

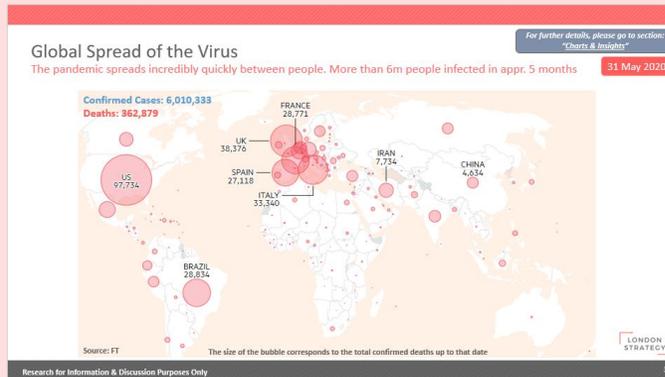
June 2020

COVID-19 Series

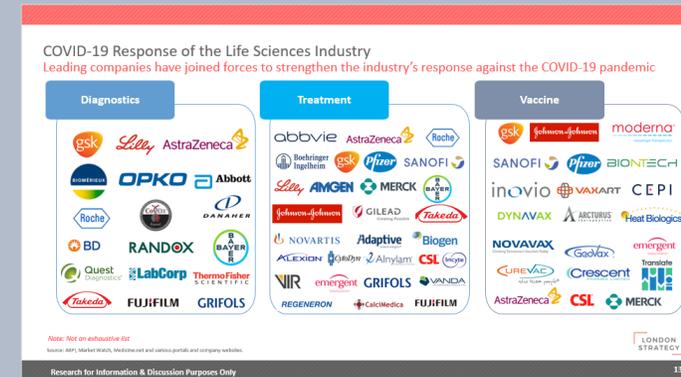
LONDON
STRATEGY

COVID-19 Series - Index

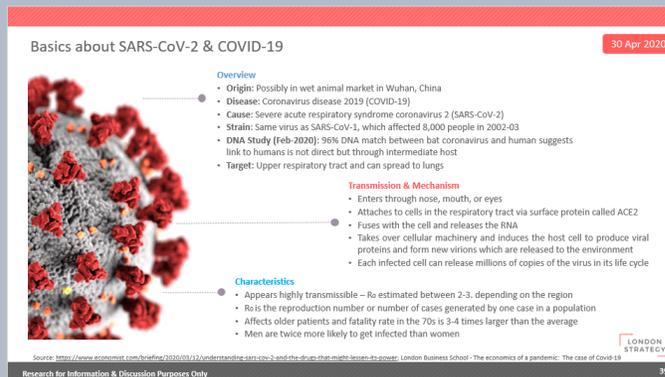
Impact on Life Sciences Sector: 3-10



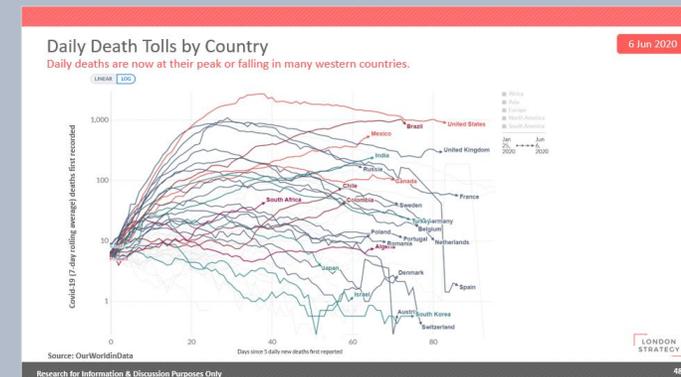
Response of the Life Sciences Industry: 12-36



Details of the Virus: 38-45



Charts & Insights: 47-70

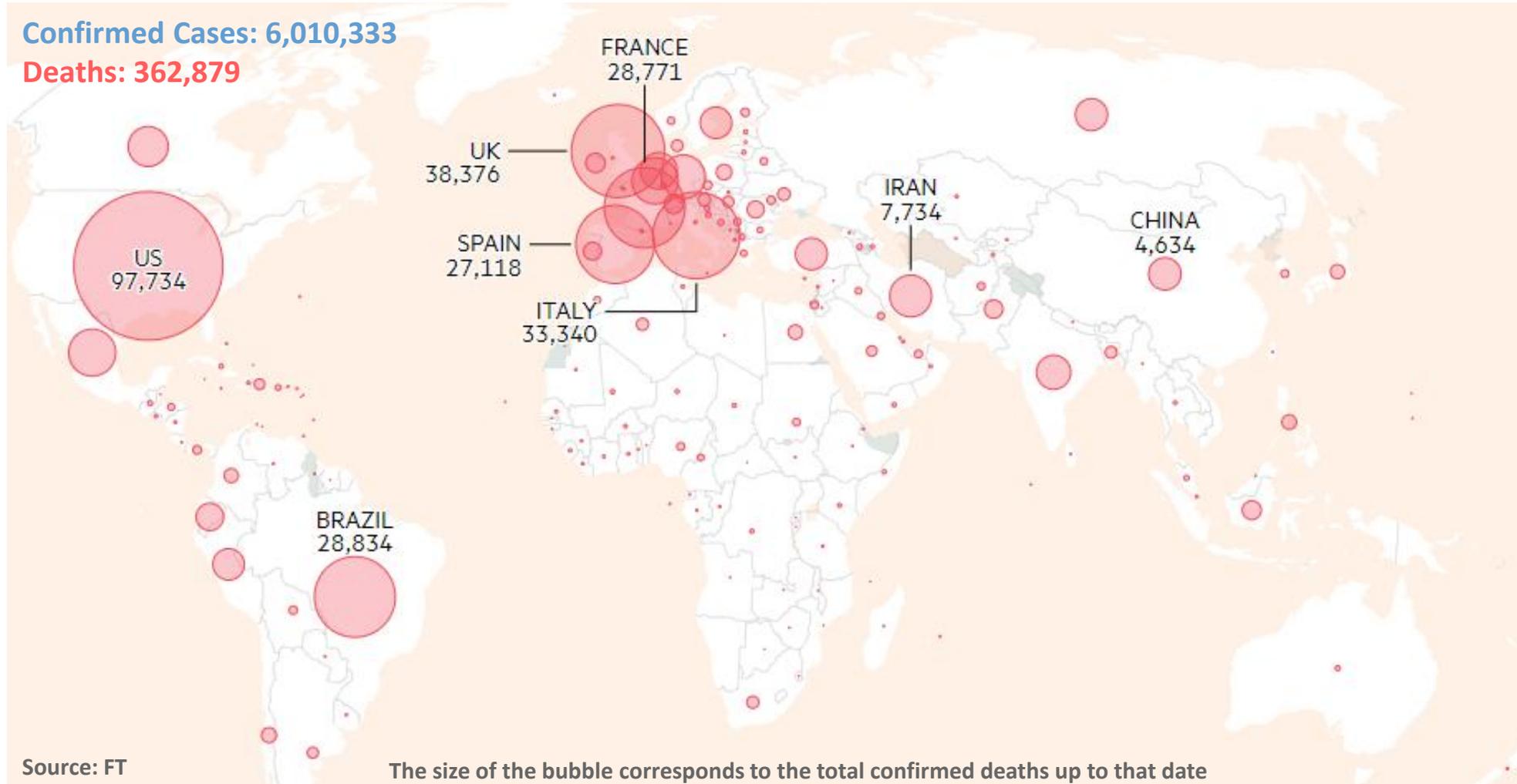


For further details, please go to section: ["Charts & Insights"](#)

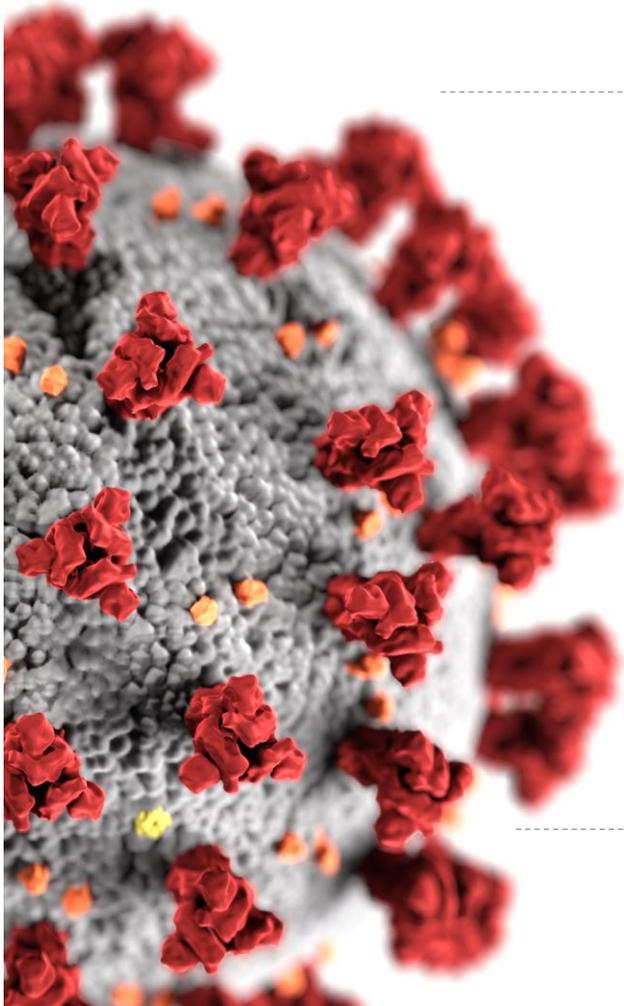
Global Spread of the Virus

The pandemic spreads incredibly quickly between people. More than 6m people infected in appr. 5 months

31 May 2020



Basics about SARS-CoV-2 & COVID-19



Overview

- **Origin:** Possibly in wet animal market in Wuhan, China
- **Disease:** Coronavirus disease 2019 (COVID-19)
- **Cause:** Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)
- **Strain:** Same virus as SARS-CoV-1, which affected 8,000 people in 2002-03
- **DNA Study (Feb-2020):** 96% DNA match between bat coronavirus and human suggests link to humans is not direct but through intermediate host
- **Target:** Upper respiratory tract and can spread to lungs

Transmission & Mechanism

- Enters through nose, mouth, or eyes
- Attaches to cells in the respiratory tract producing a protein called ACE2
- It fuses with the cell and releases the RNA
- The hijacked infected cell will produce proteins based on the “instructions” from the virus’ RNA
- Each infected cell can release millions of copies of the virus before dying

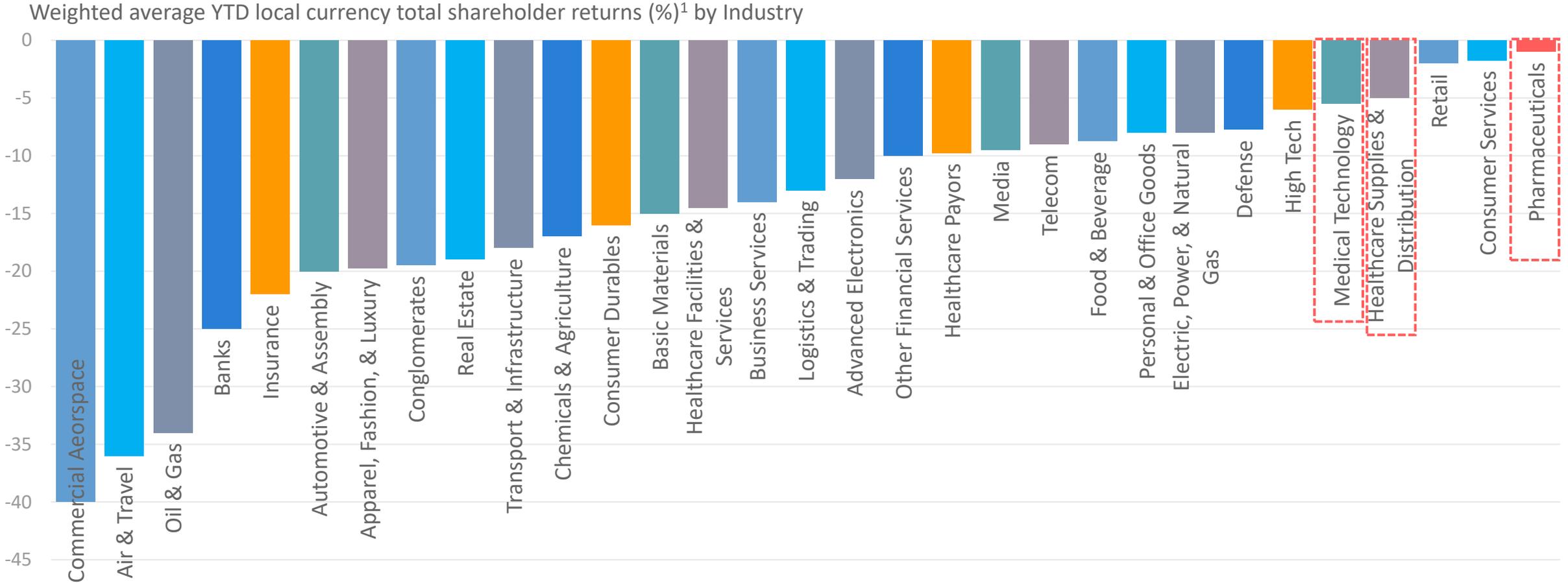
Characteristics

- Virus appears highly transmissible - Average patient infects 1.6 to 2.4 other people
- Affects older patients and fatality rate in the 70s is 3-4 times larger than the average
- Men are twice more likely to get infected than women

Source: <https://www.economist.com/briefing/2020/03/12/understanding-sars-cov-2-and-the-drugs-that-might-lessen-its-power>; London Business School - The economics of a pandemic: The case of Covid-19

Impact of Coronavirus on Financial Markets

Global stock markets spooked by surge in cases



Source: COVID-19 briefing materials – McKinsey & Co (13 April 2020)

Note 1: Data set includes global 3,000 companies by Mcap in 2019, excluding some subsidiaries, holding companies, companies with very small free float and companies that have delisted since.

For further details, please go to section: "Response of the Life Sciences"

COVID-19 Response of the Life Sciences Industry

Leading companies have joined forces to strengthen the industry's response against the COVID-19 pandemic

Diagnostics



Treatment



Vaccine



Note: Not an exhaustive list

Source: ABPI, Market Watch, Medicine.net and various portals and company websites.

Key impacts of the COVID-19 pandemic on Life Sciences Companies

Potential impacts are complex and difficult to quantify

Slowdown of Economic Growth

- Life sciences sector is sensitive to economic growth especially in countries with high out-of-pocket expenses for medicines

Demand Disruption

- Higher demand for symptomatic medicines - analgesics and cough & cold preparations
- Decline in medicines deemed non-critical
- Lower face-to-face interactions with HCP may result in lower demand

Operations Disruption

- Manufacturing delays
- API and generic shortages
- Stockpiling by Wholesalers adding pressure on the supply chain of companies
- Delays in QC testing

Virology Science

- Increased focus of life sciences sector on virology

Clinical Trial Delays

- Postponement of non-urgent trials
- Patient enrolment may be challenging

Impact on Regulatory Function

- FDA and EMA are giving expediated and extended approvals
- Agencies may be less responsive on non-critical approvals and inspections
- Site inspections delays & exemptions

Increase in Costs

- Inc. in API costs due to shortages
- CMOs and CROs may increase costs
- Inc. in warehousing and freight costs

Product Launch Delays

- Companies will prioritise responses to COVID-19 & delay other product launches
- Limited resources could cause delays in regulatory approvals & formulary listings



Short Term Action Plan for Life Sciences Companies

In the short term, it is imperative to stabilise existing operations

Secure Core Operations

- Identify and resolve situations and that may limit patient access to drugs
- Be pro-active to protect the supply of critical products
- Ensure safety of all employees

Prioritize Clinical Trials

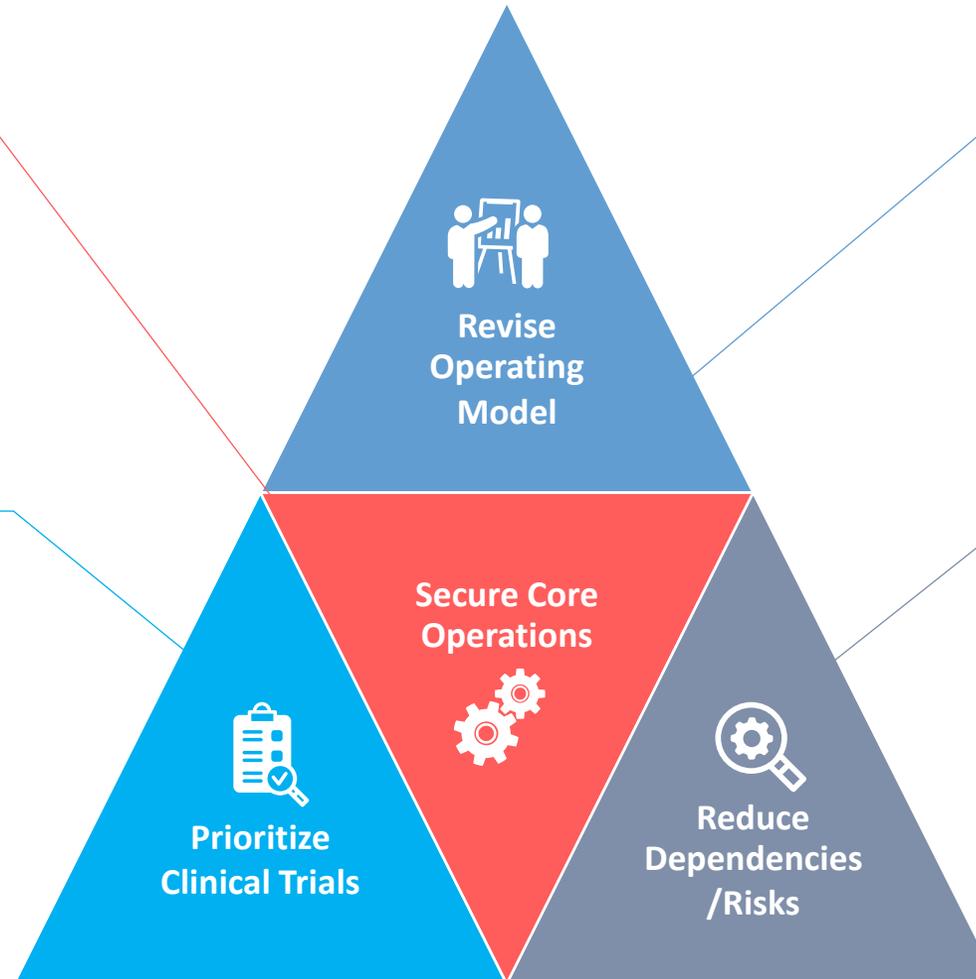
- Seek guidance from medical agencies to manage on-going trials
- Address risks and challenges impacting on-going essential trials
- Delay trials as patient enrolment may be challenging

Revise Operating Model

- Assist employees to work remotely
- Use digital platforms to maintain interactions with internal and external stakeholders

Reduce Dependencies/Risks

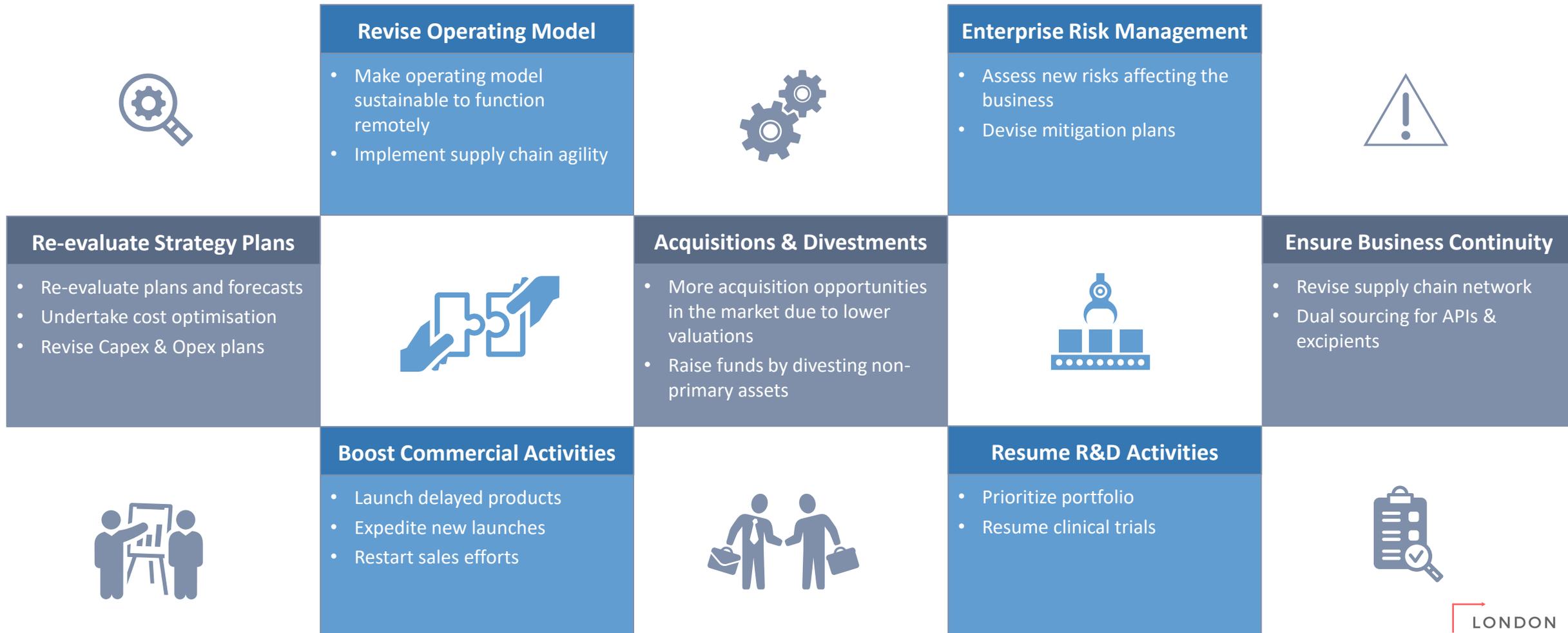
- Dependence on a single supplier
- Portfolio largely comprises of medicines deemed non-essential
- High dependence on physician or hospital administered products



Source: London Strategy™

Long Term Action Plan for Life Sciences Companies

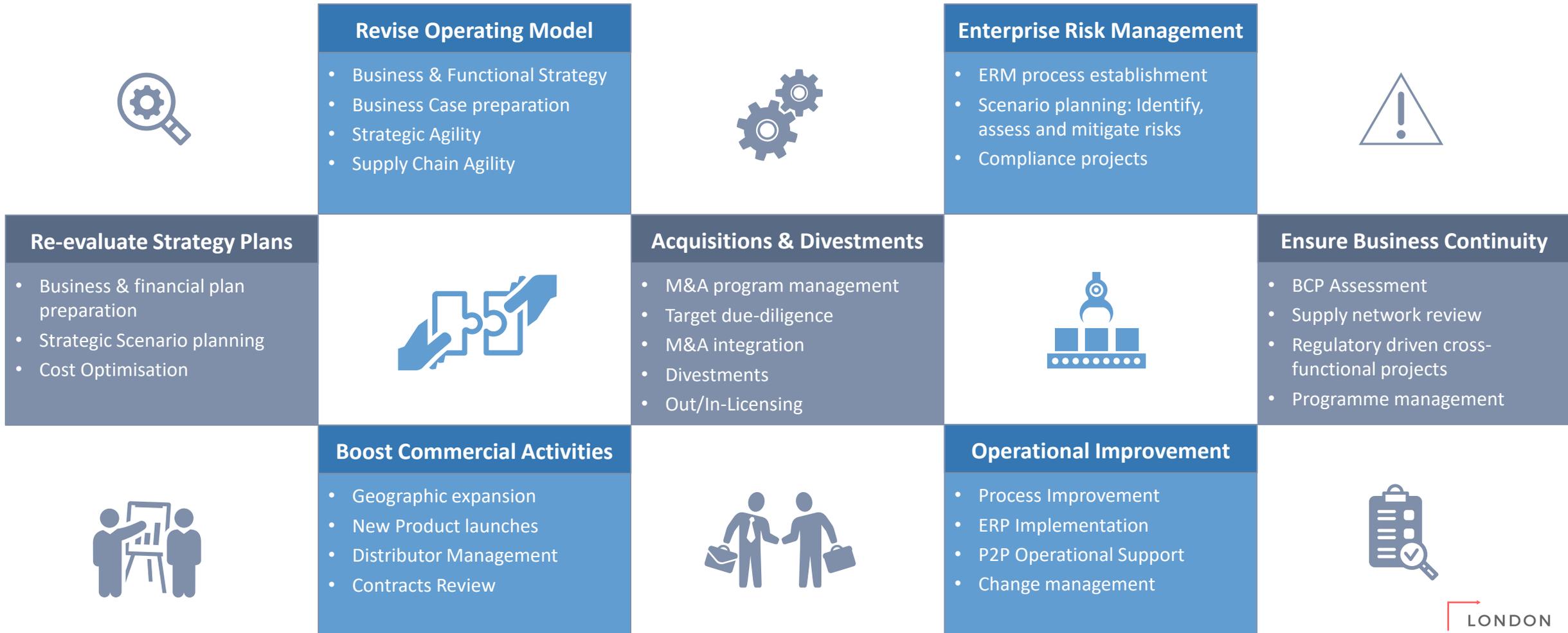
Re-evaluating business strategy can help companies revive business post COVID-19 pandemic crisis



Source: London Strategy™

How can London Strategy help?

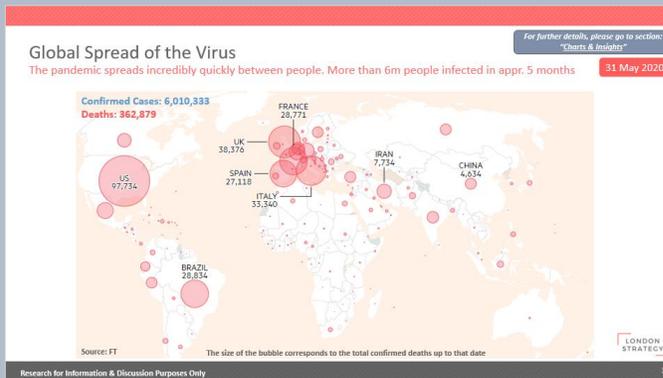
Delivering better value for patients by Designing and Driving strategic projects within Life Sciences companies.



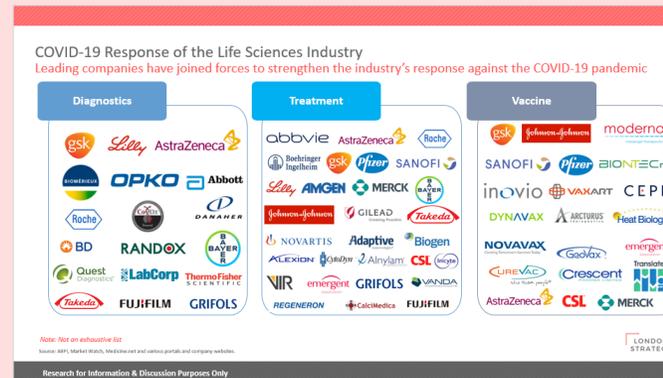
Source: London Strategy™

COVID-19 Series - Index

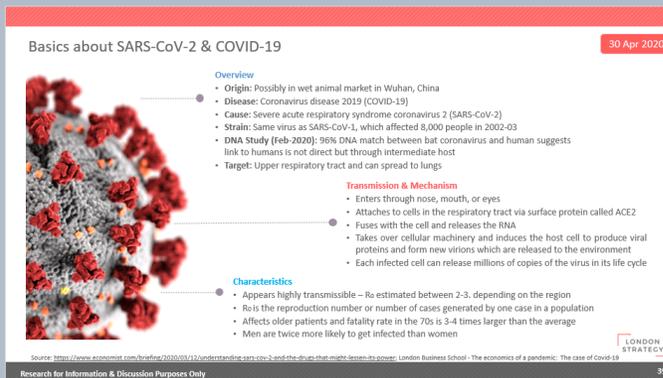
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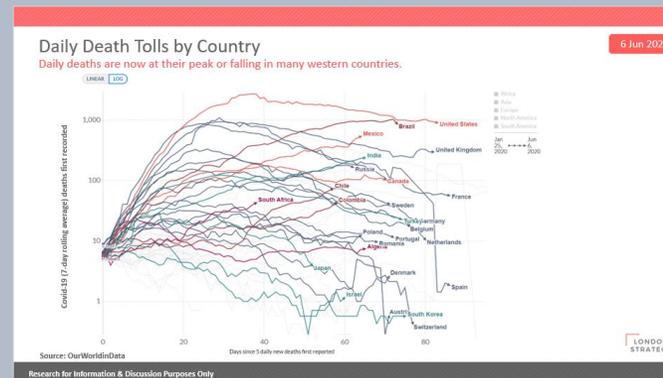
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COVID-19 Series

Response of the Life Sciences Industry

COVID-19 Response of the Life Sciences Industry

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Diagnostics



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Vaccine



Note: Not an exhaustive list

Source: ABPI, Market Watch, Medicine.net and various portals and company websites.

COVID-19 Series

Response of the Life Sciences Industry

1 Diagnostics

Diagnostic Testing

The most pressing and immediate need in the battle against COVID-19

Diagnosics



- Testing is a critical part of addressing the COVID-19 threat
- Testing is vital for mitigation efforts, and in helping investigators to characterise the prevalence, spread and contagiousness of the disease
- Pharmaceutical companies are helping in this fight by developing testing kits
- Tests for coronavirus may use two methods to detect the SARS-CoV-2 virus
 - Genomic detection-based (molecular)
 - Immunoglobulin detection-based (serology)

Source: ABPI, Market Watch, Medicine.net and various portals and company websites.

GSK & AstraZeneca



- UK Government announced a new five-pillar plan to boost testing for COVID-19
 - GSK, AstraZeneca and the University of Cambridge have formed a collaboration to support this national effort
- A new testing laboratory will be set up by GSK, AstraZeneca and Cambridge at the University's Anne McLaren laboratory
- GSK and AstraZeneca are also working together to provide process optimisation support to the UK national testing centres in Milton Keynes, Alderley Park and Glasgow

Eli Lilly and Company



- Lilly is confronting this pandemic by accelerating testing to help decrease community transmission
- The Company opened the drive-through testing facility on 23 March 2020 for Indianapolis-area (US) health care workers
- The Company also has been working with the Indiana State Department of Health to provide testing of COVID-19 samples acquired at local hospitals, using a specialised facility at Lilly Research Laboratories

bioMérieux



- bioMérieux announced the launch of 3 different tests to address the COVID-19 epidemic and to meet the different needs of physicians and health authorities in the fight against this disease
- On 21 May 2020, bioMérieux announced the CE marking of VIDAS® anti-SARS-CoV-2 serology tests
- On 4 May 2020, bioMérieux has received Emergency Use Authorisation by the FDA for the BIOFIRE® RP2.1 panel, which includes 22 pathogens that cause respiratory infections, including SARS-CoV-2 (the cause of COVID-19 disease)

OPKO Health



- OPKO Health's BioReference Laboratories has partnered with US hospitals to provide prioritised testing to inpatients with suspected coronavirus disease 2019
- BioReference Laboratories is accepting specimens for COVID-19 testing from healthcare providers, clinics and health systems throughout the US to promote earlier diagnosis and to aid in limiting the spread.
- On 8 May 2020, the Company launched COVID-19 antibody screening for New York City residents in partnership with New York City Health and Hospital Corporation

Abbott Laboratories



- From 31 March 2020, Abbott started distributing its rapid point-of-care COVID-19 tests for its ID NOW system
 - Abbott is currently manufacturing 50,000 tests per day, and plans to increase manufacturing capacity to 2mn tests a month by June
- The Company's m2000 RealTime molecular laboratory instrument can run 470 tests a day and give results in about 6.5 hours
 - Abbott has shipped c.1mn tests to customers across the US
- In April 2020, Abbott launched its third COVID-19 test
 - This new test is a serology test (antibody test) and helps to detect the IgG antibody to SARS-CoV-2

Roche Holdings



- Roche received FDA Emergency Use Authorisation for the cobas[®] SARS-CoV-2 test to detect the novel virus that causes COVID-19 disease
 - The test is also available in markets accepting the CE mark
- In April 2020, Roche announced the development and upcoming launch of its Elecsys[®] Anti-SARS-CoV-2 serology test
 - The test can detect antibodies in people who have been exposed to the SARS-CoV-2 that causes the COVID-19 disease

Co-Diagnostics



- Co-Diagnostics Logix Smart COVID-19 test is authorised for the diagnosis of SARS-CoV-2
- The Company received FDA Emergency Use Authorisation on 3 April 2020 and has shipped tests to more than a dozen US states, in addition to receiving orders from nearly 50 countries worldwide
- On 26 May 2020, Co-Diagnostics, Inc. announced that a publication used its Logix Smart[™] COVID-19 test Kit and it showed that the SARS-CoV-2 virus could be detected in cancer tissue of coronavirus patients, even before symptoms occur

Danaher Corporation



- Danaher is contributing in the fight against COVID-19 through its companies - Integrated DNA Technologies (IDT) and Cepheid
- IDT is working with the global public health and research communities to supply primers and probes designed to detect COVID-19
- On 21 March 2020, Cepheid announced that it had received Emergency Use Authorisation (EUA) from the FDA for Xpert[®] Xpress SARS-CoV-2, a rapid molecular diagnostic test for qualitative detection of SARS-CoV-2

Becton, Dickinson & Co

- On 3 April 2020, Becton, Dickinson & Co announced that the FDA had granted Emergency Use Authorisation for a new diagnostic test that will enable hospitals to screen for COVID-19 on-site and get results in under three hours
- On 13 April 2020, the Company announced that the FDA had granted Emergency Use Authorisation for an additional molecular diagnostic test for COVID-19 that can return results in two to three hours
 - The new test has been CE marked
- Both the tests run on the BD MAX™ System, a molecular diagnostic platform already in use at various laboratories across the US

Bayer AG



- Bayer has made available more than 40 virus diagnostics devices from its research operations, at various sites in Germany
 - Thereby supporting Germany's COVID-19 analysis capacity to be increased by several thousand tests daily
- At its Berlin campus, the Company is establishing a two-story testing laboratory
- In North Rhine-Westphalia, Germany, Bayer is providing equipment to certified external testing laboratories

Randox Laboratories

- Randox has developed a rapid test for SARS-CoV-2
- The Viral Respiratory Tract Infection (VRI) Array is available on The Vivalytic
 - A molecular point-of-care platform by Randox Laboratories
- The VRI Array can identify SARS-CoV-2 and differentiate it from nine other respiratory infections with similar symptoms, including influenza and all known coronaviruses
- On 25 May 2020, CE marking was granted to whole pathogen quality controls for SARS-CoV-2 from Randox Laboratories

Quest Diagnostics



- On 9 March 2020, Quest Diagnostics introduced a new lab-developed test for COVID-19
 - The molecular test detects nucleic acid of the virus that causes COVID-19 in respiratory specimens
- On 21 April 2020, the Company announced that it had begun to perform antibody (serology) testing using blood samples
 - This test may indicate that the person has been exposed to the virus and developed antibodies against it

LabCorp



- On 5 March 2020, LabCorp launched its LabCorp 2019 Novel Coronavirus (COVID-19) NAA test
 - The molecular test detects the presence of the underlying virus that causes COVID-19
- On 22 April 2020, LabCorp announced that it would expand serological testing for SARS-CoV-2 to more hospitals and healthcare organisations in the US
 - The tests determine the presence of antibodies to the virus and can help to identify individuals who have been exposed to the virus

Thermo Fisher



- On 16 March 2020, Thermo Fisher Scientific announced it had received an Emergency Use Authorisation from the FDA for its diagnostic test
- The diagnostic test is used by CLIA high-complexity laboratories in the US to detect nucleic acid from SARS-CoV-2
- The authorised test uses Applied Biosystems TaqPath Assay and real-time PCR technology and is designed to provide results within 4 hours
- On 26 March 2020, the Company announced that it had received the CE mark in the European Union for its diagnostic test

Takeda



- Takeda is partnering with public entities and other pharmaceutical companies through the Innovative Medicines Initiative in Europe
- It aims to leverage collective expertise in the hope of developing diagnostics for COVID-19 as well as inhibitors to help prevent future outbreaks

Fujifilm

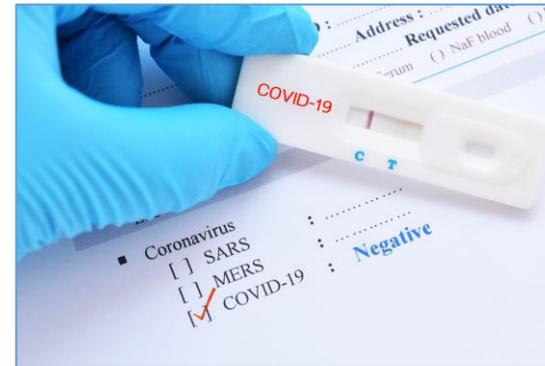


- On 19 May 2020, FUJIFILM announced the commencement of a research study to develop Artificial Intelligence based technology to aid in the diagnosis and treatment assessment of patients with COVID-19-induced pneumonia
- The Company will now embark on a joint research study with local medical institutions treating COVID-19 patients, starting with the Kanagawa Cardiovascular and Respiratory Center (Yokohama, Japan)

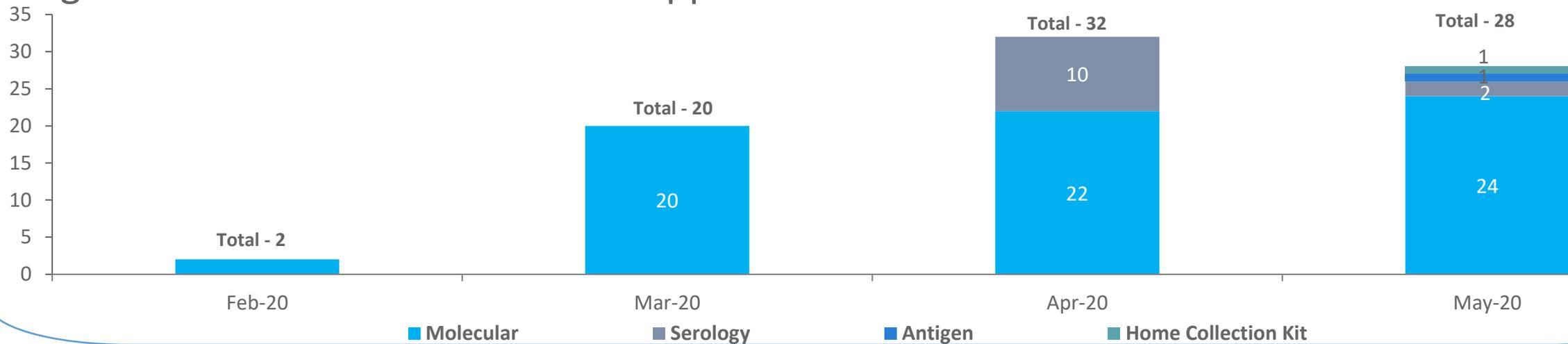
Grifols

GRIFOLS

- On 5 May 2020, Grifols announced the completion of the development of very high sensitivity molecular test to detect SARS-CoV-2 virus.
- Grifols has a productive capacity of one million tests weekly in its plant in San Diego, US
- The test technology, proprietary to Grifols, has a high sensitivity and specificity and uses the Company's own Procleix® platform, through the Panther® analyser, a completely automated system with a high throughput capacity per day



Diagnostics Tests Granted FDA-EUA Approvals



Diagnostics Tests Granted FDA-EUA Approvals in May 2020

Date EUA Issued	Manufacturer	Technology
01-May	Bio-Rad Laboratories, Inc	Molecular
01-May	BioFire Diagnostics, LLC	Molecular
02-May	Roche Diagnostics	Serology Antibody
04-May	EUROIMMUN US Inc.	Serology IgG
04-May	Sansure BioTech Inc.	Molecular
05-May	Fast Track Diagnostics (a Siemens Healthineers Company)	Molecular
06-May	OPTI Medical Systems, Inc.	Molecular
06-May	Sherlock BioSciences, Inc.	Molecular
06-May	BioMérieux SA	Molecular
07-May	Rutgers Clinical Genomics Laboratory - Rutgers University	Molecular
07-May	Zymo Research Corporation	Molecular
08-May	Quidel Corporation	Antigen
08-May	Gnomegen LLC	Molecular
11-May	1drop Inc.	Molecular
11-May	Abbott Molecular Inc.	Molecular
13-May	Applied DNA Sciences, Inc.	Molecular
14-May	Hologic, Inc.	Molecular
14-May	GeneMatrix, Inc.	Molecular
15-May	Everlywell, Inc.	Home Collection Kit
15-May	Fulgent Therapeutics, LLC	Molecular
15-May	Assurance Scientific Laboratories	Molecular
18-May	Quidel Corporation	Molecular
21-May	BioCore Co., Ltd.	Molecular
21-May	SolGent Co., Ltd.	Molecular
21-May	Seasun Biomaterials, Inc.	Molecular
21-May	P23 Labs, LLC.	Molecular
22-May	dba SpectronRx	Molecular
28-May	PrivaPath Diagnostics, Inc.	Molecular

Source: FDA

COVID-19 Series

Response of the Life Sciences Industry

2 Treatments

Treatment Development

Pharma companies and biotechs are racing to develop an effective treatment for the COVID-19

Treatment



- Pharma Companies are rushing to repurpose existing drugs and non-drug therapies, and testing promising experimental drugs that were already in clinical trials
- Even moderately effective therapies or combinations could dramatically support the fight against this disease
- Several companies are developing or testing antivirals against SARS-CoV-2
- Scientists are also looking at other ways to target the virus or treat the complications of COVID-19, such as Monoclonal antibodies, Blood plasma transfers, Stem cells and Immune suppressants

Source: ABPI, Market Watch, Medicine.net and various portals and company websites.

Abbvie



- AbbVie is in collaboration with health authorities and institutions globally to determine the efficacy and safety of KALETRA®/Aluvia against COVID-19
 - KALETRA®/Aluvia (lopinavir/ritonavir) is its antiretroviral therapy for the treatment of HIV
- The Company is supporting clinical studies and basic research with lopinavir/ritonavir, and working closely with European health authorities and FDA
- Abbvie has joined Innovative Medicines Initiative to support research and discovery of targeted medicines against COVID-19

Roche Holdings



- On 19 March 2020, Roche confirmed initiation of Phase III clinical trial in collaboration with the Biomedical Advanced Research and Development Authority (BARDA)
- The study, COVACTA, will evaluate the safety and efficacy of intravenous Actemra®/RoActemra® (tocilizumab) in hospitalised adult patients with severe COVID-19 pneumonia

AstraZeneca



- On 14 April 2020, AstraZeneca announced that it would initiate a global clinical trial to assess the potential of Calquence (acalabrutinib)
- On 23 April 2020, AstraZeneca and Saint Luke's Mid America Heart Institute initiated global Phase III trial to assess the potential of Farxiga (dapagliflozin) as a treatment in patients hospitalised with COVID-19 who are at risk of developing severe complications
- AstraZeneca has joined forces with public research bodies and academic institutions as part of a UK government-led initiative to speed up the development of medicines to treat patients hospitalised with COVID-19

Boehringer Ingelheim



- Boehringer Ingelheim team is currently searching for novel virus-neutralising antibodies
 - The Company is screening its entire molecule library for compounds that could target the virus
- Boehringer Ingelheim actively participating in COVID-19 projects with the Innovative Medicines Initiative (EU) and Bill & Melinda Gates Foundation COVID-19 Therapeutic Accelerator

GSK



- GSK announced a collaboration with Vir Biotechnology to use Vir's monoclonal antibody platform technology to accelerate existing and identify new antiviral antibodies for COVID-19
- The Company is a member of the COVID-19 Therapeutics Accelerator
 - Aimed at the collaboration of pharmaceutical companies and academic institutions to identify molecules to treat COVID-19
- GSK is evaluating its marketed pharmaceutical products and medicines in development to determine if any could be used to treat COVID-19

Pfizer



- Pfizer confirmed a lead compound and analogues are potent inhibitors of the SARS-CoV-2 3C-like (3CL) protease, based on the results of initial screening assays
- Pfizer researchers will publish a review in Clinical Pharmacology and Therapeutics which assesses published in vitro and clinical data regarding azithromycin as an agent with antiviral properties
 - This open-access review may serve to facilitate the use of azithromycin in future research on COVID-19

Sanofi & Regeneron



- On 16 March 2020, Sanofi and Regeneron announced that they had started a clinical program evaluating Kevzara® (sarilumab) in patients hospitalised with severe COVID-19
- On 27 April 2020, Sanofi announced the preliminary results from the Phase 2 portion of an ongoing Phase 2/3 trial evaluating Kevzara®
- Regeneron has isolated hundreds of virus-neutralising, fully human antibodies from the Company's VelocImmune® mice and from humans who have recovered from COVID-19

Eli Lilly & Co.



- On 12 March 2020, AbCellera and Eli Lilly entered into an agreement to co-develop antibody products for COVID-19 treatment & prevention using AbCellera's rapid pandemic response platform
- On 10 April 2020, Eli Lilly entered into an agreement with the National Institute of Allergy and Infectious Diseases to study OLUMIANT® (baricitinib) in COVID-19 Treatment Trial
- On 4 May 2020, Eli Lilly signed an agreement with China-based biopharmaceutical firm Junshi Biosciences to jointly develop therapeutic antibodies to prevent and treat Covid-19

Amgen & Adaptive Tech.



- On 2 April 2020, Amgen and Adaptive Biotechnologies announced a collaboration to discover and develop fully human neutralising antibodies targeting SARS-CoV-2
- An Antibody-based therapy could emerge as an option to prevent or treat COVID-19 until a vaccine can be found
- Potent antibodies culled from survivors could provide the basis for a therapy to prevent/treat COVID-19 in others by neutralising the virus.
- On 4 May 2020, Amgen announced that it would start testing psoriasis therapy drug, Otezla as a potential treatment for COVID-19

Merck & Co.



- On 27 April 2020, Merck and the Institute for Systems Biology (ISB), announced a new research collaboration to investigate and define the molecular mechanisms of SARS-CoV-2 infection and COVID-19
- They aim to identify targets for medicines and vaccines
- Merck has also entered into an agreement with the Biomedical Advanced Research and Development Authority to provide funding for a research

Bayer



- On 21 April 2020, Bayer announced a collaboration with Population Health Research Institute (PHRI) to launch a clinical research program aimed at identifying potential treatments against COVID-19
- An outpatient study will evaluate the combination of chloroquine with azithromycin as a treatment to prevent deterioration leading to hospital admission
- Another study will evaluate the combination of chloroquine with azithromycin, as well as interferon beta-1b, to prevent admission to intensive care, mechanical ventilation and/or death

Johnson & Johnson



- Johnson & Johnson and the Biomedical Advanced Research and Development Authority have expanded their partnership to accelerate Janssen's ongoing work in screening compound libraries
- By testing the antiviral activity of these compounds against SARS-CoV-2, the Company hopes to identify an existing, proven-safe drug that has potential to be turned into a new treatment for the virus

Gilead



- Gilead is working closely with global health authorities to respond to COVID-19 outbreak through the appropriate experimental use of the investigational compound Remdesivir
 - Remdesivir is an investigational nucleotide analog with broad-spectrum antiviral activity
- On 1 May 2020, Remdesivir received FDA's Emergency Use Authorisation for the Treatment of COVID-19
- On 7 May 2020, Gilead announced that the Japanese Ministry of Health, Labour and Welfare had granted regulatory approval to Veklury® (remdesivir) as a treatment for SARS-CoV-2 infection

Novartis



- On 28 April 2020, Novartis announced plans to initiate a Phase III clinical trial to study canakinumab in patients with COVID-19 pneumonia
- On 20 April 2020, Novartis reached an agreement with the FDA to proceed with a Phase III clinical trial of hydroxychloroquine in hospitalised patients with COVID-19 disease
- Jakavi® (ruxolitinib), Ilaris® (canakinumab) and Cosentyx® (secukinumab) and more medicines are also under evaluation

Takeda & CSL Behring



- Takeda has joined forces with CSL Behring, Biotest, BPL, LFB and Octapharma to form the CoVlg-19 Plasma Alliance to develop a potential plasma-derived therapy for treating COVID-19
- The alliance will begin the development of an investigational Hyperimmune globulin (H-Ig) medicine called CoVlg-19
- H-Igs are plasma-derived therapies that have proved effective previously in the treatment of severe acute respiratory infections
 - Takeda developed an H-Ig for H1N1, or the swine flu, in 2009

Vir, Biogen & Alnylam



- Vir Biotechnology and GSK announced a collaboration to use Vir's monoclonal antibody platform technology to accelerate existing and identify new antiviral antibodies for COVID-19
- On 4 May 2020, Vir Biotechnology and Alnylam Pharmaceuticals announced the selection of a development candidate for VIR-2703, an investigational RNAi therapeutic targeting the SARS-CoV-2 genome
- On 29 May 2020, Vir Biotechnology and Biogen announced the finalisation of a process development and manufacturing agreement to enable commercial supply of Vir's SARS-CoV-2 monoclonal antibodies

Alexion Pharmaceuticals



- On 20 April 2020, Alexion Pharmaceuticals announced plans to initiate a global Phase 3 study to investigate ULTOMIRIS® (ravulizumab-cwvz) in COVID-19 patients
 - Adults hospitalised with severe pneumonia or acute respiratory distress syndrome (ARDS)
- ULTOMIRIS® (ravulizumab-cwvz), a biologic medicine, is the first and only long-acting C5 complement inhibitor
- The study is expected to enrol approximately 270 patients across countries with high numbers of diagnosed cases, beginning in May

CytoDyn



- CytoDyn is developing Leronlimab, a CCR5 antagonist, as a combination therapy for highly treatment experienced HIV patients
- On 18 May 2020, CytoDyn announced that it would be submitting a protocol to the FDA for a factorial design trial to compare effectiveness of leronlimab vs remdesivir, and in combination with remdesivir for the treatment of COVID-19
- On 19 May 2020, CytoDyn announced it would be coordinating with the NIH of Mexico and providing leronlimab for a trial for the severe COVID-19 population in Mexico

Incyte



- On 17 April 2020, Incyte announced the initiation of RUXCOVID, a Phase 3 clinical trial evaluating the efficacy and safety of ruxolitinib (Jakafi®) plus standard-of-care (SoC) in patients aged ≥ 12 years with COVID-19 associated cytokine storm
- The collaborative study is sponsored by Incyte in the United States and Novartis outside of the United States

Emergent BioSolutions



- On 2 April 2020, Emergent BioSolutions announced a partnership with the US government to expedite development of a plasma-derived therapy for patients with COVID-19
- Emergent has received \$14.5 million from the Biomedical Advanced Research and Development Authority (BARDA) to support its COVID-HIG program, one of two hyperimmune development programs announced by Emergent in March 2020

Grifols

GRIFOLS

- On 25 March 2020, Grifols announced its collaboration with the United States Biomedical Advanced Research Development Authority (BARDA), FDA and other Federal public health agencies to collect plasma from convalescent COVID-19 patients
- The Company will process this specific plasma into a hyperimmune globulin and support the necessary pre-clinical and clinical studies to determine if anti-SARS-CoV-2 hyperimmune globulin therapy can successfully be used to treat COVID-19 disease

CalciMedica



- On 9 April 2020, CalciMedica announced it had received a “Study May Proceed” letter from the FDA to investigate the use of CM4620-IE
- On 28 May 2020, CalciMedica announced positive topline data from an interim analysis of its open-label randomised controlled clinical study of Auxora™ (formerly called CM4620-IE) in patients with severe COVID-19 pneumonia on low-flow oxygen therapy
 - The interim analysis showed Auxora plus standard of care reduced ventilator use and improved time to recovery in treated patients compared to standard of care alone

Vanda Pharmaceuticals



- On 8 April 2020, Vanda Pharmaceuticals and the University of Illinois at Chicago announced a research partnership
 - A high-throughput screening assay to identify small molecules that may prevent cathepsin-L cleavage of SARS-CoV-2 glycoproteins that are required for viral processing in host cell
- On 15 April 2020, Vanda and Northwell Health's research arm announced enrolment of the first patient in Vanda's clinical trial, ODYSSEY
 - A Phase III trial investigating the efficacy and safety of Tradipitant, a neurokinin-1 receptor antagonist

Fujifilm

FUJIFILM

- Fujifilm Life Sciences is advancing treatments and targeting solutions for COVID-19 medical needs by collaborating with pharmaceutical organisations in Europe
- Fujifilm commenced a phase III clinical trial in Japan to assess the safety and efficacy of Avigan in COVID-19 patients with non-severe pneumonia, alongside a phase II clinical trial in the United States
- FUJIFILM Diosynth Biotechnologies (FDB), a contract process development & manufacturing company, based in UK & Denmark, is supporting governments, academia and industry to rapidly scale up potential COVID-19 vaccines and therapies

COVID-19 Series

Response of the Life Sciences Industry

3 Vaccine

Vaccine

Life Sciences companies are ratcheting up their efforts with accelerated schedules for creating new vaccines



- The growing threat of the COVID-19 pandemic has prompted pharmaceutical companies to initiate R&D processes to find a vaccine that can prevent further spread of the novel coronavirus
- Pharma Companies are racing to compress the 10-year vaccine development timeline with the support of non-profit organisations, government agencies and regulatory authorities
- Vaccine developers are using previous research from the severe acute respiratory syndrome (SARS) and Middle East Respiratory Syndrome (MERS) outbreaks to inform their studies

Source: ABPI, Market Watch, Medicine.net and various portals and company websites.

GSK



- On 14 April 2020, GSK & Sanofi announced a collaboration to develop an adjuvanted vaccine for COVID-19
 - Sanofi will contribute its S-protein COVID-19 antigen, and GSK will contribute its proven pandemic adjuvant technology
 - The Companies plan to initiate phase I clinical trials in the H2 2020 and, if successful and subject to regulatory considerations, aim to complete the development required for availability by the H2 2021
- GSK is also collaborating with the University of Queensland, Clover Biopharmaceuticals and Xiamen Inovax Biotech Co.

Moderna



- On 27 April 2020, Moderna announced submission of an Investigational New Drug application to FDA for the Company's mRNA vaccine candidate (mRNA-1273) against SARS-CoV-2
 - Evaluation of mRNA-1273 in Phase 2 & late-stage studies led by the National Institute of Allergy and Infectious Diseases (NIAID)
- On 12 May 2020, the Company received FDA Fast Track designation for mRNA-1273
- On 18 May 2020, Moderna announced positive interim clinical data of mRNA-1273 from the Phase 1 study led NIAID

Johnson & Johnson



- Johnson & Johnson has selected a lead COVID-19 vaccine candidate and is expected to go into clinical trials by September 2020
- J&J has entered into a collaboration with Emergent BioSolutions to support the manufacturing of the vaccine
- The Company has collaborations with Janssen Pharmaceutical Companies of Johnson & Johnson and the Biomedical Advanced Research and Development Authority (BARDA), and the Beth Israel Deaconess Medical Center
- Vaccine discovery and development efforts will leverage Janssen's proven AdVac[®] and PER.C6[®] technology

Sanofi



- On 14 April 2020, Sanofi & GSK announced a collaboration to develop an adjuvanted vaccine for COVID-19
 - Sanofi will contribute its S-protein COVID-19 antigen, and GSK will contribute its proven pandemic adjuvant technology
 - The Companies plan to initiate phase I clinical trials in the H2 2020 and, if successful and subject to regulatory considerations, aim to complete the development required for availability by the H2 2021
- Sanofi is also collaborating with Translate Bio to discover, design, and manufacture a vaccine

Pfizer & BioNTech



- On 16 March 2020, BioNTech and Shanghai Fosun Pharmaceutical announced a strategic development and commercialisation collaboration to advance BioNTech's mRNA vaccine candidate BNT162 in China
- On 17 March 2020, Pfizer and BioNTech SE announced that the companies would co-develop and distribute (excluding China) a potential mRNA-based vaccine aimed at preventing COVID-19
- On 14 May 2020, Pfizer and BioNTech announced that first participants have been dosed in the US in the Phase 1/2 clinical trial for the BNT162 vaccine program

INOVIO Pharmaceuticals **inovia**

- On 6 April 2020, INOVIO Pharmaceuticals announced that FDA had accepted the Company's Investigational New Drug (IND) application for INO-4800, a vaccine candidate to prevent COVID-19 infection
- CEPI has granted \$6.9mn funding to INOVIO to work with International Vaccine Institute and Korea National Institute of Health (KNIH) for INO-4800 Phase 1/2 clinical trial in South Korea
- On 20 May 2020, Inovia announced the publication of the pre-clinical study data for INO-4800 demonstrating robust neutralising antibody and T cell immune responses against coronavirus SARS-CoV-2.

Vaxart



- On 30 April 2020, Vaxart announced that it had obtained positive pre-clinical results for its COVID-19 vaccine candidates
 - Several vaccine candidates generated immune responses in all tested animals after a single dose
- On 20 May 2020, Vaxart announced that it has selected its lead COVID-19 vaccine candidate and had contracted with KindredBio to manufacture bulk vaccine under cGMP to complement the manufacturing capacity of partner Emergent BioSolutions

CEPI

CEPI

- CEPI has collaborations and funding initiatives with various companies and universities to develop vaccines against the SARS-CoV-2
 - On 31 January 2020 – CureVac
 - On 3 February 2020 – GSK
 - 10 March 2020 – Novavax & University of Oxford
 - 18 March 2020 – University of Hong Kong
 - 19 March 2020 – Institut Pasteur-led consortium
 - 16 April 2020 – IVI, INOVIO and KNIH
 - 27 April 2020 - Clover Biopharmaceuticals
 - 11 May 2020 - Novavax

Dynavax Technologies



- On 2 March 2020, Dynavax announced collaboration with University of Queensland, part of a CEPI initiative, to develop a vaccine
- On 24 March 2020, the Company announced a research collaboration with Clover Biopharmaceuticals to develop a vaccine candidate (COVID-19 S-Trimer) in pre-clinical studies
- On 16 April 2020, Dynavax and Sinovac Biotech announced a collaboration
- On 22 April 2020, Dynavax and Valneva announced collaboration to evaluate Valneva's vaccine IXIARO®
- Dynavax is providing proprietary toll-like receptor 9 (TLR9) agonist adjuvant, CpG 1018, to support all its collaborations

Heat Biologics



- On 3 March 2020, Heat Biologics announced that the Company had launched a program within its wholly-owned subsidiary, Zolovax, to develop a vaccine using its immune activating gp96 vaccine platform for treating or preventing infection from the SARS-CoV-2
- On 5 March 2020, The Company announced a strategic collaboration with the University of Miami Miller School of Medicine to support the development of a vaccine leveraging Heat's proprietary gp96 platform
- Anticipated Q2 2020 milestones include, development of a cell-based vaccine expressing gp96-Ig, OX40L-Ig and SARS-CoV-2 protein S

Arcturus Therapeutics



- On 4 March 2020, Arcturus and Duke-NUS Medical School announced a partnership to develop COVID-19 vaccine for Singapore
 - The STARR™ Technology platform combines self-replicating RNA with LUNAR®, a leading nanoparticle non-viral delivery system, to produce proteins inside the human body
- On 4 May 2020, Arcturus and Catalent announced a manufacturing partnership for Arcturus' vaccine candidate (LUNAR-COV19)
- On 8 May 2020, Arcturus announced new supportive pre-clinical data, providing evidence for an adaptive cellular (CD8+ cells) and balanced (Th1/Th2) immune response data from the Company's COVID-19 vaccine program (LUNAR-COV19)

Novavax



- On 10 March 2020, Novavax received initial funding of \$4mn from CEPI to support its efforts to develop a COVID-19 vaccine
- On 8 April 2020, Novavax announced it had identified a coronavirus vaccine candidate, NVX-CoV2373
 - NVX-CoV2373 is a stable, prefusion protein made using Novavax' proprietary nanoparticle technology
- On 11 May 2020, Novavax announced that CEPI would invest up to \$384mn of additional funding to advance clinical development of NVX-CoV2373, Novavax' coronavirus vaccine candidate against SARS-CoV-2

GeoVax Labs



- On 27 January 2020, GeoVax Labs and BravoVax, a vaccine developer in Wuhan, China, announced collaboration to jointly develop a vaccine against the SARS-CoV-2
 - Under the collaboration, GeoVax would use its MVA-VLP vaccine platform to design and construct the vaccine candidate
- On 30 April 2020, GeoVax announced that Sino Biological would be its exclusive supplier of SARS-Cov-2 bioreagent research products
 - Sino Biological will provide key bioreagents such as recombinant proteins, antibodies and detection kits

Emergent Biosolutions



- On 10 March 2020, Emergent BioSolutions announced collaboration with Novavax for CDMO services to support Novavax's novel experimental vaccine candidate to protect against COVID-19
- On 18 March 2020, the Company announced collaboration with Vaxart for CDMO services to support Vaxart's experimental oral vaccine candidate for COVID-19
- On 23 April 2020, Emergent BioSolutions announced collaboration with Johnson & Johnson for CDMO services to support manufacturing of Johnson & Johnson's lead vaccine candidate for COVID-19 that leverages the AdVac® and PER.C6® technologies

CureVac



- On 31 January 2020, CureVac AG and CEPI announced a public-private partnership to accelerate development of vaccines against COVID-19
 - CEPI provided initial funding of up to \$8.3mn for accelerated vaccine development, manufacturing and clinical tests
- The Company is coordinating the development of its program with the German Paul Ehrlich Institute (PEI) for accelerated clinical development of these vaccine candidates
- On 14 May 2020, CureVac announced positive pre-clinical results at a low dose for its lead vaccine candidate against SARS-CoV-2

Crescent



- Crescent Pharma Limited is working to develop a vaccine from chloroquine phosphate, which is being used in 10 COVID-19 trials in China

Translate Bio



- On 27 March 2020, Translate Bio and Sanofi announced collaboration to develop a novel mRNA vaccine for COVID-19
- The collaboration will leverage an existing agreement from 2018 between the two companies to develop mRNA vaccines for infectious diseases
- Translate Bio has begun to produce multiple mRNA constructs and will use its mRNA platform to discover, design and manufacture SARS-CoV-2 vaccine candidates

AstraZeneca



- On 30 April 2020, AstraZeneca and the University of Oxford announced an agreement for the global development and distribution of the University's potential SARS-CoV-2 vaccine
 - The potential vaccine is known as ChAdOx1 nCoV-19 and is recombinant adenovirus vaccine
- The vaccine is being developed by the Jenner Institute and Oxford Vaccine Group, at the University of Oxford
- AstraZeneca would be responsible for the development and worldwide manufacturing and distribution of the vaccine

CSL Behring



- CSL Behring is collaborating with the University of Queensland to support the development of a COVID-19 vaccine candidate
 - The Company is providing its vaccine development expertise, proprietary technologies and laboratory facilities

Merck & Co.



- On 26 May 2020, Merck and IAVI announced a new collaboration to develop an investigational vaccine against SARS-CoV-2
- The vaccine candidate will use the recombinant vesicular stomatitis virus (rVSV) technology that is the basis for Merck's Ebola Zaire virus vaccine, ERVEBO® (Ebola Zaire Vaccine, Live), which was the first rVSV vaccine approved for use in humans

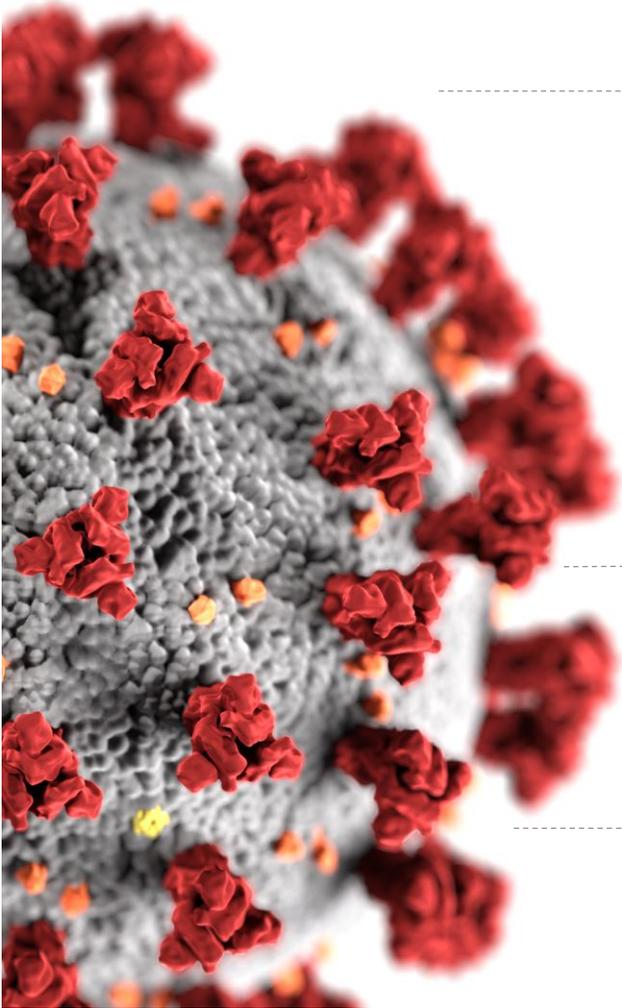


COVID-19

Details of the Virus

Basics about SARS-CoV-2 & COVID-19

30 Apr 2020



Overview

- **Origin:** Possibly in wet animal market in Wuhan, China
- **Disease:** Coronavirus disease 2019 (COVID-19)
- **Cause:** Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)
- **Strain:** Same virus as SARS-CoV-1, which affected 8,000 people in 2002-03
- **DNA Study (Feb-2020):** 96% DNA match between bat coronavirus and human suggests link to humans is not direct but through intermediate host
- **Target:** Upper respiratory tract and can spread to lungs

Transmission & Mechanism

- Enters through nose, mouth, or eyes
- Attaches to cells in the respiratory tract via surface protein called ACE2
- Fuses with the cell and releases the RNA
- Takes over cellular machinery and induces the host cell to produce viral proteins and form new virions which are released to the environment
- Each infected cell can release millions of copies of the virus in its life cycle

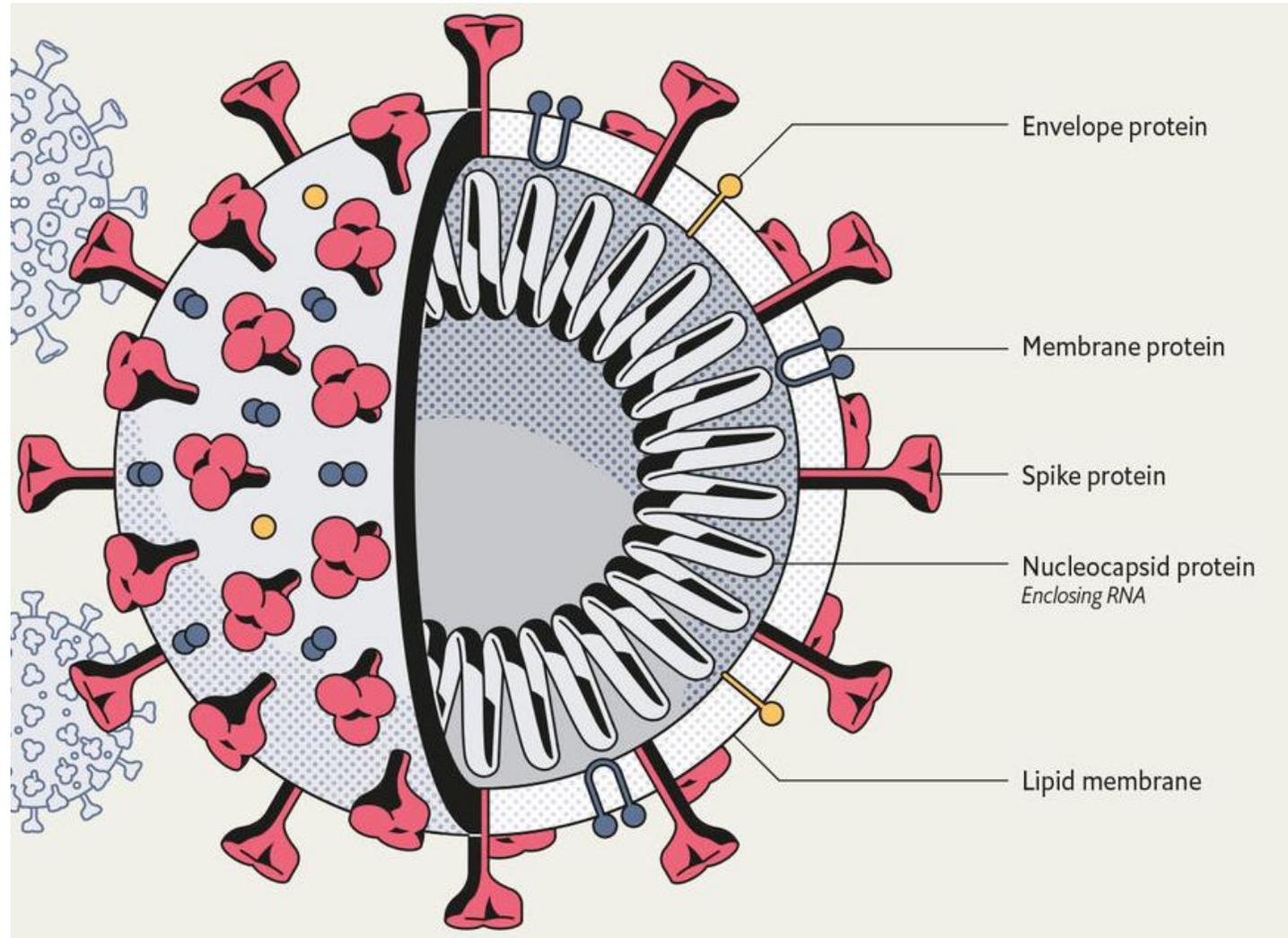
Characteristics

- Appears highly transmissible – R_0 estimated between 2-3. depending on the region
- R_0 is the reproduction number or number of cases generated by one case in a population
- Affects older patients and fatality rate in the 70s is 3-4 times larger than the average
- Men are twice more likely to get infected than women

Source: <https://www.economist.com/briefing/2020/03/12/understanding-sars-cov-2-and-the-drugs-that-might-lessen-its-power>; London Business School - The economics of a pandemic: The case of Covid-19

Anatomy of the Virus: SARS-CoV-2

30 Apr 2020



Size & Morphology

- SARS-CoV-2 has a diameter of approximately 60–140nm.
- It has a round or elliptic shape like most viruses.
- Club-shaped protrusions give a crown-like appearance under an electron-microscope.

Structure

- It is composed of 4 structural proteins; the spike glycoproteins, which are present on the surface of the envelope, that surround lipid membrane, which encapsulates the RNA-containing nucleocapsid protein.
- These surface proteins are responsible for mediating antibody neutralization and host receptor-binding.

Genomic Characteristics

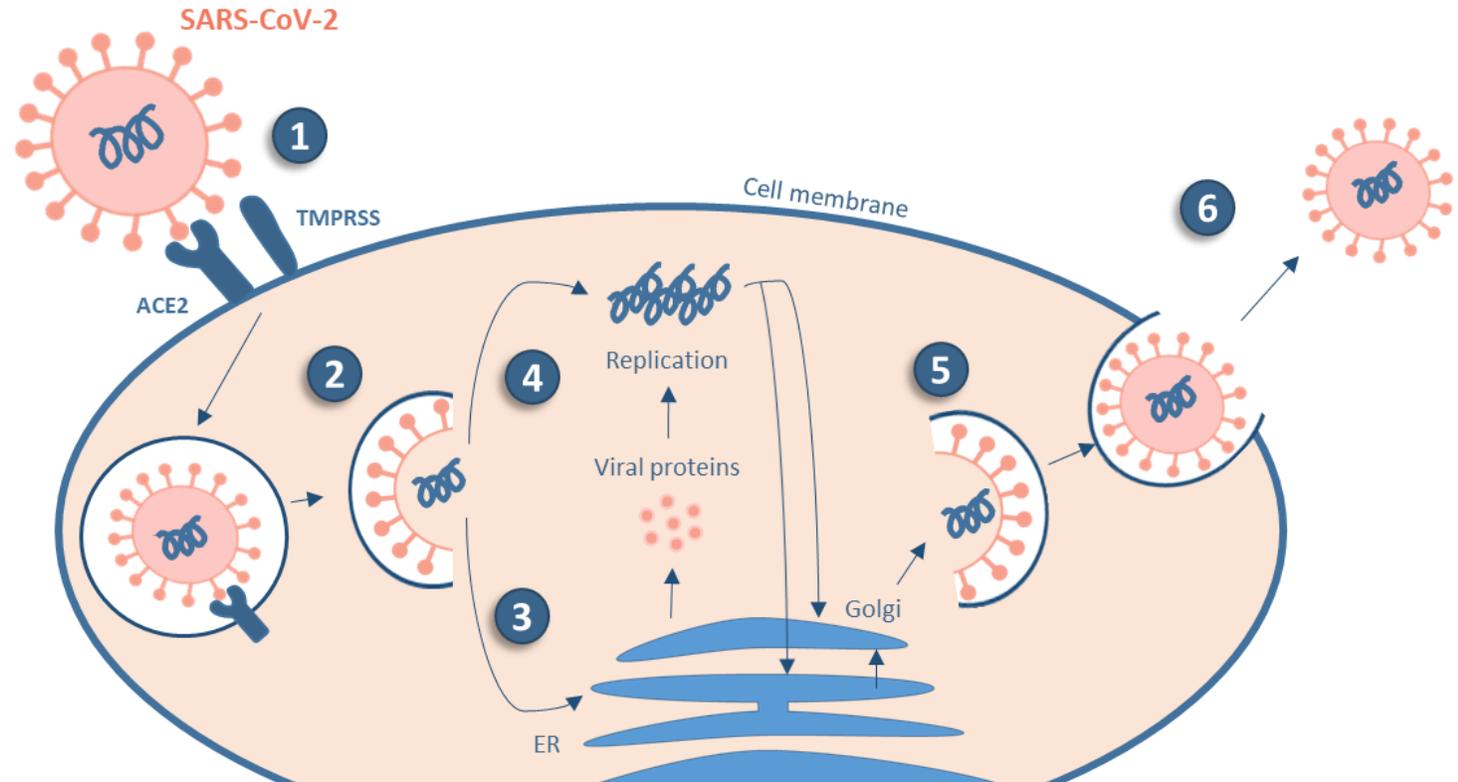
- Single-stranded positive RNA molecule with a 5'-cap structure and 3'-poly-A tail
- Coronaviruses (CoVs) possess the largest genomes (26.4–31.7 kb) among all known RNA viruses

Source: <https://www.economist.com/briefing/2020/03/12/understanding-sars-cov-2-and-the-drugs-that-might-lessen-its-power>; London Business School - The economics of a pandemic: The case of Covid-19 <https://www.ncbi.nlm.nih.gov/books/NBK554776/>; Cascella et al. 2020 Features, Evaluation and Treatment Coronavirus (COVID-19)

Cellular Pathogenesis of the Virus: SARS-CoV-2

Replication Cycle of SARS-CoV-2

- 1. Adsorption & Endocytosis:** SARS-CoV-2 binds to ACE2, a host surface receptor protein via its spike protein. Another cell-surface protein, TMPRSS, assists this internalisation process
- 2. Unfolding:** The genetic material, containing non-structural proteins essential for intracellular replication of the virus, are released into the cell.
- 3. Translation:** The viral RNA mounts the cellular machinery to translate its genetic material into new viral proteins
- 4. Synthesis:** These proteins form a replication complex which allows more viral genetic material to be transcribed and translated via the ERGIC apparatus.
- 5. Virion Assembly:** The viral RNA and proteins are assembled into a new virion
- 6. Exocytosis:** The fully-assembled virion is then released via exocytosis into the environment to infect other cells



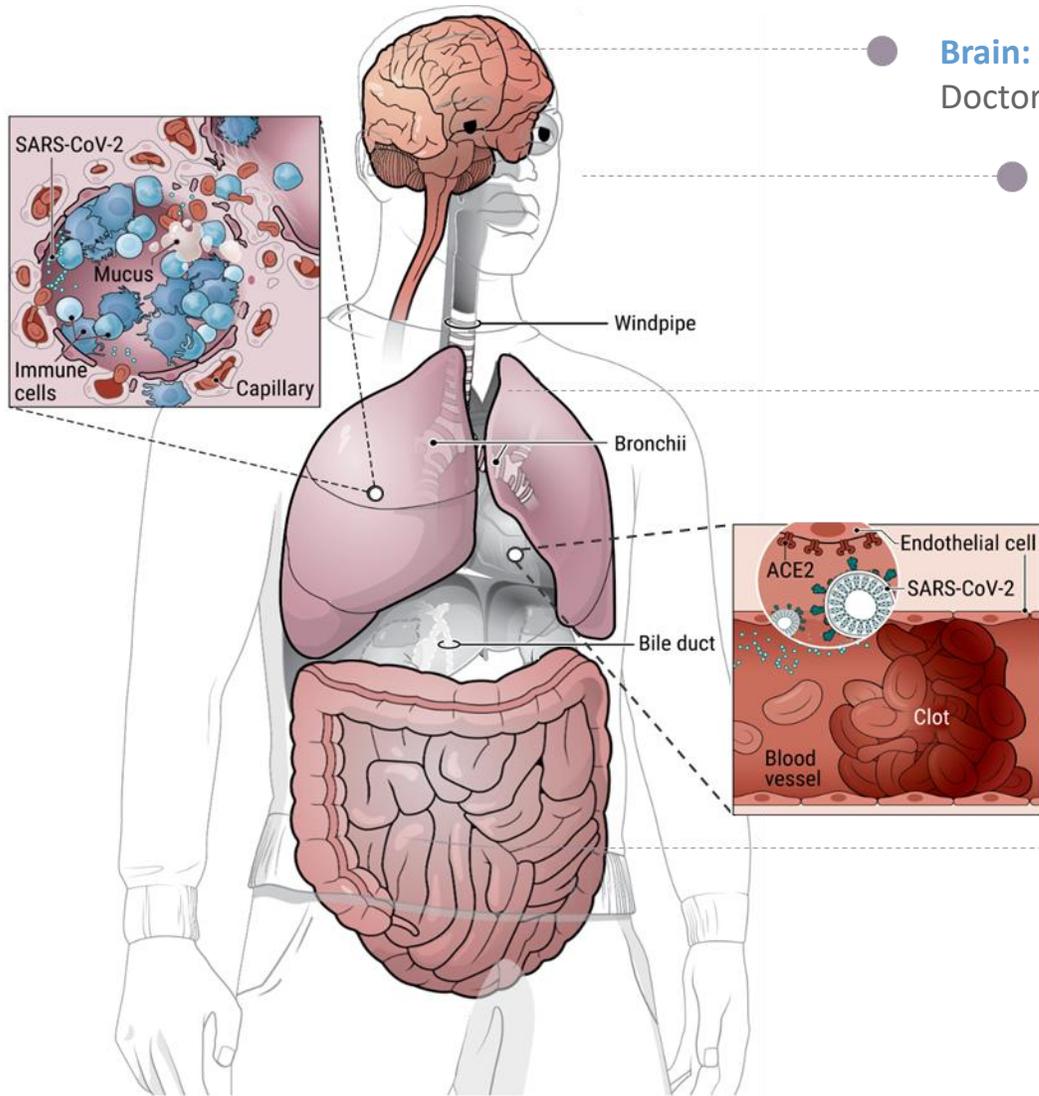
Adapted from Faculty of Pharmaceutical Medicine

Hypothesis for Pathogenesis of SARS-CoV-2

- The virus enters the respiratory system and causes infection as ACE2 receptors are highly expressed in the lower respiratory tract of humans.
- This triggers the overproduction of pro-inflammatory cytokines, leading to the development of an acute viral pneumonia.
- Some cases develop into respiratory failure and uncontrolled systemic inflammatory response, leading to further organ complications.
- This mechanism of pathogenesis of SARS-CoV-2 in humans merits further investigation.

Covid-19 Disease Progression and Multi-Organ Injuries

30 Apr 2020



● **Brain:** Patients have suffered from strokes, seizures, confusion, and brain inflammation. Doctors are trying to understand which are directly caused by the virus.

● **Nose:** There have been reports of a loss of the sense of smell. Scientists speculate this may be caused by the virus moving up the nerve endings of the nose and damaging these cells.

● **Lungs:** The primary site of infection. The cross section shows immune cells crowding an inflamed alveolus that fills with fluid and/or whose walls break down during attack by the virus, diminishing oxygen uptake. Patients cough, fevers rise, and breathing becomes laboured as pneumonia develops in the body.

● **Heart:** The virus enters endothelial cells of the heart by binding to ACE2 receptors on the cell surface. This infection can promote blood clots, cardiac inflammation and a subsequent heart attack.

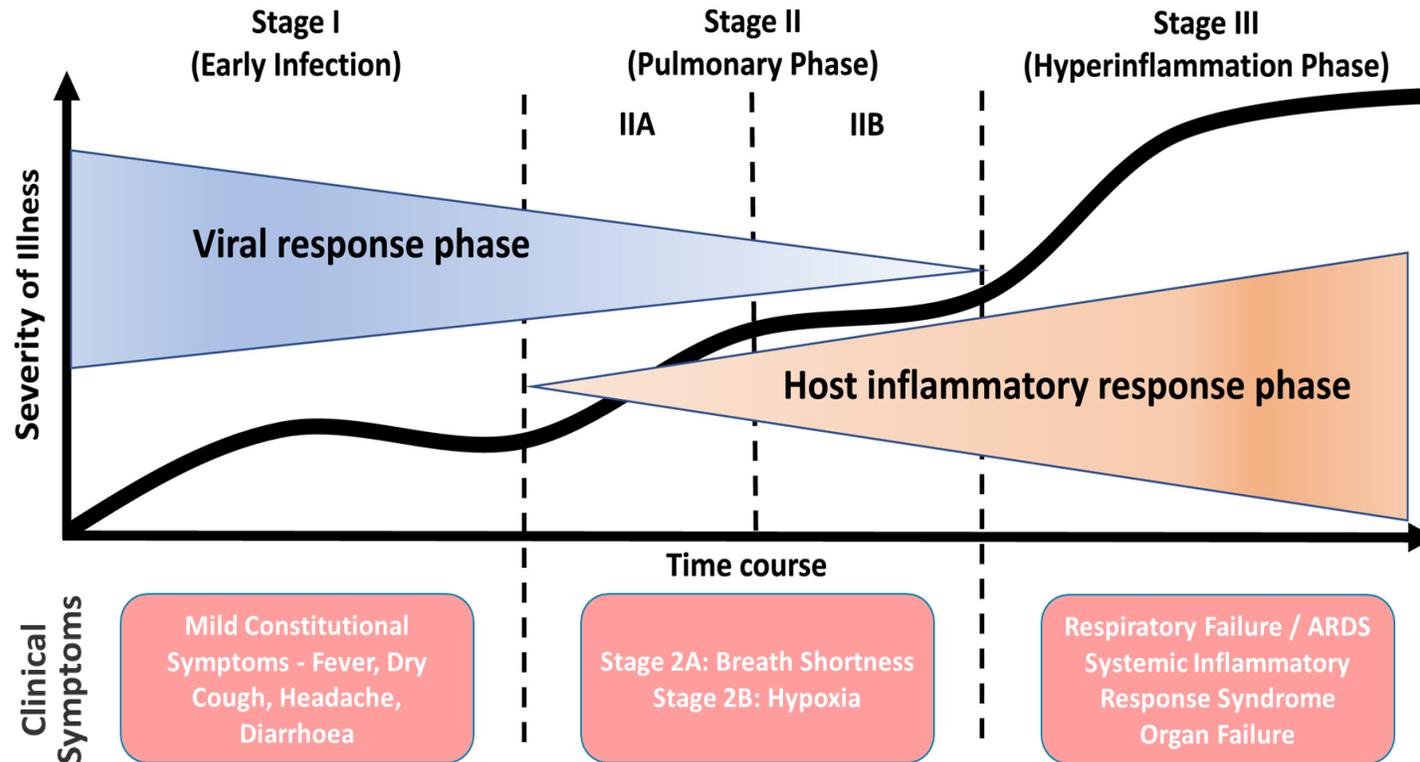
● **Intestine:** Patient reports and biopsy data suggest the virus can infect the lower gastrointestinal tract, which is rich in ACE2 receptors. Around 20% or more of patients reported symptoms of diarrhoea.

Adapted from V.Altounian/Science Interactive

Source: London Strategy Consulting 2020; Wadman et al. 2020 How does Coronavirus kill? Doi: [10.1126/science.abc3208](https://doi.org/10.1126/science.abc3208)

Three Clinical Phases of Covid-19 Infection and Disease Progression

30 Apr 2020



Adapted from The Journal of Heart and Lung Transportation

Clinical Phases of Covid-19 Infection

Stage 1: Viremia / Early Infection Phase

- This stage marks viral contraction and early establishment of disease.
- SARS-CoV-2 multiplies and establishes residence in the host, primarily focusing on the respiratory system
- Patients undergo an incubation period associated with mild and often non-specific symptoms, such as a fever and dry cough.

Stage 2: Acute Pneumonia / Pulmonary Phase

- At this stage, virus multiplication and localized inflammation in the lung is established.
- Patients develop a viral pneumonia, with cough and fever.
- This stage is sub-divided into IIA (without hypoxia) and stage IIB (with hypoxia – deprivation of adequate oxygen supply at the tissue level).
- It is at this stage IIB where mechanical ventilation is required.

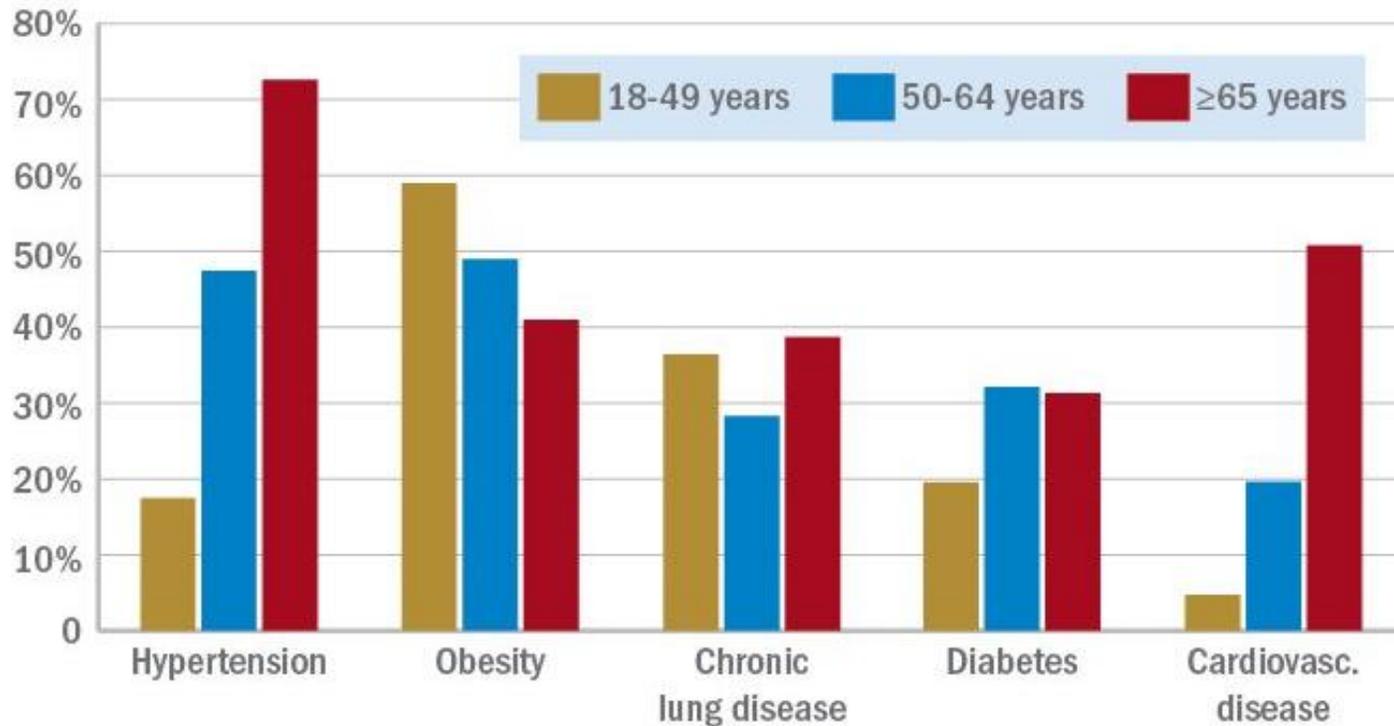
Stage 3: Hyperinflammation / Critical Phase

- A minority of Covid-19 patients will transition into this third and most severe stage of illness, which manifests as an extra-pulmonary systemic hyperinflammation syndrome
- Several markers of systematic inflammation are significantly elevated, and respiratory failure, among other systemic organ failures, are likely.
- The prognosis and recovery from this critical stage is poor.

Source: [https://www.jhltonline.org/article/S1053-2498\(20\)31473-X/fulltext](https://www.jhltonline.org/article/S1053-2498(20)31473-X/fulltext); Siddigi et Mehra 2020. COVID-19 Illness in Native and Immunosuppressed States: A Clinical-Therapeutic Staging Proposal <https://www.tandfonline.com/doi/full/10.1080/22221751.2020.1746199> Lin et al 2020. Hypothesis for potential pathogenesis of SARS-CoV-2 infection

Almost 90% of Covid-19 Hospital Admissions involve Comorbidities

Underlying Conditions among Adults Hospitalised with Covid-19



Note: This figure is based on data from the Covid-19-Association Hospitalisation Surveillance Network for patients admitted to hospitals in 99 counties in 14 states throughout March 2020

Covid-19 Disease Comorbidity Demographics

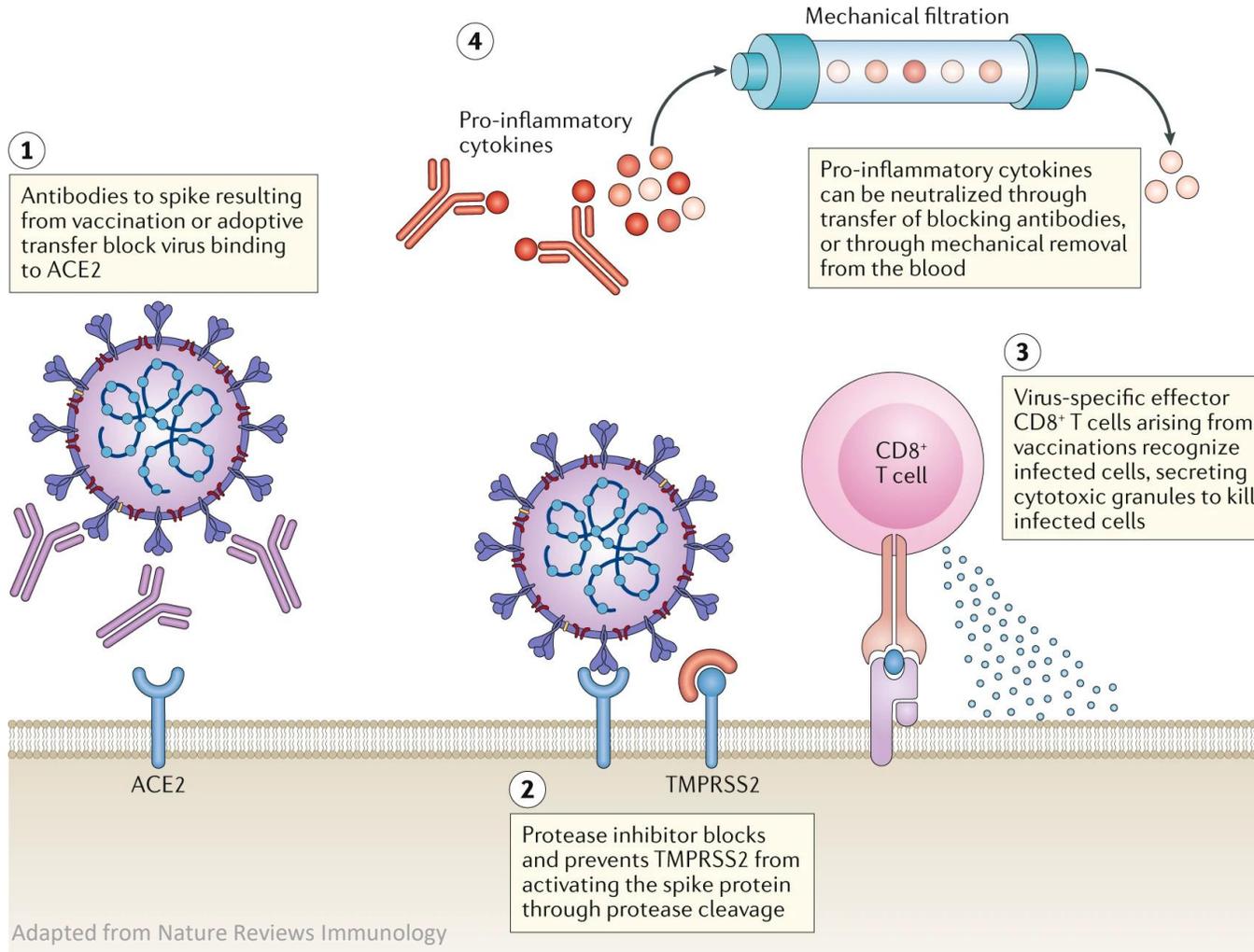
- Almost 90% of patients admitted to hospital for Covid-19 have some underlying health conditions
- Hypertension was the most common co-morbidity amongst patients aged ≥ 65 years.
- Obesity is the most prevalent underlying condition for Covid-19 patients, most specially for the younger age groups.
- Meta-analyses studies have shown that hypertension, respiratory and cardiovascular disease are the most prevalent risk factors for severe patients compared with non-severe patients.

Comorbidities and Covid-19 Pathogenesis

- All underlying health conditions are coupled with an increased risk of Covid-19 disease progression due to the associated pro-inflammatory state and attenuation to immune responses.
- Further analyses is required to determine the direct links of these observations with disease progression.

Source: <https://www.medscape.com/viewarticle/928531> Francki 2020 & MMWR. 2020 Apr 8;69 (early release):1-7
[https://www.ijidonline.com/article/S1201-9712\(20\)30136-3/pdf](https://www.ijidonline.com/article/S1201-9712(20)30136-3/pdf) Yang et al. 2020 Prevalence of comorbidities and its effects in coronavirus disease 2019 patients.

Potential Therapeutic Targets for SARS-CoV-2



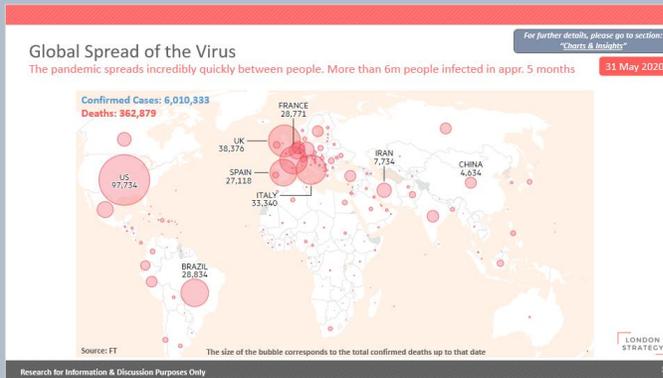
There are Four Potential Therapeutic Targets for SARS-CoV-2:

- 1. Antibodies targeting spike proteins** to inhibit interaction of the virus with the ACE2 receptor on host cells.
- 2. Protease Inhibitors against the cell-surface protein TMPRSS2** to block the receptor from assisting the internalisation process of the virus into the host cell.
- 3. Memory CD8⁺ T-cells specific to SARS-CoV-2** from a previous vaccination or infection are able to differentiate into effector cells, identify infected cells, degranulate and kill these cells before they can produce mature virions.
- 4. Blocking-antibodies or mechanical filtration of pro-inflammatory cytokines** in the blood of infected patients, via customized columns designed to trap pro-inflammatory cytokines, thereby alleviating the inflammatory reaction.

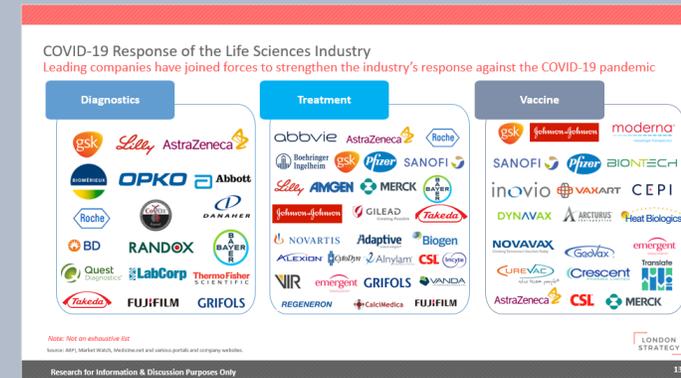
Source: <https://www.nature.com/articles/s41577-020-0311-8/figures/3>; Tay et al. 2020. The trinity of Covid-19: immunity. Inflammation and intervention

COVID-19 Series - Index

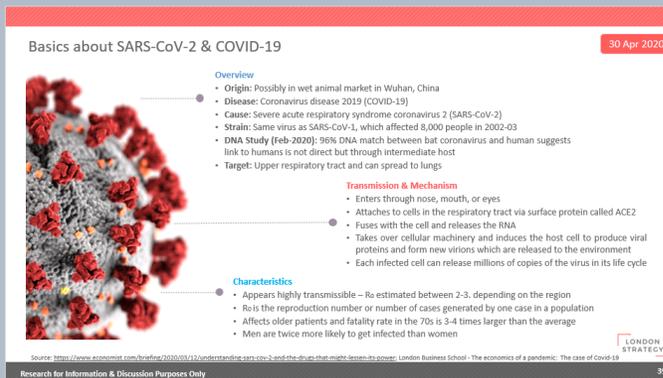
Impact on Life Sciences Sector: 3-10



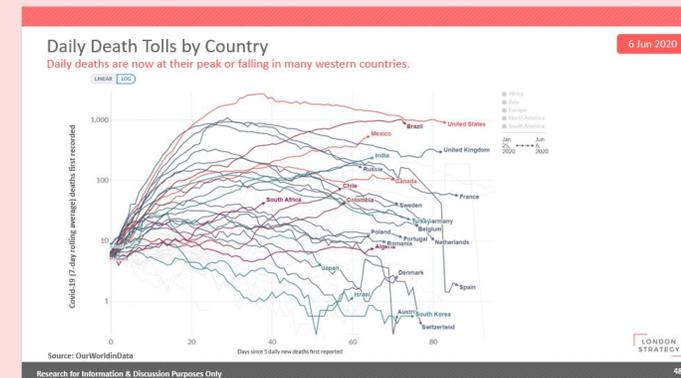
Response of the Life Sciences Industry: 12-36



Details of the Virus: 38-45



Charts & Insights: 47-70

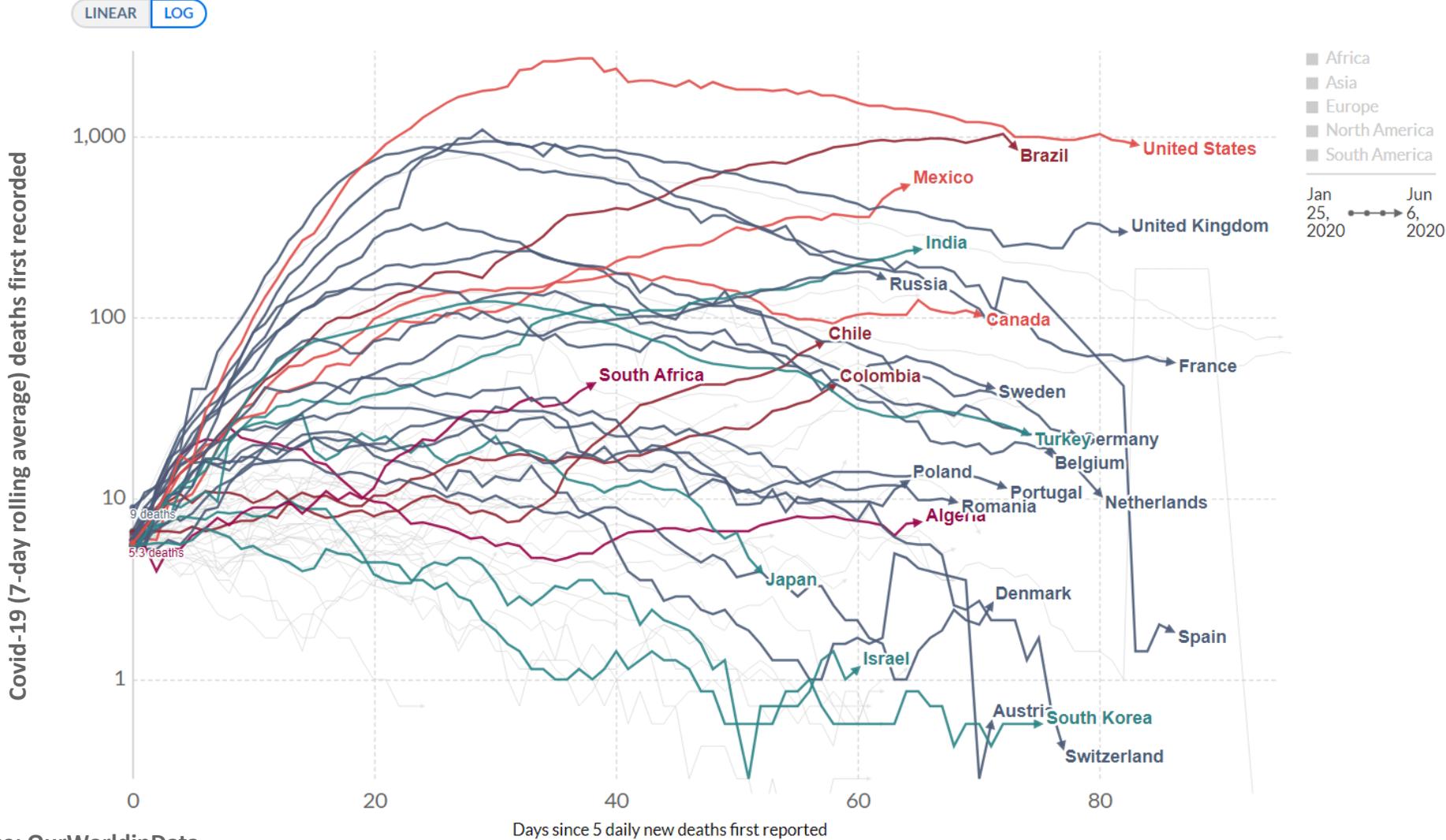


COVID-19

Charts & Insights

Daily Death Tolls by Country

Daily deaths are now at their peak or falling in many western countries.

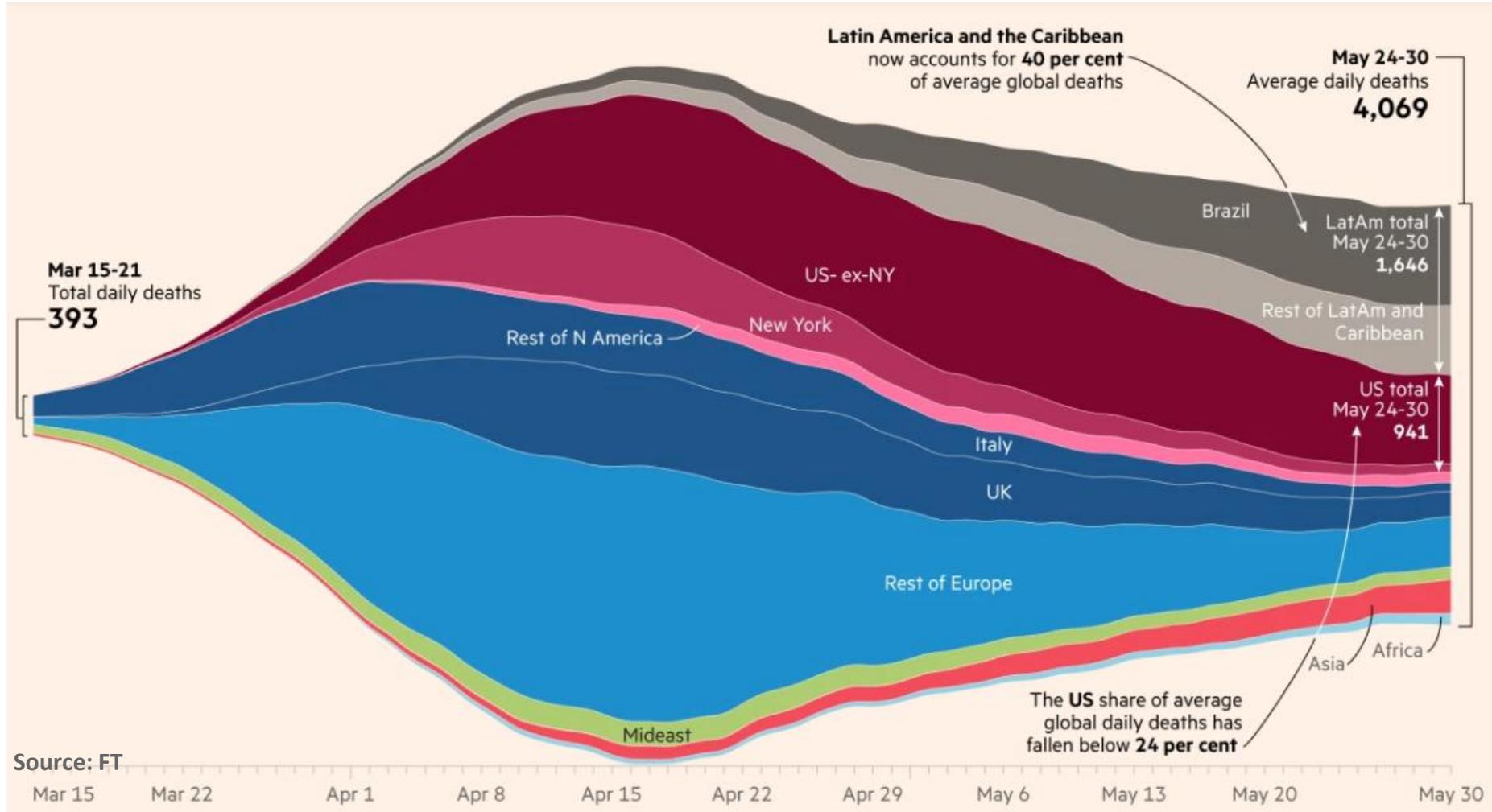


Source: OurWorldinData

Daily Deaths per Day by Country and Region

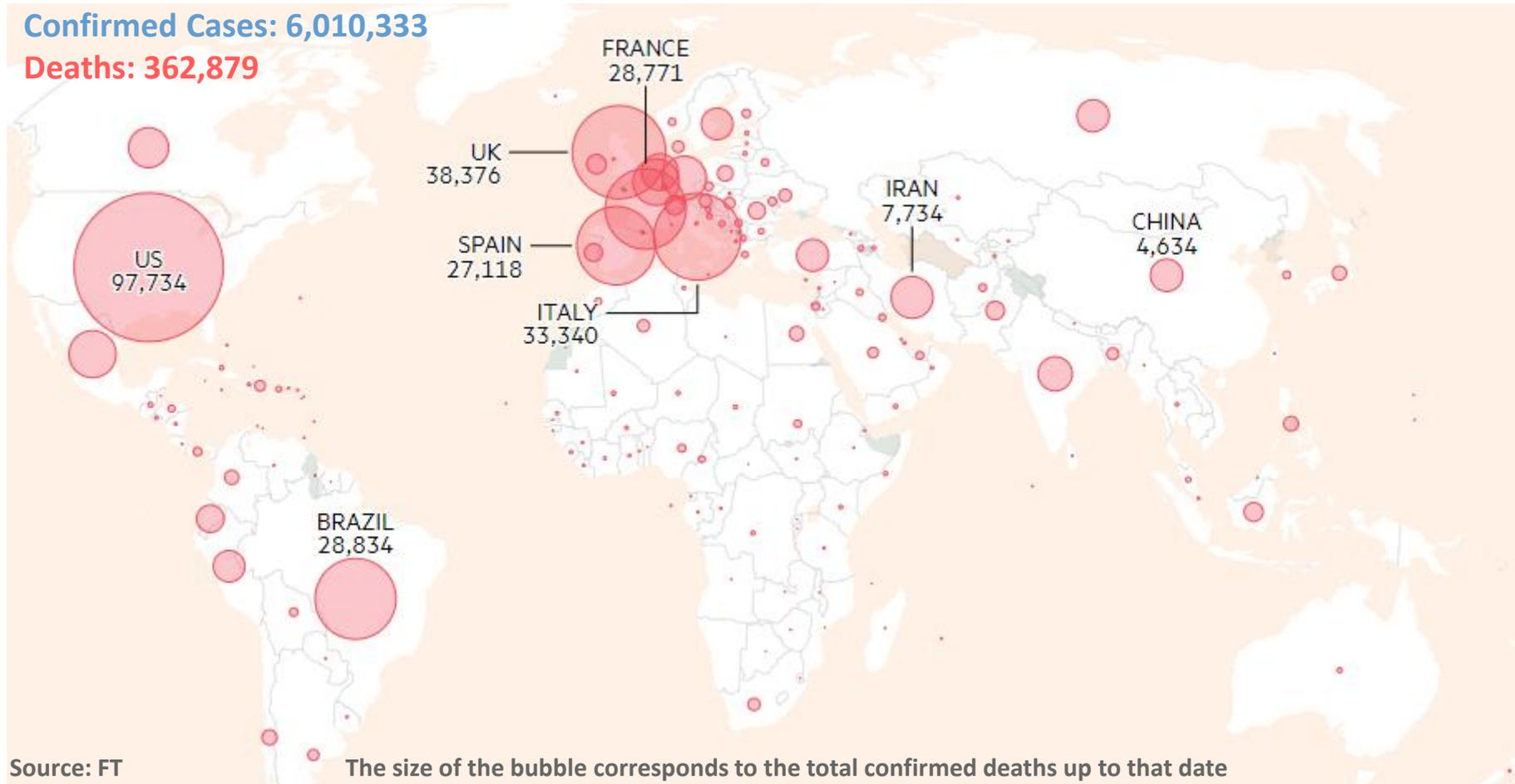
Death toll is continuing to ease slowly

30 May 2020



Mapping the Covid-19 outbreak

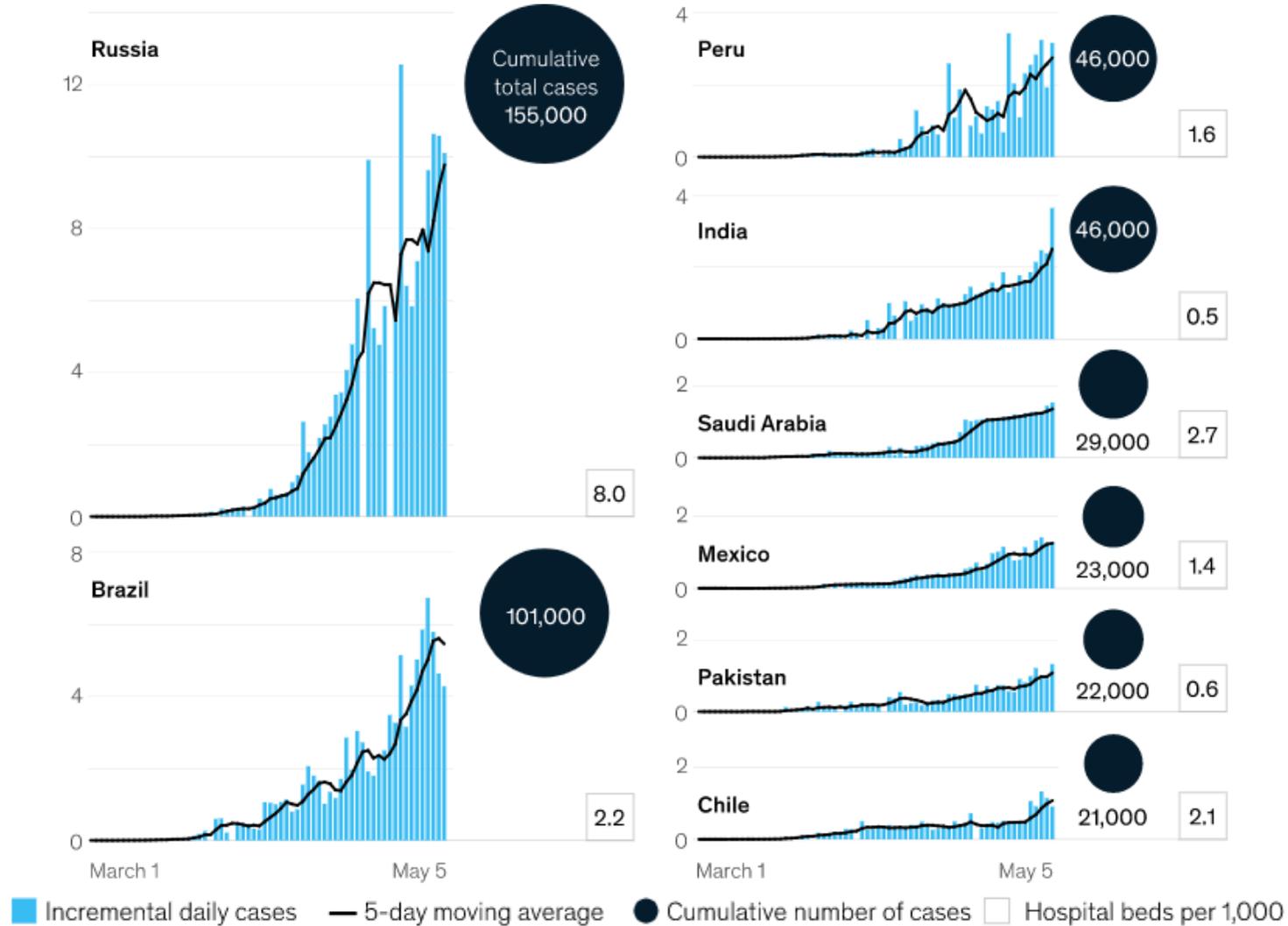
The pandemic spreads incredibly quickly between people. More than 6m people infected in appr. 5 months



Many Major Countries are still seeing rapid case growth.

27 May 2020

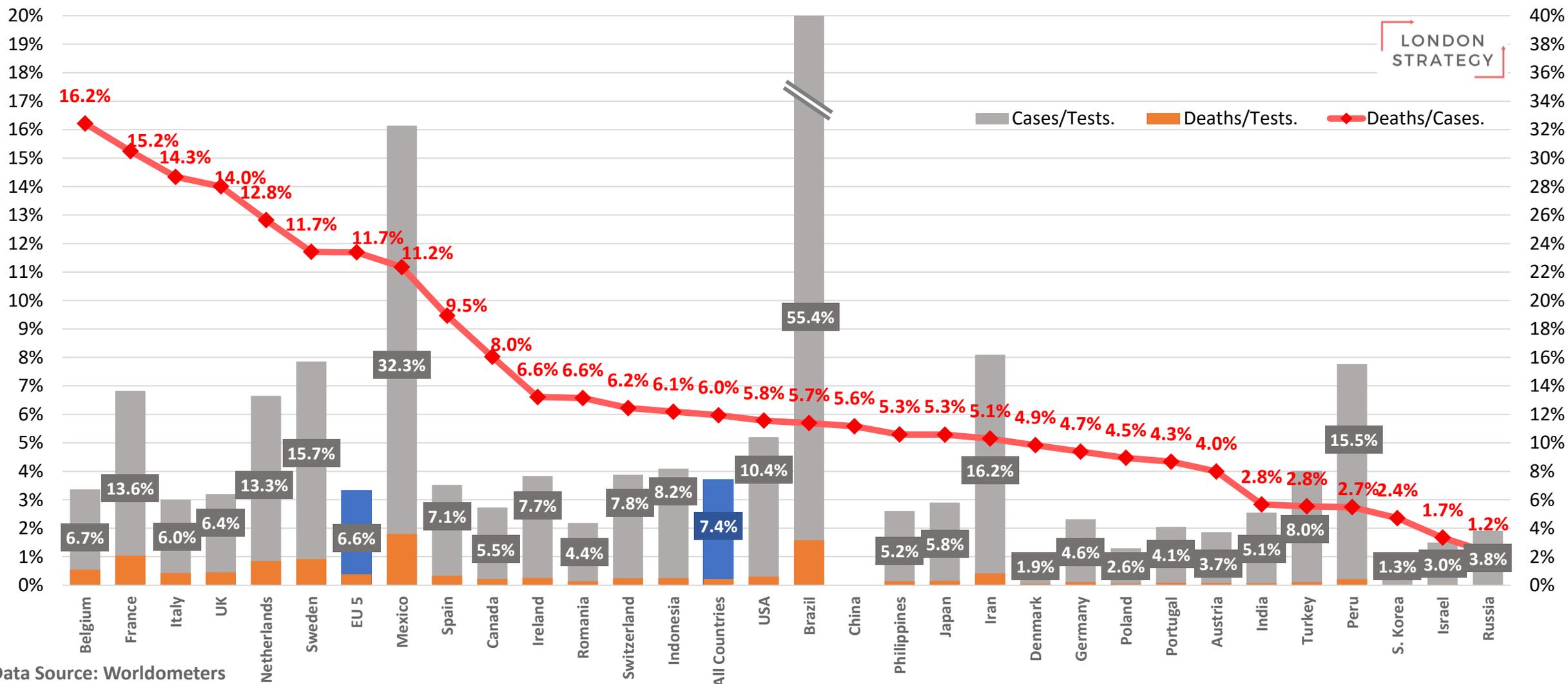
While much of the media narrative is about reopening, many countries, including several of the largest emerging economies, are still on the “upslope” of the epidemic, with daily case counts increasing



Comparison of Tests, Cases and Deaths

31 May 2020

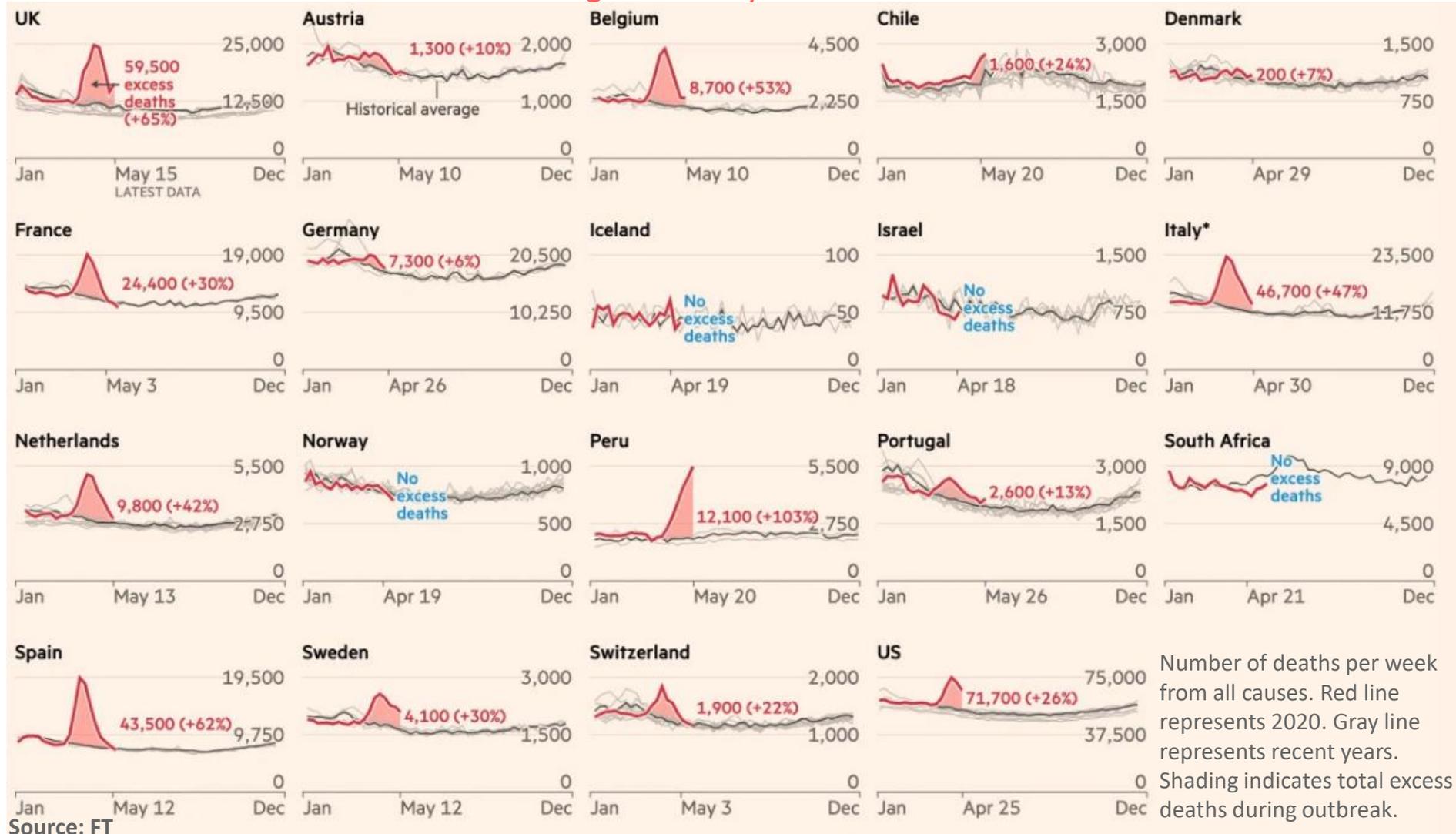
Number of cases are not correctly reflected for the countries that are not doing sufficient testing and the death rates are calculated as significantly higher.



Data Source: Worldometers

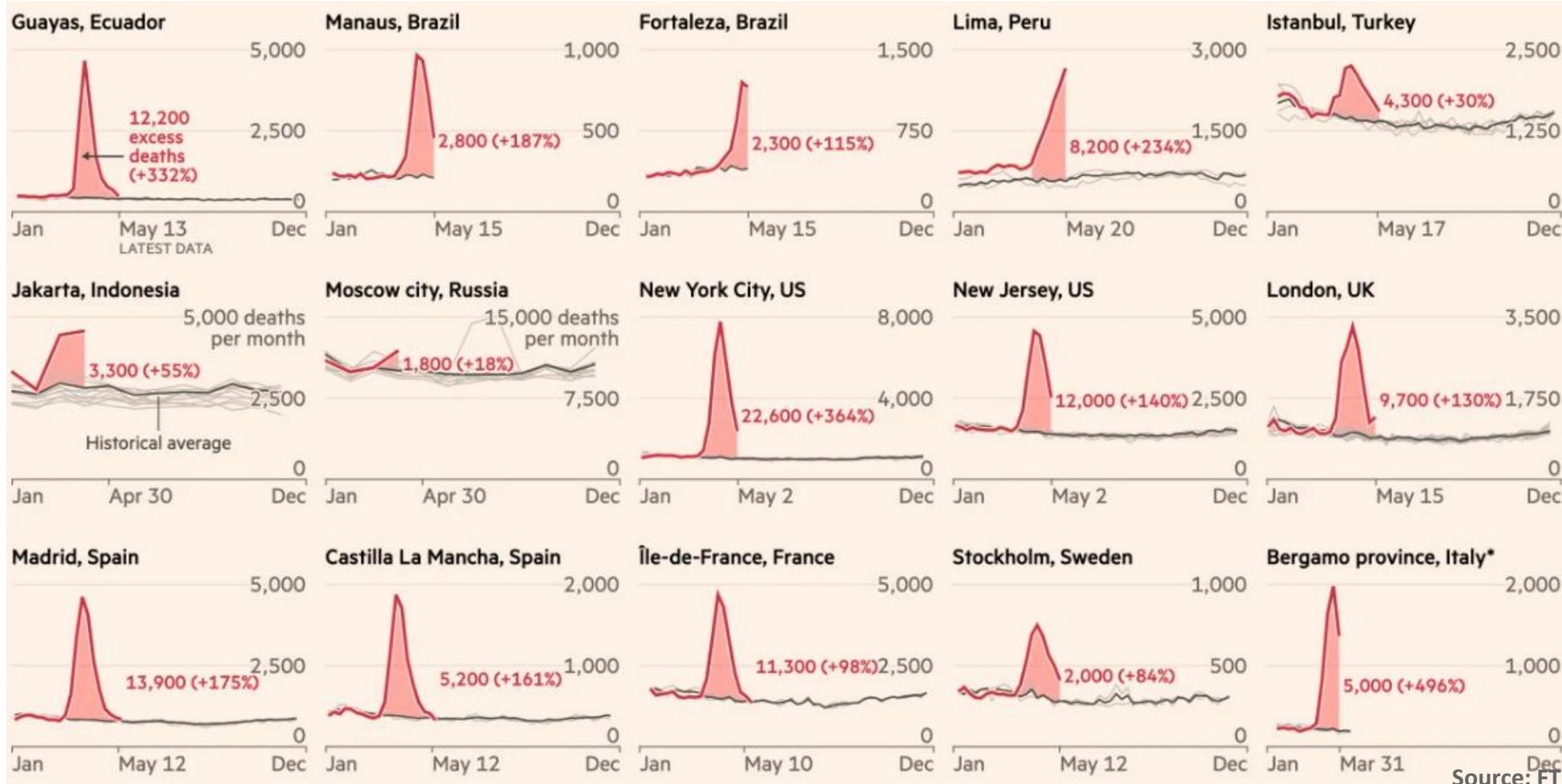
Death rates 2020 vs Historical Averages by Country

Death rates have climbed far above historical averages in many countries that have faced Covid-19 outbreaks.



Death rates 2020 vs Historical Averages by Urbans

Mortality rates have soared in urban areas worldwide, with overall excess deaths much higher than reports Covid-19 counts



Number of deaths per week from all causes. Red line represents 2020, Gray line represents recent years

Excess Mortality Since Region/Country's First 50 Covid-19 Deaths

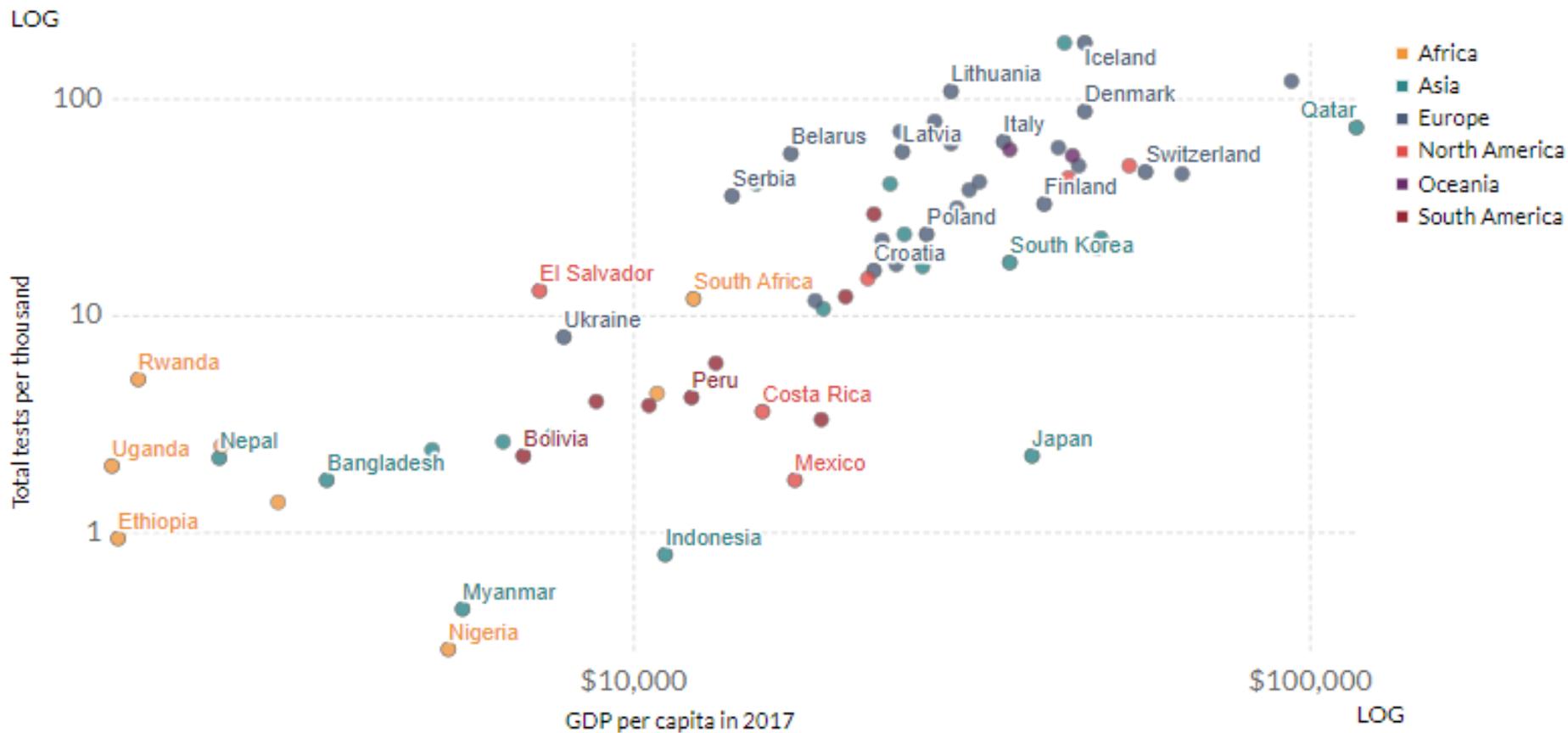
Some Western nations began releasing regular updates in early April. A few—such as Italy and the Netherlands—show an excess of deaths that is double the official Covid-19 tally for the same period.

REGION / COUNTRY	TIME PERIOD	COVID-19 DEATHS	TOTAL EXCESS DEATHS	COVID-19 AS % OF TOTAL
Britain	Mar 14th-May 15th	45,298	59,100	77%
Spain	Mar 11th-May 19th	27,758	30,940	90%
France	Mar 11th-May 5th	25,498	26,735	95%
Italy	Feb 26th-Mar 31st	12,178	24,031	51%
New York City	Mar 15th-May 9th	20,117	23,482	86%
Netherlands	Mar 16th-May 17th	5,660	9,405	60%
Belgium	Mar 23rd-May 10th	8,258	7,814	106%
Sweden	Mar 18th-May 12th	3,708	4,030	92%
Istanbul	Mar 25th-May 12th	1,925	3,817	50%
Jakarta	Mar 1st-Apr 30th	381	2,785	14%
Austria	Mar 23rd-Apr 5th	188	330	57%

Source: Economist

Total COVID-19 tests per 1,000 vs. GDP per capita

Developed countries are doing significantly more tests than developing countries.

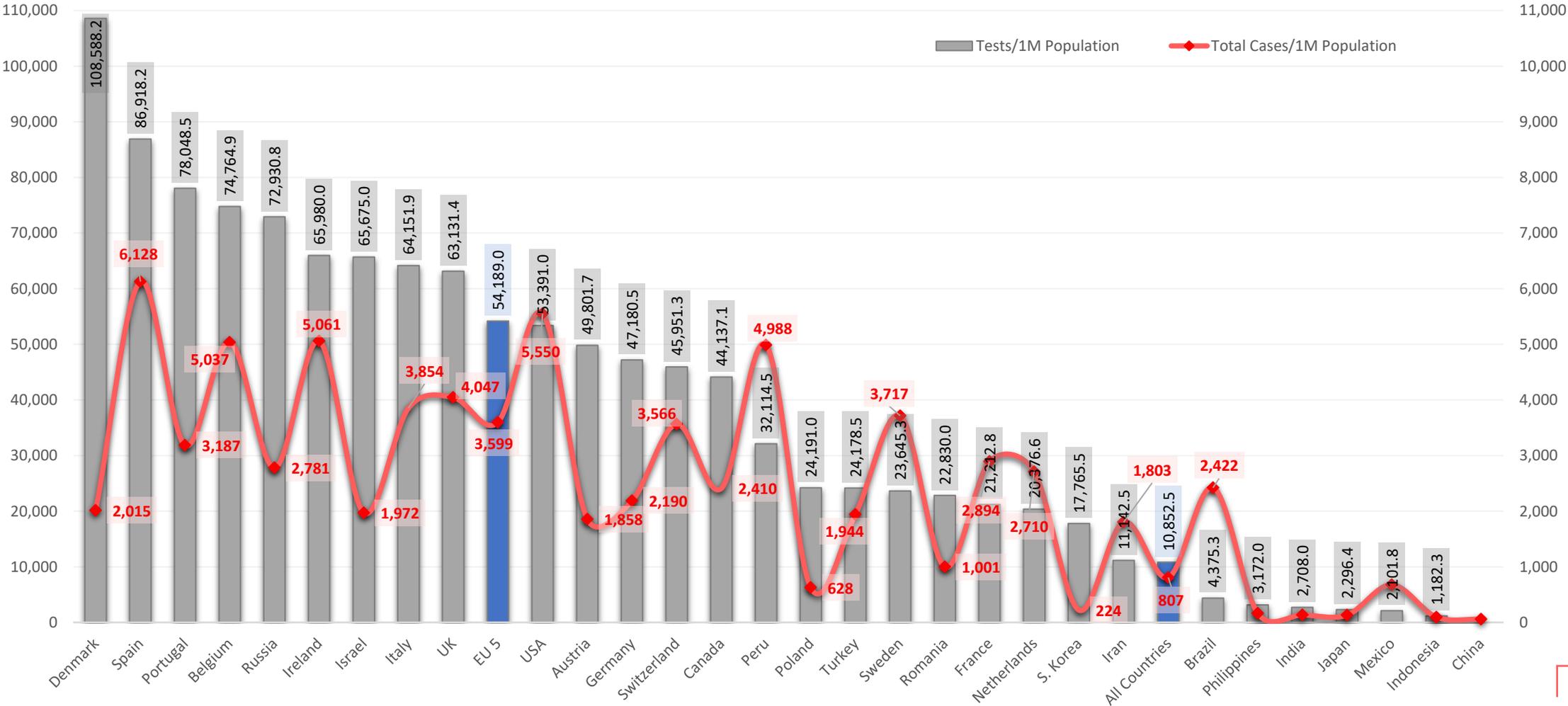


GDP per capita is adjusted for price differences between countries

Source: OurWorldinData

Comparison of Tests vs Cases

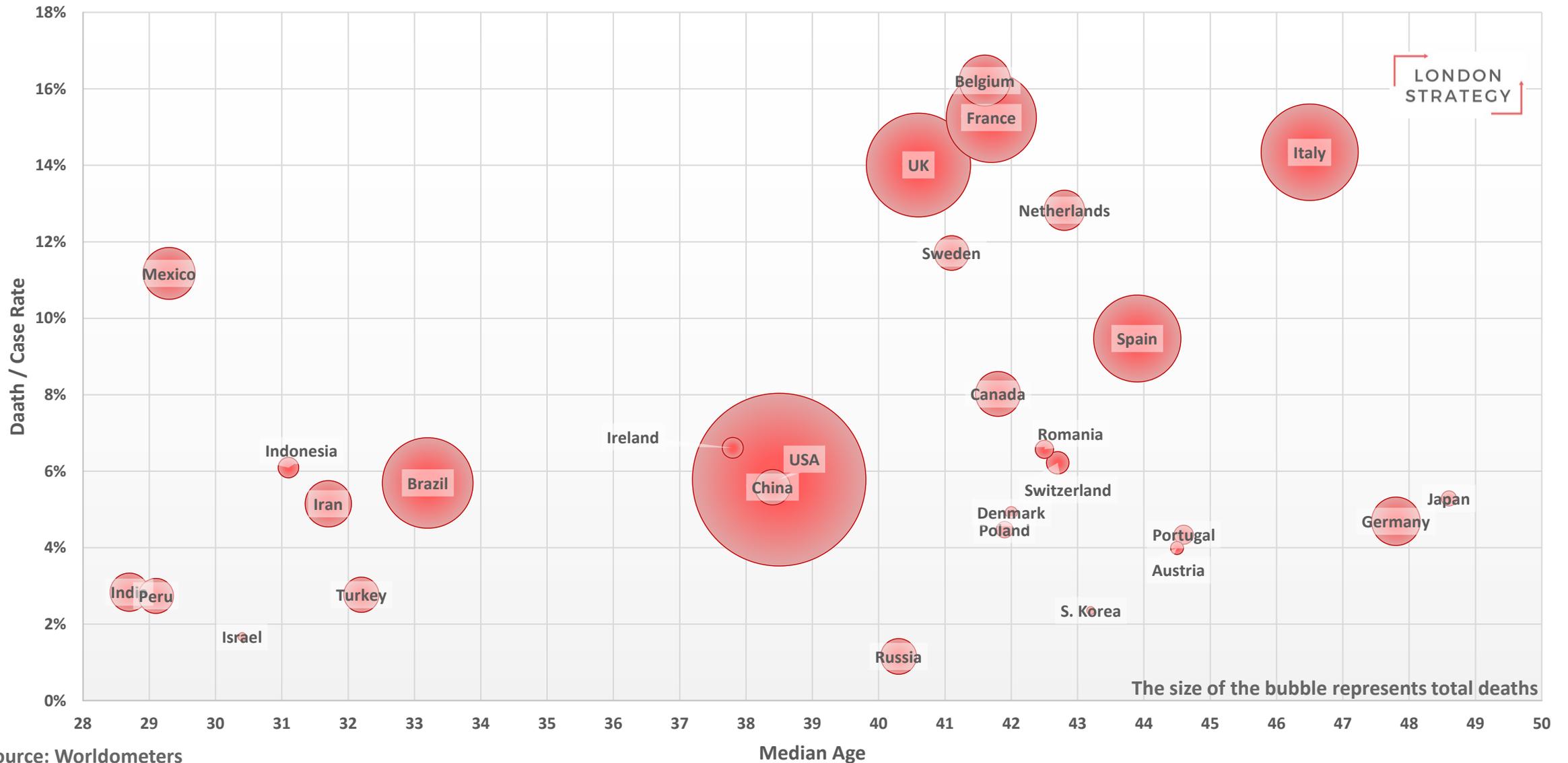
There is a clear relationship between test vs cases



Data Source: Worldometers

Comparison of Median Age and Death Rate

31 May 2020

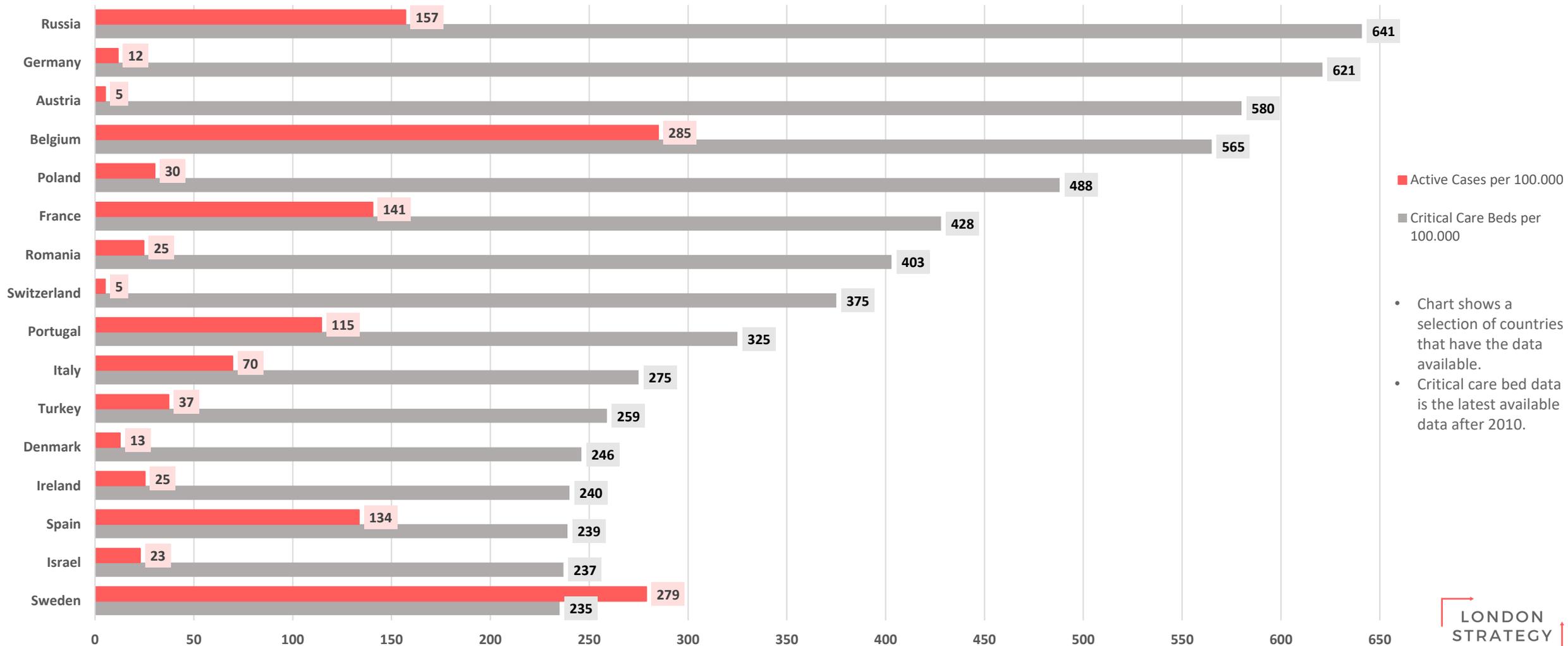


Data Source: Worldometers

The Countries with Critical Care Beds vs Active Cases

31 May 2020

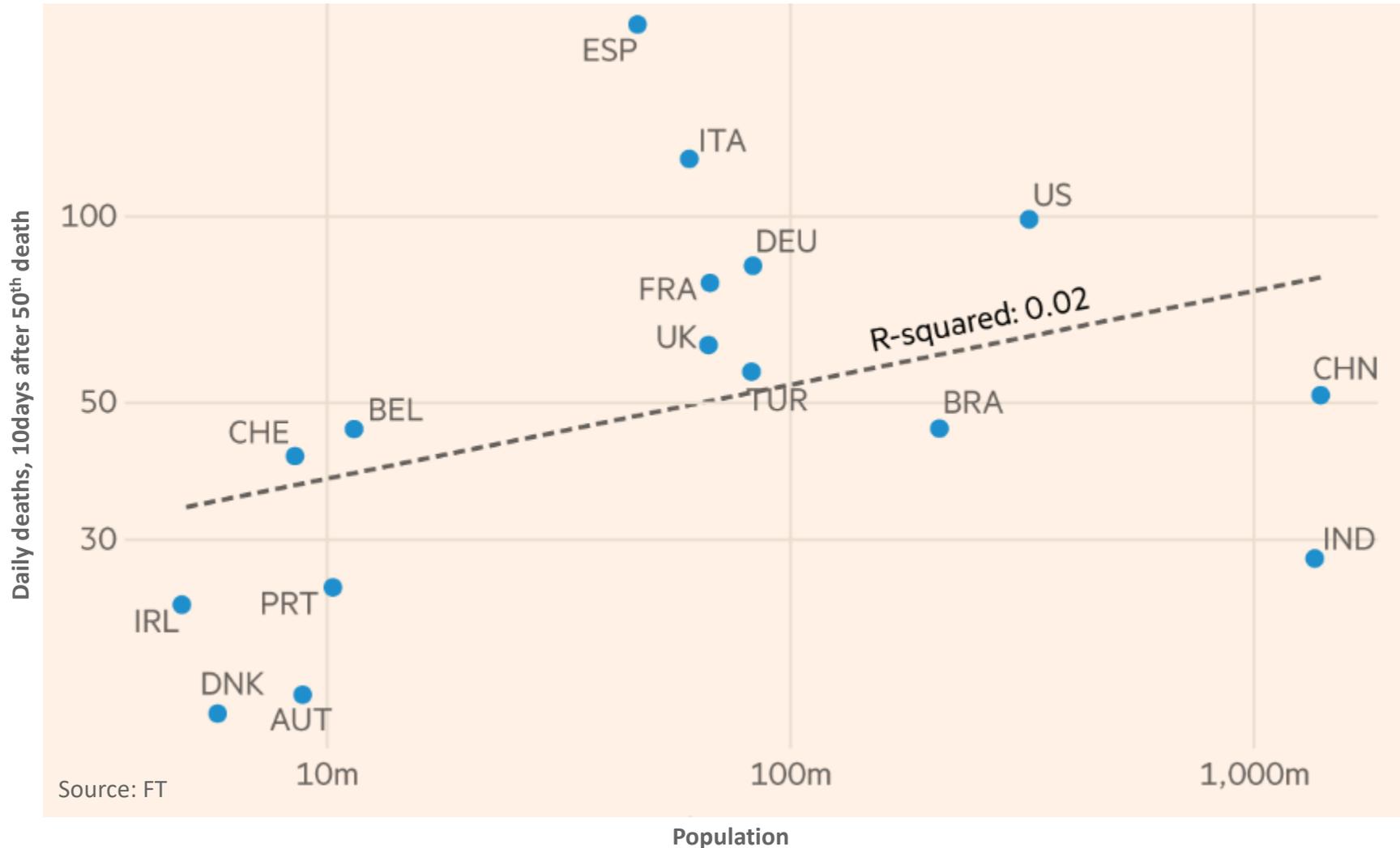
This chart is not intended to show available critical care bed capacity. It is only an indicative comparison of capacity and no-of cases in the country.



- Active Cases per 100,000
- Critical Care Beds per 100,000
- Chart shows a selection of countries that have the data available.
- Critical care bed data is the latest available data after 2010.

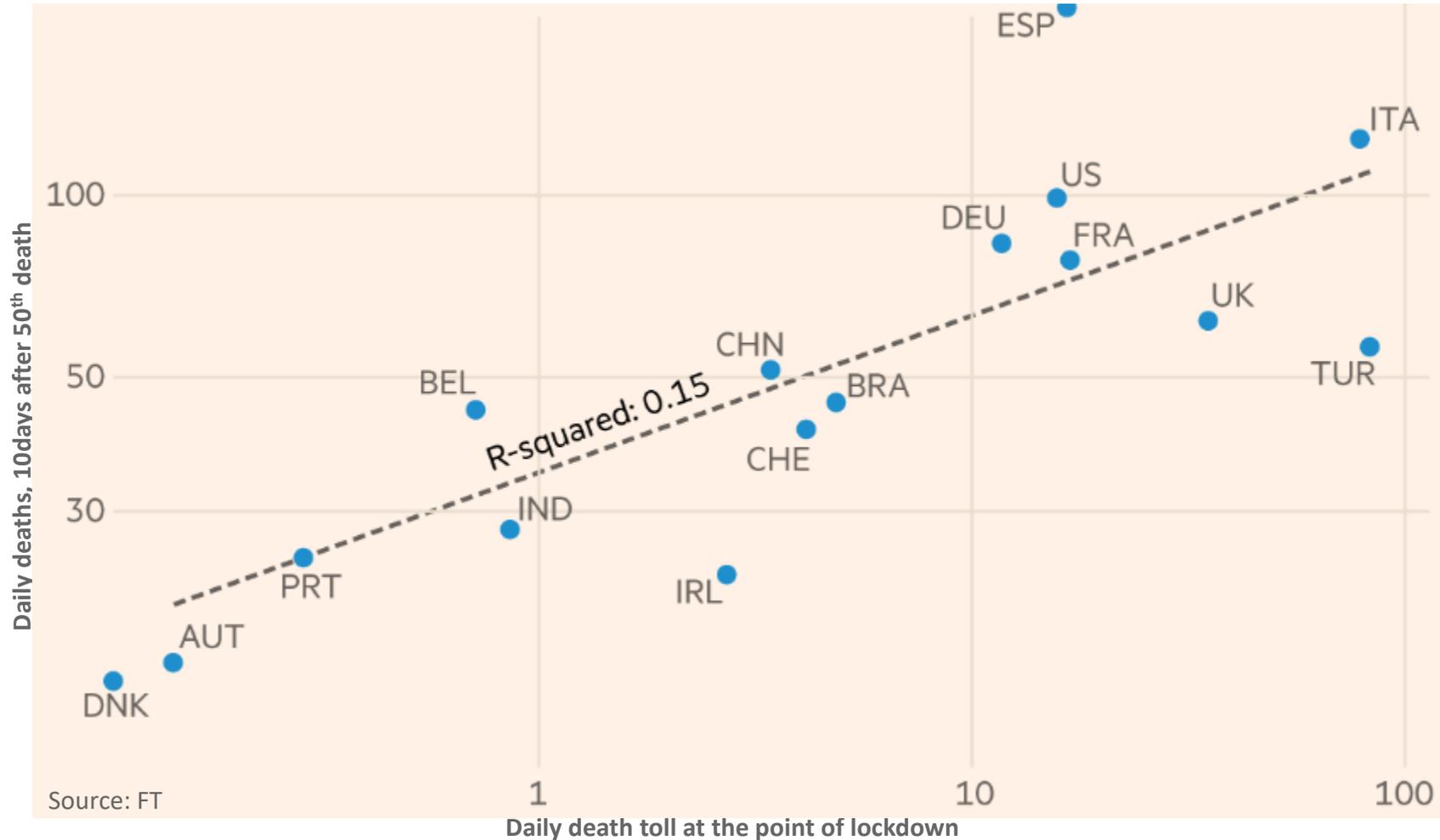
Populations Impact on Countries' Death Tolls

The size of a country's population doesn't effect the growth rate of its confirmed deaths. It doesn't tell us a story how much the country is struggling.



Lockdown Timing Impact on Countries' Death Tolls

Countries that locked down earlier went on to have lower death tolls at the same stage of their outbreaks than those that locked down later



Source: FT

Covid-19 Major Events in Global

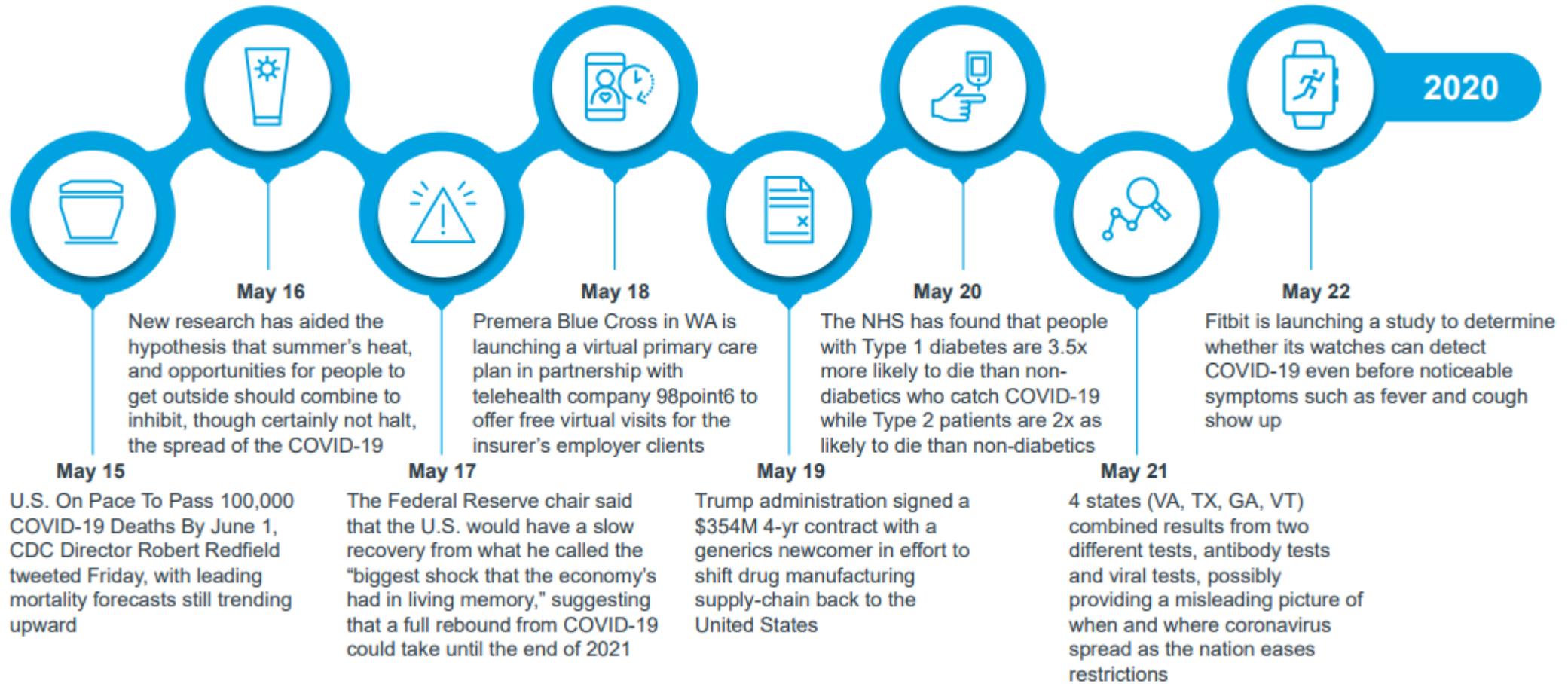
On 11th March, in the 3rd month of China's struggle against the epidemic, Covid-19 was declared by WHO as a Pandemic.



Timeline of US Government Responses to Covid-19

22 May 2020

A nationwide lockdown decision hasn't been taken to stop the spread of COVID-19 in the US.



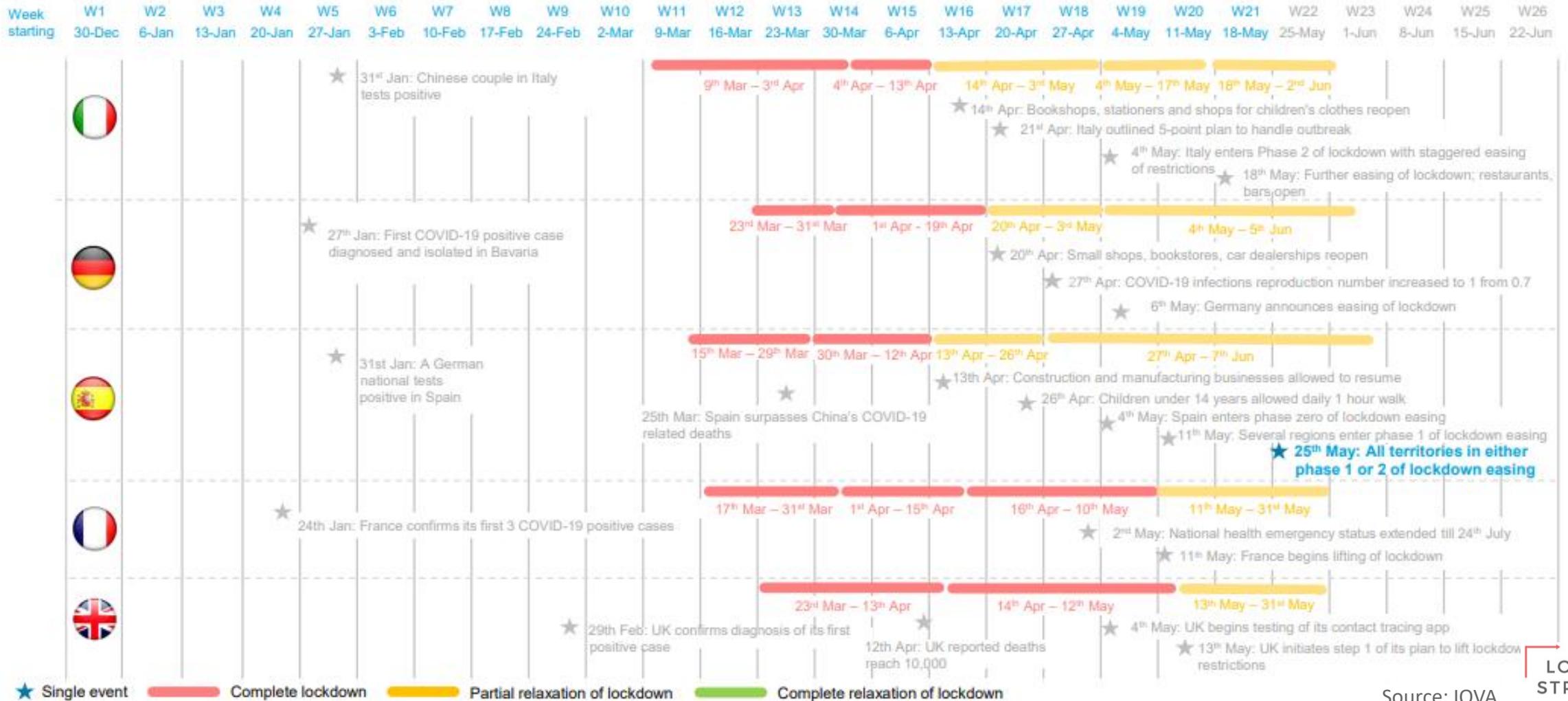
Source: IQVA

Timeline of EU5 Government Responses to Covid-19

26 May 2020

Italy is the first country, across EU5, that had a complete lockdown.

Unlike Italy and UK other EU5 countries decided to have a partial relaxation of lockdown.

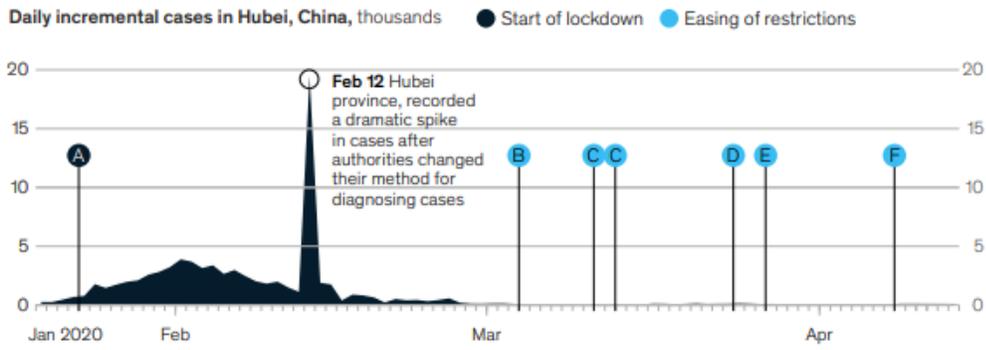


Source: IQVA

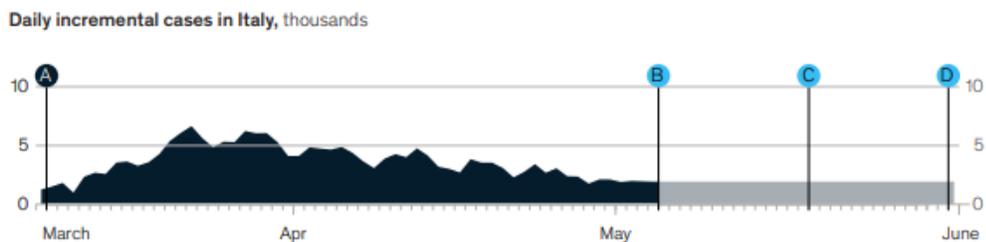


Entering lockdown and lockdown easing, by country

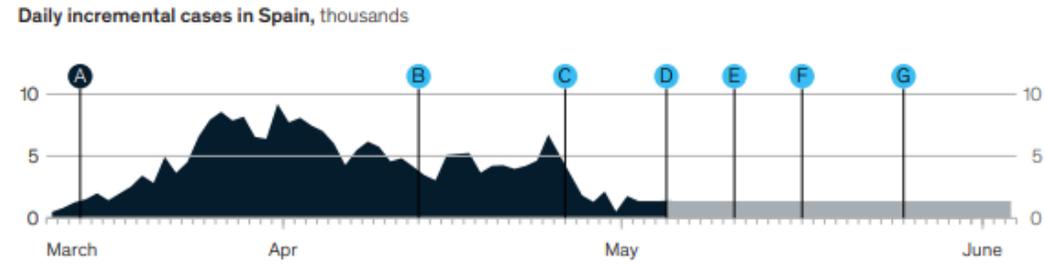
Countries will base decisions about which measures to implement on local situations and the progressions of the disease.



- A** Lockdown begins on January 23
- B** Reopened 1st wave of businesses (agriculture)
- C** Reopened 2nd and 3rd waves of businesses (eg, medical, utilities, groceries)
- D** Allowed for all businesses to reopen¹
- E** Removed full community lockdown²
- F** Resumed domestic flights and outbound highway and railway travel³



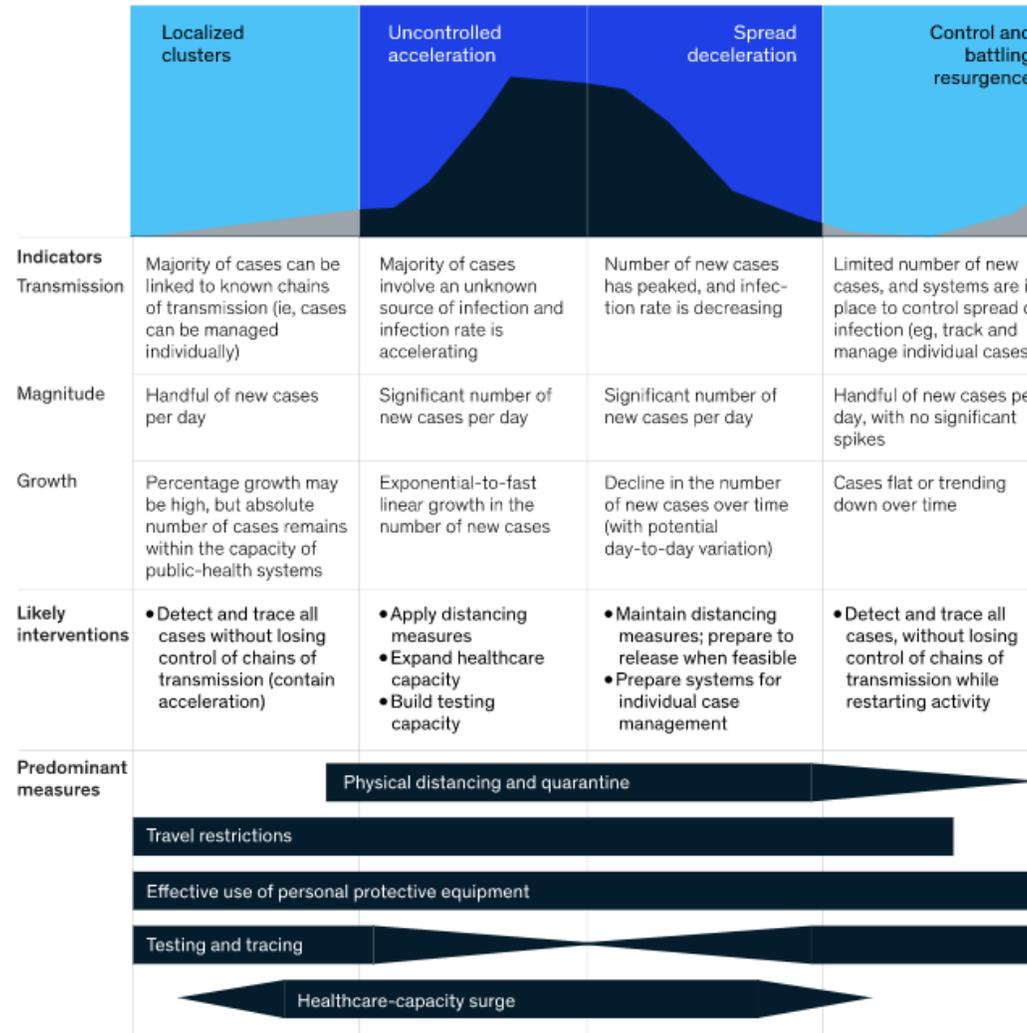
- A** Lockdown begins on March 9
- B** Outdoor exercise, take-away from restaurants, funerals allowed
- C** Shops and cultural sites to open
- D** Bars, restaurants, and hair salons to open



- A** Lockdown begins on March 14
- B** Reopened some businesses (manufacturing, construction, and some services)
- C** Children <14 years permitted to leave their homes
- D** Reopened businesses (eg, hair salons), restaurant takeaways, sports leagues
- E** Small businesses and hotels to open
- F** Restaurants can start opening their terraces
- G** Theatres and cinemas to reopen

The Public-Health Tools and Approaches

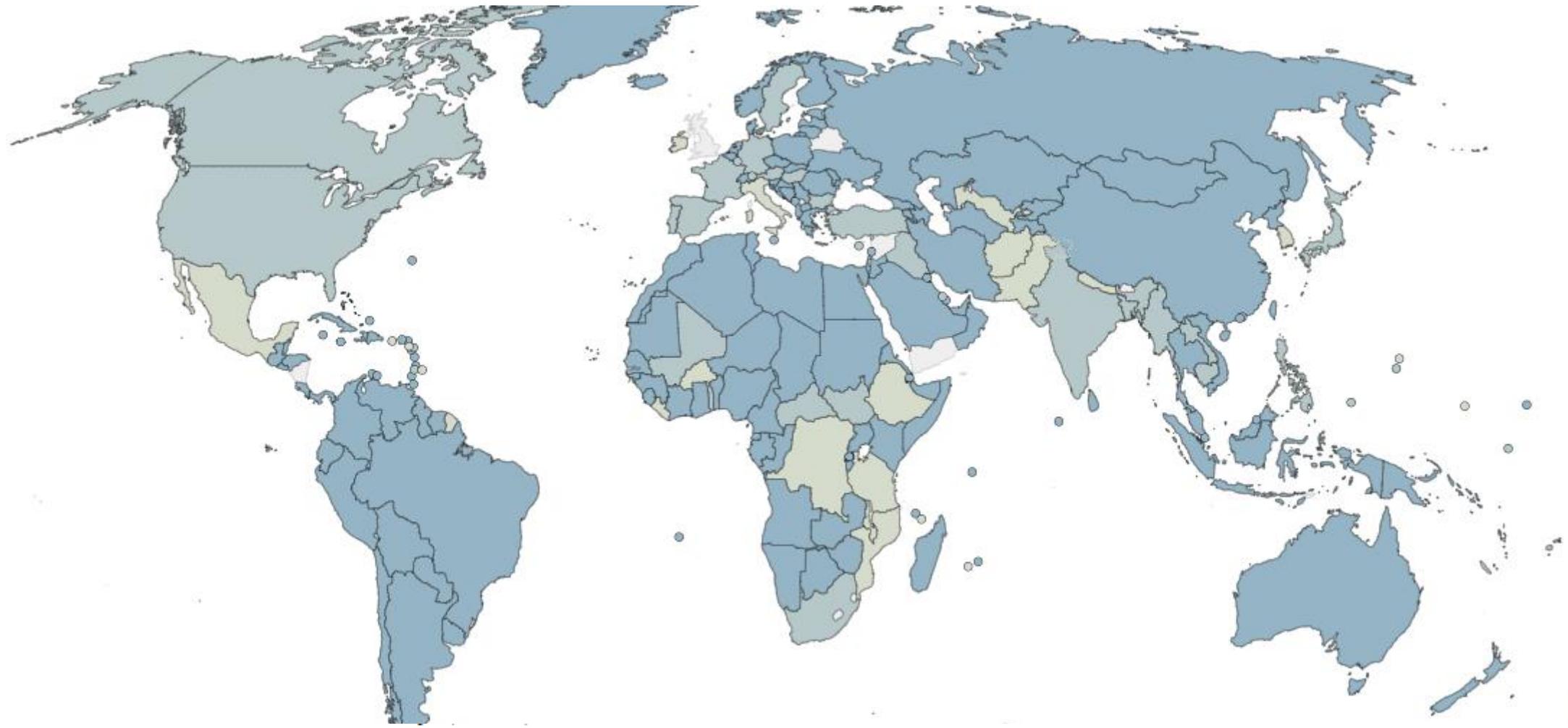
Countries will base decisions about which measures to implement on local situations and the progressions of the disease.



Places Restricting Travel Because of the Outbreak

5 May 2020

More than 140 governments have placed blanket bans on incoming travelers, and almost all have restrictions of some kind.

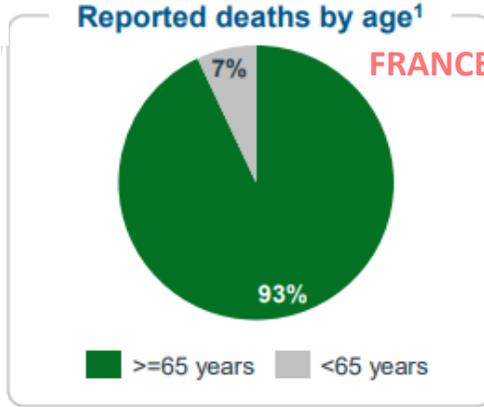
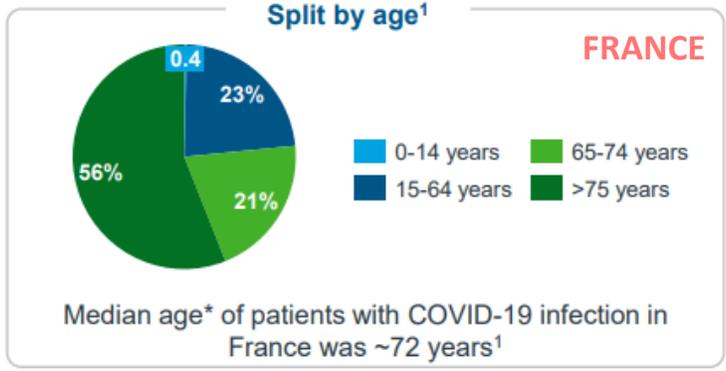
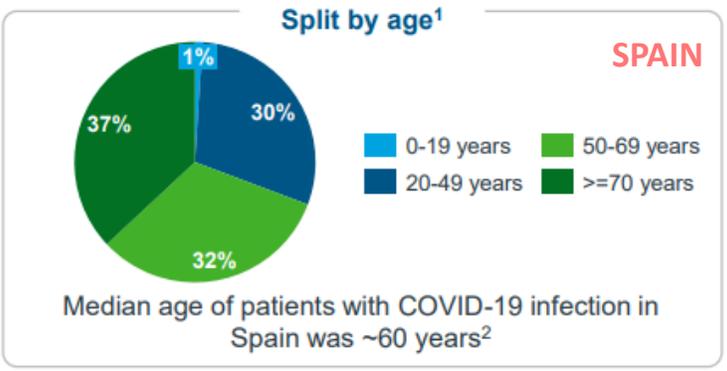
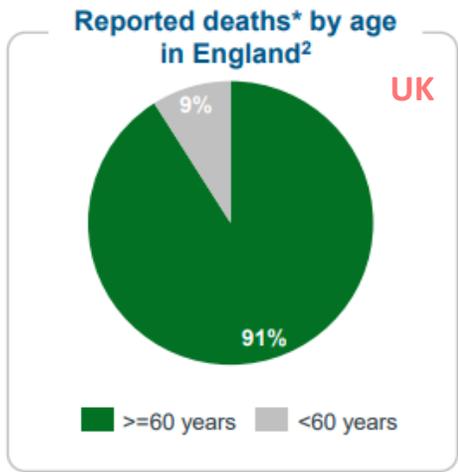
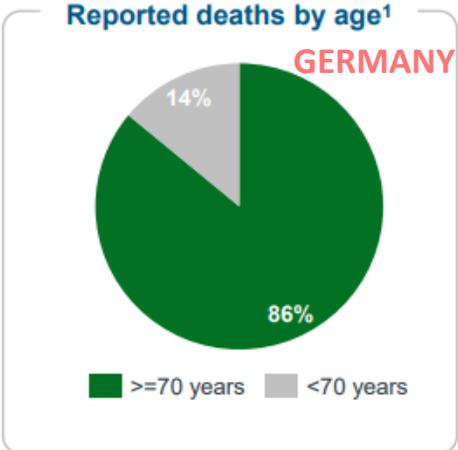
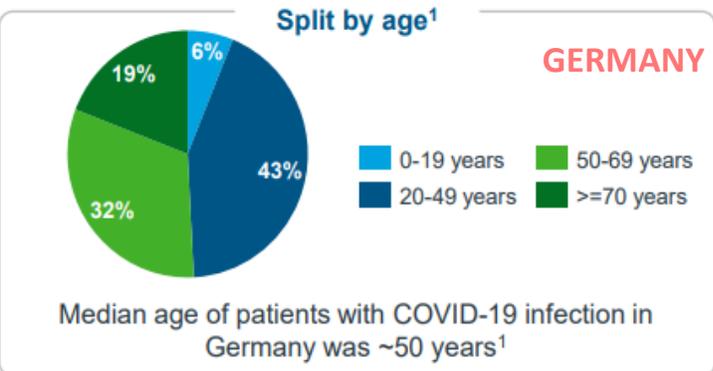
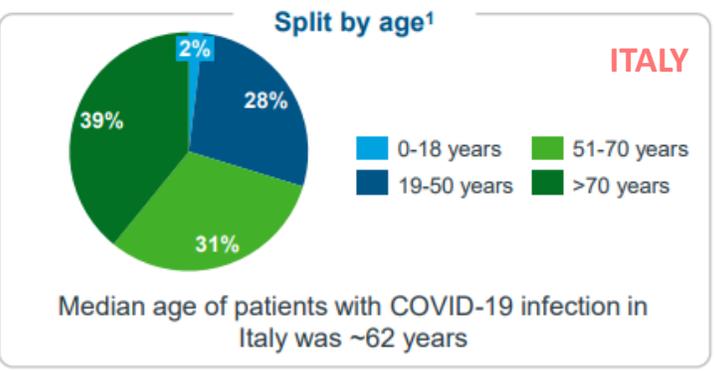


Source: Bloomberg

■ Bans all foreign visitors ■ Bans travel from various places with confirmed cases ■ Other restrictions

COVID-19 reported infections in EU5 – by age

Unlike other countries, the highest cases reported in Germany are within the 15-59 age group



Source: IQVIA

Chart Data Sources



Bloomberg





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