

CASE STUDY

How Opentrons Helped Spain Scale COVID-19 Testing to 1 Million Per Month



The global SARS-CoV-2 pandemic forced healthcare systems around the world to increase testing capacity. Hospitals and laboratories in Spain used Opentrons liquid handling robots to create a testing solution for one of the world's biggest hotspots.

Written by
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The SARS-CoV-2 pandemic pushed global health systems to their limits. In **early March**, the World Health Organization's Director-General Tedros Adhanom Ghebreyesus recommended that all nations "test, test, test" to combat the virus. Without mass testing, he said, countries were trying to "fight a fire blindfolded." Nearly every health care system in the world adopted testing to track the impact of COVID-19 on their population and prevent the further spread of the virus.

On March 15th, Spain began its state-of-emergency lockdown. With **nearly 250,000 cases and more than 25,000 deaths**, Spain had the second highest cases of coronavirus in the world.

To stop the spread of the virus, reduce SARS-CoV-2 infections, and prevent the healthcare system from being overwhelmed, Spain implemented one of the strictest lockdowns in Europe. Adults were only permitted outside for essential business. All restaurants were closed. Children were allowed outside for an hour a day.

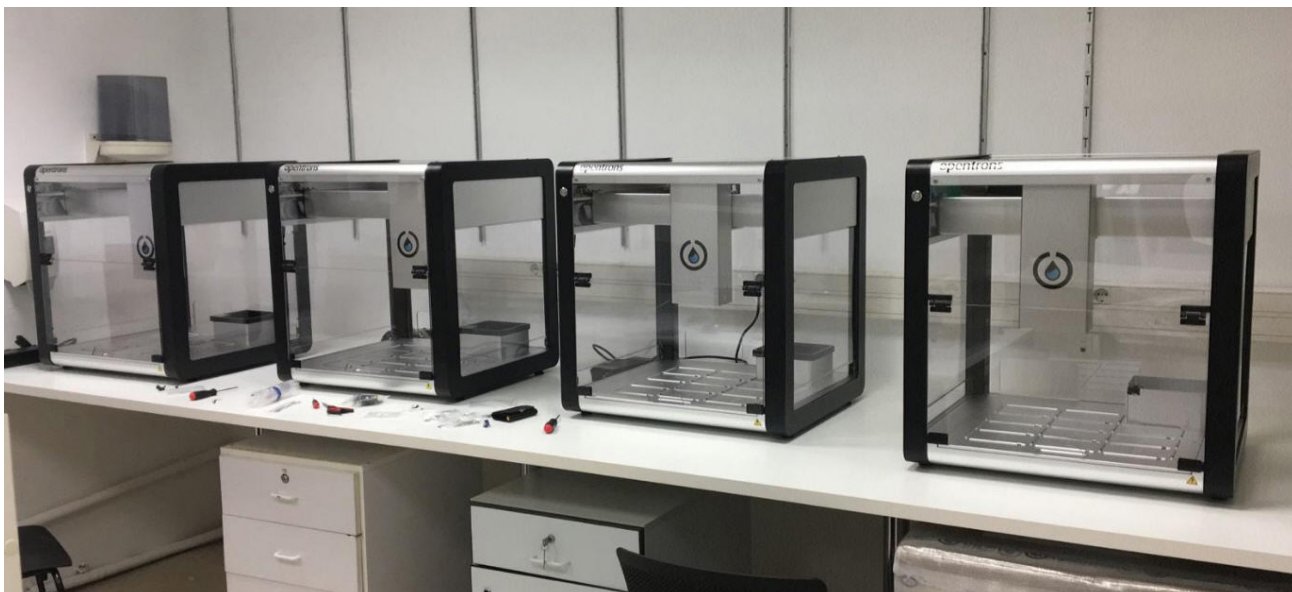
Before the lockdown, five Spanish friends at different institutions joined forces to increase COVID-19 testing capacity. Using four Opentrons COVID-19 testing systems, they added over 10,000 tests per day... and a few weeks later, they helped deploy 14 systems—212 OT-2

automated liquid handling robots—across Spain to scale up population-level testing.

This is the story of Spain's #COVIDWarriors, and how they created their own population scale testing system using Opentrons.



A customized COVIDWarriors plate. CREDIT: COVIDWarriors



A bank of OT-2s used by COVIDWarriors for COVID-19 PCR tests. CREDIT: COVIDWarriors

Ramping Up Population-Based Testing

Population-wide testing, or mass testing, is one of the best ways to prevent the spread of the COVID-19 virus because:

- identifies areas, settings, or locations where infection is prevalent, allowing for more targeted prevention methods
- enables accurate estimates of infection prevalence
- helps decrease incidence of infection to levels that may be more manageable

As one of the main pillars of the global COVID-19 public health response, many countries have adopted robust testing regimens to identify and isolate infected individuals. Identifying an infected individual is the first step in preventing mass infections and overwhelming healthcare systems.

However, at the start of the pandemic there wasn't enough testing capacity to do that. Demand exceeded capacity, even with major ramp-up efforts on the part of manufacturers and testing facilities. There were bottlenecks associated with reagent supplies and the availability of PCR machines. Another challenge was the immense amount of manual processing required to run tests for those machines.

As world health systems faced the reality of massively increasing testing capacity by hundreds of thousands of samples per day, Spanish researcher Rocio Martine, turned to Opentrons to scale testing capacity in Spain.

"We knew the only way to get ahead of the pandemic was to ramp up testing, and the only way to increase testing was to automate the process," [Dr. Rocio Martinez-Nunez](#), principal investigator and lecturer in [King's College London's Department of Infectious Diseases](#) told Opentrons. "I knew the fastest way to implement that automation was with an affordable liquid handling tool that could be adapted to any brand of commercial test and any protocol."

Martinez discovered the Opentrons OT-2 in her work at King's College in London. She appreciated Opentrons' open-source software system, the community-focused appeal of the robot, and its adaptability.

Says Martinez, "Laboratories were the frontline against the epidemic. They might not see patients but they were processing thousands of samples. But hospitals and labs across Spain were using different commercial tests, so adaptability was critical, as was the ability to get the systems up and running quickly and train staff. We knew

Opentrons COVID-19 Testing System

In late February, Opentrons developed its Opentrons COVID-19 Testing System to help labs, and other public health companies automate and scale up their surveillance and population testing systems.

The Opentrons COVID-19 Testing System consists of three stations that can work individually, can be used to complement an existing setup, or create a full testing workflow from scratch.

Opentrons automates three steps in the COVID-19 testing process: sample plating, RNA extraction, and qPCR prep.

Tested at the Open Medicine Institute in Palo Alto, California, the full Opentrons COVID-19 Testing System can automate up to 2,400 tests per day within days of an order being placed.

there were many laboratories where staff was working 24/7 with overnight shifts overwhelmed by manual pipetting. I knew that liquid automation with the OT-2s would help decrease some of the labor burden.”

Martinez recruited her long-time friend [Andreu Veà](#), a world-renowned Internet pioneer and professor. Veà in turn recruited [Javier Colas](#), ex-director of Medtronic Spain and current director of innovation at ESADE, a graduate Spanish business school; [Sandra Figaredo](#), a senior consultant at communications firm Llorente & Cuenca; and [Maria Parga](#), director of BME and president of Alastria, a non-profit consortium encouraging the digital economy.

The team ordered four systems—a total of 44 robots—for hospitals in Madrid and Barcelona, Spain’s most populous cities. Once installed, those robots helped process nearly 10,000 tests per day, 70,000 tests per week.

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Overcoming Challenges to Expand Spain’s COVID-19 Testing

To increase testing with the Opentrons COVID-19 Testing System, Martinez and her team had to overcome three hurdles:

- The effort had to be undertaken by a private entity;
- The OT-2 robots needed to be transported from China in a timely manner; and,
- The OT-2 robots needed to be programmed and end-users needed to be trained.

Like most other countries, any testing efforts within Spain’s existing healthcare system requires getting permits from local authorities. That requires filling out forms and waiting for approvals. Not only that, each of Spain’s seventeen autonomous communities had its own rules and regulations to follow on top of filling out all of that paperwork.

Despite the emergency use authorizations that would enable quick access to testing, Martinez and her team were racing the clock against spiking COVID cases, so going through normal channels would take too long to ramp up testing efforts. As a result, the team decided to keep their effort private. They knew this would allow them to increase testing capacity faster. A private donor paid for the first four robots, and soon other donors stepped forward to fund the rest of the testing systems.



COVIDWarriors conducting COVID-19 PCR testing. CREDIT: COVIDWarriors

Opentrons manufactures its OT-2 liquid handling robots in its factory in Shenzhen, China. Under normal circumstances, transporting robots to Spain would require a few weeks. In the middle of a pandemic, weeks of waiting was not an option.

One of Martinez' team members contacted the CEO of Inditex, owners of the fashion brand Zara and one of the world's largest fashion retailers. The CEO volunteered to put their logistics expertise to use and chartered a plane to fly halfway around the world to pick up and deliver the robots. Approximately 180 robots made the journey.

Once in Spain, the robots had to be programmed and the end users at laboratories across the country had to be trained in their use. Under normal circumstances, Opentrons relies on user friendly technical documentation and phone support to set users up. However, a pandemic is not normal circumstances. To provide support, Opentrons opened a live chat manned by the company's technical staff 24/7.

According to Martinez, "In an ideal world, you have someone from the lab to program, install, and troubleshoot the robots. But the population of molecular biologists and laboratory technicians trained in Python is almost non-existent in Spain. Luckily, Veà polled his

network to find a group of engineers trained in robotics and fluent in Python. Several people stepped forward, volunteering their expertise and time. They programmed the robots, delivered them, and trained the users at the first hospitals in Madrid and Barcelona."

Population Testing COVID-19 in Spain

According to Martinez, most of the Opentrons systems in Spain were set up as COVID-19 Testing Systems. For population testing, you mix or "pool" samples from several patients together, then analyze for the presence of SARS-CoV-2. If the presence of the virus is detected after pooling, then those samples are analyzed again one-by-one to identify the infected individual. In areas where the incidence of infection is low, this type of population screening can save time and money since there are typically more negative results (uninfected individuals) than infected one.

"Using the Opentrons automation tool is quite efficient and saves time because you are conducting PCR on several samples," said Rocio. "This accelerates population screening."

As mentioned above, the Opentrons COVID-19 Testing System automates three critical steps: sample plating,

RNA extraction, and setup for RT-qPCR—the primary assay used for SARS-CoV-2 testing. Most of the hospitals in Spain opted to use the complete Opentrons COVID-19 Testing system.

Once the first four systems were deployed at major hospitals in Spain's most populous cities—Barcelona and Madrid—the other systems were deployed to hospitals in the Canary Islands and the Balearic Islands, as well as in the states of Andalusia, Galicia, Catalonia, Extremadura, and Valencia.

Limitations

As mentioned above, due to the complexity of the setup and its integration across multiple hospital systems, the Spanish team required remote technical help from the Opentrons team. A shared Slack channel and a [centralized protocol repository on GitHub](#) were created to allow information and best practices sharing across the hospitals and to help new users of the OT-2 liquid automation robots.

According to Martinez, end-users of the OT-2 appreciated knowing that they could ask questions on Slack and that any time a protocol was updated or improved it would be shared via Github.

Another limitation that OT-2 users faced was the lack of traceability associated with sample prep. Since the OT-2s were developed for lab research rather than clinical laboratories—and only recently started being used to augment laboratory tools in a more diagnostic setting like the [Pandemic Response Lab](#)—they do not have a ready-made method for automating sample barcoding. The Spanish hospitals had to use external barcode readers for individual samples and for fixed well positioning. Thankfully, one of the hospitals developed a series of custom scripts to automate the barcoding of samples on the OT-2 and shared it with all the hospitals.

Testing Happens Rapidly When Teams Work Together

In three weeks, a team of five mobilized the Spanish government and major businesses to deliver a critical technology and increase testing in Spain.

“The amount of support was overwhelming,” says Rocio. “A lot of people came forward volunteering to help. Seeing that first-hand was an incredible show of the best in people and the sacrifices they were willing to make to help others.”

In June, several of the early participants published a preprint called [ROBOCOV: An affordable open-source robotic platform for SARS-CoV-2 testing by RT-qPCR](#) to help other labs incorporate learnings from Spain.

“People love the robots,” said Martinez. “We’ve received really nice notes from users across Spain. They are really helping with their population surveillance efforts. Now, they’re also asking what else can the robots do?”

As of this writing, Spain is starting to experience a second wave of the pandemic. The increased RT-qPCR testing capacity with Opentrons will help Spanish health authorities in their efforts to contain the pandemic. Now that the OT-2 platform has demonstrated its versatility and affordability, it will likely be repurposed to face this second wave... and any outbreaks facing Spain in the future.

References

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