COVID-19 PANDEMIC
THE ROLE OF SCIENCE DURING PANDEMICS

ESSAY BY MIGUEL PRUDÊNCIO
There are moments in history when what was already known by many becomes evident to all. By raising the entire world’s awareness of the essential role of science in today’s societies, the COVID-19 pandemic is undoubtedly one such moment. Rarely, if ever, have so many scientists been asked to share their knowledge or voice their opinion to the general public. Rarely, if ever, have people so eagerly relied on researchers to deliver the answers they seek in their quest for a return to normality. The vast majority of the world looks at science as the only path to the peace and tranquility that this pandemic took away from us. As a result, scientists are faced with an exceptional opportunity to make a real difference in the world, but also with the extraordinary responsibility that arises from their unprecedented visibility and from the constant scrutiny they are subjected to. What, then, can science achieve during a time of pandemics? I argue that the answer to this question lies upon three pillars, which, collectively, frame the role of scientists in the context of present or future pandemic states: (i) the ability to respond promptly to emergency situations, (ii) the constant willingness to inform and combat misinformation, and (iii) the capacity to prepare the world to effectively deal with future outbreaks.

Prompt Response to Emergency

Despite stark warnings by much of the scientific community, when the SARS-CoV-2 pandemic hit, most of the world was caught by surprise. Almost overnight, one country after another was forced to implement measures to restrict the propagation of the infection. “Flatten the curve” came to be an expression known to all, as it became apparent that only by keeping infection rates under control would health services be able to cope with the needs of their citizens¹. The scientific community became actively engaged in a race to efficiently diagnose, treat and vaccinate against COVID-19. Funds became readily available for researchers to seek these crucial objectives, and scientists started working around the clock to meet them. At the same time, scientists spared no efforts to understand the immunology of SARS-CoV-2 infection, in an attempt to determine the duration of immunity acquired upon exposure to the virus and predict the requirements for herd immunity to be attained. From big pharma to academic institutions, both in wealthy and in less wealthy countries, researchers from all ranks of the life sciences rose to the call in a forthright attempt to respond to the emergency situation the world suddenly found itself in.

Improving the Testing Capacity: The Portuguese Example

Portugal is a relatively small European country with a vibrant, albeit underfunded, research community. The first case of SARS-CoV-2 infection in Portugal was reported on March 2 2020, a few weeks later than in several other European countries. The realization of what was likely to come, made the authorities and the scientific community acutely aware of the need to test increasing numbers of people potentially infected with the virus. As nicely described in an article in The Lancet Infectious Diseases², the country’s testing capacity at that time was around 1500 tests a day. At Instituto de Medicina Molecular (iMM), it was quickly understood that this would likely become insufficient within a short period of time.
Realizing that iMM held the equipment and expertise to perform these tests, a COVID-19 testing facility was promptly implemented. Within a couple of weeks, a testing protocol has been established and validated by the National Health Authority, and a team of over 100 volunteers from among the iMM research community started to routinely perform diagnostic tests in the Institute. This initiative was quickly followed by universities and research institutes around the country and, by early July 2020, 25 such institutions were carrying out COVID-19 diagnostic tests in their facilities, in close coordination with the Ministries of Science and Technology, of Health, and of Labour, Solidarity and Social Security, who warmly welcomed and supported this enterprise. Portugal became one of the ten countries doing the highest number of daily tests per thousand individuals worldwide, a factor that certainly contributed to a capacity to control the spread of infection that was termed by the international press at the time “the Portuguese miracle”. While it is certain that miracles do not exist, as subsequent waves of the pandemic sorely showed, it is equally clear that scientists’ ability to mobilize in order to respond to an emergency can play a pivotal role in curbing the impact of the outbreaks of diseases such as COVID-19.

**Diagnostic Tests, Therapies and Vaccines**

A pandemic situation demands immediate responses that only science can deliver. As soon as the SARS-CoV-2 outbreak emerged, scientists engaged in efforts to create diagnostic tests, to identify efficient therapies, and to develop an efficacious vaccine. Research in these fields surged, and studies multiplied at an unprecedented rate. Viral and antibody-based tests were created to detect current and past infections, respectively², and affordable rapid diagnostic tests quickly became available⁴. Multiple existing drugs were evaluated to determine their potential to be repurposed to treat COVID-19⁵ and innovative therapies, such as antibody-based treatments, started to arise and multiply⁶. A plethora of vaccine candidates were created, some of which pushing the boundaries of what used to be its state-of-the-art. Within only a few months, a continuously evolving constellation of vaccine candidates against COVID-19 emerged⁷, employing methodologies ranging from mRNA- /DNA-based and viral vectored vaccines, to protein-based and inactivated vaccines⁸. All these attainments were made in record time, as the scientific community proved that it can mobilize to provide the answers the world needs. As such, there can be no doubt that science’s readiness to act decisively in the face of the unknown will continue to be absolutely critical in the event of future outbreaks.

**Debunking misinformation**

While science denial can manifest itself in different forms, it usually revolves around a mistrust in the government and the media, combined with the conviction that science is unable to handle problems and a belief that “they” have a money-driven agenda to bring harm to the world⁹. COVID-19 denial is the latest parade of this mistrust, but has spread exceptionally fast and could potentially cause significant harm. All around the world, self-titled movements “for the truth” have emerged, flaunting the most bewildering conspiracy theories, offering miraculous cures, and an assortment of unfounded claims regarding the origins of the virus, pseudo-science practices combined with the conviction of which pushing the boundaries of...
The antivaccine movement, which emerged over twenty years ago and pivoted to the far-right around 2015, found a prolific terrain where to flourish. Outlandish allegations emerged, including the claim that Bill Gates allegedly hoped to vaccinate against COVID-19 as a means to implant microchip-tracking devices.

While responsible media outlets such as The New York Times did their best to debunk such nonsensical statements, members of the anti-vaccine movement continued to proclaim the “alternative facts” that populate the “alternative reality” in which they live. In turn, these theories are amplified by social media—fueled echo chambers, which tend to strengthen false beliefs and discourage people from pursuing the truth. Noting that low scientific literacy causes “otherwise rational and competent people to misunderstand the threat of COVID-19 and feel more comfortable with false data than with scientifically sound information”, Dr. Bruce L. Miller posits that a tendency to develop false beliefs is more likely to occur in someone who has faulty systems for monitoring and evaluating scientific information, a defect akin to that observed in frontotemporal dementia.

Whether or not Miller’s suggestion holds merit, the fact remains that misinformation tends to spread and find acceptance by numerous individuals around the world. As Stephen Hawking famously said, “the greatest enemy of knowledge is not ignorance, it is the illusion of knowledge.” Therefore, scientists must constantly strive to raise scientific awareness and provide the knowledge required for any person to distinguish myth from fact.

The Crucial Role of Scientists

At a time of rampantly contradicting and often incorrect information, reliable sources of scientifically accurate information become more critical than ever. As COVID-19 unfolded, scientists, medical doctors and public health experts became a regular presence in traditional media. Conveying trustworthy information during a time of pandemics is the only way to effectively answer the questions on people’s minds and convey the knowledge that enables them to make the right decisions. In fact, as noted by Caulfield, researchers must be active participants in the public fight against misinformation and should view the correction of misrepresentations as their professional responsibility.

Strategies to counter fake news stories should include training people to recognize them, stop tolerating pseudoscience health practices, and swamping the landscape with accurate information. All these efforts can and should be undertaken by scientists. But the role of scientists during a pandemic is not only to combat misinformation. It is also to answer people’s genuine concerns, transparently and accurately. Questions like “were vaccine developed too fast?”, “are they safe?” or “should I be vaccinated?” were asked by many, as vaccines started to be rolled-out and vaccination plans started to be drawn. Researchers should strive to deliver a clear answer to such questions, in a constant effort to elucidate and inform. Only by doing so will they be fulfilling their role as both scientists and responsible members of society. Being acutely aware of its role in science outreach to general audiences, iMM played a massive role in this endeavor. This included wide-reaching information campaigns that included webinars, explanatory videos about vaccines and vaccination, as well as an unprecedented presence of several iMM researchers in the media.

Therapy and Vaccination Platforms

As the seriousness of COVID-19 and the scarcity of effective treatments against SARS-CoV-2 infection became apparent, scientists reacted promptly in an effort to develop novel therapies against disease. At the time of writing, more than 300 new treatments against COVID-19 were under investigation, comprising several innovative antiviral approaches. These efforts include antibody-based therapies, using either convalescent serum or lab-made antibodies; cell-based therapies, which work by transferring either
unchanged or modified live cells into patients to enhance their immune response; and RNA-based therapies, utilizing genetically altered RNA molecules to block the construction of viral proteins and interfere with viral replication. The major advances made in all of these fronts have enriched the scientists’ armamentarium to intervene therapeutically not only against existing diseases but also to promptly fight the threats imposed by upcoming pandemics. Until recently, most vaccines against viral infections licensed for human use were either whole-organism-based, employing inactivated or live-attenuated viruses, or subunit-based, using recombinant or purified viral proteins. Alongside the pre-clinical and clinical development of multiple vaccine candidates utilizing these “classical” approaches, the COVID-19 pandemic led to an emergence of next-generation vaccination platforms, including nucleic acid- and viral vector-based vaccines. While many of these approaches had hitherto been driven mainly by their potential use in cancer therapies, COVID-19 has fast-tracked their development as vaccine platforms for emerging viruses23. The very high success of these novel vaccination strategies, coupled with real-time data monitoring by regulatory agencies, meant that safe and effective vaccines against COVID-19 were approved for human use in record time. In fact, few people would have thought that vaccination campaigns against this disease would start worldwide before the end of the year 2020, as turned out to be the case. The extraordinary success of mRNA- and adenovirus-based vaccines, combined with their high adaptability, will certainly constitute invaluable tools to act promptly in the face of future outbreaks of viral infections. COVID-19 showed that enhancing the scientific community’s preparedness for forthcoming pandemics will be crucial for their effective management. The scientific achievements made in response to SARS-CoV-2 will undoubtedly leave the world better prepared to deal with upcoming threats. The enduring legacy of new biological tools and advanced manufacturing methods arising from the scientific community’s response to this pandemic, including the rapid scale-up of therapeutics and vaccines, may enable an increasingly effective response not only against new infectious agents but also against diseases that have long plagued humankind.

Understanding immunity against SARS-CoV-2

Monitoring and understanding immunity against SARS-CoV-2 is key not only to fight COVID-19 but also to increase the world’s preparedness to deal with future pandemic events. Medical literature databases are constantly being enriched by studies that provide the latest data about the kinetics and durability of immune responses elicited by either natural infection24,25, or vaccination26,27. In Portugal, iMM pioneered efforts to monitor naturally acquired immunity in the population, through an unprecedented serological survey of over 13,000 volunteers, performed as early as September 2020. This was followed by a longitudinal study carried out in March 2021, which involved 3,000 of those volunteers that had tested negative for the presence of antibodies in the initial panel, as well as, all of those that had tested positive in that survey25. Such screens play a pivotal role in providing not only invaluable snapshots of the immune status of the Portuguese population at specific moments in time, but also critical information about the progression of this immunity throughout time.

Unmet challenges

The unprecedented improvement in medical care, brought about by the unparalleled advances in scientific knowledge made over the last century, significantly change in the quality and in the span of human life. Infectious diseases that were once a death sentence became preventable or treatable, saving countless lives and adding many years of life to countless human beings. Nevertheless, and despite the extraordinary progress made in recent years, many challenges remain to be addressed. In fact, well into the 21st century, infectious diseases such as HIV/AIDS, tuberculosis and malaria still kill millions of people every year. Notably, fatalities due to these diseases are unequally distributed, and are more than 6 times higher in low and lower-middle income areas than in upper-middle and high income regions28. As such, the ongoing toll of infectious diseases on the lives of millions of some of the world’s most vulnerable people must be urgently addressed. The response to the COVID-19 pandemic showed that science is able to deliver the answers to these challenges, so long as this is a priority for politicians and decision-makers, and appropriate funding for research is available.
Sustained funding for scientific research

The SARS-CoV-2 pandemic has raised worldwide awareness of the crucial role of scientific research for global health security, and has prompted an unusually swift and massive financial support for COVID-19-related research. Although this kind of reactive funding is not new, it is hardly the most effective approach to follow going forward. In fact, past crises have shown that once an outbreak is under control, governments and donors tend to turn their attention to other pressing concerns. In a recent side-meeting of the United Nations General Assembly, the World Health Organization vowed to “end this cycle of ‘panic-then-forget’, [which] has prevented the development of effective health emergency preparedness across the globe.” To achieve this goal, it is imperative that lessons from the past and from the present are not forgotten, which has prevented the development of effective health emergency preparedness across the globe. At the same time, the world realized, arguably as never before, that science is a vital stepping stone to the path in well-being and prosperity. And if there is one thing that the pandemic made evident, it is that there are hardly any boundaries to what scientists can achieve, as long as they are given the opportunity and the means to pursue the world’s dreams.

References

"The first answer came after only 8 minutes!!!... and that was the beginning of the Diagnostic Task Force."

Vanessa Zuzarte Luís, postdoctoral fellow
FACTS AND FIGURES

160 TOTAL VOLUNTEERS

138 DIAGNOSTIC TASK FORCE
5 SEROLOGICAL TESTS TASK FORCE
22 RESEARCH SAMPLES TASK FORCE

Teams and coordination & logistics

TRANSPORT
CHECK-IN & CHECK-OUT
RT-PCR
RNA EXTRACTION
VIRUS INACTIVATION
PCR ANALYSIS
DIAGNOSTIC BRIDGING GAP

Max samples processed in 1 day – 820
Max swab kits prepared in 1 day – 1840
Total transport medium aliquots – +13500
Max PCR plates run in 1 day – 30
Latest after-hours samples delivery – 01:40AM
Number of phone calls in 1 day – 63
Liters of ETOH absolute – 16
EPPIS lid cut – +44000

(Working 4H shifts from 9:00-21:00)

"Vanessa and Judite allowed "us", the volunteers at iMM, to feel something we are all looking for in our daily life in research, that is the sense of making a difference and being useful for the society" - Karine Serre, Postdoctoral Fellow
"We started the test with the first samples already at night, of course no one could go home and we stayed waiting for the machine to finish"

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Sofia Marques
PAINEL SEROLÓGICO NACIONAL COVID-19 (SEPTEMBER 2020)

500 - 700 CALLS/DAY (1 WEEK)
400 CALLS/DAY (3 WEEK)
314 COLLECTING POINTS
37 DAYS
921 EMAILS/MESSAGES RECEIVED

13.400 VOLUNTEERS
102 MUNICIPALITIES

3 INFORMATIVE VIDEOS
45 NEWSLETTERS CIENTÍFICAS
63 INFORMATIVE WEBINARS INCLUDING WEBINARS PREPARED WITH COLIFE PARTNERS

"Despite the discomfort and the tension to process as many samples as possible, everything would immediately go away when, by the end of the shift, the different groups of the task force joined at the IMM"

Eunice Paisana
"When we reached big numbers, such as sample 10000, it was such a joy! Always with the corresponding "celebration" in the Whatsapp task force main group and sub-groups"

MEDIA PRESENCE
(COVID-19 ONLY, MARCH TO DECEMBER 2020)

3429 TOTAL NEWS
807 TELEVISION

388 NEWSPAPERS MAGAZINES
2112 ONLINE
122 RADIO

112 INTERNAL ZOOM SEMINARS
(MARCH TO DECEMBER 2020)
Concerns arise for shortage of diagnostic testing capacity in Portugal

Setting up a COVID-19 Diagnostics Task Force at iMM

SOP assembly and writing

First virtual Faculty meeting via and ideas to setup COVID-19 serology

First validated PCR with patient samples

Adapt iMM labs for the assay
Test RNA extraction kit
Test probes and PCR reaction
Validate the protocol with INSA

First ZOOM meeting to introduce Task Force to volunteers

First iMM Webinar about SARS-CoV-2 (Vamos Falar de Ciência: SARS-CoV-2)

Second call for volunteers for the COVID-19 Diagnostic Task Force

Constructs to generate SARS-CoV-2 protein from Krammer (US) and Bosch (NL) labs arrive in Lisbon and are sent to iBET to start testing and optimizing protein production.

Sharing of the COVID-Diagnostic SOP with other research centers and universities in Portugal

Launch of partnerships with Hospital Cruz Vermelha (CVP), CVP Shuttle, Ministry of Labour Solidarity and Social Security (MTSS) and GNR

First validated PCR with patient samples

iMM – COVID-19 diagnostic protocol validated by INSA

Adapt iMM labs for the assay
Test RNA extraction kit
Test probes and PCR reaction
Validate the protocol with INSA

Contacts with NZYTech for diagnostic kits

Concerns arise for shortage of diagnostic testing capacity in Portugal

Setting up a COVID-19 Diagnostics Task Force at iMM

SOP assembly and writing
The Veldhoven-lab tissue culture remodeled as BLS3 lab to setup full serology testing lab.

First blood samples from COVID-19 patients, Biobank COVID-19 Collection

Task Force reaches full force and teams work organized shifts, 3/4h shifts 7 days a week (100+volunteers).

April

02
05
13
16
28
30

iMM Webinar about COVID-19 (Vamos Falar de Ciência: Números, vírus e o nosso sistema imunitário)

1st COLife webinar hosted by Champalimaud Research (Sharing Information Together: Dúvidas sobre a COVID-19? Pergunte, os cientistas respondem)

COLife webinar hosted by Instituto Gulbenkian de Ciência (Sharing Information Together: Como aceder a informação fidedigna?)

ELISA optimization and first samples tested on a system of RBD vs Spike for the presence of anti-SARS-CoV-2 IgG antibodies

COLife webinar hosted by iMM (Sharing Information Together: Vamos falar de vacinas)

1st iMM informative video about the COVID-19 diagnostic operating procedure

June - July

29

Re-opening of iMM after lockdown

COLife webinar hosted by Instituto de Tecnologia Química e Biológica António Xavier – NOVA (Sharing Information Together: Cientistas na era COVID-19: Entre o confinamento e a retoma)

1st iMM informative video about the COVID-19 diagnostic operating procedure

October

06
09
17

New COVID-19 diagnostic center assembled at Estádio Universitário

Launch of Cruz Vermelha Portuguesa and iMM Protocol (Posto Fixo)

Start of weekly iMM Diagnostic PCR Tests

December

08
27

Painel Serológico Nacional COVID-19

iMM informative vaccination campaign starts to be prepared and is launched on January 4, 2021.
The COVID-19 pandemic, which started in December 2019 in Wuhan (China), imposed serious health, social and economic challenges to society at a global scale. From the onset, and from the public health perspective, without an available cure or vaccine, the World Health Organization (WHO) emphasized the crucial role of diagnostic testing for the management of the pandemic and orientation of public health decisions.

From very early days, it became clear that the most effective way to contain the SARS-CoV-2 infection was to implement physical distancing and hygiene measures combined with large-scale testing. The latter is critical to identify infected people, isolate and/or treat them and to better estimate how widely the virus has spread and potential immunity levels achieved (World Health Organisation. 2019 Novel Coronavirus: Global Research and Innovation Blueprint. 2020).

Testing requirements quickly led to a global and unanticipated increase in demand for diagnostic kits and their components and, by March, Portugal was facing a lack of sufficient diagnostic kits due to a shortage of reagents from external suppliers. As a result, when the COVID-19 pandemic reached Portugal, all healthcare units were in need to increase diagnostic capacity for COVID-19 rapidly, but were facing an acute shortage of diagnostic kits to do so. Portugal was thus facing a critical problem: insufficient capacity to obtain the necessary information of the population infection by SARS-CoV-2, crucial for the successful management of the pandemic in the country. The scientific community started to mobilize and several actions took place. At Instituto de Medicina Molecular (iMM), a team led by Maria Mota, Vanessa Zuzarte-Luís, Judite Costa and Miguel Prudêncio, developed a certified 100% Portuguese diagnostic PCR kit in collaboration with NZYtech and Hospital de Santa Maria (HSM), following WHO guidelines and approved by Instituto Nacional de Saúde Pública Doutor Ricardo Jorge (INSA). In addition, through the networks of research units, universities, and polytechnics around Portugal, coordinated by the Portuguese Minister of Science and Higher Education, this certified diagnostic PCR test and the COVID-19 diagnostic procedures were made available to the entire medical and scientific community, upscaling the necessary capacity for the national health authorities to have reliable data for the status of infection of the national population to implement the adequate and timely measures. From mid-March up to July 2020, the iMM Diagnostic Team with more than 120 volunteers successfully organized and implemented an operation that ran more than 20,000 COVID-19 PCR tests, contributing in an invaluable way to the protection of risk groups, by participating in the screening of COVID-19 in retirement homes across Portugal, among others.

"I think this Task Force made it very clear how science is needed and how we are able to unite in the goals that achieve the common good"  
Catarina Lourenço
At an earlier stage of this pandemic and in addition to acute screening for SARS-CoV-2 infected people, a critical aspect for the management of this outbreak relied on the screening for seroconversion enabling the longitudinal monitoring of the population, validation of the build-up of immunity and any potential waning of SARS-CoV-2 immunity. By mid-2020, the absence of an effective therapy or vaccine thus far, has made the identification of an immunized frontline of central importance for the cautious, safe and adequate de-confinement of the population.

Serology4COVID, a consortium of 5 research institutes from Lisbon and Oeiras (IGC, iMM, CEDOC-NMS, ITQB NOVA and iBET) joint efforts to implement a COVID-19 serological test, an initiative supported by Calouste Gulbenkian Foundation’s Emergency Fund for COVID-19, Oeiras Municipality, and Sociedade Francisco Manuel dos Santos. At iMM, this task was led by group leader Marc Veldhoen and his team Patricia Figueiredo-Campos and Birte Blankenhaus who developed a highly versatile ELISA assay that allows fast large-scale screening and accurate titre determination for anti-SARS-CoV-2 total Ig, IgM, IgG and IgA antibodies. The assay, based on reagents generously shared by Krammer Lab (US) and Bosch lab (NL) that had already cloned and introduced stabilising mutations on SARS-CoV-2 sequence, was validated with the help of the iMM Biobank and clinicians (negative and positive serum) and robustly tested for reproducibility, accuracy and sensitivity compared with commercial kits.

Based on this serology setup and collaborating with an interdisciplinary team of clinicians and researchers from Faculdade de Medicina da Universidade de Lisboa (FMUL) and Centro Hospitalar Lisboa Norte (CHLN) and collaborators at Instituto Português do Sangue e Transplantação (IPST), the research team led by Marc Veldhoen started to monitor the antibody levels of over 300 COVID-19 hospital patients and healthcare workers, and over 200 post-COVID-19 volunteers. The results of this cross-sectional study published in the scientific journal European Journal of Immunology, showed that 90% of subjects had detectable antibodies 40 days up to 7 months post contracting COVID-19. In this study, it was also evaluated the function of these antibodies, i.e. their neutralizing activity against the virus SARS-CoV-2, in collaboration with IPST and results have shown a robust neutralisation activity for up to the seventh month post-infection in a large proportion of previously virus-positive screened subjects. This work provided detailed information for the assays used, facilitating further and longitudinal analysis of protective immunity to SARS-CoV-2.
Painel Serológico Nacional

In June 2020, IMM, the Sociedade Francisco Manuel dos Santos (SFMS) and the Jerónimo Martins Group (JM), established a partnership to support diagnostic and research activities on COVID-19. After an impactful first wave of the COVID-19 and with the next winter in the horizon, a major project led by Bruno Silva-Santos, group leader and Vice-Director at IMM proposed to implement a large survey to evaluate the seroconversion of the Portuguese population to SARS-CoV-2. The National Serological Survey presented as a nationwide study, brought together epidemiologists, immunologists, microbiologists and virologists from IMM and the Faculdade de Medicina da Universidade de Lisboa, specialists in statistics from PORDATA who together with Germano de Sousa and Eurotrails / CTI, and with the central support of SFMS and JM, have implemented the logistics and operations to collect, test and evaluate the presence of antibodies against SARS-CoV-2 in a sample of 12 000 residents of Portugal. The National Serological Survey took place between September 8 and October 14, 2020 in 102 municipalities in mainland Portugal and islands. The results provided an estimate of the seropositivity of the Portuguese population to SARS-CoV-2, globally, by region and by age group, through the proportion of the study population that, by serological determination, developed antibodies against the virus.

Study

Were accepted participants residing in 102 municipalities, spread over regions of high (> 500 inhabitants/km²), medium (60-500 inhabitants/km²) and low (<60 inhabitants/km²) population densities in mainland Portugal and islands. Three age groups were considered: younger than 18 years old, between 18 and 54 years old, and older than 55 years old.

The study population included all individuals who voluntarily signed up to participate, fulfilling a convenience sample with almost proportional stratification of the Portuguese population, with over-sampling in the region classified as low population density, in order to guarantee a minimum precision of the respective prevalence. Participants were included regardless of whether or not they were previously infected with the SARS-CoV-2 virus. 13,398 individuals participated in the study, 11.7% above the number provided for in the sample design.

Participants completed an epidemiological survey and performed serological tests at one of the 314 Germano de Sousa collection stations participating in the study and which are distributed across mainland Portugal and islands. A positive final result was only attributed to participants who tested positive on the two serological tests performed (total antibodies and anti-IgG).
Results

The estimated prevalence of SARS-CoV-2 infection in the Portuguese population up to October 2020 was 1.9% (Confidence interval (CI) 95%: 1.7% -2.1%). This estimate was adjusted with respect to the relationship between the sample and the Portuguese population in each age group and population density in the region and was corrected to the sensitivity and specificity of the tests involved.

The estimated prevalence increased with population density, having a statistically higher value in high density regions: 2.5% (CI 95%: 2.1% -2.9%) compared to 1.4% (CI 95%: 1.1% -1.7%) in the regions of medium population density and 1.2% (CI 95%: 0.8% -1.6%) in the regions of low population density.

The estimated prevalence was higher in the younger age group, but the differences observed were not statistically significant: 2.2% (CI 95%: 1.6% -2.8%) in the group under 18, compared to 2.0% (CI 95%: 1.6% -2.3%) among individuals aged between 18 and 54 years and 1.7% (CI 95%: 1.3% -2.0%) among individuals older than 54 years. However, the group of the youngest in regions with high population density stands out with 3.2%, a one-off rate almost 10 times higher than that of young people with low population density, and from a statistical point of view this difference is at least twice (with 95% confidence).

“There was something that brought us together in this phase in a remarkable way that we will not forget anytime soon”

Luisa Lopes, group leader

1.9%

Low density

1.2%

Medium density

1.4%

High density

2.5%

<18 years old

2.2%

18–54 years old

2.0%

>55 years old

1.7%
"This time to come was not as calm as I had thought on the afternoon of that Friday 13th, but also not so isolated, in so many ways!"

**TASK FORCE BIOBANK**

Clinical research requires access to biological samples from patients. In the early days of the COVID-19 pandemic, with the first outbreak cases in the country arising, a group of clinicians and researchers felt it was urgent to implement a collection of samples from patients with COVID-19 to support research. The advantage of having side by side a major hospital and a research institute has proven once more to be extremely valuable and procedures to collect and store such samples together with appropriate clinical information were rapidly put in place. This task force that combined clinicians from CHLN, FMUL and iMM was composed by 22 volunteers headed by Helena Cabaço, António Mendes, Ana Espada de Sousa and Luís Graça who worked side by side with the Biobank staff allowing the samples processing and the establishment of a complete collection with detailed clinical information and follow-up samples. With the instrumental financial support of Fundação Luso-Americana Desenvolvimento (FLAD), more than 6700 samples from patients and professionals infected with COVID-19 were donated and collected, since April 2020. These biobanked samples were already used for several research projects from different research institutions. Also, because of the COVID-19 collection, the Biobanco-iMM was also included in the Biobanking and BioMolecular Resources Research Infrastructure (BBMRI) directory.

The iMM COVID-19 collection remains available to the research community to support the effort to contain this pandemic.

Daniel Inácio
Several private donors join and potentiated the collective COVID-19 effort at iMM: Fundação Oriente and SEMAPA sponsored equipment, while Fundação Luso-Americana Desenvolvimento (FLAD) critically funded the extension of the iMM Biobank to store samples and their detailed information as a resource to the global scientific community. Additional efforts were made by launching fundraising campaigns for academic institutions across Portugal, including the iMM, led by Garrafeira Soares and Herdade da Maiahdinha, among others, that helped increasing the testing capacity. A major private holding named Sociedade Francisco Manuel dos Santos (SFMS) and the Jerónimo Martins group were instrumental in this process and funded the professionalization of the diagnostic and serology labs, purchasing dedicated equipment, and recruiting committed staff. These joint efforts, successfully increased the national COVID-19 testing capacity. In addition, they constituted the basis for a structured response to the pandemic, professionalizing the teams and helping creating a new diagnostic and research center in Lisbon – The COVID-19 Molecular Diagnostic Center, hosted at Estádio Universitário in the grounds gently loaned by the Universidade de Lisboa. The new center is now home to a large network of projects intertwined with the needs of the country and planned according to the evolving pandemic situation. The setup has allowed the dedicated processing of large numbers of swabs by PCR (1500/day, expanding to 3000/day). Additionally, this center homes a dedicated serology team responsible for testing of over 2500 members of staff of ULisboa, continued testing of COVID-19 patients, contributions to a large national survey screening, support for scientific projects to determine antibody titres in defined patient cohorts and important work to screen for potential plasma donors for use in convalescent serum therapy with the Portuguese blood bank.

The interactions between the public, private, social and academic sectors have been key for the successful response that a small European country, such as Portugal, has produced in response to the COVID-19 pandemic. The challenging and unprecedented situation brought visibility to science and to the scientific community that demonstrated extraordinary plasticity and ability to respond. Social recognition, participation in decision-making and private donations are hopefully some of the long-term positive consequences that this unfortunate pandemic has brought to our society. *

* Vanessa Zuzarte-Luís, Marc Veldhoen, Inês Domingues and adapted from: “(...) and realised the exceptional dimension of the task force of volunteers”
"The people, that make this absolute outstanding activity... are absolutely special, AMAZING"

Bruno Cardoso, postdoctoral fellow

TAKING SCIENCE TO THE SOCIETY
A combined and intense effort has been made at IMM to act as an integral part of the communication and dissemination efforts related to this pandemic. Reaching a wider audience through the direct communication with scientists has been a major achievement as observed by the more than 11,200 visualizations (YouTube) that our Q&A sessions collected. Translating complex concepts into simple and accessible information has also been important during this period and in fact, our multimedia materials on COVID-19 and SARS-CoV-2 were widely accessed and counted with more than 11,800 visualizations. Together, the development and implementation of these tools helped to not only reach a wider audience, but to create a network of reliable sources of medical and scientific information, to help citizens to take the necessary measures in an informed way. This pandemic period has also promoted a close interaction with several media outlets and particularly some not used to talk about science. As a result, our scientists were constantly requested to be interviewed and to help explaining the scientific aspects related to COVID-19. This effort established the scientific community as an important partner in the mission and surely contributed to a greater scientific and health literacy in the Portuguese society.

For more information, visit our COVID-19 dedicated webpage:

![QR Code]

Adriana Temporão

"The things that I will remember for a long time: - The improvised dance at the entrance of the building at the end of a busy shift"
We created a regular newsletter with digested scientific information coming from reliable and peer-reviewed papers and sources, providing a first snapshot of the most recent discoveries on COVID-19. These issues are accessible through our website and can be downloaded for future reading.

We organized a series of online Q&A sessions with IMM virologists, immunologists and epidemiologists, focusing on different aspects of the COVID-19 pandemic, such as, the biology of the virus, the immune response, bio-mathematical models that explain the evolution of the pandemic, among others. These sessions had more than 490 participants and count more than 11 200 visualizations on YouTube. Also, in collaboration with the COLife alliance of research institutes of Lisbon and Oeiras, we have organized and participated in a joint social media campaign that included a series of webinars covering several aspects of the COVID-19 pandemic - Sharing Information Together.
ANIMATED VIDEOS

To better explain the laboratory procedures of the SARS-CoV-2 diagnosis and serology testing, we produced animated videos explaining how the genetic material of the virus is obtained and analyzed in the lab and what is basis for a serology test that looks for antibodies against SARS-CoV-2 in previously infected people. Additionally, in early 2021, a video explaining the different types of vaccines was also produced. The videos were disseminated through our social media channels.

DIAGNOSTIC OPERATING PROCEDURE
Visualizations: 5682

Watch the video:

SEROLOGICAL TESTS
Visualizations: 2528

Watch the video:

VACCINES
Visualizations: 3003

Watch the video:

"During this time, Birte has become my family! We spent all the time in the lab, developing, validating and testing samples"

Patrícia Campos
"I found it fascinating that this work united us more than what I had ever experienced before, in retreats or any other activity"
COVID-19 VACCINES - AN INFORMATIVE SOCIAL MEDIA CAMPAIGN

Following the urgent need to provide reliable and accessible information about vaccination for COVID-19, we have prepared, produced and launched an informative campaign about COVID-19 vaccines, at the end of 2020 and early 2021, on the onset of the vaccination process in Portugal (which started in December 27, 2020).

In a series of videos, some of our scientists, namely, two of our immunologists - Bruno Silva-Santos and Luís Graça; a virologist - Pedro Simas; and a parasitologist - Miguel Prudêncio, answer questions about the COVID-19 vaccines that had been on everyone’s heads:

“How was it possible to develop a COVID-19 vaccine so quickly?”; “Is the COVID-19 vaccine safe?”; “Will the COVID-19 vaccine allow us to return to normality in our lives?”; “Should I get vaccinated for COVID-19?”.

The videos disseminated through iMM’s social networks were followed by an open Q&A (Questions and Answers) session where the public was invited to participate and post their questions live and clarify doubts about the vaccine development process, its safety and efficacy, and the prospect of the pandemic for the coming months.
"A few days after Vanessa, Judite and Miguel started the Task Force, which we still have no idea how strong it would be, I get a call from Vanessa and Inês asking for help to ensure the volunteers food"

"The result: I never saw her again, but at least we had energy and sugar during the shift, even though I ate 7 chocolates in 4 hours"
"It helped me to know the place better and to meet very nice people, with an extraordinary adaptation capacity and team spirit!"