## Test, trace, isolate: potential implementation agenda & key questions for SC
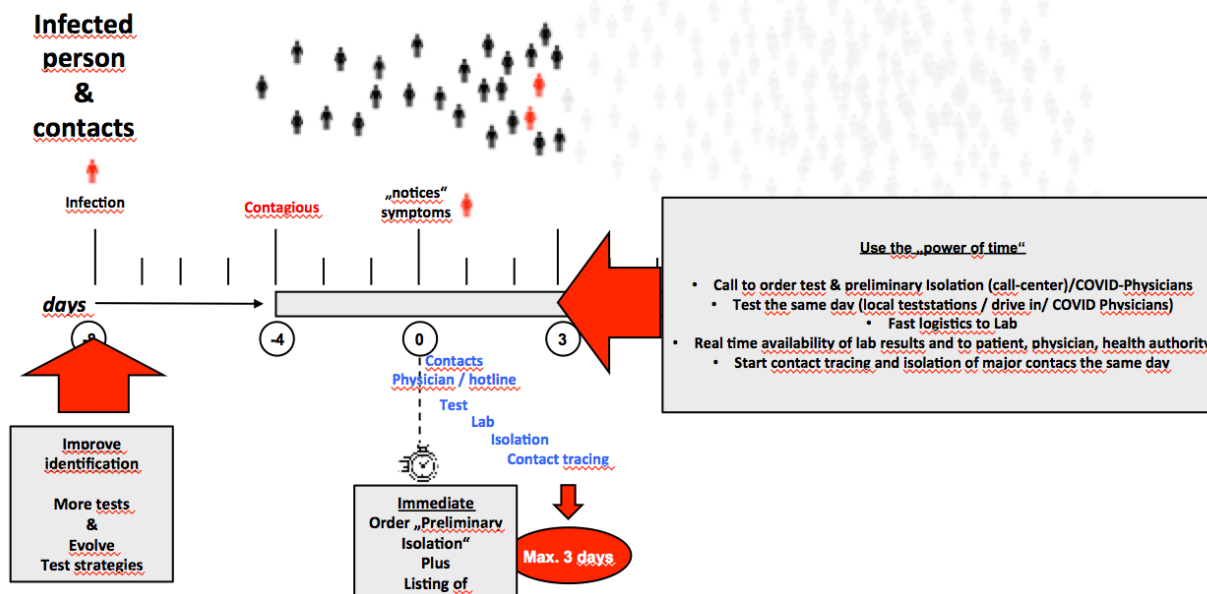
Note: Background document to support UK government's TTI strategy including laying out the challenge, framework for thinking about the implementation logistics, and some key questions for when and how to re-introduce it to the UK. Last part a briefing note on international TTI strategies to contain COVID.

Key issues to discuss are highlighted.
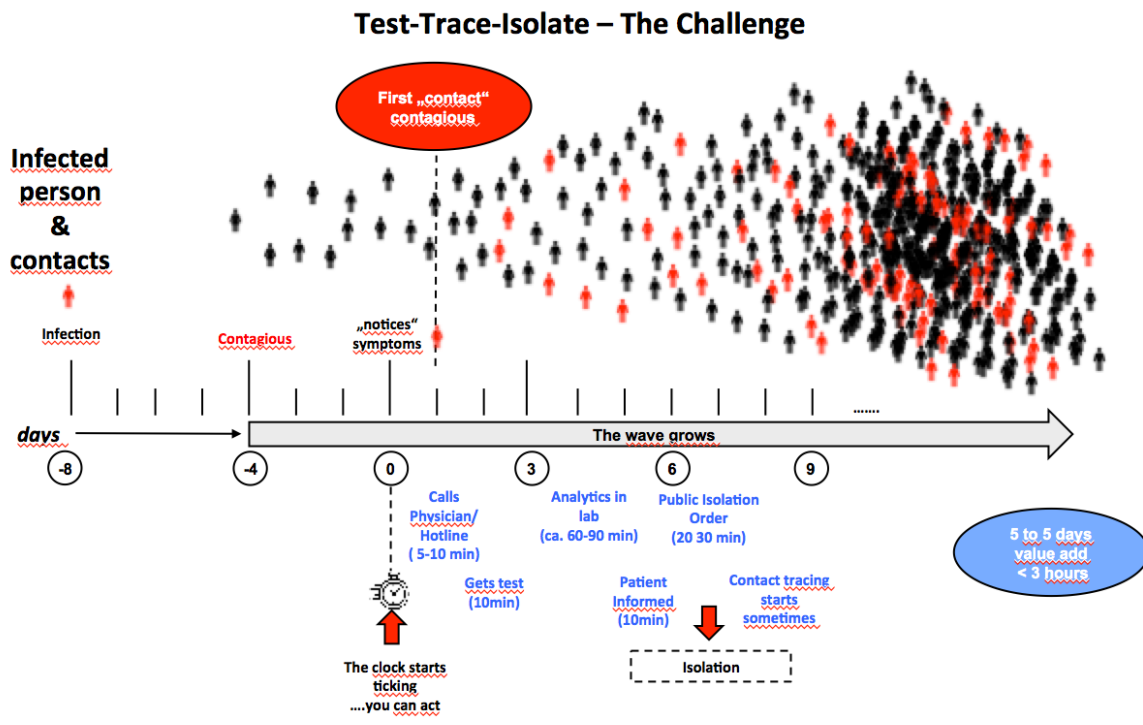
Slides & framework below: translated & adapted from Germany's TTI strategy

1. Testing

   Ordering to test:
   - Patient calls either his physician or a hotline or website
   - Decisions – should he / she have a test?
     - Criteria for "yes"
       - Symptoms regardless how severe? [any type of COVID symptom? Dependent on age?]
       - Contact to persons with Corona? [exposed in past week?]
     - Need to create guidelines on who is testing, how are these guidelines implemented (by GP on the phone, by trained call centre, by website?).
     - Comment: Symptom-based testing will only catch certain percent of those ill. How to distinguish between COVID symptoms and general flu symptoms. How to manage demand on phonelines/websites.

<mark>Testing strategy- what are key objectives of offering testing?</mark>
- Testing used to identify geographical differences in spread
- Testing used to identify particular sectors at risk (care homes, hospitals, etc)
  - Testing used to establish magnitude of problem. German criteria is
    - \> 10 % positive test and you do have a problem
    - <10% we are getting handle on the problem
    - ~5%   you are likely to be in control
    - ~2 % you are on the safe side (benchmark Taiwan, Korea, Australia, New Zealand)
- Testing to break chains of transmission (through TTI).
- Rough estimation is 100 tests required for each daily new confirmed case.

Testing:
- Where should it be done? Should be not in hospital settings to protect hospital staff. Drive-through stations? Walk-through stations? Mobile service to visit people at home? Needs to be easy to access for people wherever they live.

- How fast do we need results? How can the speed be increased so that people are tested, swabs get to the lab quickly, and results are communicated to them asap either through SMS, email, etc, as well as to local public health authority.

- How to build capacity in testing and ensure that the capacity is fully used by having a clear strategy on scaling-up? Using private/university/veterinary labs to increase capacity?

Case Management and Contact Tracing
- Needs to be done at local level coordinated by PHE/PHS, etc.
- They receive guidance on exact strategy and logistics.
- What are they supposed to be doing
  - Contact each infected person, order him / her to isolate (written order per post) and explain and advice him / her how to do it best
  - Check during the quarantine per phone to support attention for the importance of isolation
  - Go through the possible contact with the infected person and trace them
  - <mark>Classify the contacts (German guidelines below)</mark>
    - Category I : important exposure, e.g. 15 minutes face-to-face contact, living together, etc..

- - - ■ Action: isolation at home or in a special facility (does rarely happen) for 14 days
      - ■ Action: separate from other family members (separate meals, different room etc..)
      - ■ Track temperature , daily contact with the public health authority (rarely happens)
      - ■ Ongoing discussion: should be tested after 7 days and 9 days to ensure control of the situation
    - ■ Category II : no significant exposure
      - ■ Action: increase awareness and watchfulness
    - ■ Category III: minimal exposure < 2 min.
      - ■ Action: increase awareness and watchfulness
  - ■ Infected and contact persons are registered in a database of the public health authorities to manage the case

- ○ Challenges:
  - ■ Enough staff? Recruitment of contact tracers with back up capacity provided by military? Germany's political target: 5 per 20.000 inhabitants. ==The real capacity is estimated with 1.5 to 2 man-days for each new infection to manage the infected person and to trace the contacts.== But these are preliminary estimations
  - ■ Real-time monitoring of
    - ■ Local new cases
    - ■ Local R
    - ■ # of test and ratio pos. to neg. tests
    - ■ # of contacts per infected person
    - ■ Time from decision to test to
      - ■ Test
      - ■ Lab results
      - ■ Official isolation
      - ■ Tracing of contacts
      - ■ Official isolation of contacts
  - ■ Clear key success factors from S. Korea are
    - ■ Broad testing – to find as many cases
    - ■ Reduce the time from test to isolation and to contact identification / the faster the less opportunity to transmit
    - ■ Thoroughness in identifying contacts

<u>Isolation</u>

- ○ Ask people to stay at home and to isolate themselves as much as possible form the rest of the family for 14 days
- ○ Public health authorities verify the health status by phone and if symptoms have not abated they will extend the duration of isolation
- ○ How to isolate those who live with vulnerable/elderly individuals? Do isolation facilities need to be offered?
- ○ What kind of incentive/compensation for those who isolate? S. Korea (see background brief at end) provided monetary incentive.
- ○ What kind of fine/consequence to ensure compliance? S. Korea has a financial fine.

<u>Role of Apps</u>

Given that at least 60% need to download the app, Germany has decided to leave the usage to the individual. Apparently, if left voluntary, the participation rates are likely to remain much more around 20 to 30 % (Singapore rates). In addition privacy concerns have led to difficulties in using central databases.

Remaining Scientific Questions

1. What is the evidence from other countries about the effectiveness of TTI in keeping R below 1? How much does TTI need to be supported by relaxed physical distancing?
2. What is the maximum number of daily new cases that enables TTI to be effective and permits easing of harsher lockdown? At what R would this become feasible to manage community transmission?
3. What minimum proportion of someone's contacts would we need to be able to trace for TTI to be able to suppress transmission? How quickly do you need to get the test results back for it to be effective (given what we know about covid latent periods etc)?
4. How does R vary across the regions of the UK (based on STP area)? How does this vary across different locations/sectors (hospitals, care homes, communities)?
5. At what point, can mass testing (ie random community testing) be introduced?
6. Does TTI resume in all parts of the UK at same time? Starts in economic centres like London, Edinburgh, Manchester? Or start in rural areas and small islands? How to account for population mobility?
7. Some basic questions:
   a. What is the current number of new infections in the population, including untested ones.
   b. What do we know about heterogeneity of epidemic across regions and sectors?
   c. What do we know about the distributions of days since infection before individual becomes infectious, and before symptoms appear?

8.   [SC- any other key ones are we missing?

Data sources: Review modelling studies coming out from Hong Kong/China/Germany/Italy.

'TEST, TRACE AND ISOLATE' STRATEGY FOR CONTAINING COVID-19

A Review of International Approaches (by Dr. Genevie Fernandes, Edinburgh Uni)

Summary:

The 'test-trace-isolate' strategy has helped countries such as Germany, South Korea, Taiwan, Singapore, New Zealand and Iceland to lower the number of COVID-19 cases and minimise related deaths. A review of these international approaches around this strategy offers key lessons for the UK.

·   First, each of these countries initiated this strategy as soon as the first COVID-19 cases were reported and have been consistently implementing it. More importantly, all the three components of testing, contact tracing and isolation have been implemented in tandem.

·   Second, each of these countries have an expanded testing criteria in place. All countries use polymerase chain reaction (PCR) tests for symptomatic cases, high risk individuals, and health workers. South Korea, New Zealand and Iceland have gone a step further by introducing mass testing for individuals at the community level regardless of symptoms. Germany and Iceland have also started conducted antibody testing. One area that needs to be further investigated is the consideration of repeat testing, especially for health workers as they have repeated risk of exposure.

·   Third, random community testing and antibody tests are being used to inform countries' future steps such as plans to exit from lockdowns.

·   Fourth, all of these countries offer testing across healthcare settings (clinics and hospitals) as well as novel locations (drive through centres, walk-through centers, mobile sites outside supermarkets).

·   Fifth, these countries have managed a rigorous contact tracing through a combination of physical teams (consisting of multisectoral public staff), big data analytics and mobile-based applications. While digital applications can aid contact tracing teams, they can also raise privacy concerns such as the risk of repurposing private information for causes other than outbreak control and location and duration of storage of personal data. Iceland has tried to address these privacy concerns before launching their contact tracing application, by gaining certification by an independent reviewer, making it voluntary for users to download the application and agree to share GPS information, and storing anonymised data on the user's device.

·   Sixth, societal response to isolation and quarantine measures need to be considered. While Germany, New Zealand and Iceland have recommended isolation for certain individuals, South Korea, Taiwan and Singapore have made quarantine mandatory and enforce it through the use of smart phone applications and fines.

·   Sixth, countries played to their strengths in implementing this strategy. Germany and South Korea used their robust biotechnology industry and laboratory networks and Iceland employed a public-private partnership to ramp up testing. Singapore and Taiwan used big data and multisectoral response teams.

·   Finally, these countries also reported challenges in implementing this strategy, including staff fatigue (especially frontline and laboratory staff), logistical hurdles of sourcing testing materials, privacy concerns over smart phone applications, and public breach of social distancing and isolation.

GERMANY

Total population	82.79 million	
Date of first reported case of COVID-19[i]	25 February 2020	
Epidemiological situation[ii]	Confirmed: 155,193 Deaths: 5,750 Recovered: 114,500	
Testing[iii] [iv][v] [vi] [vii] [viii][ix] [x]	Who gets tested?	Initially, those with symptoms, travel history and close contact with confirmed cases were tested. Since 25 March 2020, the testing criteria has been relaxed to include anyone who has symptoms including healthcare workers.

	What kind of tests are being used?	Real-time PCR assay is being used. Germany developed its first rapid PCR test on 16 January. Since February, a nationwide network set up between doctors' practices, normally used to monitor the flu, is being used for testing for Covid-19. Labs are also using pooled testing procedures that produce reliable results in short times, thereby increasing the overalll testing capacity. Antibody testing is also being conducted, drawing from blood donation services, samples from regions with large outbreaks and representative samples from broader population.
	Where are tests conducted?	· Healthcare facilities · Drive-through testing centres
	What is the daily testing capacity?	As of 22 April, a total of 2,072,669 tests have been conducted. Daily testing capacity as of 21 April was reported at 1,20,000 tests a day.
Contact tracing [xi] [xii] [xiii]	Under Germany's contact tracing policy, implemented as soon as first cases were recorded, every person who has come into contact with an infected patient in the last two weeks is tracked and tested. Public contact tracing teams use phone calls to trace and monitor close contacts. Contact tracing teams will soon be assisted with Germany's home-grown smartphone app, developed for the Robert Koch Institute, to trace infections. Further, mobile carriers in Germany have started to share cellphone location data with health officials in an aggregated, anonymized format. On 21 March, the German health ministry also drafted changes to the Infection Protection Act to allow, among other things, the tracking of people who were in contact with those infected with the coronavirus.	
Isolation [xiv][xv]	Since late February, self-isolation for 14 days on becoming symptomatic or having close contacts with confirmed or suspected cases is a recommended measure. Visits and events in nursing homes are canceled in an effort to isolate and shield the over 800,000 seniors who live in around 11,700 facilities across the country.	

Facilitators [xvi] [xvii]	Early response, strong biotechnology industry and laboratory testing capacity, decentralised diagnostic system have been the major facilitators for Germany's test, trace and isolate strategy for COVID-19.
Challenges[xviii] [xix]	Regional bodies have reported bottlenecks such as the struggle to recruit additional staff to deal with increased work load and backlog as well as coordinating with the limited number of global suppliers for testing materials. Privacy concerns have been raised around mobile-based applications, particularly on the location of the data storage viz. government hosted central servers versus decentralised on user phones, with the latter being recommended by privacy experts.

SOUTH KOREA

Total population[xx]		51.47 million
Date of first reported case of COVID-19[xxi]		20 January 2020
Epidemiological situation[xxii]		Confirmed: 10,738 Deaths: 243
Testing[xxiii]	Who gets tested?	Mass testing began in February regardless of symptoms or travel history. Test results are delivered between 24 to 72 hours, via text messages or phone calls along with corresponding advice. Around 20% of all those who tested positive were found to be asymptomatic.
	What kind of tests are being used?	Real-time PCR assay is being used. As of 15 April 2020, five diagnostic reagent companies (Companies KogeneBiotech, Seegene, Solgent, SD Biosensor, and Biosewoom) have obtained emergency use approval from the Korean Center for Disease Control and are producing RT-PCR reagents in the country.

	Where are tests conducted?	· Primary health clinics and hospitals · Public health and environment research institutes · Private healthcare providers · Drive-through testing centres · Walk-through testing centers
	What is the daily testing capacity?	As of 27 April 2020, 601,660 tests have been conducted, leading to nearly 11,000 tests per million.[xxiv]Daily testing capacity increased from 200 in January to 20,000 in March.[xxv]
Contact tracing[xxvi]	Korean public health authorities, national police agency, financial services commission, and local governments collaborated for contact tracing through interviews, analysis of closed-circuit television, credit card and smartphone GPS data, and publicizing the moving histories of anonymised Covid-19 patients on the Ministry of Health website (all measures are legally sanctioned by the government).The effective contact tracing system, known as the Covid-19 Smart Management System, is run by the Korean Centers for Disease Control and Prevention and can analyse a person's movements in just 10 minutes.	

Isolation[xxvii][xxviii][xxix]	South Korea uses a combination of local teams, mobile-based applications and fines to ensure mandatory 14-day quarantine for asymptomatic cases, those with minimal symptoms, close contacts of confirmed cases, as well as those who have tested negative. The government-endorsed Corona 100m (Co100) application, launched on February 11, using government data, alerts users when they come within 100 metres of a location visited by a confirmed case. Another government GPS-based application named 'self-quarantine safety protection' launched on March 7, enforces self-quarantine measures. South Koreans are encouraged to download this application after getting tested. If they are advised to self-quarantine based on test results, then they have to input their symptoms into the mobile application twice a day for the period of the quarantine, and the application will monitor their locations and set off an alarm if they leave their designated quarantine location. For those who do not use the application, a local monitoring team calls twice daily to make sure the quarantined stay put and check for symptoms. Citizens and international visitors are also encouraged to used a government-based self-diagnosis mobile application, launched on February 12, allows users to monitor health conditions and access readily available information on follow-up actions such as physical checkups, using helplines and finding clinics. Quarantine violators face up to 3 million won ($2500) fines. If a recent bill becomes law, the fine will go up to 10 million won and as much as a year in jail.
Facilitators [xxx]	Preparedness, early response, government leadership and transparent communication, and innovations have been the key facilitators for ensuring that the test, trace and isolate strategy works. Following the 2015 MERS outbreak, the government invested in its research and development for PCR testing kits, creating financial incentive for competition among private biomedical companies to develop rapid diagnostic tools. In the last week of January 2020, South Korean health officials convened a meeting with representatives from more than 20 medical companies on developing rapid testing kits, and by early February, two companies received approval for PCR tests. Transparent government communication has been demonstrated by daily press briefings and emergency texts to all citizens. Innovations including drive-through and walk-in test centres have speeded up the testing and have been adopted around the world.

Challenges[xxxi]	Challenges have included privacy concerns owing to publicising people's movements, healthworker fatigue, unintended negative economic consequences on businesses as people avoid places that have been visited by confirmed or suspected cases, and hardships for vulnerable groups due to mandatory quarantine.

TAIWAN

Total population	23.78 million
Date of first reported case of COVID-19[xxxii]	21 January 2020
Epidemiological situation[xxxiii]	Confirmed: 429 Deaths:6 Recovered: 290

Testing [xxxiv][xxxv] [xxxvi][xxxvii] [xxxviii]	Who gets tested?	Targeted testing for symptomatic indidviduals with travel history, close contact with suspected or confirmed cases, and vulnerable individuals including patients with severe respiratory symptoms and healthcare workers with pneumonia. Most recently, any patients who report a loss of the sense of smell or taste are mandated to be tested.
	What kind of tests are being used?	PCR tests began in January. In early March, Taiwanese genome researchers developed a rapid COVID-19 diagnostic test, which reduces time to test from the current 4 hours to 15 minutes. With funding from Taiwan, in early April, Taiwan and Denmark jointly developed ViroTrack, a diagnostic test that can produce a result within 12 minutes, indicating whether the person is carrying the virus or has recovered from a COVID-19 infection.
	Where are tests conducted?	· Taiwan Centers for Disease Control · Designated hospitals
	What is the daily testing capacity?	As of 27 April, 60,956 tests have been conducted. Daily testing capacity for COVID-19 is approximately 1,300 samples.
Contact tracing [xxxix] [xl]	Taiwan's contact tracing teams are heavily aided by big data analytics. The country leveraged its digital national health insurance database and integrated it with its immigration and customs database to generate real-time alerts during a clinical visit based on travel history and clinical symptoms to aid case identification. The government also creates real-time digital updates alerting citizens to avoid locations where infections had been detected. Once confirmed cases are	

	identified, close contacts are traced, and then digital fencing is utilised to ensure mandatory quarantines.
Isolation [xli]	The government enforces a mandatory 14-day home quarantine for through a mobile-based location-tracking application that essentially geofences those at high risk (travellors from high risk areas, close contacts of suspected or confirmed cases). Home quarantines are monitored by the police and flouting these rules can result in heavy fines.
Facilitators [xlii] [xliii]	Taiwan effectively delayed and contained community transmission as a result of its preparedness owing to SARS outbreak (including outbreak simulations), early and multisectoral response, transparent communication, big data analytics, and digital tracking. Public acceptance of its protective policies have been influenced by the SARS experience.
Challenges	Taiwan will have to expand its testing criteria as community transmission spreads. Concerns have been raised regarding the digital tracking of those under quarantine as well as the heavy fines imposed. Finally, it is unclear if the current intensive nature of Taiwan's response can be maintained until the end of the epidemic.

SINGAPORE

Total population	5.6 million	
Date of first reported case of COVID-19[xliv]	23 January 2020	
Epidemiological situation	Confirmed: 14,423 Deaths:12 Recovered: 1060	
Testing [xlv][xlvi] [xlvii]	Who gets tested?	Any individual (citizens, migrants, visitors) who are symptomatic, or have been in contact with a confirmed case, or are at high-risk including

		healthcare workers and those with pneumonia regardless of symptoms.
	What kind of tests are being used?	PCR test. Singapore developed its first rapid diagnostic test in early February and since March, ten companies have received provisional government authorisation for COVID-19 tests that can be supplied to healthcare institutions, private hospitals, medical clinics and clinical laboratories.
	Where are tests conducted?	· Public hospitals · Public Health Preparedness Clinics (GPs)
	What is the daily testing capacity?	As of 20 April, Singapore has tested 121,774 people, which accounts to 21,400 tests per million.
Contact tracing [xlviii]	Public health staff have been working in partnership with police and detectives from the Criminal Investigation Department, in teams of 10, for 7 days a week, to trace, test and isolate contacts of patients with Covid-19. These teams have been using interviews, CCTV analysis, and the recently launched government mobile application 'Trace Together' for contact tracing. The government encourages the public to download this application on their mobile phones, which then uses Bluetooth technology to track and identify close contacts of a patient with Covid-19, including timestamps. Individual patients can chose to allow the Ministry of Health to access the data in the application to identify close contacts.	
Isolation [xlix]	Since 27 January, people returning to Singapore from hot zones (countries with widespread community transmission) were given a 'leave of absence', where they don't go to work but can leave their homes for meals and necessities. From 28 January, suspected carriers are being given a 'quarantine order' (QO) and have to be isolated at home or a government facility. On 18 February, the government announced the 'stay at home notice' (SHN), wherein all Singaporeans have to stay at home for 14 days, and can leave their residence to purchase daily necessities and attend to important personal matters. Those who flout SHN or the QO may face penalties and can be prosecuted under Section 21A of the Infectious Disease Act. Singaporeans can also calculate the number of days of social distancing based on their arrival in the country, using a government-based website.	

Facilitators	Multisectoral task force, early response, targetted testing and rigorous contact tracing, and timely and transparent communication have served as as facilitators.
Challenges [l][li]	It appears that Singapore was slow to test in the crowded dormitories leading to a large cluster of cases among migrant populations. Government enforced social distancing is difficult to follow in such crowded settings. More than half of the 43 registered dormitories have reported active viral clusters. The government has now responded by placing medical teams within the dormitories and enforcing quarantines.

NEW ZEALAND

Total population	4.88 million	
Date of first reported case of COVID-19	28 February 2020	
Epidemiological situation[lii]	Confirmed: 1469 Deaths:19 Recovered: 1180	
Testing [liii] [liv]	Who gets tested?	Any individual with symptoms can be tested, including health workers and those at high risk. Random community testing started in April.
	What kind of tests are being used?	PCR tests.
	Where are tests conducted?	· Public health facilities · Mobile clinics (set up for community testing in settings such as supermarkets and car parks)
	What is the daily testing capacity?	As of 24 April 2020, there have been 108,238 tests completed in total.

Contact tracing [lv] [lvi]	New Zealand has 12 public health units (PHU) that manage health services for clusters of its districts. Contact tracing is conducted by each PHU, which is supported by the centralised 'National close contact service' (NCCS) hub that sits within the Ministry of Health and has been operational since 24 March. PHUs continue to receive notifications of new confirmed or probable cases from laboratories and clinicians. PHUs experiencing heavy workloads can choose to divert parts of the workflow to the NCCS. PHUs inform the case of their result, arrange their home-isolation and identify close contacts. Close contacts who live with the index case are managed by the PHU. Other contacts can be transferred to the NCCS for tracing. These lists of close contacts, which take various forms, are forwarded to the NCCS either via entry into REDCap (an existing webbased database used by some Public Health Units), secure file transfer, or email. The NCCS has developed a 'finding service' that seeks contact information from various health and other government datasets. NCCS staff call close contacts and advise they are contacts of a Covid-19 case and obtain the contacts' agreement to quarantine (commonly called self isolation). As of April, contact tracing application is in the process of being developed.
Isolation [lvii]	Apart from self-isolation for close contacts of suspected or confirmed cases, on March 23, New Zealand imposed a lockdown requiring all citizens except essential workers to stay home at all times, unless they are accessing vital services or walking for exercise.
Facilitators [lviii]	Strong government leadership, early and coordinated government response, transparent and empathethic communication have been the major facilitators for ensuring New Zealand's test-trace-isolate strategy.
Challenges [lix]	Logistical hurdles of sourcing kits and testing materials, challenges in contact tracing (to be offset by increased funding and staffing) and public breaches of lockdown measures have been reported as issues.

ICELAND

Total population	3,64,164
Date of first reported case of COVID-19[lx]	28 February 2020

Epidemiological situation	Confirmed: 1792 Deaths:0 Recovered: 1624	
Testing [lxi] [lxii][lxiii] [lxiv]	Who gets tested?	Targeted testing of persons living in Iceland who are at high risk for infection (mainly those who are symptomatic, with travel history to risk areas, or had contact with infected persons) began on 31 January. This targetted approach is supplemented with mass population screening (initiated on 13 March) using two strategies: issuing an open invitation to 10,797 persons and sending random invitations to 2283 persons. Nearly 50% of positive cases are asymptomatic.
	What kind of tests are being used?	PCR tests. Screening for antibodies started on 8 April 2020.
	Where are tests conducted?	· Symptomatic and those at high risk are tested at the national public hospital · Mass screening conducted in clinics by biopharma company deCODE genetics
	What is the daily testing capacity?	As of 27 April, 46, 377 people have been tested. The daily testing capacity is 2600.
Contact tracing [lxv] [lxvi]	Iceland's contact tracing team is about 160 members strong and operates from part of a hotel in the capital. This team includes public health staff, police and experts in counter-terrorism and organised crime. All individuals who tested positive for COVID-19 are contacted by telephone by a team designated by the public health authorities to track their infection and contacts. All registered contacts are interviewed by telephone, asked about their symptoms, and requested to go into 2 weeks of quarantine. Those with symptoms and those in whom symptoms developed in quarantine are tested for COVID-19. Contact tracing teams are also aided by a government-backed mobile application that was launched on 1 April.	

Draft, prepared by the Global Health Governance Programme, Usher Institute, Edinburgh Uni.

Isolation [lxvii]	All individuals who test positive for COVID-19 are required to self-isolate until 10 days after fever had subsided or until they tested negative, and all contacts of these individuals are required to self-quarantine for 2 weeks. To protect the elderly and other groups who are at increased risk for serious illness, health authorities promoted self-isolation and banned visits to nursing homes and hospitals. Icelanders returning back to the country must also go into quarantine.
Facilitators	Early response, public-private partnership for widescale testing and transparent government communication have been the key facilitors for Iceland's success in containing COVID-19.
Challenges[lxviii]	Logistical issues such as a shortage of tests at certain points have acted as barriers for Iceland's control and tracing efforts.

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