

Diagnostic accuracy of six commercial SARS-CoV-2 IgG/total antibody assays and identification of SARS-CoV-2 neutralizing antibodies in convalescent sera

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Abstract

The reliable detection of immunoglobulin G (IgG) or total antibodies directed against the novel severe acute respiratory syndrome coronavirus type 2 (SARS-CoV-2) is important for clinical diagnostics and epidemiological studies.

Here, we compare the diagnostic accuracy of six commercially available SARS-CoV-2 IgG (Abbott SARS-CoV-2 IgG; Diasorin Liaison® SARS-CoV-2 S1/2 IgG; Epitope EDI™ Novel Coronavirus COVID-19 IgG ELISA Kit; Euroimmun Anti-SARS-CoV-2 ELISA (IgG); Mikrogen *recomWell* SARS-CoV-2 IgG) or total SARS-CoV-2 antibody assays (Roche Elecsys Anti-SARS-CoV-2).

The test sensitivities were analyzed with a set of 34 sera obtained from 26 patients after PCR-confirmed SARS-CoV-2 infection and varied from 76.9% (Euroimmun) to 96.2% (Abbott). The majority of assay results were confirmed in a laboratory-developed plaque reduction neutralization test and by a SARS-CoV-2 IgG-specific line assay including measurement of generally low IgG avidities (Mikrogen *recomLine* Coronavirus IgG [Avidität], prototype).

Moreover, 100 stored sera collected during summer 2018 (N = 50) and winter season 2018/2019 (N = 50) were included to demonstrate test specificities. These varied from 96.0% (DiaSorin) to 100% (Epitope EDI™).

A subset of sera were retested with a lateral flow test (STANDARD Q COVID-19 IgM/IgG Duo) and a considerably lower sensitivity was noted.

Overall, the diagnostic accuracy of the six SARS-CoV-2 IgG/total antibody assays was good and varied from 92.9% (Euroimmun) to 98.4% (Abbott). Due to the different specificities, results of commercially available SARS-CoV-2 antibody tests should be interpreted with caution. A high proportion of antibody-positive patient sera demonstrated neutralizing capacity against SARS-CoV-2.

Introduction

At the end of the year 2019, Chinese local health authorities reported the occurrence of a cluster of pneumonia cases in Wuhan, a megapolis in the Hubei province [1]. Shortly after, a novel beta coronavirus – which is now designated as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [2] - was discovered in the bronchoalveolar lavage fluid of a patient with pneumonia [3,1]. This virus emerged globally. As of June 15, 2020, the World Health Organization reported 7,761,609 SARS-CoV-2 infections and 430,241 deaths worldwide. So far, 186,461 cases and 8791 deaths have been registered for Germany (Robert Koch-Institute, data of June 15, 2020).

The diagnosis of acute coronavirus 2019 infection (COVID-19) needs the demonstration of SARS-CoV-2 ribonucleic acids in respiratory samples by real-time reverse transcription polymerase-chain reaction (real-time RT-PCR). Their specificity has been reported with 100% [4].

More recently, the measurement of immune response against SARS-CoV-2 came into the focus of clinical diagnostics, particularly by the detection of virus-specific antibodies. The use of SARS-CoV-2 antibody tests could clarify the etiology of the disease in patients who present late, after two weeks from onset of symptoms. Moreover, these tests can demonstrate the viral spread in the community and may even identify individuals who are potentially protected from re-infection by neutralizing antibodies [4].

It is believed that the majority of developed antibodies is directed against the abundant viral nucleocapsid protein while antibodies directed against the spike protein are considered more specific and may possess neutralizing capacity [4]. The diagnostic value of serological tests, however, is limited due to their potential cross-reactivity with other human coronaviruses. Furthermore, it is still unclear, how long SARS-CoV-2 antibodies will persist and whether they are protective at all [4].

In the following, we present data on the diagnostic performance of six commercially available SARS-CoV-2 IgG or total SARS-CoV-2 antibody tests. Variations in their diagnostic sensitivity and specificity were observed. The latter could lead to a considerable number of false positive results in countries with a currently low SARS-CoV-2 prevalence such as Germany. Moreover, we demonstrate SARS-CoV-2 neutralizing antibodies in a marked proportion of convalescent sera.

Material and Methods

This retrospective study includes 37 serum samples obtained from 26 COVID-19 patients. Blood was drawn between four and 60 days (median 19 days) after a positive real-time RT-PCR result in which parts of the SARS-CoV-2 E or N genes [5] were detected in respiratory samples. Only sera from individuals that exhibited a cycle threshold (CT) ≤ 35 (median CT 26.8) in the initial real-time RT-PCR were included. These samples should contain SARS-CoV-2 IgG/total antibodies and, therefore, were considered to determine serological assay sensitivities. Seven subjects with repeated sample entries were included in the study group. Among them were two patients, each with a serum taken 0 and 9 days before the diagnosis of COVID-19.

For calculation of assay specificities, 100 archived sera collected during summer 2018 (N = 50) and during winter 2018/2019 (50) were used. In addition, two sera exhibiting a serological pattern of a recent Epstein-Barr virus (EBV) infection (EBV VCA IgG and IgM positive, EBNA-1 IgG negative, Abbott GmbH, Wiesbaden, Germany) were included to ensure that cross-reactivity is not occurring. None of these 102 sera were expected contain SARS-CoV-2 antibodies.

Test results were also used to calculate the accuracy of the assays, i.e. the proportion of correctly identified samples from all samples.

Twelve sera that were sent to us for routine SARS-CoV-2 antibody tests without a previous SARS-CoV-2 PCR result were also included to show test performance.

The Ethics committee of the Medical Faculty of the Kiel University approved the setting of this study (AZ D467/20). All sera were stored at -20°C until testing.

The testing was done with five SARS-CoV-2 IgG assays (Abbott SARS-CoV-2 IgG; DiaSorin Liaison® SARS-CoV-2 S1/2 IgG, Diasorin, Dietzenbach, Germany; Epitope EDI™ Novel Coronavirus COVID-19 IgG ELISA Kit, Epitope Diagnostics, San Diego, USA; Euroimmun Anti-SARS-CoV-2 ELISA (IgG), EUROIMMUN AG, Lübeck, Germany; Mikrogen *recomWell* SARS-CoV-2 IgG, Mikrogen GmbH, Neuried, Germany) as well as one total SARS-CoV-2 antibody test (Roche Elecsys Anti-SARS-CoV-2, Roche Diagnostics, Mannheim, Germany). The recombinant antigens of these tests cover the viral nucleocapsid protein (Abbott, Epitope, Mikrogen, Roche) or the S1 domain alone (Euroimmun) or together with the S2 domain (DiaSorin) of the spike protein. All tests were conducted strictly following the recommendations of the manufacturers on an Architect (Abbott), a Liaison XL (DiaSorin), a Cobas e 411 (Roche) or for the assays of Epitope, Euroimmun and Mikrogen on the BEP 2000 system (Siemens Healthcare GmbH, Erlangen, Germany), respectively.

In general, borderline results were counted as positive. In order to allow a better comparison of the test results, the raw data were converted to relative indices according to the decision limits specified by the manufacturer. A signal/cut-off value of <1 was valued as negative and ≥ 1 as positive, which corresponds to a previous study [6].

A subset of sera was tested with and without avidity reagent in an IgG line assay (Mikrogen *recomLine* Coronavirus IgG [Avidität], prototype, lot LCO042001). This assay is based on the nucleocapsid proteins of the human coronaviruses 229E, NL63, OC43 and HKU1, which are used separately as antigen, and on the nucleocapsid proteins of the "classic" SARS-CoV from 2002/2003 and SARS-CoV-2. For this, a Dynablot Plus system (Mikrogen) was used. Blots were evaluated automatically with a BLOTrix reader and the *recomScan* software (Mikrogen).

Exemplarily, 18 sera were retested in a rapid lateral flow assay that distinguishes SARS-CoV-2 IgG- and IgM-antibodies (STANDARD Q COVID-19 IgM/IgG Duo, SD Biosensor, Suwon-si, Republic of Korea). The manufacturer did not report the kind of epitope used in this assay.

Forty-seven sera were also tested under biosafety level 3 conditions in a plaque reduction neutralization assay (PRNT) using an own SARS-CoV-2 isolate (M16502) and Vero cells (order no. 605372, CLS Cell Lines Service GmbH, Eppelheim, Germany). The conditions were in accordance to previous reports [7,8] with slight modifications. One to two days before infection, 1.0×10^5 cells were seeded per well. The 48-well plates were then incubated under standard conditions until the cells became confluent. Directly prior to the PRNT, patient sera were heat-inactivated at 56°C for 30 minutes and then diluted from 1:10 to 1:1280 in cell-culture medium consisting of DMEM (Bio&SELL GmbH, Feucht/Nürnberg, Germany) supplemented with 3.7 g/l NaHCO_3 , 4.5 g/l glucose, 2mM L-glutamine, and 1% (v/v) Pen/Strep/Fungi Mix (Bio&SELL). A serum dilution series was made by mixing 50 μl of each dilution step with 50 μl virus suspension containing 100 plaque forming units, followed by an incubation for 1 h at 37°C . The cells were washed with phosphate-buffered saline (PBS, Bio&SELL GmbH), inoculated with 100 μl of these virus serum dilutions and incubated for one hour at room temperature on a rocking shaker. Then, 100 μl of the cell-culture medium extended by 20 % (v/v) fetal calf serum (FCS) was added to each well to achieve a FCS concentration of 10 % (v/v). After fixation with 4 % (w/v) paraformaldehyde in PBS, the cells were stained with aqueous solution of 1 % (w/v) crystal violet and 20 % (v/v) methanol. The stained 48-well plates were photo documented. All dilution steps were tested in quadruplicates and plaque formation was compared to an untreated cell-control and a virus control. A serum dilution $\geq 1:20$ that prevented the formation of plaques by 50% compared to the virus control (PRNT₅₀) was considered likely to be protective.

Results

Thirty-seven samples taken from 26 patients with a PCR-confirmed SARS-CoV-2 infection were analyzed with six SARS-CoV-2 IgG or total antibody assays. Samples #1, #7, and #9 were taken nine days before to four days after PCR and were all found to be free of SARS-CoV-2 antibodies by the assays. These samples were not considered for calculation of sensitivity but clearly demonstrated seroconversion (Figure 1). Out of the remaining 34 samples, only one serum (#20; Figure 1) which was obtained ten days after a positive RT-PCR was tested negative for SARS-CoV-2 IgG/total antibodies in the six assays. However, this sample exhibited a PRNT₅₀ 1:10 to 1:20. All other samples were reactive in at least one assay (Figure 1). With respect to the sample size, assay sensitivities ranged from 76.9% (Euroimmun, 26 individuals after diagnosis of COVID-19) to 97.1% (Abbott, 34 sera including follow-up entries) (Table 1). When three samples (#32, #33, #34; Figure 1), that all exhibited isolated reactivities in the Abbott assay but did not reveal SARS-CoV-2 neutralizing capacities in the PRNT₅₀, were excluded from the data set, sensitivities varied from 87.1% to 96.8%. Twenty of the other 24 COVID-19 patients developed virus neutralizing antibodies as shown by a PRNT₅₀ ≥1:20 (including two samples with a PRNT₅₀ 1:10 to 1:20). A comparison of S/CO values of follow-up samples #2 to #6, #26 to #27, #28 to #29, and #32 to #33 showed no clear trend towards higher values while an increase in PRNT₅₀ titer was evident in the first patient (#1 to #6) (Figure 1, Supplementary material).

Specificity was calculated using 100 archived samples that should not contain SARS-CoV-2 antibodies. Overall, ten sera were found to be reactive in the six assays, and four of them were found to be reactive in one assay. None contained SARS-CoV-2 neutralizing antibodies (Figure 2, Supplementary material). Thus, assay specificities ranged from 96.0% to 100.0% (Table 1). Two samples with a typical constellation of an acute EBV infection did not show cross reactivity with any of the SARS-CoV-2 IgG/total antibody assays (data not shown).

Taken together, assay accuracies varied from 92.5% to 98.5% (Table 1).

Twelve routine samples obtained from individuals who were interested in their SARS-CoV-2 antibody status were re-evaluated by all six assays (Figure 3). Six of them – including three family members of a confirmed COVID-19 case (#22; Figure 1) - were classified SARS-CoV-2 IgG/total antibody positive by the majority of the tests. Isolated reactivity was observed in two sera (#2, #10; Figure 3).

Thirty of the 37 sera obtained from COVID-19 cases were retested in the IgG *recomLine* assay. Among them, 27 (90%) were confirmed as SARS-CoV-2 IgG positive (Figure 1, Supplementary material). One out of the ten archived sera that were reactive in at least one of the six SARS-CoV-2 IgG/total antibody tests

was also classified as SARS-CoV-2 IgG positive by the blot results. The underlying sample was collected in winter 2018/2019 and was found to be reactive for SARS-CoV-2 IgG/total antibodies by the Mikrogen (S/SCO 1.33) and Roche (S/SCO 3.46) assays in parallel (Figure 2). As well, nine of the twelve pretested routine samples were analyzed by the blot and pre-known results were largely confirmed (Figure 3, Supplementary material). All measured SARS-CoV-2 IgGs were of low avidity (Supplementary material). Eighteen samples, including eight sera from confirmed COVID-19 cases were retested in a lateral flow assay. Of the eight COVID-19 sera, two were clearly positive for IgG, while three were tested weakly positive and three negative (Figure 1, Supplementary). Five archived samples that were valued reactive in at least one of the six SARS-CoV-2 IgG/total antibody tests were also re-evaluated by this lateral flow assay. All of them had negative IgG results (Figure 2, Supplementary material). In addition, five routine samples were retested by the rapid antibody assay, and three were found to be weakly IgG positive (Figure 3, Supplementary material). There was no evidence of the presence of SARS-CoV-2 IgM in the 18 samples (Supplementary material).

Figure 1

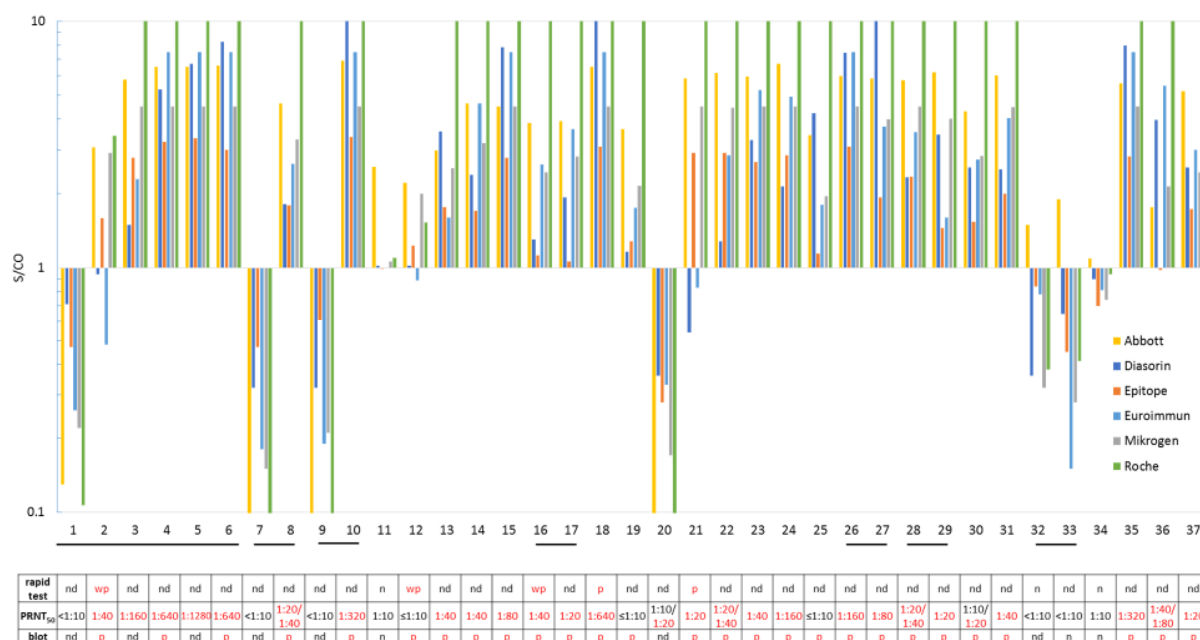


Figure 1: Detection of SARS-CoV-2 IgG/total antibodies in confirmed COVID-19 cases. Serum samples (N = 37) obtained from 26 COVID-19 patients were tested. A signal/cut-off value ≥ 1 is considered as positive for SARS-CoV-2 IgG/total antibodies. The sera marked by underlined numbers are follow-up samples from seven patients, and three among them demonstrate seroconversion. Sample #1 was taken four days and sample #2 sixth days after the PCR. The last serum (#6) of this patient was obtained 26 days after PCR. Sample #7 was taken nine days before PCR and the corresponding sample #8 19 days after the PCR. Serum #9 was taken on the day of the PCR and serum #10 29 days thereafter. Results of the rapid lateral flow test, the plaque reduction neutralization assay (PRNT₅₀) and the line assay (blot) are shown in the table. P, positive; wp, weakly positive; n, negative; nd, not determined.

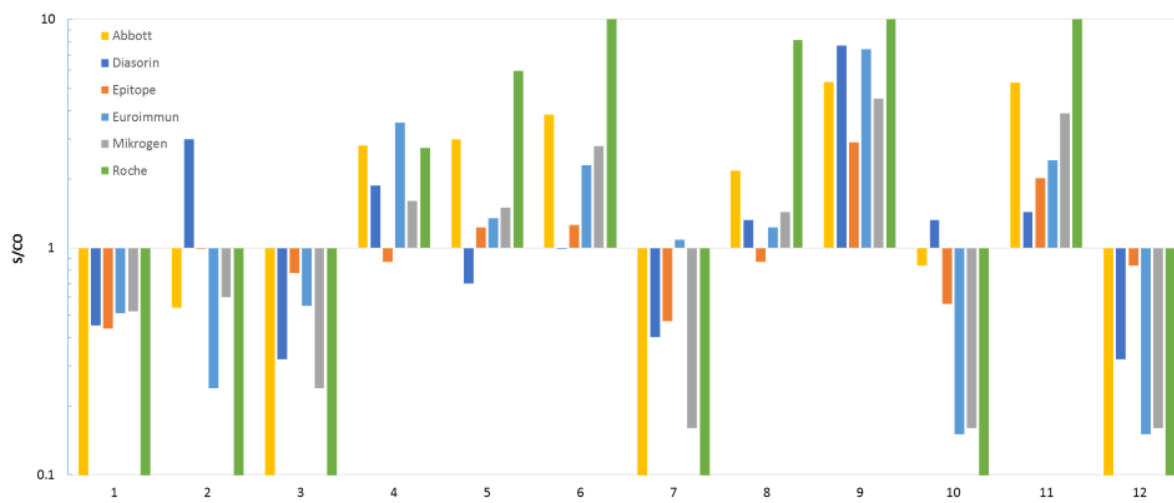
Figure 2:



rapid test	nd	n	nd	n	nd	n	n	nd	n	nd
PRNT ₅₀	<1:10	<1:10	<1:10	<1:10	<1:10	<1:10	<1:10	<1:10	<1:10	<1:10
blot	n	n	n	n	n	n	p	n	n	n

Figure 2: False positivity of SARS-CoV-2 IgG/total antibody tests in ten out of 100 archived sera collected in summer 2018 and winter 2018/2019. A signal/cut-off value ≥ 1 is considered as positive for SARS-CoV-2 IgG/total antibodies. Results of the rapid lateral flow test, the plaque reduction neutralization assay (PRNT₅₀) and the line assay (blot) are shown in the table. P, positive; n, negative; nd, not determined.

Figure 3



rapid test	n	n	nd	wp	wp	wp	nd	nd	nd	nd	nd	nd
blot	nd	n	nd	p	p	p	n	n	p	n	p	nd

Figure 3: Detection of SARS-CoV-2 IgG/total antibodies in twelve routine samples. A signal/cut-off value ≥ 1 is considered as positive for SARS-CoV-2 IgG/total antibodies. The underlined samples #4 to #6 were obtained from family members of a COVID-19 case (sample #22 in Figure 1). Results of the rapid lateral flow test and the line assay (blot) are shown in the table. P, positive; wp, weakly positive; n, negative; nd, not determined.

199 **Table 1: Diagnostic performance of six commercial SARS-CoV-2 IgG and total antibody assays**

	sensitivity in %			specificity in %	accuracy in %		
	number of samples						
	34	31*	26 [#]	100	134	131*	126 [#]
Assay							
Abbott	97.1	96.8	96.2	99.0	98.5	98.5	98.4
Diasorin	82.4	90.3	80.8	96.0	92.5	94.7	92.9
Epitope	82.4	90.3	80.8	100.0	95.5	97.7	96.0
Euroimmun	79.4	87.1	76.9	97.0	92.5	94.7	92.9
Mikrogen	88.2	96.8	88.5	98.0	95.5	97.7	96.0
Roche	88.2	96.8	88.5	99.0	96.3	98.5	96.8
*Three sera obtained from COVID-19 cases that showed isolated reactivity in the Abbott assay were excluded in this setting.							
[#] Sera from 26 individuals after PCR-confirmed SARS-CoV-2 infection. Follow-up sera were excluded.							

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Discussion

In a rather short period, various assays for detection of SARS-CoV-2 antibodies were introduced to the market. A meta-analysis of 38 studies on the performance of different format SARS-CoV-2 antibody tests mainly manufactured from Chinese companies was reported recently [9]. Furthermore, studies on the sensitivity and specificity of SARS-CoV-2 IgG tests, including the ELISAs from Epitope, Euroimmun, and Mikrogen, were published previously [6,10,8,7]. Here, we compare six different commercially available tests, all of which have been released within the past few months. Three of them (Abbott, DiaSorin, Roche) were applied in a random access manner which reduces the needed hands-on-time markedly. A subset of samples were retested in a laboratory-developed PRNT₅₀, in an immunoblot including the determination of SARS-CoV-2 IgG avidities and in a rapid lateral flow assay. To our knowledge, such a comprehensive study has not yet been carried out.

The sensitivities between the six tests differ from 76.9% to 97.1% (Table 1), which is in accordance to other studies [6,8,10] and to the meta-analysis [9]. Our data indicate that assays based on the more abundant viral nucleocapsid protein as an epitope are slightly more sensitive compared to tests using domains of the spike protein as an antigen. Furthermore, a lack of reactivity in the latter IgG tests does not necessarily mean that SARS-CoV-2 neutralizing antibodies are missing (compare Figure 1). However, three sera from two COVID-19 patients, which were only recognized as IgG positive in the Abbott test, could not be confirmed in the blot and in the PRNT₅₀. In addition, four other COVID-19 patients did not develop a PRNT₅₀ $\geq 1:20$ (Figure 1). Thus, 76.9% (20/26) of COVID-19 patients developed SARS-CoV-2 neutralizing antibodies as demonstrated by a PRNT₅₀ $\geq 1:20$ (including two patients with a PRNT₅₀ of 1:10 to 1:20). The absence of measurable neutralizing antibodies in several COVID-19 patients was reported recently [11]. The evaluability of the simple PRNT₅₀ technique used in our study may be further improved by overlaying the cells with cellulose or by using specific antibodies to detect remaining viral antigens in the cells, as shown previously [7].

The specificities of SARS-CoV-2 IgG/total antibody tests are at a comparatively high level between 96.0 and 100.0%, as has also been reported by others [6,8,10]. Interestingly, one sample collected in winter 2018/2019 was found to be reactive in the Mikrogen and Roche assays as well as in the blot but could not be confirmed by the PRNT₅₀ (Figure 2, Supplementary material). For all other 99 archived samples, a random pattern of rare, isolated reactivity was demonstrated and none was confirmed as possessing SARS-CoV-2 neutralizing antibodies by PRNT₅₀ (Figure 2, Supplementary material). In addition, two sera obtained from patients with acute EBV infection were tested negative for SARS-CoV-2 IgG/total antibodies. Thus,

cross-reactivity to epitopes of endemic human coronaviruses or triggered by active EBV infection may not represent a major problem. Nevertheless, it should be noted that due to the currently estimated low prevalence of SARS-CoV-2 antibodies in the overall German population, even a rather high specificity of 99% would produce a relevant number of false positive results. Thus, these assays - that all show a comparable high accuracy of 92.5%-98.5% (Table 1) - should be preferentially used for testing of patients with a history of a probable infection. In case of doubt, the implementation of the labor-intensive and time-consuming PRNT₅₀ should be considered.

The majority of SARS-CoV-2 IgGs in sera from COVID-19 patients were confirmed by an immunoblot but were shown to possess a low avidity (Supplementary material). This result may come from the short observation period. The last sample was obtained 60 days after COVID-19 diagnosis but the median of sample collection dates was only 19 days after PCR. Furthermore, seroconversion in three SARS-CoV-2 patients was demonstrated. So far, it is not clear when SARS-CoV-2 IgGs of high avidity will appear and how long such SARS-CoV-2 specific antibodies will persist at all. A marked proportion of COVID-19 patients, however, developed neutralizing antibodies in their sera, which might be protective and prevent a re-infection.

Lateral flow assays for the detection of SARS-CoV-2 antibodies are becoming increasingly important as they can be used by less experienced persons under point-of-care conditions and should lead to reliable results in a relatively short time [8]. Here, 18 sera were retested with a rapid antibody test. Only two convalescence sera obtained from COVID-19 patients were clearly identified as IgG positive by this assay. In addition, only very weak bands were visible in three of these well-characterized samples, while three further convalescent sera were rated negative (Supplementary material). A similar situation with hardly visible IgG bands was observed in three routine samples obtained from family members of a confirmed SARS-CoV-2 case (Supplementary material). In contrast, five archived samples that were classified reactive for SARS-CoV-2 IgG/total antibodies by at least one of the six assays were all negative by this lateral flow assay. Thus, this rapid antibody test is believed to have a good specificity but sensitivity is reduced. Particularly the occurrence of faint IgG bands is a diagnostic challenge. The interpretation of results obtained from this assay should be done with caution.

Taken together, all six tested SARS-CoV-2 IgG/total antibody assays demonstrate a good performance. Their slightly reduced specificities, however, may produce a relevant number of false positive results in low prevalence countries. Future studies should address the long-term course of SARS-CoV-2 antibodies as well as the virus-specific cellular immune response. For the latter, the development of routine test

264 procedures is urgently required. The PRNT results indicate that a high proportion of antibody-positive sera
265 are actually able to neutralize the virus in culture and, thus, may be relevant for immunity.

266 **Acknowledgments**

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270 **Author's contributions**

271 AK conceived the study and supervised all experiments. AS and OG prepared samples. AS performed
272 testing of all sera in the commercially available assays with help of OG. RR performed the PRNT with
273 support by AK and HF. AK, AS, OG and RR prepared the manuscript with help of HF and TL. Results are part
274 of the MD thesis of AS.

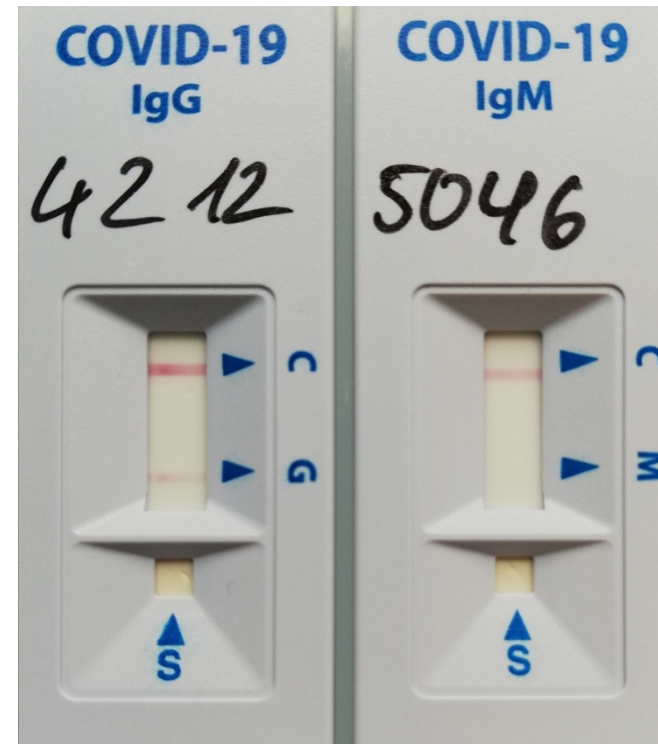
275 **Declaration of Interest**

276 All authors declare no conflict of interest.

References

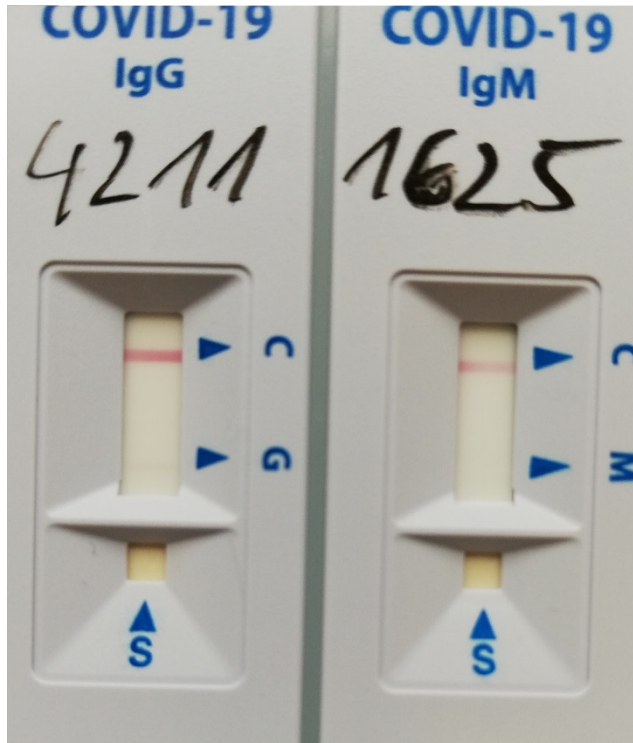
1. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, Zhao X, Huang B, Shi W, Lu R, Niu P, Zhan F, Ma X, Wang D, Xu W, Wu G, Gao GF, Tan W, China Novel Coronavirus I, Research T (2020) A Novel Coronavirus from Patients with Pneumonia in China, 2019. *N Engl J Med* 382 (8):727-733. doi:10.1056/NEJMoa2001017
2. Coronaviridae Study Group of the International Committee on Taxonomy of V (2020) The species Severe acute respiratory syndrome-related coronavirus: classifying 2019-nCoV and naming it SARS-CoV-2. *Nat Microbiol* 5 (4):536-544. doi:10.1038/s41564-020-0695-z
3. Tan W, Zhao X, Xuejun M, Wenling W, Peihua N, Wenbo X, Gao GF, Guizhen W (2020) A novel coronavirus genome identified in a cluster of pneumonia cases - Wuhan, China 2019 - 2020. *China CDC Weekly* 2:61-62
4. Sethuraman N, Jeremiah SS, Ryo A (2020) Interpreting Diagnostic Tests for SARS-CoV-2. *JAMA*. doi:10.1001/jama.2020.8259
5. Corman VM, Landt O, Kaiser M, Molenkamp R, Meijer A, Chu DK, Bleicker T, Brunink S, Schneider J, Schmidt ML, Mulders DG, Haagmans BL, van der Veer B, van den Brink S, Wijsman L, Goderski G, Romette JL, Ellis J, Zambon M, Peiris M, Goossens H, Reusken C, Koopmans MP, Drosten C (2020) Detection of 2019 novel coronavirus (2019-nCoV) by real-time RT-PCR. *Euro Surveill* 25 (3). doi:10.2807/1560-7917.ES.2020.25.3.2000045
6. Kruttgen A, Cornelissen CG, Dreher M, Horneff M, Imohl M, Kleines M (2020) Comparison of four new commercial serologic assays for determination of SARS-CoV-2 IgG. *J Clin Virol* 128:104394. doi:10.1016/j.jcv.2020.104394
7. Okba NMA, Muller MA, Li W, Wang C, GeurtsvanKessel CH, Corman VM, Lamers MM, Sikkema RS, de Bruin E, Chandler FD, Yazdanpanah Y, Le Hingrat Q, Descamps D, Houhou-Fidouh N, Reusken C, Bosch BJ, Drosten C, Koopmans MPG, Haagmans BL (2020) Severe Acute Respiratory Syndrome Coronavirus 2-Specific Antibody Responses in Coronavirus Disease 2019 Patients. *Emerg Infect Dis* 26 (7). doi:10.3201/eid2607.200841
8. Kohmer N, Westhaus S, Rühl C, Ciesek S, Rabenau HF (2020) Clinical performance of SARS-CoV-2 IgG antibody tests and potential protective immunity. *bioRxiv*
9. Kontou PI, Braliou GG, Dimou NL, Nikolopoulos G, Bagos PG (2020) Antibody Tests in Detecting SARS-CoV-2 Infection: A Meta-Analysis. *Diagnostics (Basel)* 10 (5). doi:10.3390/diagnostics10050319
10. Lassaunière R, Frische A, Harboe ZB, Nielsen AC, Fomsgaard A, Krogfelt KA, Jørgensen CS (2020) Evaluation of nine commercial SARS-CoV-2 immunoassays. *medRxiv*
11. Wu F, Wang A, Liu M, Wang Q, Chen J, Xia S, Ling Y, Zhang Y, Xun J, Lu L, Jiang S, Lu H, Wen Y, Huang J (2020) Neutralizing antibody responses to SARS-CoV-2 in a COVID-19 recovered patient cohort and their implications. *medRxiv*

COVID-19 sera #18, #21



→ IgG positive

COVID-19 serum #2



→ IgG weakly positive

COVID-19 serum #12



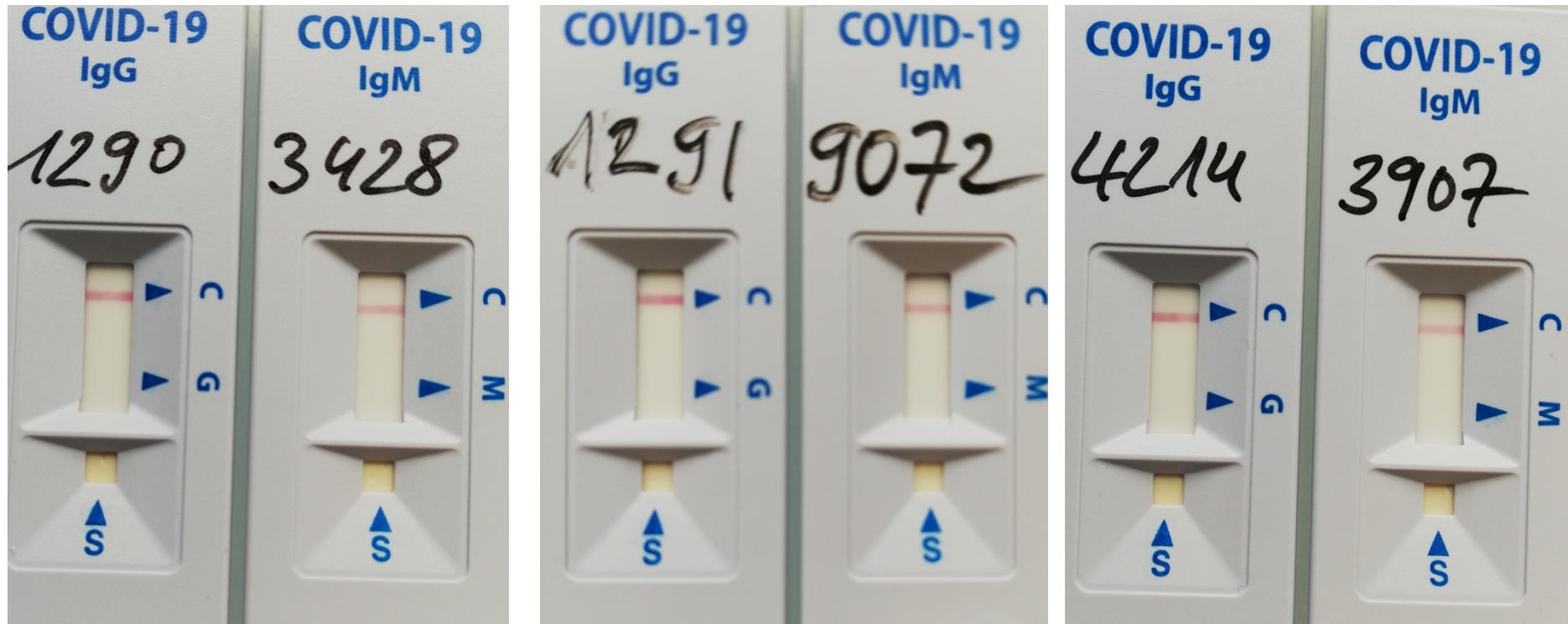
→ IgG weakly positive

COVID-19 serum #16



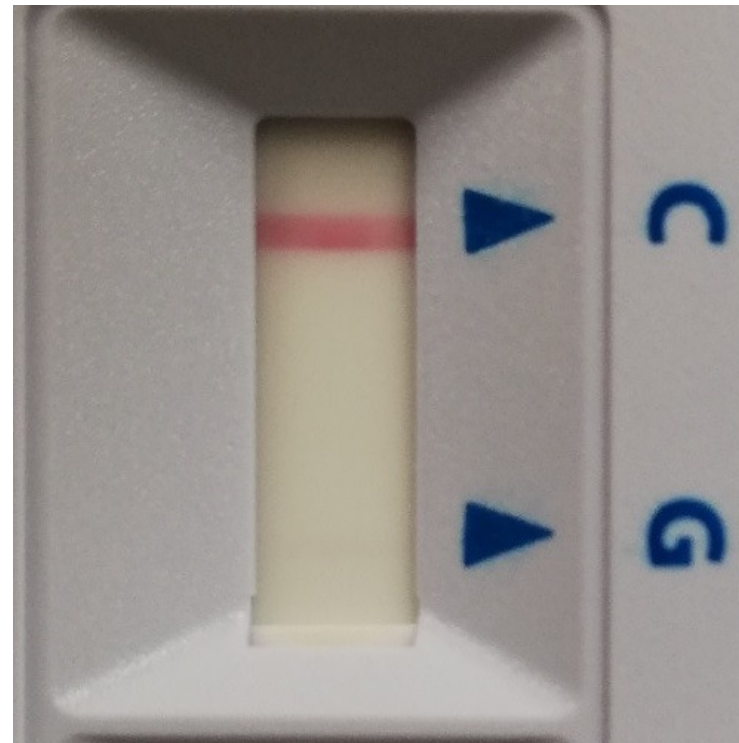
→ IgG weakly positive

COVID-19 sera #11, #32, #34



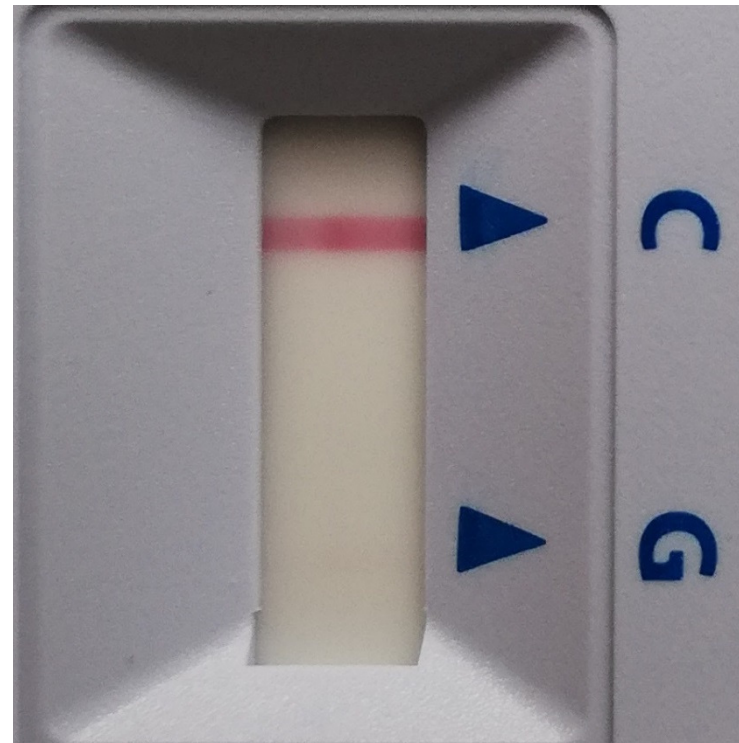
→ IgG negative

Routine serum #4



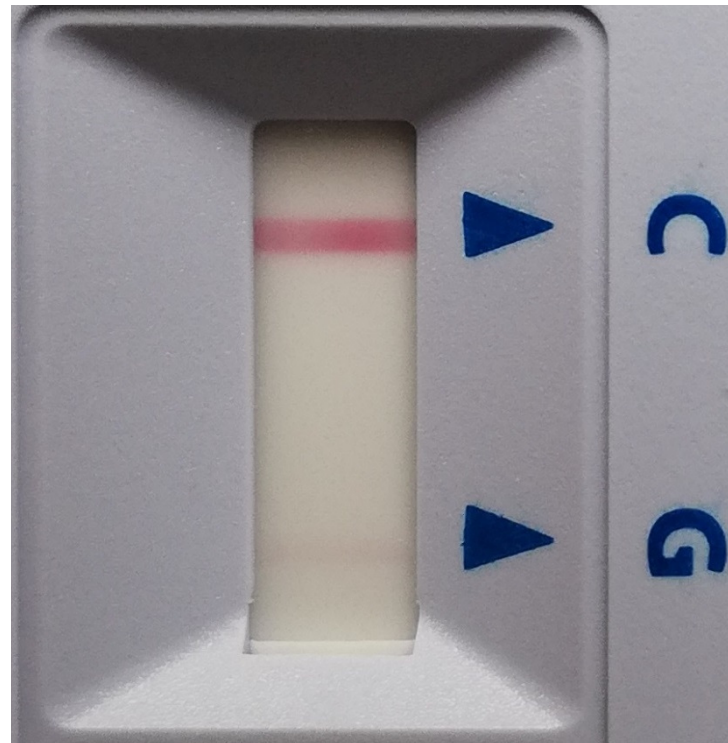
→ IgG weakly positive

Routine serum #5



→ IgG weakly positive

Routine serum #6



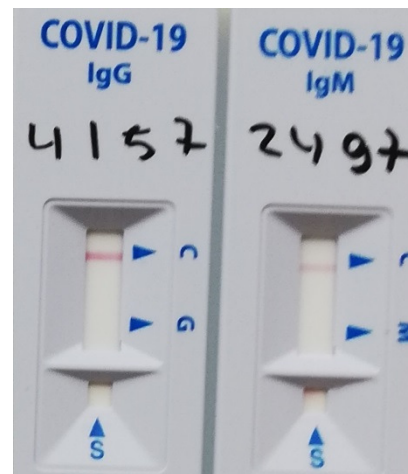
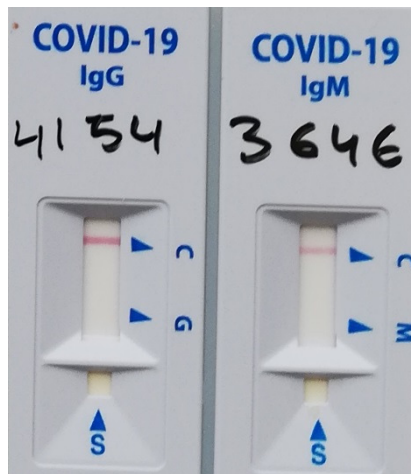
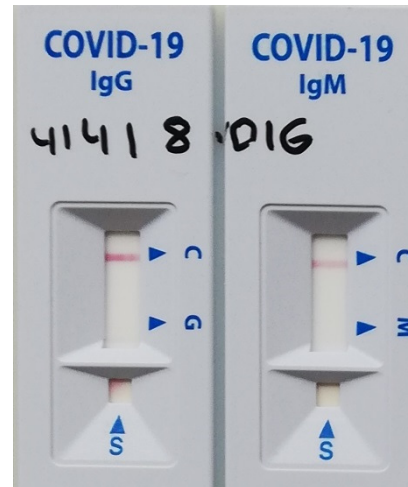
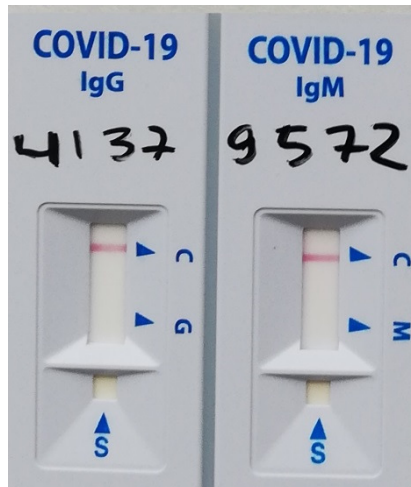
→ IgG weakly positive

Routine sera #1, #2



→ IgG negative

Archived sera #23, #49, #66, #69, #101



→ IgG negative

Info	Nr.	Typ	Ig	PID	Proben Nr.	Streifen	Antigene	Überarbeitete Antigene	Ergebnisse
						ReaktKontr(0) IgG(1) IgA(2) IgM(3) CutOff(4) NP_229E(5) NP_NL63(6) NP_OC43(7) NP_HKU1(8) NP_SARS_1(9) NP_SARS_2(10)		Sample	
	1	Patient	IgG		41580810	LC0 01 0 1 4 7 8 9			
	2	Patient	IgG		41572497	LC0 02 0 1 3 4 5 6 7 8	NP_NL63(1,2)		Ten archived sera from summer 2018 and winter 2018/2019 that were found to be reactive in the six SARS-CoV-2 IgG/total antibody assays (compare Figure 2).
	3	Patient	IgG		12700966	LC0 03 0 1 4 6 8			
	4	Patient	IgG		41543646	LC0 04 0 1 4 5 6 7 8 9 10	NP_NL63(4,1); NP_OC43(1,6); NP_HKU1(3,6); NP_SARS_1(2,7); NP_SARS_2(3,0)		
	5	Patient	IgG		41533704	LC0 05 0 1 4 6 8	NP_NL63(1,8)		
	6	Patient	IgG		41413833	LC0 06 0 1 4 6	NP_NL63(1,8)		
	7	Patient	IgG		41418016	LC0 07 0 1 4 7			
	8	Patient	IgG		12641696	LC0 08 0 1 4 6 7 8	NP_OC43(2,1); NP_HKU1(2,2)		
	9	Patient	IgG		41379572	LC0 09 0 1 4 5 6 7 8 9 10	NP_229E(1,2); NP_NL63(3,3); NP_OC43(6,0); NP_HKU1(5,5)		
	10	Patient	IgG		41354992	LC0 10 0 1 4 5 6 7 8	NP_NL63(3,6); NP_OC43(1,4); NP_HKU1(1,2)		
	11	Patient	IgG		12928406	LC0 11 0 1 4 5 6 7 8 9 10	NP_NL63(2,8); NP_OC43(2,9); NP_HKU1(2,6); NP_SARS_1(2,4); NP_SARS_2(3,2)	COVID-19 #37	
	12	Patient	IgG		42143907	LC0 12 0 1 4 6 7 8 9 10	NP_NL63(1,6); NP_OC43(1,3); NP_HKU1(1,6)	COVID-19 #34	
	13	Patient	IgG		12903427	LC0 13 0 1 4 6 7 9 10	NP_NL63(4,4); NP_SARS_1(1,1); NP_SARS_2(1,1)	COVID-19 #12	
	14	Patient	IgG		42111496	LC0 14 0 1 4 5 6 7 8	NP_229E(4,7); NP_NL63(3,5); NP_OC43(10,9); NP_HKU1(8,9)	COVID-19 #9	
	15	Patient	IgG		12903428	LC0 15 0 1 4 7 8 9 10		COVID-19 #11	
	16	Patient	IgG		42125046	LC0 16 0 1 4 5 6 7 8 9 10	NP_NL63(4,0); NP_OC43(2,2); NP_HKU1(2,9); NP_SARS_1(6,5); NP_SARS_2(6,2)	COVID-19 #21	
	17	Patient	IgG		42141894	LC0 17 0 1 4 5 6 7 8 9 10	NP_NL63(2,3); NP_OC43(2,8); NP_HKU1(3,5); NP_SARS_1(5,1); NP_SARS_2(6,6)	COVID-19 #31	
	18	Patient	IgG		12913830	LC0 18 0 1 4 5 6 7 8 9 10	NP_229E(1,5); NP_NL63(4,3); NP_SARS_1(7,6); NP_SARS_2(9,3)	COVID-19 #24	

Info	Nr.	Typ	Ig	PID	Proben Nr.	Streifen	Antigene	Überarbeitete Antigene	Ergebnisse
						ReaktKontr(0) IgG(1) IgA(2) IgM(3) CutOff(4) NP_229E(5) NP_NL63(6) NP_OC43(7) NP_HKU1(8) NP_SARS_1(9) NP_SARS_2(10)		Sample	
	19	Patient	IgG		12906187	LCO 19 01456910	NP_NL63(3,3); NP_SARS_1(3,2); NP_SARS_2(4,3)	COVID-19 #14	
	20	Patient	IgG		42117064	LCO 20 0145678910	NP_NL63(2,7); NP_OC43(5,5); NP_HKU1(4,7); NP_SARS_1(3,0); NP_SARS_2(3,5)	COVID19 #13	

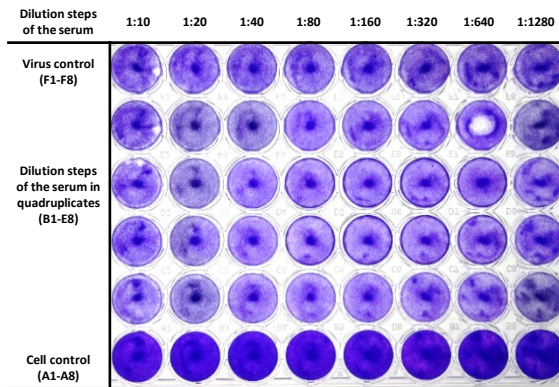
Info	Nr.	Typ	Ig	PID	Proben Nr.	Streifen	Antigene	Überarbeitete Antigene	Ergebnisse
						ReaktKontr(0) IgG(1) IgA(2) IgM(3) CutOff(4) NP_229E(5) NP_NL63(6) NP_OC43(7) NP_HKU1(8) NP_SARS_1(9) NP_SARS_2(10)		Sample	
	1	Patient	IgG		42120619	LCO 11 0 1 4 6 9 10	NP_SARS_1(1,8); NP_SARS_2(1,9)	COVID-19 #16	
	2	Avidität	IgG		42120619	LCO 01 0 1 4 6	NP_SARS_1(0.00=n);NP_SARS_2(0.00=n)	COVID-19 #16	
	3	Patient	IgG		42125794	LCO 12 0 1 4 6 9 10	NP_SARS_1(2,0); NP_SARS_2(2,7)	COVID-19 #17	
	4	Avidität	IgG		42125794	LCO 02 0 1 4	NP_SARS_1(0.00=n);NP_SARS_2(0.00=n)	COVID-19 #17	
	5	Patient	IgG		12931483	LCO 13 0 1 4 5 6 7 8	NP_NL63(2,4); NP_OC43(2,6)	COVID-19 #33	
	6	Avidität	IgG		12931483	LCO 03 0 1 4 6	NP_NL63(0.54=n);NP_OC43(0.00=n)	COVID-19 #33	
	7	Patient	IgG		42111625	LCO 14 0 1 4 5 6 7 8 9 10	NP_NL63(2,3); NP_OC43(6,0); NP_HKU1(5,8); NP_SARS_2(1,3)	COVID-19 #2	
	8	Avidität	IgG		42111625	LCO 04 0 1 4 6 7 8	NP_NL63(0.85=h);NP_OC43(0.64=h);NP_HKU1(0.53=n);NP_SARS_2(0.00=n)	COVID-19 #2	
	9	Patient	IgG		42115601	LCO 15 0 1 4 5 6 7 8 9 10	NP_229E(1,5); NP_NL63(4,1); NP_OC43(4,5); NP_HKU1(4,0); NP_SARS_1(6,8); NP_SARS_2(8,0)	COVID-19 #4	
	10	Avidität	IgG		42115601	LCO 05 0 1 4 5 6 7 8 9 10	NP_229E(0.30=n);NP_NL63(0.72=h);NP_OC43(0.57=n);NP_HKU1(0.54=n);NP_SARS_1(0.22=n);NP_SARS_2(0.19=n)	COVID-19 #4	
	11	Patient	IgG		42127890	LCO 16 0 1 4 5 6 7 8 9 10	NP_229E(1,8); NP_NL63(4,7); NP_OC43(5,6); NP_HKU1(5,3); NP_SARS_1(8,3); NP_SARS_2(9,7)	COVID-19 #6	
	12	Avidität	IgG		42127890	LCO 06 0 1 4 5 6 7 8 9 10	NP_229E(0.42=n);NP_NL63(0.85=h);NP_OC43(0.68=h);NP_HKU1(0.54=n);NP_SARS_1(0.21=n);NP_SARS_2(0.22=n)	COVID-19 #6	
	13	Patient	IgG		42136433	LCO 17 0 1 2 4 6 7 8 9 10	NP_OC43(1,1); NP_HKU1(1,3); NP_SARS_1(4,9); NP_SARS_2(6,5)	COVID-19 #26	
	14	Avidität	IgG		42136433	LCO 07 0 1 2 4 6 7 8 9 10	NP_OC43(0.32=n);NP_HKU1(0.61=h);NP_SARS_1(0.07=n);NP_SARS_2(0.19=n)	COVID-19 #26	
	15	Patient	IgG		42158360	LCO 18 0 1 2 4 6 7 8 9 10	NP_HKU1(1,0); NP_SARS_1(4,8); NP_SARS_2(6,2)	COVID-19 #27	
	16	Avidität	IgG		42158360	LCO 08 0 1 2 4 6 8 9 10	NP_HKU1(0.77=h);NP_SARS_1(0.17=n);NP_SARS_2(0.32=n)	COVID-19 #27	
	17	Patient	IgG		42136466	LCO 19 0 1 4 5 6 7 8 9 10	NP_229E(2,2); NP_NL63(4,8); NP_HKU1(1,1); NP_SARS_1(6,2); NP_SARS_2(7,4)	COVID-19 #28	
	18	Avidität	IgG		42136466	LCO 09 0 1 4 5 6 8 9 10	NP_229E(0.81=h);NP_NL63(0.86=h);NP_HKU1(0.49=n);NP_SARS_1(0.11=n);NP_SARS_2(0.27=n)	COVID-19 #28	

Info	Nr.	Typ	Ig	PID	Proben Nr.	Streifen	Antigene	Überarbeitete Antigene	Ergebnisse
						ReaktKontr(0) IgG(1) IgA(2) IgM(3) CutOff(4) NP_229E(5) NP_NL63(6) NP_OC43(7) NP_HKU1(8) NP_SARS_1(9) NP_SARS_2(10)		Sample	
	19	Patient	IgG		42158482	LCO 20 014568910	NP_229E(1,7); NP_NL63(4,1); NP_SARS_1(5,2); NP_SARS_2(6,2)	COVID-19 #29	
	20	Avidität	IgG		42158482	LCO 10 014568910	NP_229E(0.77=h);NP_NL63(0.92=h);NP_SARS_1(0.12=n);NP_SARS_2(0.29=n)	COVID-19 #29	

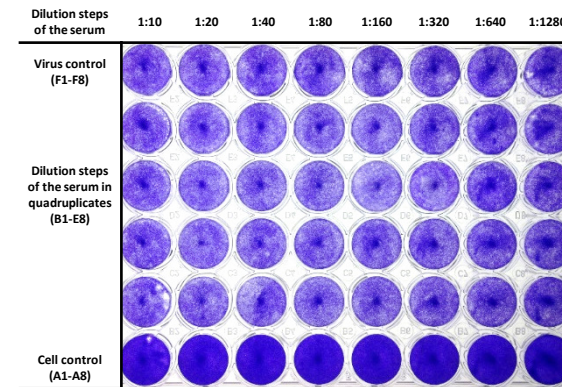
Info	Nr.	Typ	Ig	PID	Proben Nr.	Streifen	Antigene	Überarbeitete Antigene	Ergebnisse
						ReaktKontr(0) IgG(1) IgA(2) IgM(3) CutOff(4) NP_229E(5) NP_NL63(6) NP_OC43(7) NP_HKU1(8) NP_SARS_1(9) NP_SARS_2(10)		Sample	
	1	Patient	IgG		42122445	LC0 01 0 1 4 5 6 8 9 10	NP_229E(1,9); NP_NL63(4,2); NP_SARS_1(5,7); NP_SARS_2(7,2)	COVID-19 #18	
	2	Avidität	IgG		42122445	LC0 01 0 1 4 5 6 10	NP_229E(0.43=n);NP_NL63(0.63=h);NP_SARS_1(0.00=n);NP_SARS_2(0.07=n)	COVID-19 #18	
	3	Patient	IgG		12922540	LC0 02 0 1 4 6 7 8 9 10	NP_OC43(2,0); NP_HKU1(2,1); NP_SARS_1(4,8); NP_SARS_2(5,9)	COVID-19 #35	
	4	Avidität	IgG		12922540	LC0 02 0 1 4	NP_OC43(0.00=n);NP_HKU1(0.00=n);NP_SARS_1(0.00=n);NP_SARS_2(0.00=n)	COVID-19 #35	
	5	Patient	IgG		12922858	LC0 03 0 1 4 5 6 7 8 9 10	NP_NL63(2,3); NP_OC43(2,4); NP_HKU1(3,4); NP_SARS_1(2,6); NP_SARS_2(3,3)	COVID-19 #36	
	6	Avidität	IgG		12922858	LC0 03 0 1 4 5 6 7 8	NP_NL63(0.59=n);NP_OC43(0.75=h);NP_HKU1(0.77=h);NP_SARS_1(0.00=n);NP_SARS_2(0.00=n)	COVID-19 #36	
	7	Patient	IgG		12908291	LC0 04 0 1 4 5 6 7 8 9 10	NP_NL63(1,6); NP_OC43(1,2); NP_HKU1(1,9); NP_SARS_1(1,7); NP_SARS_2(2,3)	COVID-19 #19	
	8	Avidität	IgG		12908291	LC0 04 0 1 4 5 6 7 8	NP_NL63(0.92=h);NP_OC43(0.79=h);NP_HKU1(0.68=h);NP_SARS_1(0.00=n);NP_SARS_2(0.00=n)	COVID-19 #19	
	9	Patient	IgG		42134726	LC0 05 0 1 4 6 8 9 10	NP_NL63(1,3); NP_HKU1(2,8); NP_SARS_1(2,8); NP_SARS_2(3,4)	COVID-19 #8	
	10	Avidität	IgG		42134726	LC0 05 0 1 4 6 8 10	NP_NL63(0.87=h);NP_HKU1(0.65=h);NP_SARS_1(0.00=n);NP_SARS_2(0.08=n)	COVID-19 #8	
	11	Patient	IgG		12913160	LC0 06 0 1 4 5 6 7 8 9 10	NP_NL63(4,2); NP_OC43(4,5); NP_HKU1(6,2); NP_SARS_1(4,4); NP_SARS_2(5,5)	COVID-19 #22	
	12	Avidität	IgG		12913160	LC0 06 0 1 4 5 6 7 8 9 10	NP_NL63(0.63=h);NP_OC43(0.54=n);NP_HKU1(0.64=h);NP_SARS_1(0.08=n);NP_SARS_2(0.16=n)	COVID-19 #22	
	13	Patient	IgG		42130212	LC0 07 0 1 4 5 6 7 9 10	NP_NL63(2,3); NP_SARS_1(5,6); NP_SARS_2(6,0)	COVID-19 #23	
	14	Avidität	IgG		42130212	LC0 07 0 1 4 5 6 8 9 10	NP_NL63(0.97=h);NP_SARS_1(0.19=n);NP_SARS_2(0.24=n)	COVID-19 #23	
	15	Patient	IgG		12906186	LC0 08 0 1 4 5 6 7 8 9 10	NP_229E(1,6); NP_NL63(3,6); NP_OC43(1,4); NP_HKU1(1,5); NP_SARS_1(4,8); NP_SARS_2(5,2)	COVID-19 #15	
	16	Avidität	IgG		12906186	LC0 08 0 1 4 5 6 9 10	NP_229E(0.39=n);NP_NL63(0.64=h);NP_OC43(0.00=n);NP_HKU1(0.00=n);NP_SARS_1(0.11=n);NP_SARS_2(0.26=n)	COVID-19 #15	
	17	Patient	IgG		12916572	LC0 09 0 1 4 6 9 10	NP_NL63(1,8); NP_SARS_1(2,4); NP_SARS_2(3,1)	COVID-19 #30	
	18	Avidität	IgG		12916572	LC0 09 0 1 4 6 10	NP_NL63(0.82=h);NP_SARS_1(0.00=n);NP_SARS_2(0.13=n)	COVID-19 #30	

Info	Nr.	Typ	Ig	PID	Proben Nr.	Streifen	Antigene	Überarbeitete Antigene	Ergebnisse
						ReaktKontr(0) IgG(1) IgA(2) IgM(3) CutOff(4) NP_229E(5) NP_NL63(6) NP_OC43(7) NP_HKU1(8) NP_SARS_1(9) NP_SARS_2(10)		Sample	
	19	Patient	IgG		12915660	LCO 10 0 1 4 6 7 8 9 10	NP_NL63(1,2); NP_SARS_1(1,0); NP_SARS_2(1,3)	COVID-19 #25	
	20	Avidität	IgG		12915660	LCO 10 0 1 4 6	NP_NL63(0.47=n);NP_SARS_1(0.00=n);NP_SARS_2(0.00=n)	COVID-19 #25	
	21	Patient	IgG		42137338	LCO 11 0 1 4 5 6 7 8 9 10	NP_229E(2,7); NP_NL63(3,7); NP_OC43(5,4); NP_HKU1(4,2); NP_SARS_1(5,3); NP_SARS_2(7,1)	COVID-19 #10	
	22	Avidität	IgG		42137338	LCO 11 0 1 4 5 6 7 8 10	NP_229E(0.33=n);NP_NL63(0.34=n);NP_OC43(0.47=n);NP_HKU1(0.24=n);NP_SARS_1(0.00=n);NP_SARS_2(0.14=n)	COVID-19 #10	
	23	Patient	IgG		12905320	LCO 12 0 1 2 4 5 6 7 8	NP_NL63(1,1); NP_OC43(1,9); NP_HKU1(3,8)	Routine #2	
	24	Avidität	IgG		12905320	LCO 12 0 1 4 6 7 8	NP_NL63(0.52=n);NP_OC43(0.64=h);NP_HKU1(0.68=h)	Routine #2	
	25	Patient	IgG		12915631	LCO 13 0 1 4 6 9 10	NP_NL63(1,4); NP_SARS_2(1,0)	Routine #4	
	26	Avidität	IgG		12915631	LCO 13 0 1 4 6	NP_NL63(0.61=h);NP_SARS_2(0.00=n)	Routine #4	
	27	Patient	IgG		12915630	LCO 14 0 1 4 6 9 10	NP_NL63(1,4); NP_SARS_1(3,1); NP_SARS_2(1,9)	Routine #5	
	28	Avidität	IgG		12915630	LCO 14 0 1 4	NP_NL63(0.00=n);NP_SARS_1(0.00=n);NP_SARS_2(0.00=n)	Routine #5	
	29	Patient	IgG		12915632	LCO 15 0 1 4 6 8 9 10	NP_HKU1(2,3); NP_SARS_1(3,0); NP_SARS_2(3,9)	Routine #6	
	30	Avidität	IgG		12915632	LCO 15 0 1 4 8	NP_HKU1(0.46=n);NP_SARS_1(0.00=n);NP_SARS_2(0.00=n)	Routine #6	
	31	Patient	IgG		12917370	LCO 16 0 1 4 5 6 7 8	NP_229E(1,4); NP_NL63(2,2); NP_OC43(7,5); NP_HKU1(7,8)	Routine #7	
	32	Avidität	IgG		12917370	LCO 16 0 1 4 5 6 7 8	NP_229E(1.09=h);NP_NL63(0.90=h);NP_OC43(0.94=h);NP_HKU1(0.98=h)	Routine #7	
	33	Patient	IgG		42137926	LCO 17 0 1 4 5 6 7 8 9 10	NP_229E(1,7); NP_NL63(3,4); NP_OC43(1,6); NP_HKU1(3,8)	Routine #8	
	34	Avidität	IgG		42137926	LCO 17 0 1 4 5 6 7 8	NP_229E(0.92=h);NP_NL63(0.92=h);NP_OC43(0.65=h);NP_HKU1(0.70=h)	Routine #8	
	35	Patient	IgG		42130220	LCO 18 0 1 4 5 6 7 8 9 10	NP_229E(3,1); NP_NL63(4,8); NP_OC43(2,4); NP_HKU1(2,4); NP_SARS_1(6,5); NP_SARS_2(7,4)	Routine #9	
	36	Avidität	IgG		42130220	LCO 18 0 1 4 5 6 7 8 9 10	NP_229E(1.02=h);NP_NL63(1.03=h);NP_OC43(0.80=h);NP_HKU1(0.88=h);NP_SARS_1(0.30=n);NP_SARS_2(0.49=n)	Routine #9	

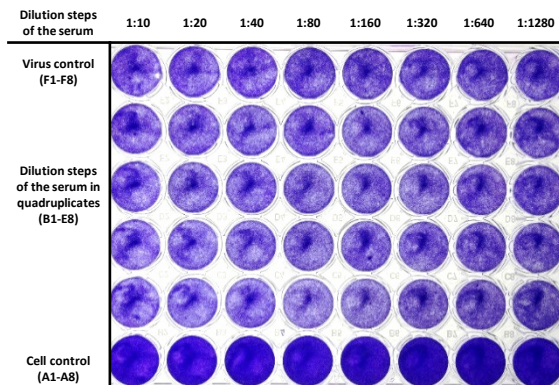
Info	Nr.	Typ	Ig	PID	Proben Nr.	Streifen	Antigene	Überarbeitete Antigene	Ergebnisse
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	37	Patient	IgG		12918648	LCO 19 01478		Routine #10	
	38	Avidität	IgG		12918648	LCO 19 0145		Routine #10	
	39	Patient	IgG		42139828	LCO 20 01459678910	NP_NL63(2,4); NP_HKU1(1,1); NP_SARS_1(4,5); NP_SARS_2(5,3)	Routine #11	
	40	Avidität	IgG		42139828	LCO 20 01468910	NP_NL63(0.67=h);NP_HKU1(0.64=h);NP_SARS_1(0.16=n);NP_SARS_2(0.27=n)	Routine #11	



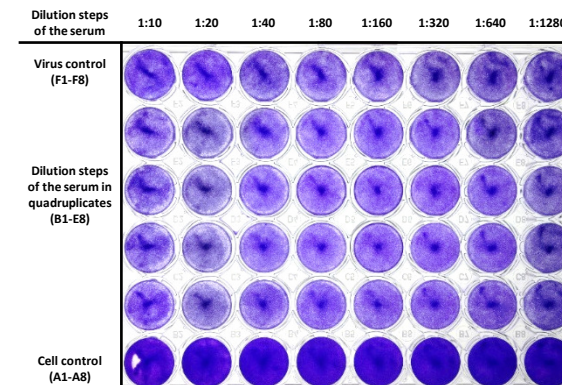
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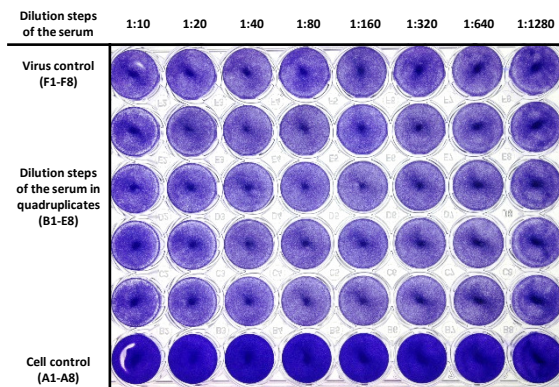
Archived serum (12700966): PRNT₅₀ < 1:10.



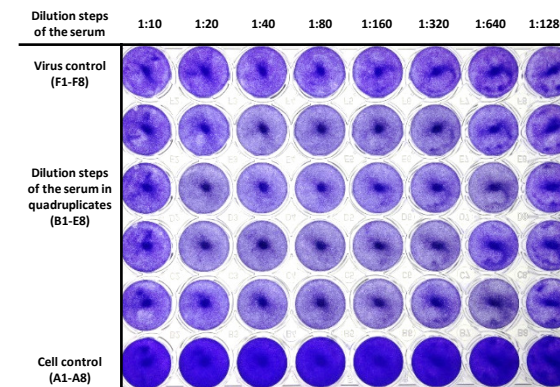
Archived serum (41354992): PRNT₅₀ < 1:10.



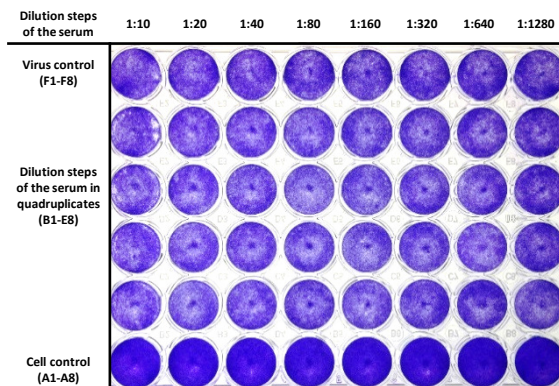
Archived serum (41379572): PRNT₅₀ < 1:10.



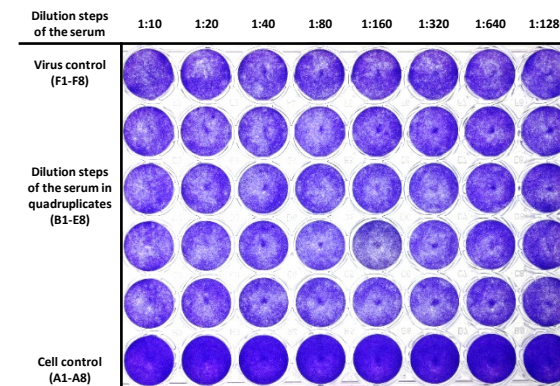
Archived serum (41413833): PRNT₅₀ < 1:10.



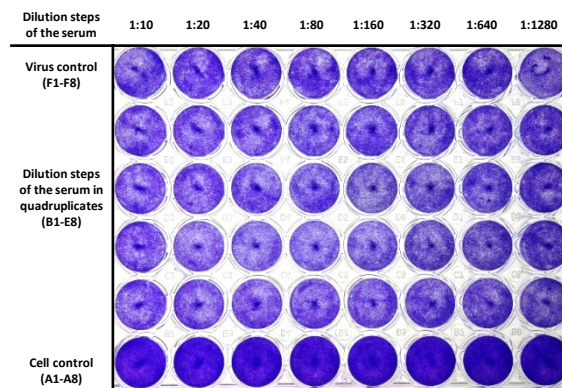
Archived serum (41418016): PRNT₅₀ < 1:10.



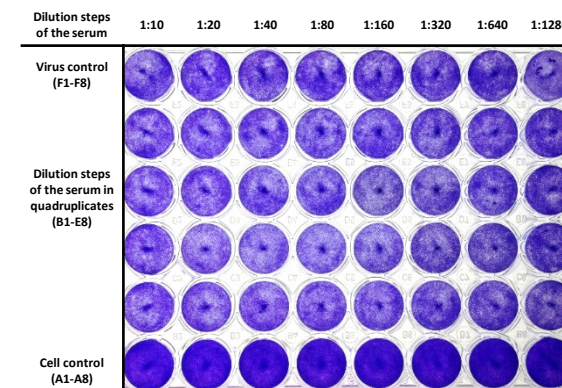
Archived serum (41533704): PRNT₅₀ < 1:10.



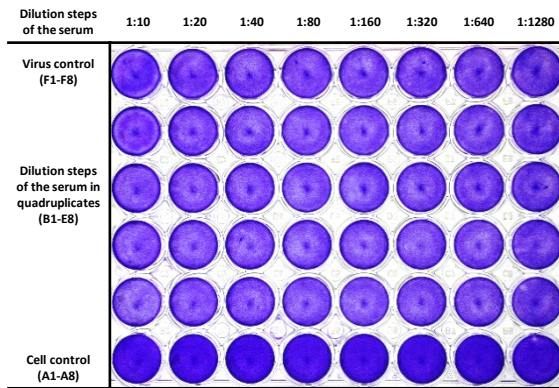
Archived serum (41543646): PRNT₅₀ < 1:10.



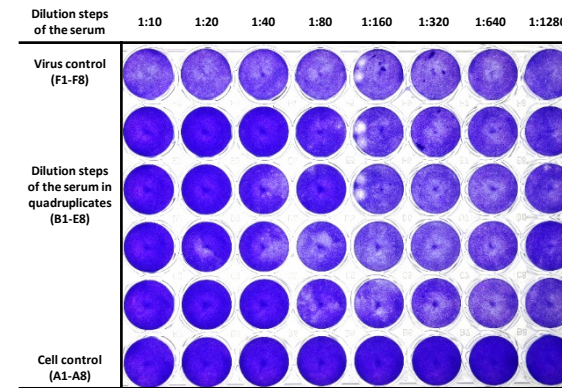
Archived serum (41572497): PRNT₅₀ < 1:10.



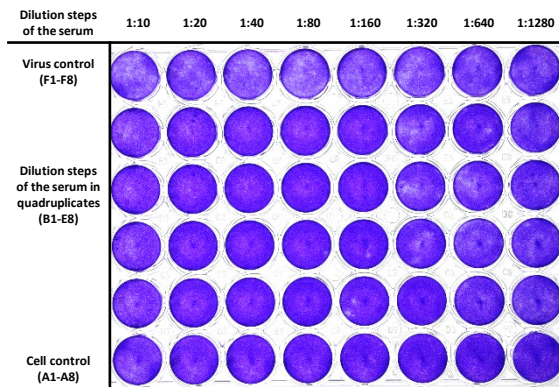
Archived serum (41580810): PRNT₅₀ < 1:10.



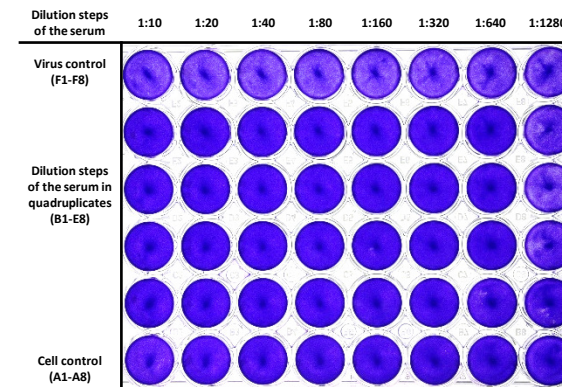
COVID-19 serum #1 (42110507): PRNT₅₀ < 1:10.



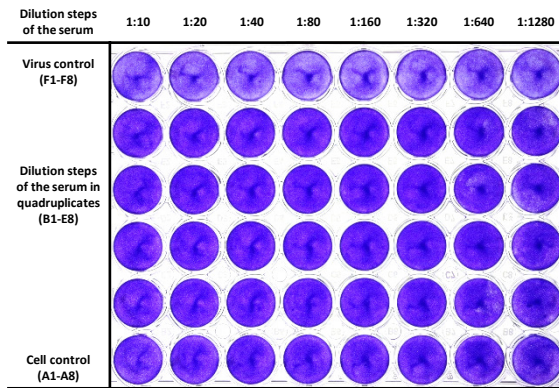
COVID-19 serum #2 (42111625): PRNT₅₀ 1:40.



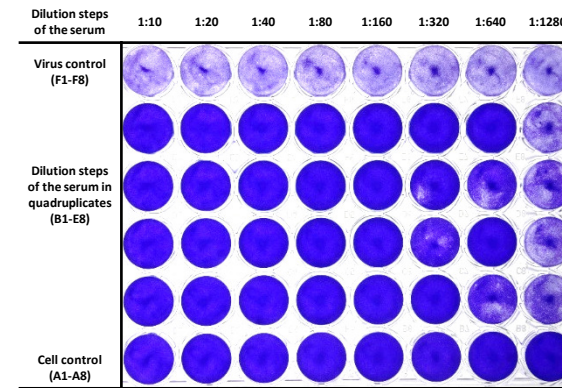
COVID-19 serum #3 (42114145): PRNT₅₀ 1:160.



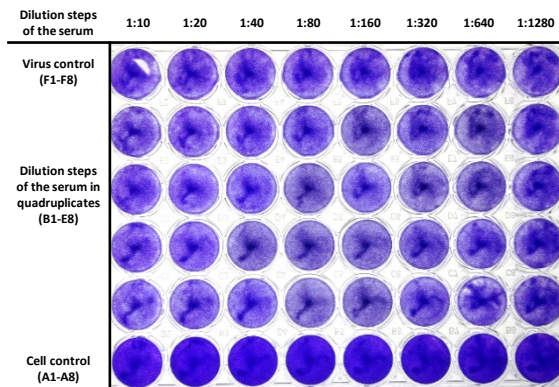
COVID-19 serum #4 (42115601): PRNT₅₀ 1:640.



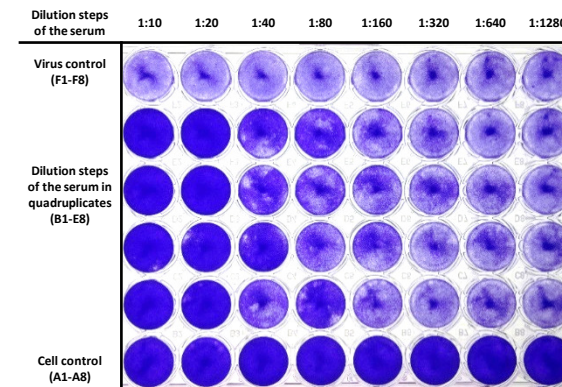
COVID-19 serum #5 (42120066): PRNT₅₀ 1:1280.



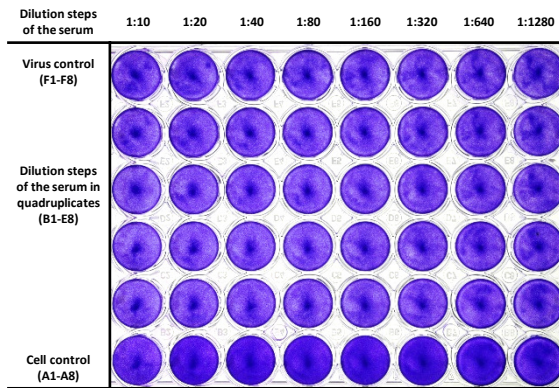
COVID-19 serum #6 (42127890): PRNT₅₀ 1:640.



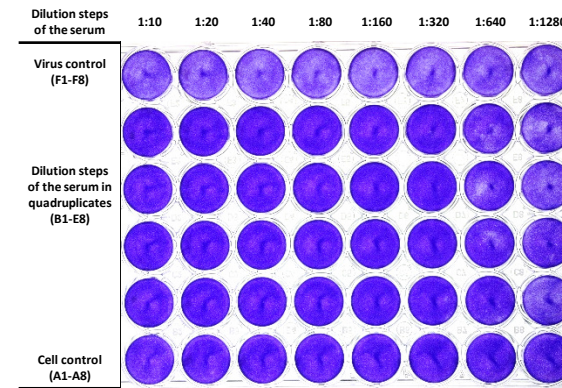
COVID-19 serum #7 (42110783): PRNT₅₀ < 1:10.



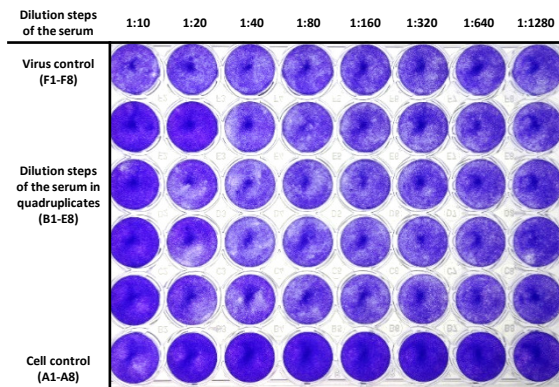
COVID-19 serum #8 (42134726):
PRNT₅₀ 1:20 - 1:40.



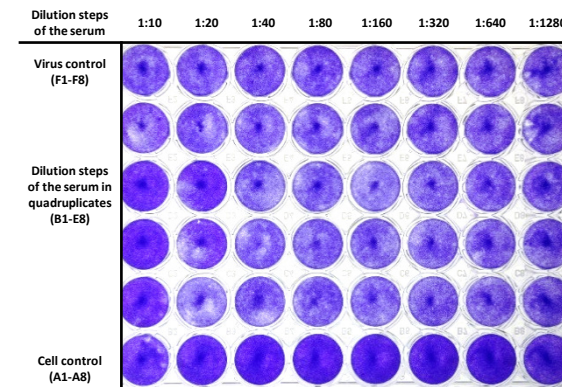
COVID-19 serum #9 (42111496): PRNT₅₀ < 1:10.



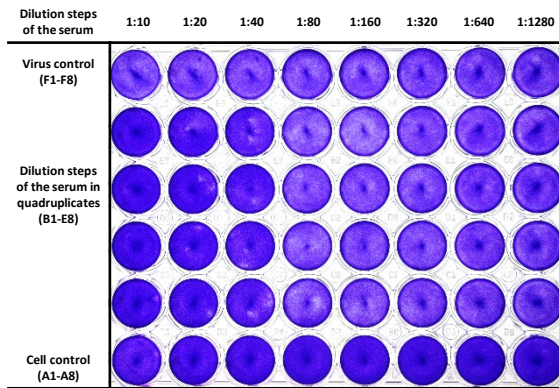
COVID-19 serum #10 (42137338): PRNT₅₀ 1:320.



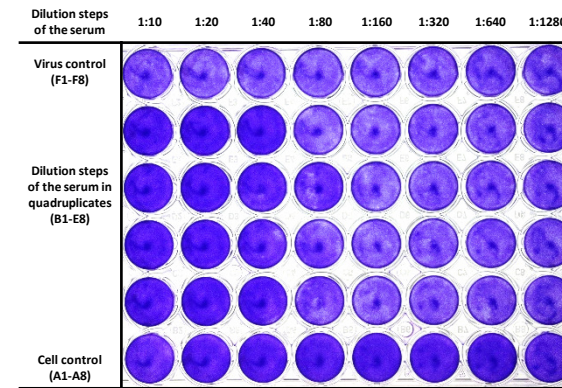
COVID-19 serum #11 (12903428): PRNT₅₀ 1:10.



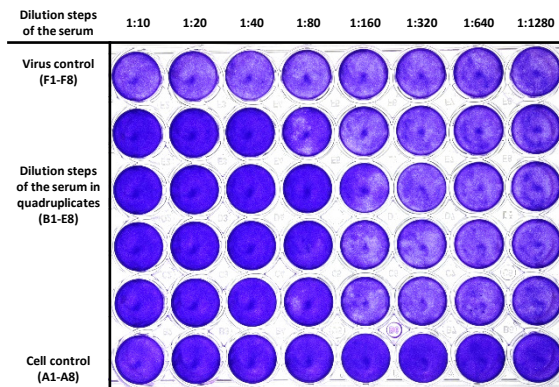
COVID-19 serum #12 (12903427): PRNT₅₀ ≤ 1:10.



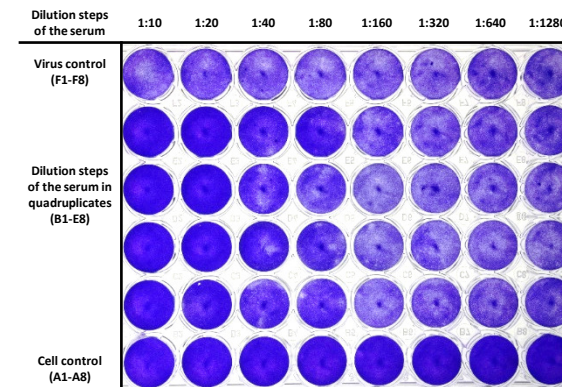
COVID-19 serum #13 (42117064): PRNT₅₀ 1:40.



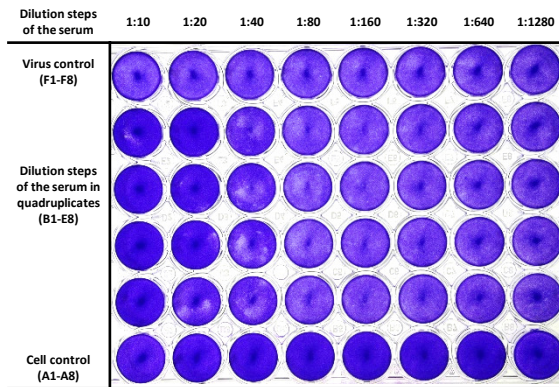
COVID-19 serum #14 (12906187): PRNT₅₀ 1:40.



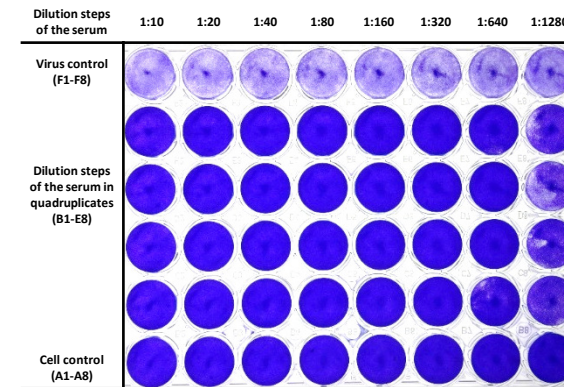
COVID-19 serum #15 (12906186): PRNT₅₀ 1:80.



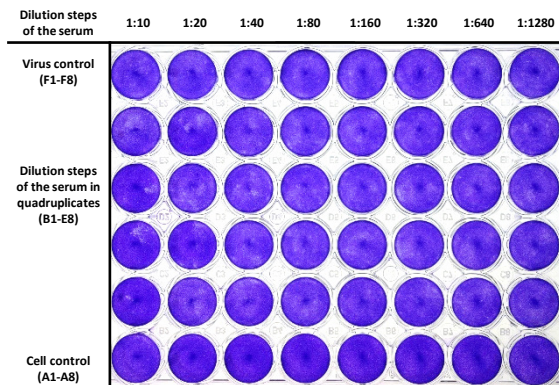
COVID-19 serum #16 (42120619): PRNT₅₀ 1:40.



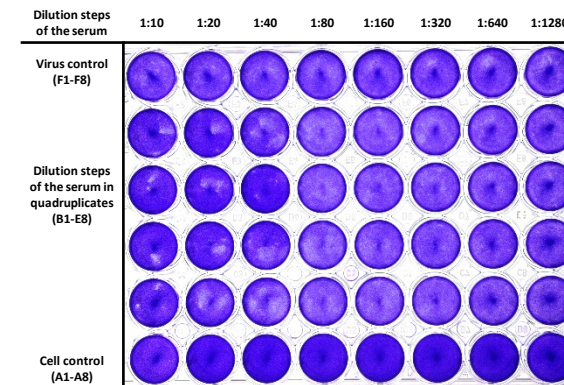
COVID-19 serum #17 (42125794): PRNT₅₀ 1:20.



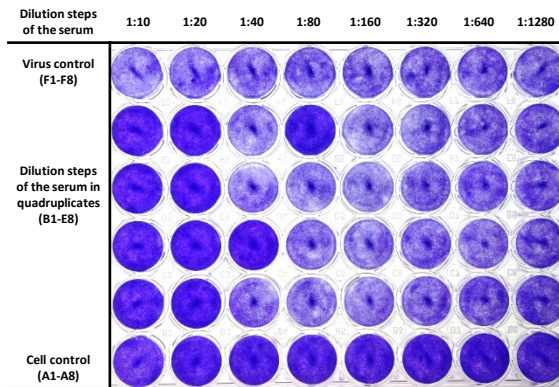
COVID-19 serum #18 (42122445): PRNT₅₀ 1:640.



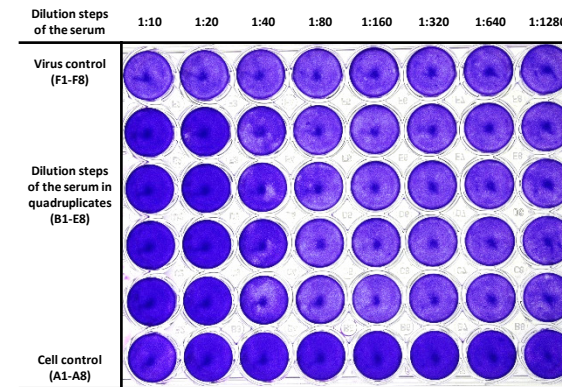
COVID-19 serum #19 (12908291): PRNT₅₀ ≤ 1:10.



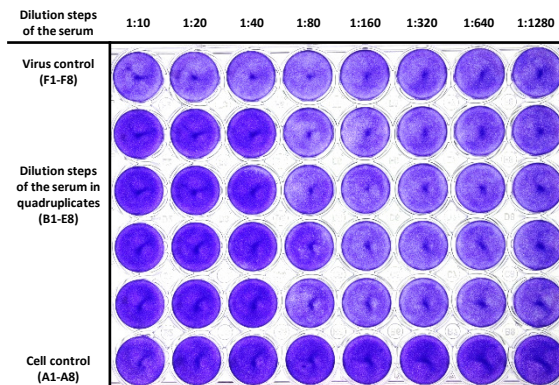
COVID-19 serum #20 (42124178):
PRNT₅₀ 1:10 - 1:20.



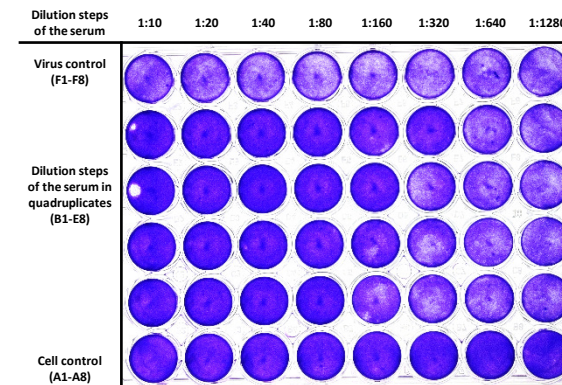
COVID-19 serum #21 (42125046): PRNT₅₀ 1:20.



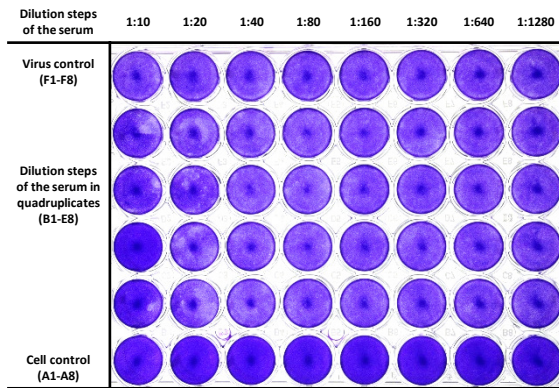
COVID-19 serum #22 (12913160):
PRNT₅₀ 1:20 - 1:40.



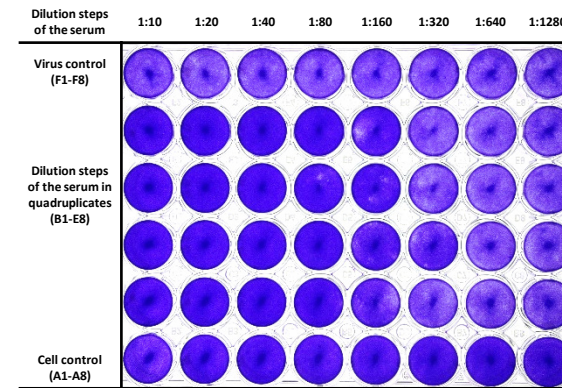
COVID-19 serum #23 (42130212): PRNT₅₀ 1:40.



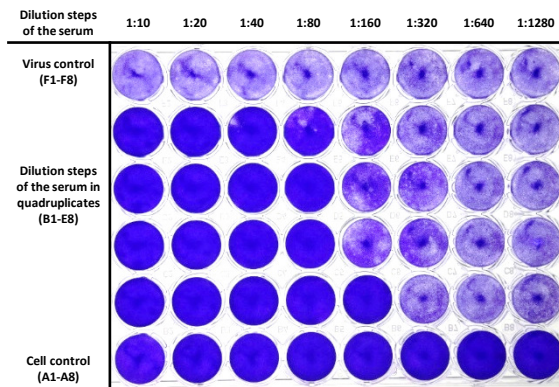
COVID-19 serum #24 (12913830): PRNT₅₀ 1:160.



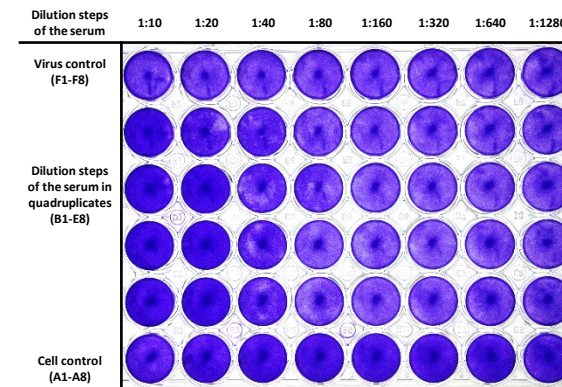
COVID-19 serum #25 (12915660): PRNT₅₀ ≤ 1:10.



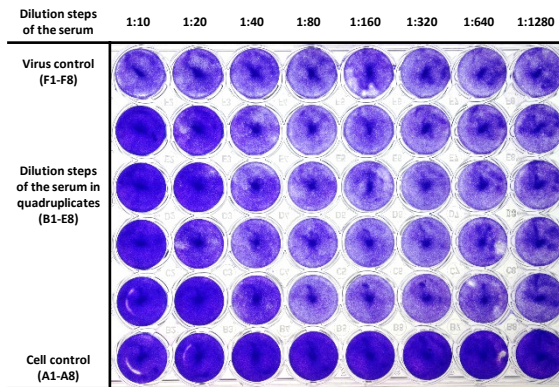
COVID-19 serum #26 (42136433): PRNT₅₀ 1:160.



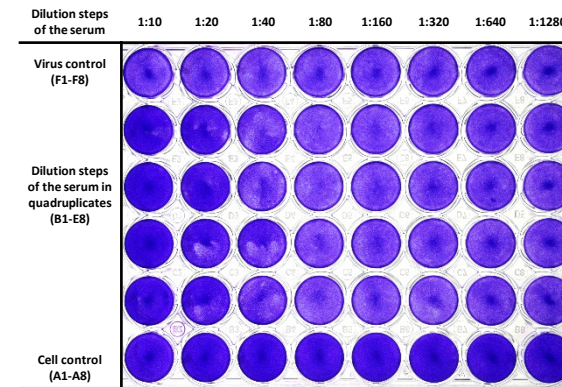
COVID-19 serum #27 (42158360): PRNT₅₀ 1:80.



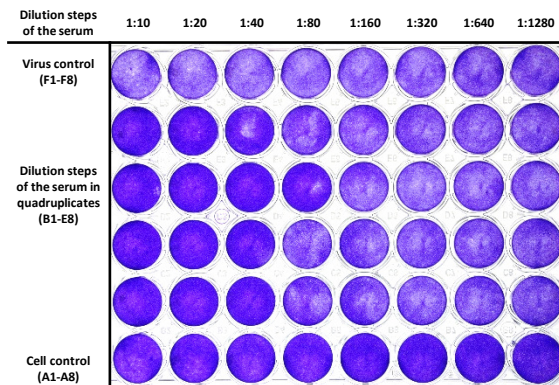
COVID-19 serum #28 (42136466):
PRNT₅₀ 1:20 - 1:40.



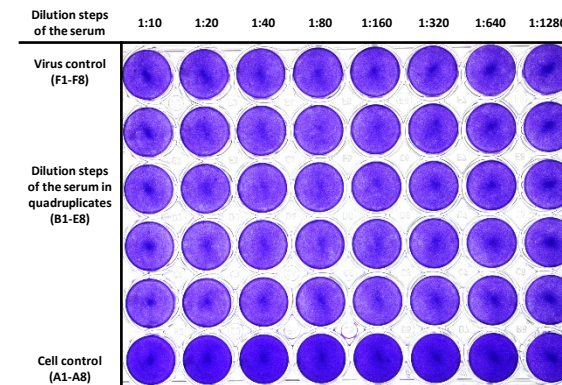
COVID-19 serum #29 (42158482): PRNT₅₀ 1:20.



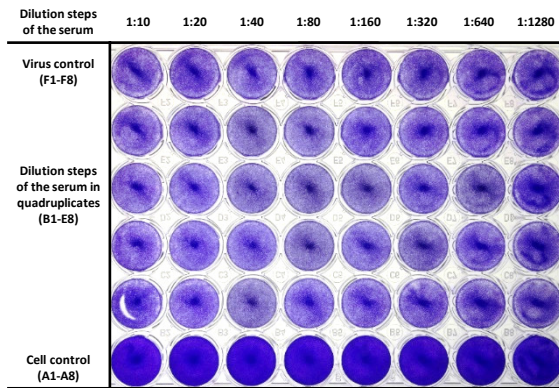
COVID-19 serum #30 (12916572):
PRNT₅₀ 1:10 - 1:20.



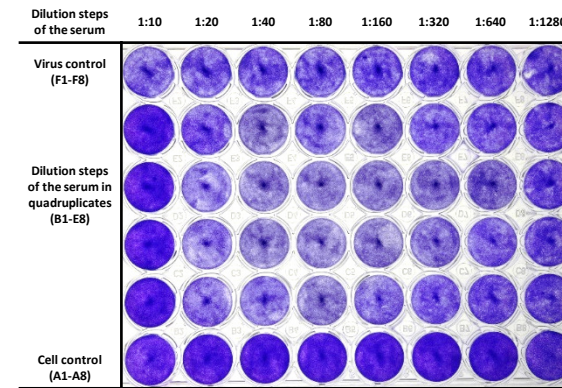
COVID-19 serum #31 (42141894): PRNT₅₀ 1:40.



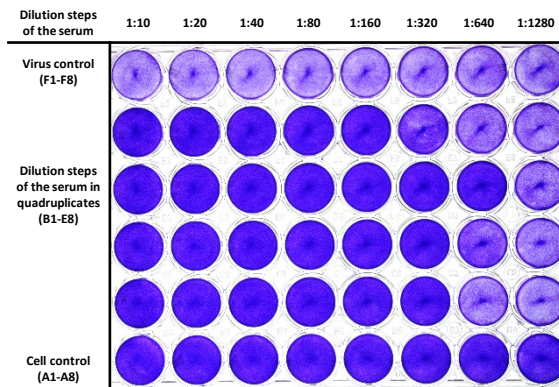
COVID-19 serum #32 (12919072): PRNT₅₀ < 1:10.



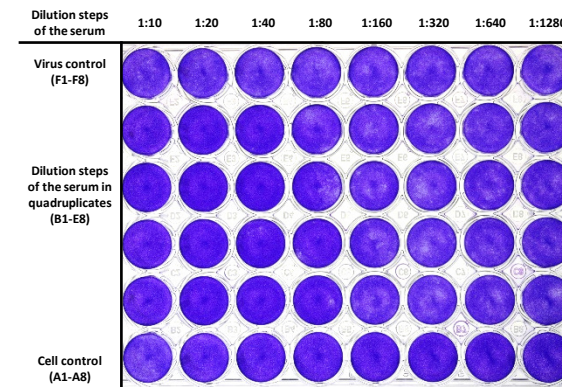
COVID-19 serum #33 (12931483): PRNT₅₀ < 1:10.



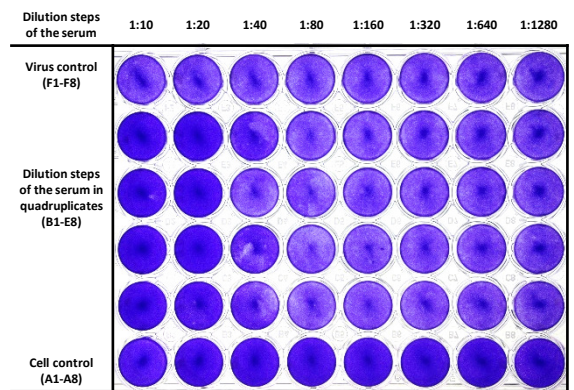
COVID-19 serum #34 (42143907): PRNT₅₀ 1:10.



COVID-19 serum #35 (12922540): PRNT₅₀ 1:320.



COVID-19 serum #36 (12922858):
PRNT₅₀ 1:40 - 1:80.



COVID-19 serum #37 (12928406): PRNT₅₀ 1:20.