High-Throughput Automated ELISA for the Detection of Anti-SARS-CoV-2 IgG

Authors: Mike Rutherford[1], Jen Morio[1], Lindsay Rutherford[1], Adan Orta[2], Steve A Smith[2], John Tipton[2], Cole Yancey[2], Casey Snodgrass[2]

[1]Namida Lab, Fayetteville, AR, USA. [2]Hamilton Company, Reno, NV, USA.

Introduction

The emergence of COVID-19, the disease caused by the novel coronavirus SARS-CoV-2, has challenged the world to rapidly develop testing infrastructure in an unprecedented way. Part of the need for testing is to detect anti-SARS-CoV-2 antibodies. The reasons why serological testing is important are numerous: determining the infection fatality rate, identifying potential donors of convalescent plasma, understanding whether previous infection confers immunity, among others. Many SARS-CoV-2 antibody test kits have entered the market but some have unfortunately underperformed with regard to sensitivity and specificity.

Immunoassays are ideal for addressing the need for effective SARS-CoV-2 antibody testing. These tests, known as Enzyme-Linked ImmunoSorbent Assays (ELISAs), are widely used and trusted by research and diagnostic laboratories around the world. They demonstrate high sensitivity and specificity for the target analyte which is essential to having a meaningful impact on controlling the COVID-19 pandemic.

Performing ELISA testing manually opens the possibility for human error and can increase the turnaround time for crucial results, especially considering the current need to process large numbers of antibody testing samples. For this reason, Namida Lab has developed an automated system for high-throughput processing of thousands of serology samples per day to meet the testing demand of employers and large population studies. The system utilizes the Hamilton Microlab® STARplus and integrated devices to fully automate a commercially available anti-SARS-CoV-2 ELISA.

Materials and Methods

Automated SARS-CoV-2 ELISA

Human serological samples were analyzed for the presence of anti-SARS-CoV-2 IgG using Eagle Biosciences (Nashua, NH) EDI™ Novel Coronavirus COVID-19 IgG ELISA kit per the manufacturer's recommendation on the Hamilton (Reno, NV) Microlab STARplus automated liquid handling platform. Briefly, samples were diluted 100-fold and 100 µL of samples and controls were plated according to the plate map on the next page. Assay plates were washed using an integrated Biotek® 405™ LS microplate washer. Final absorbance measurement was taken at 450 nm using an integrated Biomed plate reader.

Benefits-Based Highlights

- High-throughput ELISA processing of up to 3,000 samples per day.
- Automation delivers consistent results, increased walk-away time for operators, and reduces inter-plate variability.
- Minimize sample handling by laboratory personnel to reduce the risk of exposure.
- Continuous sample loading enables high-throughput parallel processing.

Results and Discussion

Namida Lab's automated platform utilizes the Eagle Bioscience EDI™ Novel Coronavirus COVID-19 IgG ELISA kit on a Hamilton STARplus liquid handling robot with integrated peripheral devices. This ELISA is a qualitative test that detects the presence of anti-SARS-CoV-2 IgG in human serum with positive and negative controls included in each assay plate (Figure 1).

The assay is fully-automated from loading serological samples through reading assay plate absorbance. Using Hamilton's Venus Dynamic Scheduler, assay plates are processed in parallel under continuous operation of the system to yield the highest throughput possible (Figure 2). The technician loads samples and consumables onto the system when prompted to enable the uninterrupted flow of sample dilution and assay plate processing.

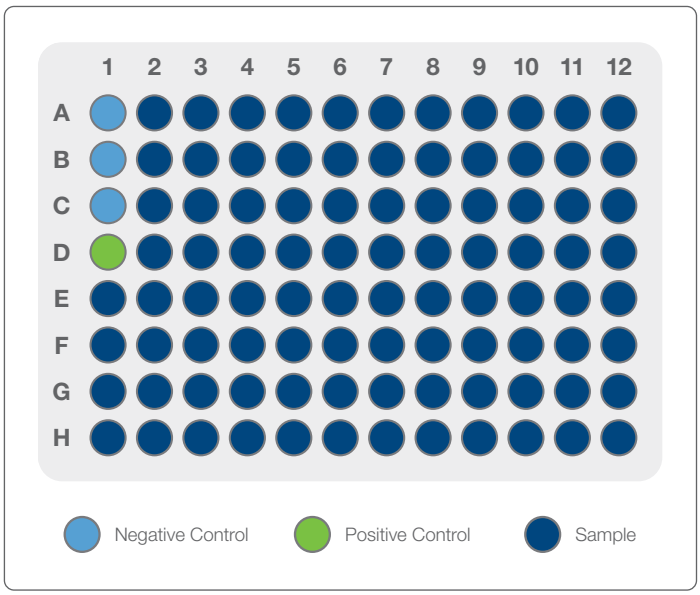


Figure 1. Qualitative anti-SARS-CoV-2 ELISA.

Figure 2. High-throughput automated parallel processing of ELISA plates.

As a comparison, intra-plate precision was analyzed for positive and negative control samples using both the automated system and manual preparation by a trained technician. Automated ELISA processing yielded less variability as compared to data generated from manual preparation (Table 1).

Table 1: Improved Precision Using Hamilton Automation

Sample	Control 1	Control 2	Positive 1	Positive 2
Hamilton %CV	4.0	5.8	5.8	8.4
Manual %CV	10.0	3.6	1.6	17.5

Intra-plate precision was analyzed for positive and negative control samples using both the automated system and manual preparation by a trained technician. Automated ELISA processing yielded less variability as compared to data generated from manual preparation.

When the ELISA is performed manually by a technician, approximately six assay plates can be processed per shift as compared to 18 plates on the automated platform (Table 2). When considering that a single technician can operate the liquid handling instrument, the throughput benefits become clear. Another benefit of using liquid handling robotics is the improvement in assay sensitivity and specificity. When performed manually the ELISA demonstrated 94% sensitivity and 100% specificity, where the automated platform achieved 100% sensitivity and 100% specificity.

Table 2: Increased Laboratory Efficiency and Reproducibility

	Number of Technicians Required	Total Assay Plates	Samples Analyzed Per Technician	Process Time (hours)	Sensitivity (%)	Specificity (%)
Hamilton	1	18	1,656	10	100	100
Manual	3	18	552	9	94	100

Hamilton automation delivers higher throughput per technician and improved sensitivity compared to manual processing.

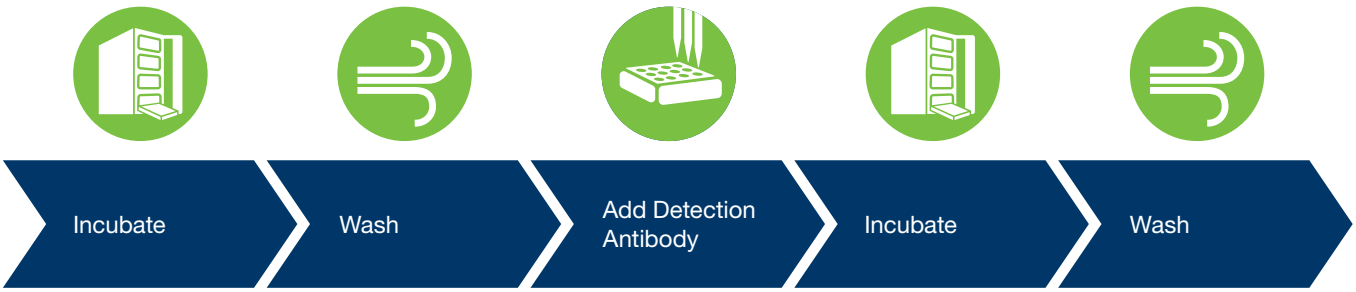
Conclusion

The data reported here demonstrates the efficiency of automation and the ability of liquid handling robotics to meet the demand for high-throughput antibody testing during the COVID-19 pandemic. Namida lab is able to process up to 3,000 patient samples per day and can report results within 24 hours using their STARplus ELISA platform. The system is operated by a single technician, which enables physical distancing among laboratory technicians and the safe operation of the instrument. Furthermore, liquid handling automation delivers highly reproducible pipetting and assay plate processing that yields lower variability in results and reduces the possibility for human error.

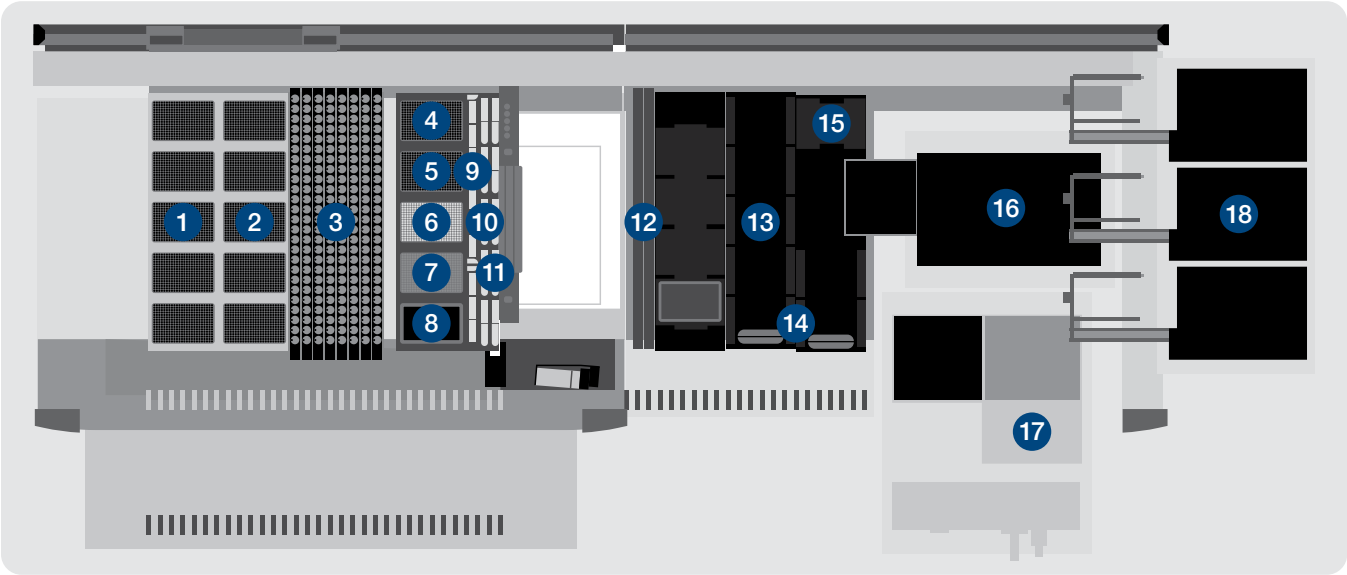
SARS-CoV-2 ELISA Workflow

Sample Dilution and Plating

Assay Plate Processing



Namida Lab Anti-SARS-CoV-2 ELISA Platform Using the Hamilton Microlab STARplus



1. CO-RE 300 µL NTR Tips
2. CO-RE 50 µL NTR Tips
3. Samples
4. CO-RE 1,000 µL Tips
5. CO-RE 1,000 µL Tips
6. Dilution Plate
7. Assay Plate
8. Controls
9. Diluent Reservoirs
10. Reagent Reservoirs
11. Reagent Reservoirs
12. CO-RE 5,000 µL Tips
13. Dilution Plate Stacks
14. Assay Plate Stacks
15. CO-RE Grippers
16. Absorbance Reader
17. Microplate Washer
18. Hamilton Incubators

HAMILTON®

To find a subsidiary or distributor in your area, please visit, www.hamiltoncompany.com/contacts.

Web: www.hamiltoncompany.com/robotics
Email: marketingrequest@hamiltoncompany.com

United States
+1-775-858-3000

United Kingdom, Ireland
+44 (0) 121 272 92 80

Brazil
+55 (11) 126 50562

China
+86 21 6164 6567

Denmark, Norway, Sweden, Finland
+46 (0) 8 410 273 73

France
+33 184 008 420

Germany, Switzerland, Austria, Benelux
+49 (089) 248 804 808

Italy
+39 39 689 33 93

Japan
+81 3 6435 6850

Spain, Portugal
+34 930 186 262