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Passing the Test: How to Safely Reopen the Economy

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Foreword

Covid-19's superpower is delayed symptom onset. Early symptoms – fatigue, fever, cough – are the result of the mobilisation of the immune system's early inflammatory defences. These are the "something seems to be wrong here" signals – the body's autonomous non-specific processes that are mobilised before the immune system has a chance to identify and tailor a more effective adaptive response that takes days to weeks to evolve. These innate immune system responses are the same, whether awoken by a fungal, bacterial or viral attack, or even a splinter of wood. When these signs are absent, it means the autonomous immune system has not yet been mobilised, and infected individuals have no means to recognise that a dangerous attack is underway. It is this same superpower that the HIV/AIDS virus employs to continue infecting people worldwide.

Fast, frequent testing is therefore our only effective first line of defence. It can be widely available in weeks, not months, especially if we retain the capacity now built to manufacture tens of millions of cheap rapid antigen lateral-flow tests. Development of these tests requires waiting for the genomic and proteomic data, but this process is quick – the full sequence of SARS-CoV-2 was made available on 12 January 2020, weeks after identification of this epidemic.

Vaccination is, of course, our ultimate defence against infectious disease by tailoring a finely tuned immune response *before* infection in a majority of the vulnerable population. But it is slow, even when it is fast. Vaccines, until Covid-19, have taken an average of ten years to be developed, tested and made widely available. The achievement of immunologists globally to bring a portfolio of effective vaccines for Covid-19 forward in just ten months or less is truly extraordinary, but it will take another ten months to vaccinate everyone around the globe. Even with vaccines, viruses will mutate, so vaccines without tests will not be effective in the medium or long term. We must continue to test to track our progress in beating the virus and remain vigilant for the establishment of more virulent strains.

Infectious diseases will always be with us, and it would be an unforced error if next time around we have not learned the tragic and expensive lessons of SARS-CoV-2. We have to be ready to immediately deploy fast (while-you-wait), frequent (daily or weekly), cheap ($1 to $5 each) rapid testing as our first line of defence to contain the spread, buying the time needed for therapies and vaccines to be ready for action.

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Overview

The government has published its plan to reopen the country. And with an ending to this phase of Covid-19 nightmare now in sight, optimism has returned. But this plan can only become a reality if it takes a number of careful steps.

First, the vaccine programme must continue to move at speed. Second, the country urgently needs a domestic Covid-19 ID – which demonstrates an individual's vaccine or recent test status – as we have argued several times. Finally, and crucially, we need a viable and robust system of mass testing in place to break chains of transmission and plug any gaps in the vaccine rollout programme.

While vaccines and digital health passes have taken centre stage in recent weeks, the role of mass testing cannot be underestimated. Large numbers of people will soon begin moving around again. Transmission of the virus will likely spike – and vaccines are neither 100 per cent effective nor will they cover 100 per cent of the population.

The only way we can safely and sustainably exit lockdown is to know who has the virus, who is contagious and, therefore, who needs to isolate.

The UK has made pockets of progress on this front. We now have a vastly increased testing capacity. Rapid testing for asymptomatic people is being rolled out. Schools will have access to testing to ensure students are clear of the virus. Liverpool conducted a successful trial of mass asymptomatic testing, catching 70 per cent of those without symptoms but who were still contagious. What is missing is turning these different parts into a coherent and robust whole.

This paper sets out:

- The progress the UK has made on mass testing.
- What rapid tests are now available.
- Why the critical element of our testing capacity will be rapid tests.
- The role of testing, using the right tests for the right purpose.
- How we incentivise people to test and, where necessary, isolate.
- How we get testing in schools right.
- How testing links to an overall digital health passport.

Things we thought impossible at the beginning of this crisis have now become reality. We must continue to be ambitious in our thinking and embrace innovation and new ideas. This paper sets out the

“moonshots” the UK and others should focus on when it comes to monitoring the spread of Covid-19, and also proposes a new “testing wallet”, where people are paid to be tested.

Our recommendations offer a way forward for the country that will allow the economy to revive and lives to be protected. It offers an alternative to the blunt instrument of lockdowns and a way for the government to truly ensure that this latest exit out of lockdown is indeed irreversible.

State of Play

Over the past year, the importance of mass testing has, at times, been championed and brought to the forefront of the government's agenda. The UK's testing rate is higher than many countries around the world and it has one of the highest rates in Europe, especially when it comes to tests performed relative to population size.

Figure 1 – Total Covid-19 tests per 1,000 people across Europe

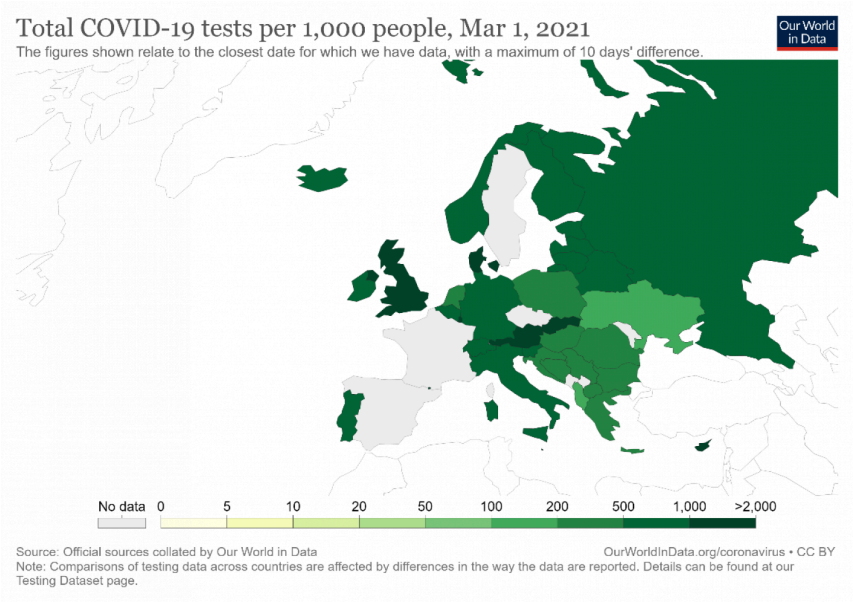
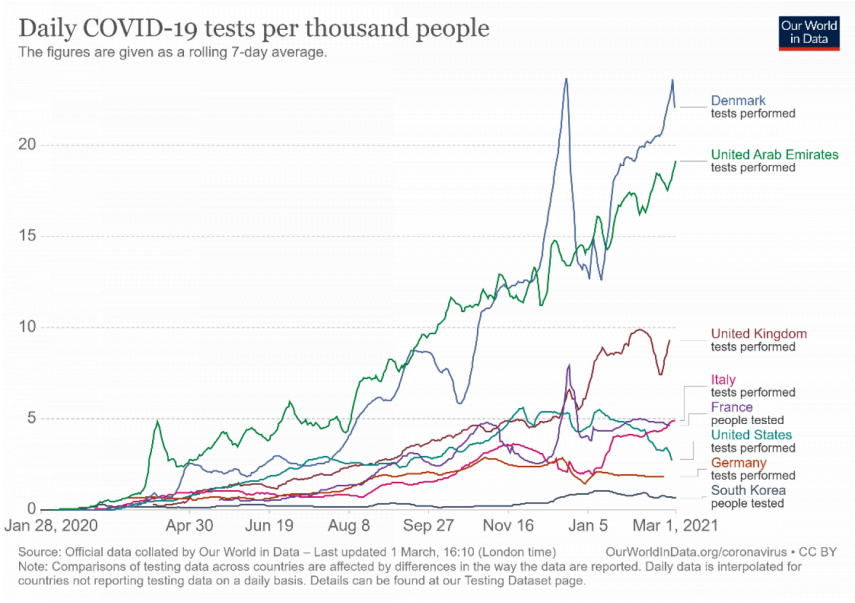


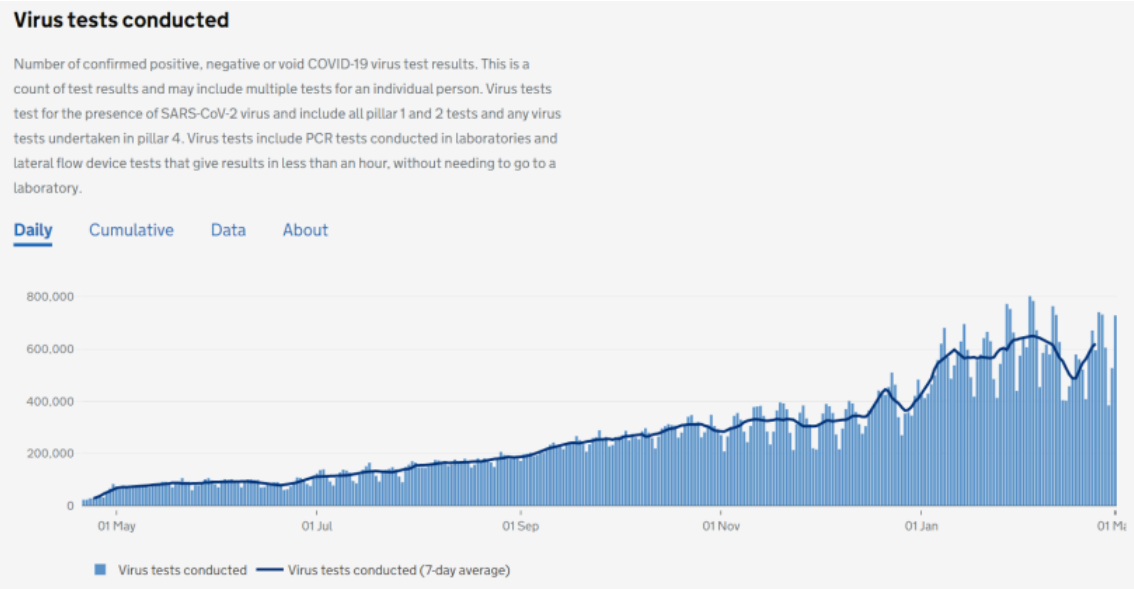
Figure 2 – Daily Covid-19 tests per 1,000 people across Europe, over time



However, the positive moves we saw in the summer and autumn are at risk of being reversed, with the latest roadmap out of lockdown including little reference to it.

The most recent data by the government indicated that on 1 March 2021, 727,972 tests for Covid-19 were conducted.

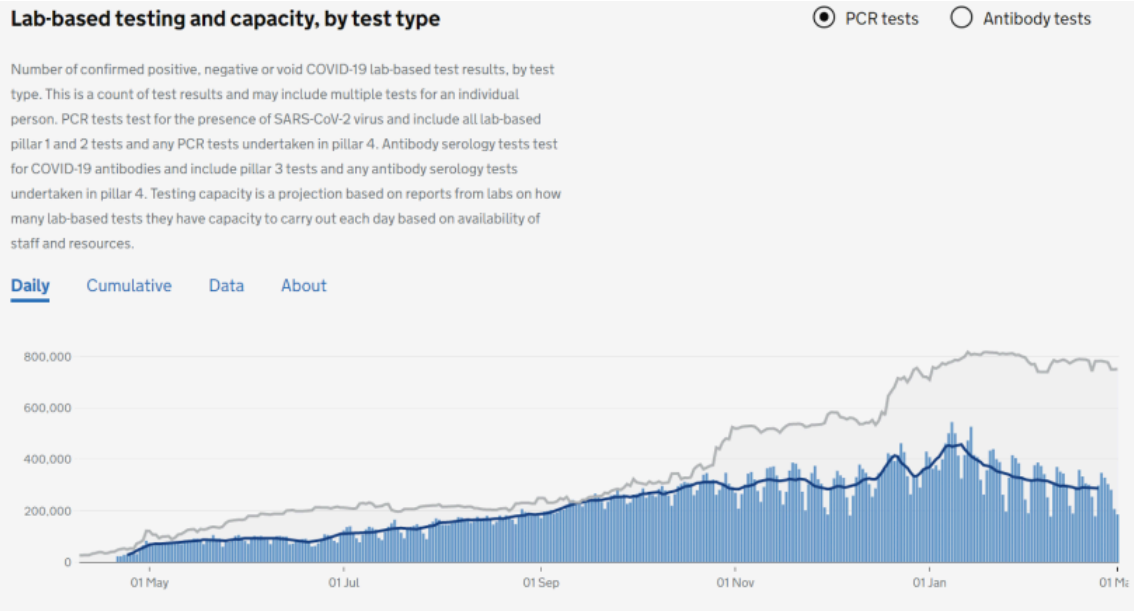
Figure 3 – Number of Covid-19 tests conducted in the UK, up to 1 March 2021



Source: https://coronavirus.data.gov.uk/details/testing

However, Lab-based PCR testing has been declining since mid-January, even as capacity increases. On 1 March, just 186,007 of the 727,972 virus tests conducted were PCR tests, despite capacity being at 750,650. The other 541,965 were lateral-flow tests.

Figure 4 – Testing and capacity for Covid-19 lab-based PCR tests, up to 1 March 2021



Source: https://coronavirus.data.gov.uk/details/testing

Available Tests

PCR Tests

PCR testing is currently the most common form of testing in the UK and is often considered the gold standard of Covid-19 testing. The results take up to two days to come back, however they tend to be the most accurate. PCR tests are the tests used by the NHS in many of their testing centres around the country and are the tests sent out by the NHS to people who report symptoms.

DnaNudge's 90-minute lab-free PCR tests were trialled in eight hospitals in London last May, and in August the government placed a £161 million order for 5.8 million of the high-speed test kits. [1] Now, in addition to being used in hospitals, DnaNudge's test is available for purchase by customers. They also offer Covid-19 travel certificates for tests purchased in stores. [2]

Lateral-Flow Tests

Lateral-flow tests are a point-of-care test used to detect active infections. No laboratory processing is needed, and they usually produce results within 30 minutes. They utilise a cheap technology that can be made in large volumes, making them well suited for mass-testing schemes that require large quantities of tests. Below are four lateral-flow devices that have passed the UK government's minimum standards for quality: [3]

- Healgen Coronavirus Antigen Rapid Test
- SD Biosensor lateral-flow test (used in Slovakia's mass-testing scheme)
- Innova SARS-CoV-2 Antigen test (used in the Liverpool pilot and now nationwide)
- Excalibur SARS-CoV-2 Antigen Screening test

Excalibur's SARS-COV-2 Antigen test is the first lateral-flow test to receive regulatory approval for use in mass screening for Covid-19 in asymptomatic and pre-symptomatic populations, in addition to those displaying symptoms. With this regulatory approval, the test can now be deployed for widespread mass screening of populations to rapidly track down infectious asymptomatic individuals. [4]

Loop-Mediated Isothermal Amplification (LAMP) Tests

LAMP tests are also swab tests, but they don't require a laboratory to process samples. They can give a quicker result than PCR tests but have slightly lower sensitivity and specificity. The UK has used some LAMP tests in pilots, and they are an option for travellers looking to take a test privately. [5]

OptiGene RT-LAMP tests were confirmed to be accurate and sensitive enough to be used after they were trialled with NHS staff and in asymptomatic testing pilots in Southampton – including at the University of Southampton, which tested over 55,000 people. [6] The RNA RT-LAMP kits have since been CE-IVD (the European CE mark for in vitro diagnostic devices) registered and the DIRECT PLUS RT-LAMP are available for purchase through the Department for Health and Social Care. [7]

Antibody Tests

Antibody tests can determine whether an individual has had the virus in the past, but they cannot be used to identify current infections. According to the NHS website, free antibody tests are available for individuals who work in primary care, social care and education; they are not widely available to the public for free. However, individuals not in those lines of work who still wish to take an antibody test can pay to do so privately, and purchase an antibody kit from pharmacies like Lloyds and Superdrug.

Role of Testing

While vaccination is the long-term route out of Covid-19, short-to-medium term the threat of the virus will remain, both nationally and internationally.

We should be rightly proud that the UK has now vaccinated 20 million people, but we should be clear that we soon face the immediate prospect of large numbers of people circulating who can transmit the virus with those who are not protected from it.

The Oxford University/AstraZeneca vaccine reduces transmission by 67 per cent 12 days after the first does is received, but does not fully prevent it. By the time the economy begins to reopen, the majority of the public will also not be protected by a vaccine.

This leaves a critical role for ensuring those contagious with the virus are identified and that they isolate. This is only possible in the short term via two routes of testing:

1. Testing for those with symptoms:

At present those with symptoms self-report and then do a PCR test. PCR tests are highly accurate, lab-based and ideal for this purpose.

2. Testing for those without symptoms:

Estimates on the number of asymptomatic Covid-19 cases varies, with some suggesting it is as high as 80 per cent, but more recent estimates suggesting around 20 per cent. [8]

Whatever the exact number within this range, it is clear that asymptomatic carriers of the virus represent a significant chunk of those infected. Identifying asymptomatic carriers is therefore a critical element of the overall testing programme.

The route to achieving this is through regular mass testing with rapid tests. Such testing has been gradually increased in recent months, after the successful pilot in Liverpool last year.

The UK is now well placed on PCR testing, having significantly increased capacity over the last year, with a current PCR testing capacity of 750,650 tests per day. Now the critical element is ensuring the country has the large-scale and nationwide access to rapid testing that it needs.

Finally, the role of antibody testing should not be overlooked. This form of testing will play an important role in monitoring antibody levels of those vaccinated, for instance. Monitoring antibody levels could become important as populations get vaccinated and we need to determine how long antibodies last. We will be writing more on this specific role of antibody testing soon.

Case Study: New York

In a bid to speed up a reopening, the New York City Economic Development Corp is investing in reliable and inexpensive rapid tests through its Rapid Testing Innovation Competition. This week it awarded the first round of funding to Columbia University, giving $164,000 to accelerate deployment of Columbia's rapid-testing technology. The hope is that these tests will become available directly to the city, without passing through federal or state channels.

This is happening alongside a statewide rollout of a rapid-test programme with BioReference Laboratories. At the end of February, New York City opened 11 new rapid-test centres, with plans to open an additional 200 pop-up sites across the state. The current sites can conduct a combined 5,000 tests per day.

In Defence of Rapid Tests

The critical need for rapid tests for Covid-19 cannot be denied, particularly for use in detecting asymptomatic carriers of the virus. It appeared last autumn, with the launch of the government's mass-testing strategy, that the case for rapid tests had been proven.

In recent weeks, however, these tests have come under renewed criticism. This criticism stems from misunderstandings, or lack of understanding, and risks damaging confidence in this critical element of our route out of lockdown.

This section of the paper seeks to put the record straight on rapid tests.

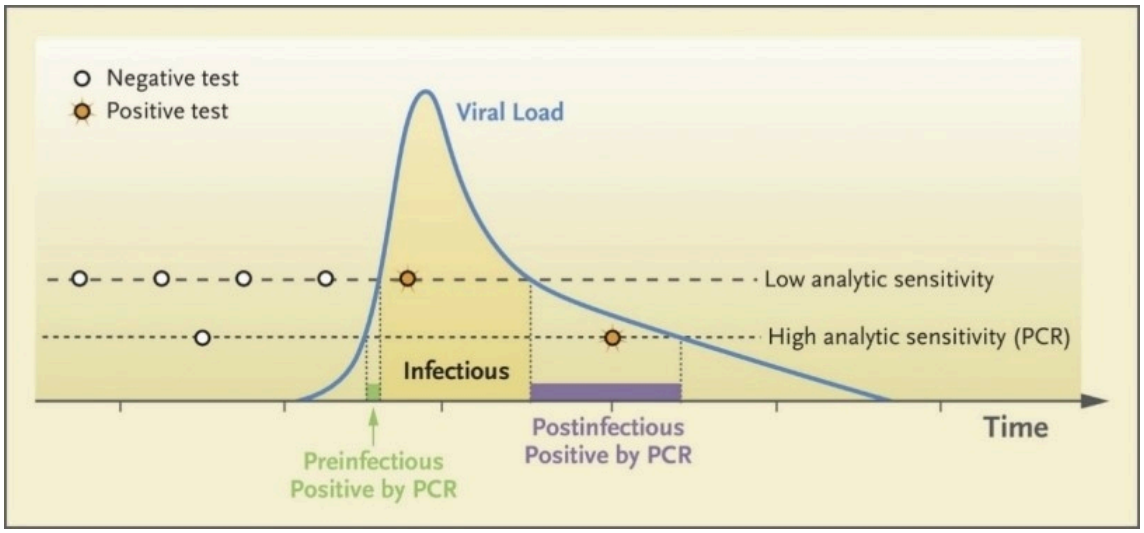
1. Rapid tests have a vital but specific role.

As set out above, rapid tests have a clear and vital role in the overall testing framework. Too often they are compared like-for-like with PCR tests and discounted on this basis. This is a mistake.

Lab-based PCR tests are indeed the gold standard and vital for checking if someone has the virus, particularly those with symptoms. But rapid tests play a critical role in mass testing for those without symptoms. At least one-fifth of those with the virus are asymptomatic. These people will never be detected under the current PCR-only testing regime, which covers only those with symptoms.

Rapid antigen tests are ideal for testing asymptomatic people because they are highly sensitive (accurately identifying Covid-19), while their sensitivity (minimum standard of 80 per cent) means they identify not simply if someone has the virus, but when they are contagious. This is set out in Figure 5. So while PCR tests may pick up pre- and post-infectious positives, rapid tests pick up cases where someone has a high viral load and is contagious, which is ideal for asymptomatic testing.

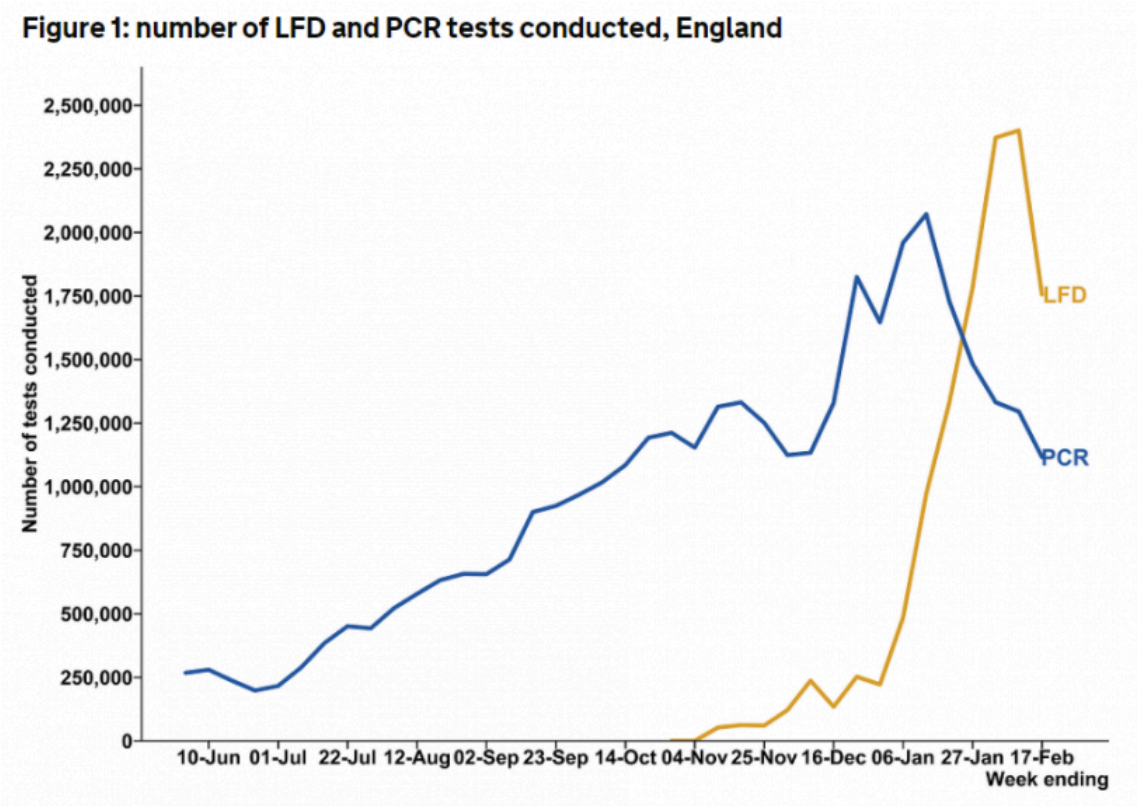
Figure 5 – Detection rates for high-frequency rapid testing vs lower-frequency PCR testing



Source: https://www.nejm.org/doi/full/10.1056/NEJMp2025631

It is for this reason rapid tests are quickly becoming the workhorse element of the UK's testing regime.

Figure 6 – Testing rates in England by device type, over time



Source: https://www.gov.uk/government/publications/nhs-test-and-trace-england-statistics-11-february-to-17-february-2021/weekly-statistics-for-rapid-asymptomatic-testing-in-england-11-february-to-17-february-2021

2. They are accurate.

From all the research we have done on testing, we believe rapid antigen tests need to be around 80 per cent accurate to be effective.

The WHO has also set this as its minimum standard and the European Centre for Disease Prevention and Control has seconded this level, especially, it says, when the tests are "applied in a manner that compensates for their lower performance as compared to RT-PCR, i.e., by including confirmatory or repeat testing in certain situation". [9]

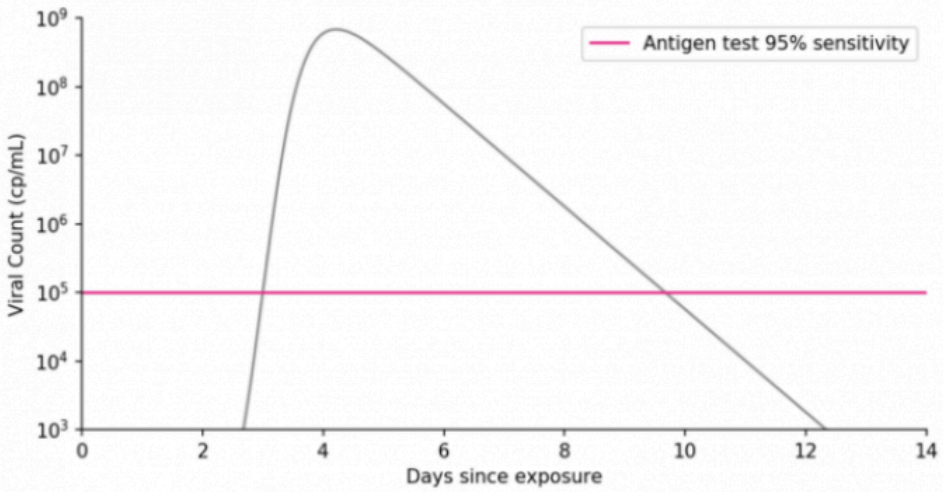
The tests should also be targeted at those people without symptoms but who are contagious with the virus. These people, because they are contagious, will have a higher viral load of Covid-19 (more of the virus in the body), which means it is easier to detect with rapid tests. This is well set out by work carried out by RapidTests.org.

Figure 7, which features RapidTests.org's data, sets out how antigen tests detect higher viral loads, i.e., those contagious with Covid-19.

When people are infected, the amount of viral RNA starts off low but rises quickly to very high numbers.

Good antigen tests can detect around 95 per cent of cases when the RNA count is above a certain level (10^5 cp/mL – the pink line in the graph). People above this line are likely to be contagious, the higher above the line, the more so. Those lower than the pink line (10^5) are unlikely to be contagious. RapidTests.org state that "a reasonable assessment of the data shows these people are likely not meaningfully contagious" below this level.

Figure 7 – How antigen tests detect Covid-19



Viral kinetics from Larremore, et al 2020.

Source: https://www.rapidtests.org/blog/antigen-tests-as-contagiousness-tests

As this graph brings to life, rapid antigen tests are ideal at detecting infectious cases, when the person has a high viral load. This is particularly valuable in the case of mass population testing in identifying those without symptoms but who are contagious.

3. Data show they are working.

When it comes to the task of identifying who is contagious, rapid tests work. Compelling data from the use of rapid tests in the UK makes this clear.

Innova Test:

The workhorse rapid test in the UK is the Innova test. Data show that there is at least a 90 per cent chance that this test will detect infections when the viral loads are high, i.e., when someone is infectious. Public Health England's Porton Down lab conducted an evaluation of this test and found that while it had an overall sensitivity of 76.8 per cent for all individuals confirmed as positive with a PCR test, they detected over 95 per cent of individuals with high viral loads. In the field, the accuracy levels will be lower. The best data we have is from the Liverpool trial from last year. These findings indicate that the Innova tests performed best at identifying those with higher viral loads, picking up about 70 per cent of

these cases. Its specificity was 99.9 per cent, meaning it was effective at detecting almost everyone not infected with Covid-19.

Put simply, if rapid antigen tests are used regularly – around once a week for most people and around every three days for key workers – they are highly likely to detect those with the virus, who are without symptoms but are still contagious.

Without the regular use of rapid antigen tests, everyone without symptoms will be considered free of the virus. With regular rapid testing in place, we will be able to pick up at least two-thirds of asymptomatic contagious carriers, more still with regular testing. The equation is therefore very simple: detect 0 per cent of asymptomatic contagious carriers without regular rapid testing, or the vast majority with this testing in place. Put simply, we cannot get back to anything resembling normal without these tests.

Incentives to Test

Having the right tests for the right purpose is important, but ultimately none of the testing strategies work if people are not using the tests or abiding by the results.

Surveys between March and August 2020 found that only 11 per cent of people of contacted by NHS Test and Trace isolated for the full time asked, and Sage found that less than 20 per cent of people in England who needed to self-isolate have done so fully.

To ensure this system works, we need to remove barriers to isolation and incentivise people to isolate and also to test. There are a number of ways this can be done.

Incentives to Test:

- Allowing those with a negative test freedom from restrictions.
- Considering offering monetary incentives to test for those contacted by NHS Test and Trace.
- Linking test results to a Covid health passport.

Incentives to Isolate:

- If someone tests positive, they should be given better financial support to isolate.
- They should also be tested regularly during isolation and allowed out of it when they receive a negative test.

In the following sections, we explore these suggestions in more detail, also giving international examples of how these types of incentives work.

Incentives to Test

Case Study: Slovakia

Slovakia tested 3.6 million people (97 per cent of the eligible population of 10- to 65-year-olds). The process identified 38,000 new cases in two days, which is 15 times more than Slovakia's testing system identifies on an average day. [10]

> In order to ensure compliance, the country used a carefully calibrated mix of carrot and stick. Most important among the incentives was the granting of a certificate for those who took part and tested negative. This certificate enables the bearer to exit the curfew regime, go to non-essential shops and go to work. For those not taking part in the testing, the assumption then became that the person is positive for Covid-19 and needs to isolate.

Pay to Test

As we have set out, one of the biggest challenges facing the government is compliance with positive test results: How do we get people to stick to the rules, to stay at home when told to, to self-isolate when needed?

We believe the option of monetary incentives should be explored. Every piece of research tells us the same thing: People are scared of losing income or even their jobs. [11] Until that barrier is removed, a positive test or a ping from a test and trace app will do little to shift behaviour – and even the most well-designed suite of measures will have little impact.

It should be seen as an investment. Test and trace is cheaper than lockdown, but only if people isolate when they're required to do so.

A recent publication by the Nuffield Trust set out the importance of thinking imaginatively on this front:

- Surveys between March and August of 2020 found that only 11 per cent of people notified as having been in close contact with a confirmed Covid-19 case didn't leave their home.
- Sage suggests that 80 per cent of contacts need to isolate to control spread.
- The UK performs towards the bottom of OECD countries in terms of the generosity of sick pay.
- England, Scotland and Wales introduced £500 payments to support low-paid workers when quarantining, but this is low by international standards, with some areas reporting insufficient funds to meet demand. [12]

Later in this report, we give further detail on how to support the wages of those needing to isolate, but one further idea we believe needs to be explored is providing people with the right incentives to test. This means not just mitigating the effects of needing to isolate but also positively encouraging people to take part in the testing regime.

There are a number of ways people could be incentivised to test.

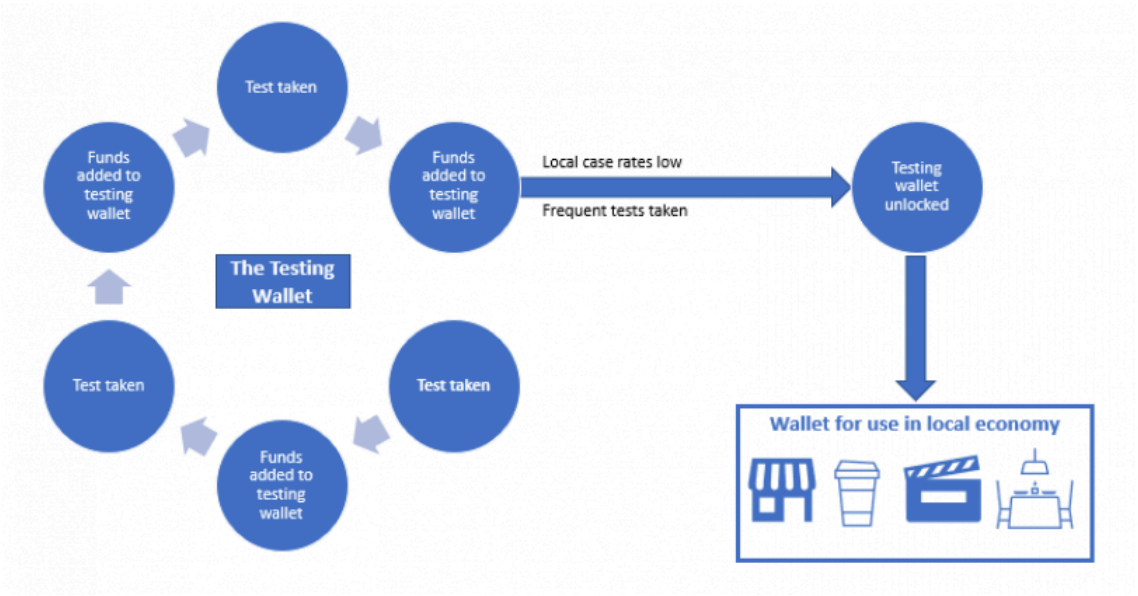
The Testing Wallet

Individuals contacted by NHS Test and Trace would receive a payment into a digital wallet (the amount should be of reasonable significance) if they comply with the request to test. Over time, funds could be accessed based on certain criteria being met that would encourage collective behaviours and compliance such as:

- Local case levels falling
- When an individual has successfully engaged with tracers
- When someone has isolated for a certain number of days if they test positive

The testing digital wallet is a long-term, sustainable alternative to the blunt instrument of lockdown, and would enable economies to remain open. Further, they could be used to actively support local economies with spending restricted to local retailers or hospitality. This could be done through high-street vouchers, directing spend to cafes, restaurants, cinemas and those businesses that have been hardest hit during the pandemic.

Figure 8 – The Testing Wallet



Removing Barriers to Isolation

Financial Support

One practical reason many people do not seek a Covid-19 test is because they cannot afford to isolate, as the information cited above from the Nuffield Trust shows. Many countries have recognised this and

have implemented policies that ensure those isolating continue to receive some sort of income. For example:

- **Germany:** In most cases, employees in Germany are entitled to their full renumeration when isolating with Covid-19. Even if an individual is too ill to continue working while isolating, they are still entitled to their normal income, and in those cases the employer can receive compensation from the state. [13]
- **Slovenia:** Depending on the circumstance, those isolating in Slovenia will receive at least 80 per cent of their full amount of usual earnings. The payments are either made directly to individuals, or as compensation to employers. [14]
- **Finland:** Full salary compensation is provided for those isolating, and accommodation where isolating at home is not possible. [15]
- **France:** Support to the amount of 90 per cent of gross salary is provided, and a daily allowance of 50 per cent of the daily basic wage. [16]

Shortened Isolation Periods

Many countries, including in the UK, are using "test out" schemes to reduce the length of self-isolation and make it easier for people to comply.

- **England:** International travellers can choose to participate in England's Test to Release scheme by opting in on the passenger locator form and then paying for a private test that must be taken at least five days after arriving in the country. Tests can be taken where arrivals are isolating or at test sites. Passengers arriving from countries on the travel ban red list do not qualify for this scheme. [17]
- **Belgium:** In the instances where someone is asked to self-isolate, either after being in contact of a positive case or those returning from trips abroad, individuals have the opportunity to take a test to reduce the length of their isolation period. In Belgium, after seven days in isolation a negative test immediately releases an individual from isolation. [18]

As a basic principle, we believe testing every three days during isolation with rapid tests is a viable model. Once someone has received a negative rapid test – indicating they are not infectious – they should be allowed to leave isolation. This rapid-test result could be backed up with a secondary PCR where needed.

Testing in Schools

Students will return to schools on 8 March and testing will play a large role in the return to face-to-face education. Students and staff will have the option to test frequently, with the government sending 32 million lateral-flow tests to families with school-aged children by post. Test kits are also available to be collected from 500 local sites. [19] The testing strategy varies by age group and is set out below. [20]

Table 1 – Rapid testing for school staff and children

Group	Testing Frequency/Location
Nursery staff	Access to tests to use 2x per week, at home
Primary school students	Households sent tests to use 2x per week
Primary school staff	Access to tests to use 2x per week, at home
Secondary school and college students	Must take a test 3x in the first week back at school testing facilities, then students provided tests to use 2x per week, at home
Secondary school and college staff	Access to tests to use 2x per week, at home

Additional school community members (i.e., bus drivers, after school club leaders, etc.)	Access to tests to use 2x per week, at home
University students on practical courses	Access to tests to use 2x per week, on campus

In the case of a positive result from a lateral-flow test, a confirmatory PCR test is required either to be taken at home or at a testing site. Since 4 January, over 3 million rapid tests have been conducted in education settings and asymptomatic testing has begun to scale up in workplace settings and in communities. [21]

As we proposed last June in *Back in September: A Test for Our Schools*, we recommend that the government designates "super-spreader-setting status" to certain schools based on real data on the number of cases that arise within that type of school. For example, an urban secondary school with over 2,000 pupils is likely to be more susceptible to Covid-19 spread than a small, single form, rural primary. Schools designated as super-spreader settings should be allocated more tests and more support to administer test.

Link Testing to a Digital Health Passport

As we have stated previously, there must be an efficient and scalable way in which to track the results of the rapid-test scheme, as well as the vaccinated population. This can only be practically achieved by instituting a digital health pass, or digital health passport, that fully integrates mass lateral-flow test results. This could be done at the individual level, whereby data is stored only on a person's phone, or in a centralised database. There are positives and negatives to each approach, but the results from the lateral tests must be integrated regardless.

For this programme to function effectively, both businesses and individuals must have the proper incentive structures in place. This means the system needs to be easy to use, reliable and widely adopted. The first course of action will be to ensure that lateral-flow test results are integrated into the health pass efficiently so that a person can conduct an at-home test and know their status within 30 minutes. By integrating at-home testing, we can avoid the inevitable quagmire of long lines and thereby potential health risks around pubs, shops and other businesses while customers wait to see their test results.

There are concerns regarding fraudulent at-home testing. How are we to know that someone took the test they said they did, and that they didn't have a friend or family member take it in their place? Steep penalties for the fraudulent use of at-home lateral-flow testing and reporting is one way to incentivise proper adherence. However, there is wide domestic support for these health passes, indicating that fraud might not be as large an issue as one might expect. [22]

This digital pass could operate based on a risk rating, calculated by an individual's current rapid-test or vaccination status. A simple colour-coded ranking system could work as people are already familiar with this type of classification. A red ranking indicates the person hasn't been vaccinated and hasn't had a rapid test done within a certain timeframe. This would mean they would need to complete a rapid test before they can move about freely. A green ranking would indicate that someone has been either vaccinated or passed a rapid test within the required timeframe.

As with any data collection, there are privacy concerns to be addressed. Many will not want such sensitive personal data out in the world constantly being traced and collated. This can be resolved by creating simple QR codes on the user's phone which don't reveal any personal data, but only show the person or business scanning their pass their colour-coded risk level. Through this self-sovereign model (whereby the data is stored on the user's phone, similar to a virtual wallet) people may feel more comfortable utilising this technology.

Other countries are experimenting with health passes and are already reaping the benefits. In Israel for example, the "green pass" is available to anyone who has received both of their vaccine shots (they are

utilising the Pfizer/BioNTech vaccine, which requires two doses) or has recovered from Covid-19 and is assumed immune, enabling them to engage in more "high-risk" activities such as going to the gym. [23] However, as Israel has vaccinated over 46 per cent of their population of 9 million, they have decided to focus on vaccination status and immunity of recovering patients instead of including mass-testing results. [24]

The government's current timeline for reopening and rate of vaccinations per day in the UK means mass-testing infrastructure and tracking will be a required piece for safely reopening the economy.

The UK government's next three steps should be to continue their investigation into whether the existing NHS app could support the integration of mass lateral flow testing into the health pass, establish the digital infrastructure needed to generate the QR codes and colour-coded system, and begin the information campaign to prepare the public for widespread adoption of the health pass.

Relaunching "Moonshots"

Last summer we set out how the UK government needed to invest in a "moonshot" testing strategy. We said investment was needed to bring onstream "high-risk, high-reward innovations … which would change the game on testing". [25] This ambition remains as important now as then.

Our current roadmap out of lockdown relies centrally on rapid testing, with PCR tests being used for those with symptoms. **But the moonshot aim of developing and bringing onstream a rapid test with PCR-levels of accuracy would allow us to take a different posture in our testing strategy.**

What a test of this kind would make possible is a rapid, at-home, totally accurate "enabling" test. Such a test would give the option of regular, population-level testing that is quick and cheap, and provides a point-of-use and fully reliable result that gives us confidence those with a negative test can be fully active without risk to others.

While this type of test remains a moonshot ambition, many promising new tests are in development and coming onstream. We set out a range of these below.

CRISPR

CRISPR stands for Clustered Regularly Interspaced Palindromic Repeats, and CRISPR tests use technology originally created for gene editing. In May 2020 Sherlock Biosciences received the first US Food and Drug Administration Emergency Use Authorisation (EUA) for a CRISPR test with its SHERLOCK CRISPR SARS-CoV-2 test kit. However, most CRISPR tests still require a lab to process samples but research aimed at developing point of care tests using CRISPR technology is ongoing. [26]

Cannabis Strip Tests

The ideal rapid antigen test would be cheap to produce and purchase *and* be accurate. One expert we spoke to gave the example of cannabis strip tests, which test for traces of cannabis in urine, to exemplify a test that that was low-cost but still effective. The test results are easy to read, produced in around five minutes, and a single strip usually costs less than one dollar. These tests are available for purchase at pharmacies around the US and online. This technology could be repurposed to create a low-cost, quick-turnaround rapid test for Covid-19.

Breath Tests

When most people think of breath tests, they imagine the handheld tool used by police officers to determine alcohol intoxication. However, researchers have explored using them to analyse exhaled breath for indicators of diabetes, certain cancers, respiratory diseases, and other conditions. [27] A Covid-19 breath test is non-invasive, would provide rapid results, and could be used in settings with big crowds.

Exhalation Technology Ltd in Cambridge has announced a large clinical study for its CoronaCheck breath test for Covid-19. The point-of-care rapid antigen test provides results in five minutes and has reported very high sensitivity and specificity thus far. The device was developed based on the company's existing test, the Inflammacheck, which detects well-documented biomarkers for inflammatory conditions in the airways system. [28]

Conclusion and Recommendations

As this document sets out, testing will remain an integral part of the response to Covid-19 for some time. Vaccinations are our long-term route out of the pandemic but in the short- to medium-term, testing – with results linked to a digital health passport – will be as important.

The backbone of this testing programme will be rapid testing, used to identify those who are infectious but do not show symptoms. This group represents at least 20 per cent of those with the virus, with many studies indicating a higher number (as many as 80 per cent). https://www.bmj.com/content/371/bmj.m4851

Ensuring we have enough of the right tests being used for the right purpose is important, but only if they are used widely and their results respected.

For this reason, we also give clear information on how we believe testing can be incentivised and those who need to isolate better supported.

Recommendations

Bring onstream all viable rapid tests. Government should ensure the speedy rollout of all viable rapid tests (specificity over 95 per cent and sensitivity over 80 per cent). This will allow the country to have in place the largest number of rapid tests to underpin population-level testing over the coming months.

Introduce weekly population-level testing. The UK should have weekly population-level testing with rapid tests, with key workers tested every three days.

Incentivise participation in mass testing. To ensure testing is carried out we urge the government to consider and introduce incentives to test.

Remove barriers to self-isolation. A range of steps are needed to ensure people isolate.

- First, we believe the UK should move to provide full salary support for those isolating.
- Second, we should provide accommodation support where needed.
- Finally, rapid tests should be used every three days to allow someone to leave isolation when they are no longer contagious.

Explore the potential for a testing wallet. Citizens require to take a test should be paid a small amount each time they test. The funds would accumulate and would be unlocked when certain criteria are met

such as a minimum number of tests taken and/or local cases falling below a certain threshold. These funds could be directed towards sectors that were the heaviest hit in the pandemic, such as local hospitality or leisure.

(Re)launch the "moonshots". While it is hugely welcome that the UK has increased its capacity to undertake large-scale PCR and rapid testing, we believe the government needs to go further. We will be living alongside Covid-19 for some time, to do so in the most economically efficient and safe way we need faster and more reliable tests. For this reason, we urge the government:

- To identify a team within government that is responsible for identifying and supporting "moonshot" testing capability.
- This should be led by a publicly named individual, ideally appointed from the private sector and with a testing background.
- The team should be easily accessible for the private sector, with open channels with testing manufacturers.
- It should publish monthly progress reports on "moonshot" tests and likely timelines for them to be in use.
- The team should focus resource on developing: a rapid test that is equivalent to a PCR test in accuracy, a "penny test" that detects infectiousness, and a breath test that provides rapid results.

Roll out a digital health passport for Covid that includes both testing and vaccine status. The government should take urgent steps to:

- Finalise investigations into whether the NHS app can support integration of mass rapid-testing data into the health pass.
- Set up the digital infrastructure needed to generate QR codes and the colour-coded system we believe is needed to provide clarity and simplicity to a digital health passport.
- Begin an information campaign to prepare the public for adoption of a digital health passport. This should involve careful and detailed explanation of the security of the system (including addressing concerns around privacy and data anonymity), how it is used and what it is used for.

Footnotes

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