COVID-19 IgM/IgG Antibody Test, Lot:20200408-CF.

4. Study Design:

4.1. The clinical performance was evaluated in SARS-COV-2 infected blood specimens and non- SARS-COV-2 infected blood specimens from subjects in the chosen hospital.

Total at least 100 SARS-COV-2 positive blood samples from RT-PCR confirmed SARS-COV-2 infected patients and 200 non- SARS-COV-2 blood samples from non-febrile and non-respiratory patients should be collected; all the samples should be tested with Artron COVID-19 IgM/IgG Antibody Test.

4.2. Examiner and clinical laboratories

Evaluation Center 1: Clinical Laboratory Department, The third Affiliated Hospital, Chongqing medical University, PRC.

Evaluation Center 2: Otogenetics Corporation (Atlanta, GA, USA), (Detail see the attachment clinic information)

Evaluation Center 3: BC CDC

4.3. Test Procedure:

- All tests were performed by the clinical technicians in the clinical laboratory according to the manufacturer's instructions using the confirmed samples.
- The experiment followed the principle of random double blind.

- Visual interpretations of the results of COVID-19 IgM/IgG Antibody Test were made independently by the clinical technicians.
- The testing center was responsible for summarizing the results.

5. Evaluation Criteria

	C Line	M Line	G Line	Test Result Interpretation
1	Not present	Any	Any	Invalid Test. The specimen must be retested with another device.
2	+	-	-	Valid Test, Negative for antibodies for SARS-CoV-2.
3	+	+	-	Valid Test, IgM positive for antibodies for SARS-CoV-2.
4	+	+	+	Valid Test, IgM and IgG positive for antibodies for SARS-Cov-2.
5	+	-	+	Valid Test, IgG positive for antibodies for SARS-CoV-2.

6. Results

6.1 Results from Evaluation Center 1: Clinical Laboratory Department, The third Affiliated Hospital, Chongqing medical University, PRC.

A total 125 serum/plasma samples from COVID-19 infected patients including 6 asymptomatic infections, 8 patients with symptoms within 7 days, 49 patients with symptoms within 8-14 days, 62 patients with symptoms over 14 days were used. In addition to this, a total of 123 non-COVID-19 infected sera/plasmas were collected before November 2019 and stored in the Clinical Laboratory Department, The third Affiliated Hospital, Chongqing medical University as well. Amongst all the chosen samples, Artron COVID-19 IgM/IgG Antibody identified a total 124 COVID-19 IgM &/or IgG positive cases including 108 IgM positive and 114 IgG positive cases from 125 COVID-19 infected patients samples. The diagnostic sensitivity for IgM was 86.40%, for IgG was 91.20%; the combined sensitivity was 94.40%; 1 equivocal IgM false positive case from a total of 123 non-COVID-19 sera was observed; the diagnostic specificity for IgM was 99.19% and for IgG was 100%; the combined specificity was 99.19%.

Table 1 Summary for the test results of confirmed COVID-19 samples from clinic center1

Plasma/serum (RT-PCR Confirmed)					
Days from onset	Specimen#	IgM(+)	IgG(+)	Combined(+)	Combined Sensitivity
>14 days	62	54	61	62	100.0%
8-14 days	49	45	45	47	95.9%
≤7 days	8	5	4	5	62.5%
Asymptomatic infection	6	4	4	4	66.7%
Total	125	108	114	118	
Sensitivity		86.40%	91.20%	94.40%	
Days from onset	Specimen#	IgM(+)	IgG (+)	Combined (+)	
≤7 days Sensitivity	8	62.5%	50.0%	62.5%	
>7days Sensitivity	111	89.2%	95.5%	98.2%	

Table 2 Diagnostic sensitivity and specificity from clinic center 1

		RT-PCR/Clinic truth		
		Positive	Negative	Total
Artron COVID-19 IgM/IgG Antibody Test	Positive	118	1	119
	Negative	7	122	129
	Total	125	123	248

Diagnostic sensitivity: 118/(118+7)×100%=94.4%
Diagnostic specificity: 122/(122+1) ×100%=99.19%
Overall agreement: (118+122)/248×100%=96.77%

6.2 Results from Evaluation Center 2: Otogenetics Corporation, (Atlanta, GA, USA)

A total of 780 samples were collected including 89 RT-PCR confirmed SARS-COV-2 positive samples and 691 SARS-COV-2 negative samples. Amongst all the chosen samples, Artron COVID-19 IgM/IgG Antibody Test identified 78 IgM positive and 80 IgG positive cases out of a total of 83 COVID-19 IgM &/or IgG positive from 89 COVID-19 infected patients samples. The diagnostic sensitivity for IgM was 87.64%, for IgG was 89.89%, and the combined sensitivity was 93.26%; 9 of the IgM false positive and 2 of the IgG false positive cases from a total of 691 non-COVID-19 sera were observed and the diagnostic specificity for IgM was 98.70% and for IgG was 99.71%; the combined specificity was 98.41%.

Table3 Summary for the test results of confirmed COVID-19 samples from clinic center2

Plasma/serum/whole Blood (Mol Confirmed)					
Days from onset	Specimen#	IgM(+)	IgG(+)	Combined(+)	Combined Sensitivity
>14 days	69	65	68	69	100.00%
8-14 days	8	7	8	8	100.00%
≤7 days	12	6	4	6	50.00%
Total	89	78	80	83	93.26%
Sensitivity		78/89(87.64%)	80/89(89.89%)	83/89(93.26%)	
Days from onset	Specimen#	IgM(+)	IgG (+)	Combined (+)	
≤7 days Sensitivity	12	50.00%	33.33%	50.00%	
>7days Sensitivity	77	93.51%	98.70%	100.00%	

Table 4 Diagnostic sensitivity and specificity from clinic center 2

		RT-PCR confirmed/clinic truth		
		Positive	Negative	Total
Artron COVID-19 IgM/IgG Antibody Test	Positive	83	11	94
	Negative	6	680	686
	Total	89	691	780

Diagnostic sensitivity: 83/(83+6)×100%=93.26%
Diagnostic specificity: 680/(11+680) ×100%=98.41%
Overall agreement: (83+680)/780×100%=97.82%

6.3 Results from Evaluation center 3: BC Centre for Disease control(CDC)

A total 134 samples from hospitalized patients including 71 RT-PCR confirmed SARS-COV-2 positive samples and 63 SARS-COV-2 negative samples were collected. Among all the chosen samples, Artron COVID-19 IgM/IgG Antibody identified 67 IgM positive and 65 IgG positive out of a total of 68 COVID-19 IgM&/or IgG positive from 71 COIVD-19 infected patients samples; the diagnostic sensitivity for IgM was 94.37%, for IgG was 91.55% and the combined sensitivity was 95.77%; 4 of the IgM false positive and 0 of the IgG false positive from a total of 63 non-COVID-19 sera were observed and the diagnostic specificity for IgM was 93.65% and for IgG was 100%; the combined specificity was 93.65%.

Table 5 Summary for the test results of confirmed COVID-19 from clinic center 3

POCT(Confirmed positive)					
Days from onset	Specimen#	IgM(+)	IgG(+)	Combined(+)	Combined Sensitivity
>14 days	32	32	32	32	32/32(100%)
8-14 days	28	27	25	28	28/28(100%)
≤7 days	11	8	8	8	8/11(87.5%)
Total	71	67	65	68	6/6(100%)
Sensitivity		94.37%	91.55%	95.77%	
Days from onset	Specimen#	IgM(+)	IgG (+)	Combined (+)	
≤7 days Sensitivity	11	72.73%	72.73%	72.73%	
>7days Sensitivity	60	98.33%	95.00%	100.00%	

Table 6 Diagnostic sensitivity and specificity from clinic center 3

		RT-PCR confirmed/clinic truth		
		Positive	Negative	Total
Artron COVID-19 IgM/IgG Antibody Test	Positive	68	4	72
	Negative	3	59	62
	Total	71	63	134

Diagnostic sensitivity: 68/(68+3)×100%=95.77%
Diagnostic specificity: 59/(59+4) ×100%=93.65%
Overall agreement: (68+59)/134×100%=94.78%

6.4 Summary for all the test results from the three evaluation centres

A total of 1162 samples including 285 of RT-PCR confirmed SARS-COV-2 positive sera/plasma/whole blood samples and 877 of RT-PCR confirmed SARS-COV-2 negative sera/plasma or clinic true sera/plasma samples (collected before Nov. 2019) were used to evaluate Artron COVID-19 IgM/IgG Antibody Test from three evaluation centers. Among all of the 285 positive samples, Artron COVID-19 IgM/IgG Antibody Test identified 253 of IgM positive and 259 of IgG positive out 269 of COVID-19 IgM&/or IgG positive samples. The diagnostic sensitivity for IgM was 88.77%, for IgG was 90.88% and the combined sensitivity was 94.39%. The diagnostic specificity for IgM was 98.40%, for IgG was 99.77% and the combined specificity was 98.18%. The overall agreement for IgM and IgG was 96.04% and 97.59%, respectively. The combined overall agreement was

98.18%. The PPV for IgM and IgG was 94.76% and 99.23%, respectively. The combined IgM and IgG PPV was 94.39%. The NPV for IgM and IgG was 96.42% and 97.11%, respectively. The combined IgM and IgG PPV was 99.42%.

Table 7 Summary for all the test results of SARS-COV-2 patients from three evaluation centres:

Summary for the Sensitivity					
Days from onset	Specimen#	IgM(+)	IgG (+)	Combined (+)	Sensitivity
>14 days	163	151	161	163	100.0%
8-14 days	85	79	78	83	97.65%
<7 days	31	19	16	19	61.30%
Asymptomatic infection	6	4	4	4	66.67%
Total	285	253	259	269	94.39%
	Sensitivity	88.77%	90.88%	94.39%	
Days from onset	Specimen#	IgM(+)	IgG (+)	Combined (+)	
≤7 days Sensitivity	31	19/31(61.29%)	16/31(51.61%)	19/31(61.29%)	
>7days Sensitivity	248	230/248(92.74%)	239/248(96.37%)	246/248(99.19%)	

Table 8 Summary for all the test results from three evaluation centres

Artron COVID-19 IgM/IgG Antibody Test	RT-PCR confirmed /clinic truth						
	Positive(N=285)			Negative(N=877)			
	IgM(+)	IgG(+)	Combined (+)	False positive IgM(+)	False positive IgG(+)	Combined False Positive	True negative
Clinic Centre 1	108/125	114/125	118/125	1/123	0/123	1/123	122/123
Clinic Centre 2	78/89	80/89	83/89	9/691	2/691	11/691	680/691
Clinic Centre 3	67/71	65/71	68/71	4/63	0/63	4/63	59/63
Total	253/285 (88.77%)	259/285 (90.88%)	269/285 (94.39%)	14/877 (1.60%)	2/877 (0.23%)	16/877 (1.82%)	861/877 (98.18%)

Table 9 Summary for IgM diagnostic sensitivity and specificity

	RT-PCR confirmed		
	Positive	Negative	Total

Artron COVID-19 IgM/IgG Antibody Test-IgM Testing	Positive	253	14	267
	Negative	32	863	895
	Total	285	877	1162

Diagnostic sensitivity for IgM of Artron COVID-19 IgM/IgG Antibody Test: 253/(253+32) ×100%=88.77%

Diagnostic specificity for IgM of Artron COVID-19 IgM/IgG Antibody Test: 863/(863+14) ×100%=98.40%

PPV: 253/(253+14) ×100%=94.76%
NPV: 863/(863+32) ×100%=96.42%
Overall agreement: (253+863)/1162×100%=96.04%

Table 9 Summary for IgG diagnostic sensitivity and specificity

		RT-PCR confirmed		
		Positive	Negative	Total
Artron COVID-19 IgM/IgG Antibody Test-IgG Testing	Positive	259	2	261
	Negative	26	875	901
	Total	285	877	1162

Diagnostic sensitivity for IgG of Artron COVID-19 IgM/IgG Antibody Test: 259/(259+26) ×100%=90.88%

Diagnostic specificity for IgG of Artron COVID-19 IgM/IgG Antibody Test: 875/(875+2) ×100%=99.77%

PPV: 259/(259+2) ×100%=99.23%
NPV:875/(875+26) ×100%=97.11%
Overall agreement: (259+875)/1141×100%=97.59%

Table 10 Summary for combined IgM&IgG diagnostic sensitivity and specificity

		RT-PCR confirmed/Clinic Truth		
		Positive	Negative	Total
Artron	Positive	269	16	285

COVID-19 IgM/IgG Antibody Test	Negative	16	861	877
	Total	285	877	1162

Diagnostic sensitivity of Artron COVID-19 IgM/IgG Antibody Test:
269/(269+16) ×100%=94.39%
Diagnostic specificity of Artron COVID-19 IgM/IgG Antibody Test:
861/(861+16) ×100%=98.18%

PPV: 269/(269+16) ×100%=94.39%
NPV: 861/(861+5) ×100%=99.42%

Overall agreement: (259+861)/1141=98.18%

7. Conclusion

The clinical evaluation was carried out for the clinical performance of COVID-19 IgM/IgG Antibody Test. at three different evaluation sites from a total of 1162 samples, including 285 SARS-COV-2 positive cases confirmed by RT-PCR and 877 SARS-COV-2 negative samples.

The first evaluation was carried out at Affiliated Hospitals of Chongqing medical University, PRC. A total of 125 serum/plasma samples from COVID-19 infected patients were used: these included 6 asymptomatic infections, 8 patients with symptoms within 7 days, 49 patients with symptoms within 8-14 days, 62 patients with symptoms over 14 days. In addition to this, 123 non-COVID-19 infected sera/plasmas collected before November 2019 and stored in the third Affiliated Hospital, Chongqing medical University were also tested. Among all the chosen samples, Artron COVID-19 IgM/IgG Antibody identified 124 COVID-19 IgM&/or IgG positive samples including 108 IgM positive and 114 IgG positive from 125 COVID-19 infected patients samples. The diagnostic sensitivity for IgM was 86.40%, for IgG was 91.20%; the combined sensitivity was 94.40%; 1 equivocal IgM false positive from total 123 non-COVID-19 sera was observed, the diagnostic specificity for IgM was 99.19% and for IgG was 100%; the combined specificity was 99.19%.

The Second evaluation was conducted through Otogenetics Corporation in the US at 5 different clinic locations. A total of 780 samples were collected including 89 RT-PCR confirmed SARS-COV-2 positive samples and 691 SARS-COV-2 negative. Artron COVID-19 IgM/IgG Antibody identified a total of 83 COVID-19 IgM&/or IgG positive samples including 78 IgM positive and 80 IgG positive from 89 COIVD-19 infected patients samples. The diagnostic sensitivity for IgM was 87.64%, for IgG was 89.89%; the combined sensitivity was 93.26%. From a total of 691 non-COVID-19 sera, 9 of IgM false

positives and 2 of IgG false positives were observed; the diagnostic specificity for IgM was 98.70% and for IgG was 99.71%; the combined specificity was 98.41%.

The third evaluation was conducted by BC CDC. A total 134 samples from hospitalized patients included 71 RT-PCR confirmed SARS-COV-2 positive samples and 63 SARS-COV-2 negative samples were collected. Among all the chosen samples, Artron COVID-19 IgM/IgG Antibody identified 68 COVID-19 IgM&/or IgG positive cases including 67 IgM positive and 65 IgG positive from 71 COVID-19 infected patients samples. The diagnostic sensitivity for IgM was 94.37%, for IgG was 91.55%; the combined sensitivity was 95.77%. From a total of 63 non-COVID-19 sera, 4 of IgM false positives and 0 of IgG false positive cases were observed; the diagnostic specificity for IgM was 93.65% and for IgG was 100%; the combined specificity was 93.65%.

Summary of the clinical evaluation results:

A total of 1162 samples including 285 of RT-PCR confirmed SARS-COV-2 positive sera/plasma/whole blood samples and 877 of RT-PCR confirmed SARS-COV-2 negative sera/plasma or clinic true sera/plasma (collected before Nov. 2019) were used to evaluate Artron COVID-19 IgM/IgG Antibody Test amongst all three clinical evaluations. Out of all the 285 positive samples, Artron COVID-19 IgM/IgG Antibody Test identified 269 of COVID-19 IgM&/or IgG positive cases including 253 of IgM positive; 259 of IgG positive. The diagnostic sensitivity for IgM test was 88.77%; for IgG was 90.88%; the combined sensitivity was 94.39%. The diagnostic specificity for IgM was 98.40%; for IgG was 99.77%; the combined specificity was 98.18%. The overall agreement for IgM and IgG was 96.04% and 97.59%, respectively. The combined overall agreement was 98.18%. The PPV for IgM and IgG was 94.76% and 99.23%, respectively. The combined IgM & IgG PPV was 94.39%. The NPV for IgM and IgG was 96.42% and 97.11%, respectively. The combined IgM & IgG PPV was 99.42%.

8. Report

8.1 Original raw data is archived at Quality Control Department
8.2 The original final report is archived in Quality Control Department.