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June 17, 2020

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The Independent Scientific Advisory Group for Emergencies (SAGE)

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## **The Independent SAGE Report 5**

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### **Final Integrated Find, Test, Trace, Isolate, Support (FTTIS) response to the Pandemic**

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Submitted to The UK Government and the People of Great Britain  
& Northern Ireland by Sir David King, former Chief Scientific Adviser,  
UK Government, Chair of Independent SAGE

## The Challenge

We are in the midst of the release of lockdown. Meanwhile, the latest ONS surveillance figures estimate more than 4000 infections per day in the UK. Even in those countries which have successfully suppressed the virus we are now seeing re-emergence: in China, USA, Germany, South Korea and many other countries. To minimize the high risk of such a resurgence in the UK, we require an effective system to chase down every viral infection and prevent its ongoing spread.

The lack of PHE tracing and testing capacity to cope with a large pandemic was noted back in February (SAGE Minutes 11<sup>th</sup> February; 18<sup>th</sup> February). Rather than an immediate investment in existing systems, there was a 3-month delay before the announcement of a new Test and Trace system on 27<sup>th</sup> May - during which time the UK suffered one of the highest death rates in the world.

The key components of this system are themselves based on outsourced services, are fragmented, suffer from poor data linkage, and do not provide an integrated system based on the existing public health and NHS infrastructure. Whilst welcoming the setting up of these systems, they are currently working at suboptimal levels by the admission of Baroness Dido Harding, Head of NHS Test and Trace.

## Solutions

This report highlights **three crucial ways** in which the government must strengthen its 'test and trace' system if we are to build a protective shield against further outbreaks or, worse, a second wave.

1. Testing and tracing alone using a centralised system alone simply will not work. We need **local involvement and ownership** using our existing public health and primary care teams, GPs, local hospital laboratories, school nurses and environmental health officers to ensure we can respond quickly to outbreaks and to build local trust.
2. We outline a framework for an integrated and sustainable approach, based on well-established systems of population infection control, which we term **Find, Test, Trace, Isolate, and Support (FTTIS)** as recommended by the World Health Organisation. We need national and local campaigns to ensure people know about the **key symptoms** and how and where to respond. GPs should be involved in testing hubs and ordering of tests as quickly as possible and results returned within 24 hours for the system to work. **Rapid isolation of cases and contacts is critical. Successful countries** provide facilities available for those asked to isolate including **food and finance** for vulnerable groups, and appropriate guarantees from employers. **Clinical support** for monitoring the health of suspected cases, cases and contacts in the community is vital.
3. The system must link **data into the NHS immediately**, especially local public health general practices. We need community feedback and strong governance to protect privacy. And we suggest clear and detailed **national performance indicators** that support local decision-making.

This report from Independent SAGE follows a public consultation held on 9<sup>th</sup> June and the views submitted on-line by a range of professionals and members of the public. We call on the government to implement these changes to prepare for possible further waves of infection over the coming months and even years.

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## High level recommendations

**LOCAL.** The most effective implementation of FTTIS is led locally, through integrated services coordinated by Directors of Public Health. This should be embedded as much as possible within existing networks and utilise Local Authority and local health services including health commissioners, primary care, local hospital laboratories, school nurses and environmental health officers. This will ensure a robust system in place for finding cases and monitoring future upsurges in infection, and for decision making.

**TRUST.** The success of a FTTIS system is based on trust. This needs 1) transparency about the accuracy of the tests and how problems arising from inaccuracy are being mitigated, 2) accountability mechanisms to review evaluation and other evidence, advice on and oversight of implementation, and conducting real-time scrutiny of emerging data and policy formulation, and 3) effective community engagement to discuss implementation, problems and solutions, working in partnership with trusted local and national groups.

**DATA.** A rigorous system must be implemented to ensure FTTIS data flows are embedded within existing NHS, local authority and PHE systems with real time access to granular data for the local response. We recognise this requires smooth and rapid integration between currently disparate datasets. It is important to provide high quality information to the community and ensure appropriate governance and safeguards for privacy and data misuse, to ensure trust and engagement. The future application of apps must be implemented within such a framework.

**FIND, ISOLATE and SUPPORT.** These are critical to the success of FTTIS if reductions in infection spread are to be realised. Clear information and reassurance must be provided to encourage those with possible COVID-19 symptoms to become tested in the easiest way (FIND). There must be facilities available for those asked to isolate including material support including food and finance, and appropriate guarantees from employers, to ensure that those in isolation are not disadvantaged. Clinical support for monitoring the health of suspected cases, cases and contacts in the community is vital.

**KEY PERFORMANCE INDICATORS (KPI).** A set of key performance indicators based on local data should be developed and reported weekly, including data that are timely, relevant, and useful to key stakeholders, at a sufficient level of granularity to support local decision-making. Suggested indicators are set out in this report. These data should be subject to community feedback.

# 1 Introduction

## 1.1 Why is Find, Test, Trace, Isolate, and Support important?

Our nation faces the worst economic crisis since the second world war. To restore the economy and jobs we must get control of the COVID-19 pandemic. Unchecked, SARS-CoV-2, the cause of COVID-19 spreads rapidly through populations. Each person infected will, on average, transmit it to more than one other. As long as this happens, the pandemic will continue to grow. In the absence of a vaccine, the only way to prevent this happen is to break transmission, so that each infected person transmits it to fewer than one other. This has been achieved in the UK, with the number of new cases falling each week since 8<sup>th</sup> April, by means of a set of measures that have worked in two ways; social distancing and enhanced personal protective equipment (PPE) in high risk settings. Yet, while these measures have worked, even if not as well as in many other countries, the social distancing of lockdown has come at great cost, both financially and in terms of the health and wellbeing of those particularly vulnerable, for example through worsening mental health or failure to obtain necessary care for other conditions, leading to excess mortality for non-COVID as well as COVID disease. At some point, we must reduce these restrictions. However, to do so, we must try to find *every* new case, test them, trace their contacts, and then ask the new case and their contacts to isolate for two weeks to prevent further spread, with the support they need to continue with their lives in these new circumstances. We must go beyond a narrow response of simply testing people suspected of being infected and tracing their contacts, which is implied by the Westminster government's use of the term "test and trace". Instead, we recommend that *the "test and trace" approach should be extended to include all of the elements necessary to control the pandemic, specifically Find, Test, Trace, Isolate, and Support (FTTIS).*

While FTTIS has long been a core public health function, used many times every year by health protection teams and local public health departments in cases of tuberculosis, meningitis, food-borne outbreaks and some other infections, it only works if it is well organised, with health professionals working with contact tracers, laboratories, and social services among others. This should be relatively straightforward when there are only a few cases of the disease in question. It is very different in a pandemic when there are thousands.

## 1.2 Performance of NHS Test and Trace System

The goal of COVID-19 contact tracing is to isolate contacts of cases **within 4 days of initial contact**- the estimated time before that contact is likely to become infectious themselves. This requires a) the index case to recognize their possible COVID-19 symptoms, b) present themselves to a testing centre, c) receive the result, d) identify their contacts to the Test and Trace team, e) successful communications with these contacts, and f) subsequent isolation of the contacts. This is a huge requirement within the 4-day window.

The NHS Test and Trace system is led by Baroness Dido Harding, and involves the follow up of COVID-19 positive swabs from community testing through a bespoke call centre, to identify contacts of these cases, and issue subsequent advice to these contacts regarding isolation. Online resources, and local public health officials may also be involved. We welcome the recent publication of performance indicators for the NHS Test and Trace system.<sup>1</sup> We have scrutinized the data, and are disappointed that, as presented, the data are very difficult to interpret. They represent a mix of public health led investigations of care home outbreaks, together with the call centre initiated follow up of others. The report states that 26,895 of 31,794 (85%) contacts were reached. However, it appears that only around 15% of these contacts were within the Test and Trace programme (compared to public health led outbreak investigations). Further, there is no integrated dataset presenting each step of the Find, Test, Trace and Isolate cascade, nor any planning for specific support of those asked to isolate. For instance, the latest ONS surveillance data<sup>2</sup> suggest around 4500 infections per week in England. Assuming 2700 of these to be symptomatic (60%), then the Test and Trace programme is only

identifying 45% of such cases. This is not the place to undertake a detailed evaluation of the operation of the system that has been created but it is sufficient to note that Baroness Harding, who has been given responsibility for implementing it, has conceded that the programme will not be functioning fully until September.

We recommend a clear description of the key performance indicators of the programme, including a “cascade” of the total number of cases through to contacts successfully isolated. We identify the key data required in section 4 of this report.

We argue that the current government approach to what is called “Test and Trace” is severely constrained by lack of coordination, lack of trust, lack of evidence of utility, and centralisation, such that achieving the goal of isolating 80% of close contacts is impossible. As lockdown is slowly released, worrying evidence shows that the pandemic is still growing in some parts of the country, such as the North West of England (and potentially in others, given the uncertainty about the estimates of the reproduction number  $R$ ). Thus, while it is also extremely important to enhance support for those who are shielding and distancing, and especially those with mental or physical health problems, there is widespread concern that current proposals to ease some restrictions are premature. A fully functioning FTTIS system is an absolute priority to minimise the risk of widespread resurgence of COVID-19.

These views are not controversial. Indeed, the recommendations from the SAGE, from 1<sup>st</sup> May, are summarised in Box 1.

**Box 1-1 Advice on test and trace systems from SAGE, 1 May 2020**

- At least 80% of contacts of an index case would need to be contacted for a system to be effective.
- The objectives of the system were to isolate as many contacts as possible as quickly as possible (within 48 hours of symptoms in the index case) while minimising false positives (i.e., isolating contacts when the index case did not have COVID-19).
- Ideally testing results should be available so rapidly that contacts should only be asked to isolate on the back of a positive test (although they recommended all contacts should be sought once symptoms are notified, and contacts asked to isolate as soon as they are identified even in the absence of a positive test)
- There is insufficient evidence to determine whether the testing of case contacts would impact the epidemic compared with isolation alone.
- There were concerns about the accuracy of home swabbing and whether they produced too many false negatives. A case should also have TWO negative tests before contacts are released.
- High level of adherence to requests to isolate is required for the system to be effective.

**“I feel our training was very inadequate. I’m concerned the public are given a false sense of security from the government that we’ve got a functioning test and trace system - when we actually don’t.” -**  
Anonymous contact tracer during ISAGE public consultation

## 2 FTTIS as a System

### 2.1 Systems theory

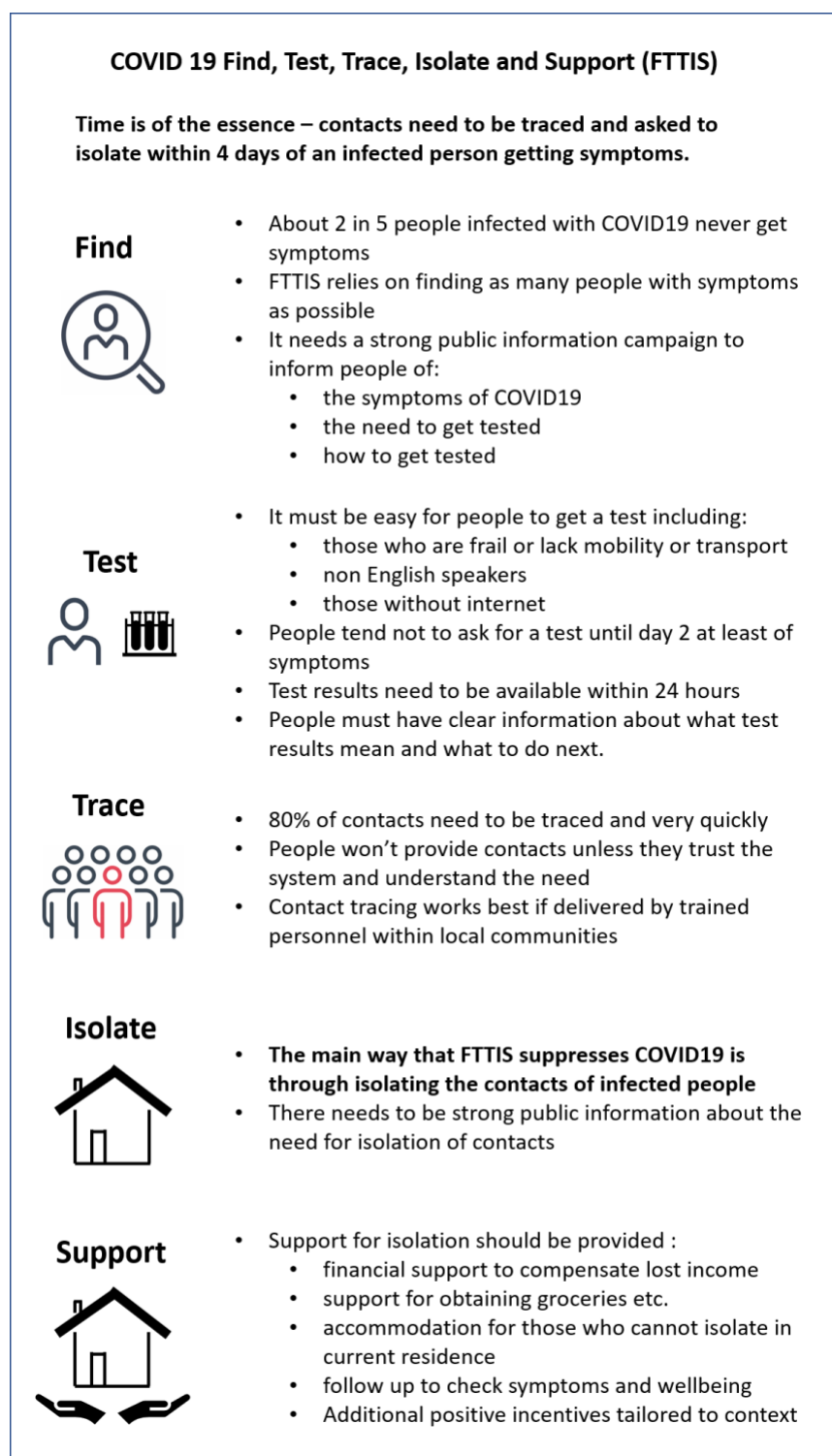
High quality, accurate, real-time and disaggregated local data about suspected and confirmed cases are crucial for monitoring epidemics and contact tracing **for effective** outbreak control. This is especially important at this stage of the current COVID-19 epidemic when lockdown measures are being relaxed. A modelling approach to our proposals is provided in Appendix 1.

Our approach is based on systems theory.<sup>3</sup> We have tried to identify the many subsystems that must be working for a broader FTTIS system to work as well as possible (Appendix 2). Some of the key ones are shown in Figure 2-1. Some of these subsystems are inside the health system and others outside it, each involved in transformations, for example the collection, processing, and transmission of information to other systems. It also allows flexibility to meet the requirements of the whole population. Given the high burden of disease in disadvantaged and BAME groups, we have specifically identified some of these requirements to reach all such members of the community, in Appendix 3. We are also informed by the well-established policies and protocols developed for, for instance, population cancer screening programmes. A more detailed description of the principles underpinning testing and screening in the context of COVID-19 is found on our Independent SAGE website (Dr Angela Raffle).

### 2.2 Population awareness of, and access to FTTIS

A FTTIS system will only work if people are aware of it, including its purpose, its importance, its implications for them, and how and in what circumstances they should access it. This needs to be managed, with someone responsible for framing the narrative around the system and communicating it, recognising the importance of reaching everyone, with a particular focus on overcoming language and literacy barriers. FTTIS will only work if those who are aware of the need to take action on developing symptoms are able to do so, taking account of differential access to general practice, telephones, the Internet, transport as well as the incentives for those in certain circumstances, such as the gig economy, to avoid providing this information. At present, in England, this is provided by the call centres that are at the core of the NHS Test and Trace programme. A more detailed description of requirements for acceptability, engagement and support are provided in Section 3.

**Figure 2-1 Elements of a Find, Test, Trace, Isolate, and Support system**



### 2.3 Find and Test

We use the term “Find” as the initial entry into our proposed FTTIS system, prior to the test itself. This is important, since it underlines the importance of widespread knowledge of symptoms of early disease, and the subsequent access to testing. We are concerned that the low levels of diagnoses in comparison to the predicted number of cases through the ONS surveillance programme may reflect this knowledge gap.



With a requirement for a 24-hour turnaround from sampling to test result precipitating contact tracing, the system must be efficient. This is even more so with the decision to only test symptomatic cases (estimated at 60% of all infections- this proportion may change in light of new surveillance data), as opposed to widespread testing of all. The current NHS Test and Trace online guidance states that they should contact the service either online or by phoning 119 to enable them to order a test. Tests can be ordered in one of five ways:

- drive-through regional testing sites
- mobile testing units
- swab kits delivered to home
- hospital-based testing for NHS patients and staff
- dedicated testing centres in other care settings (for example, care homes)

The existence of multiple test providers has the advantage of improving access. Nevertheless, this is a major logistic and distributional challenge especially as GPs have been unable to order tests. Many people may be unable to access drive-through testing sites and may face postal delays. It is therefore self-evident that a FTTIS system can only function if there is a process in place to conduct testing at scale and pace. There are, however, many concerns about this component in England, including delays in reporting test results, a multiplicity of organisations with poor communication among them, and lack of training among those managing the testing centres. The legal situation in relation to disease notification is set out in Appendix 4, which also highlights concerns about information flows in England. There are also particular concerns about the quality of samples taken at home or in drive-through centres- which in fact is likely to be the major determinant of false negative results amongst those infected.

This has been addressed in other countries by the widespread availability of tests in pharmacies, local health centres and other community settings- approaches which need urgent assessment in our setting.

## 2.4 Contact tracing

Once someone has been identified as having COVID-19 or is suspected as such, the system must contact them to advise isolation and ensure community monitoring of their health status (see above).

Normally, infectious disease contact tracing and case finding would be undertaken by local public health teams, for example in the event of an outbreak of meningitis in a school. Unlike in many other countries, the four countries of the UK have opted for centralised systems for COVID-19, based on call centres bypassing GPs. The effective operation of this subsystem is also complicated by the apparent sub-optimal performance of the app that was designed to facilitate identification of contacts of those who have COVID-19. During planning and testing, it was hailed by ministers as being essential. Now it is described as of marginal importance. Importantly, this is one of the many areas where the UK went its own way, taking an approach that was very different from other countries.

We recommend the tracing programme (Figures 2-1; 2.2) be moved from central to local control, in preparation for further local spikes of infection. This will also contribute to recovering trust, and the monitoring of wellbeing of those isolating.

**“Contact tracing works best if delivered by trained personnel within local communities, this is key to our recommendation” - Sir David King**

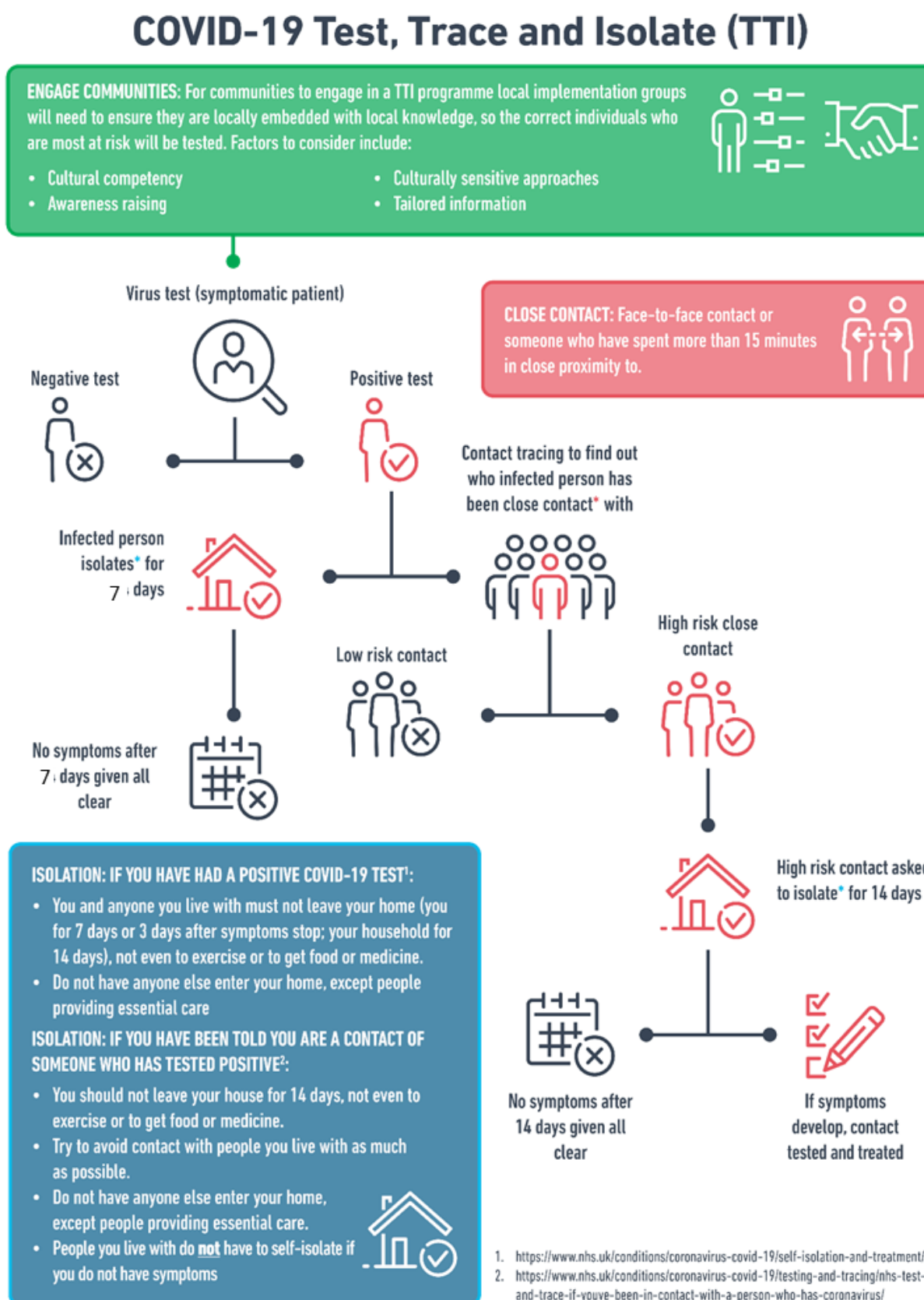
## 2.5 Data analysis and dissemination

Once test results are obtained and contacts traced, it is necessary to have a system that can synthesise the emerging data, providing seven digit postcodes and occupation , age and gender and ethnicity for each case, and which can then be provided in real time to local authority directors of public health and primary care teams. Although an assessment of such performance of the Test and Trace system has not been made publicly available, but there are numerous accounts in the media which suggest significant failures in communication, in particular the lack of sufficient information collected at the drive-through centres. Critically, many samples currently tested at Lighthouse Laboratories are not yet linked to NHS numbers, and results are therefore not accessible to GPs. GPs provide first level care for COVID-19 patients, so this is a critical failure. We identify some key performance indicators in section 4.

## 2.6 Enforcement

As problems with the NHS Test and Trace system, as originally designed, have become apparent, there has been, at last, a recognition of the crucial role that general practice, local public health and health protection teams and local NHS labs should play. However, there have clearly been problems in communicating their responsibilities to them. We welcome the additional funding has recently been made available but there seem to be major challenges in distributing the funds effectively. That said, if the information that is collected is to be acted on, it is essential that those responsible for public health at a local level, which in this case is a local authority, must have the power to act. Although the government did move rapidly to enact an emergency Coronavirus Act, this does not provide local authorities with significant additional powers. Rather, it removes many of their responsibilities to act in particular circumstances, presumably in recognition of the many pressures they face at this challenging time. In other countries, local government bodies would normally have the power to impose temporary restrictions on movement or on opening of facilities. For the system to be operational, we need a rapid assessment of the powers of local authorities, and where necessary emergency legislation.

Figure 2-2 How contact tracing and isolation fits within FTTIS



**“Out of 200 tracers at my agency we have only had four contacts to call between us in four weeks. There is no data, test results are not being passed to tracers. It’s an absolute scandal”** - Anonymous contact tracer during ISAGE public consultation

## 2.7 Oversight

A system of oversight is needed to ensure that the different elements of the system are working together as well as possible to achieve an FTTIS system that can suppress further growth of the pandemic as lockdown is eased. Put simply, someone must be in charge of the entire FTTIS system, with clearly defined lines of accountability. While many individuals and organisations have responsibility for the subsystems listed above, other than the Prime Minister, who is ultimately responsible for everything undertaken by his Government, and who can reasonably argue that he has many other priorities, **it is not clear who else is in charge**. Whoever is in charge of oversight of the FTTIS should be supported by a programme of continuing evaluation and, where necessary, rapid targeted research, to understand why problems are arising.

## 2.8 Responsibility and accountability

FTTIS transcends all levels of society, from individuals and families to central government. Each has a part to play. However, given the importance of local knowledge and engagement, ***we recommend that all issues should be dealt with at the most local level that is consistent with their resolution***. In England, the upper tier local authorities must play a key role. Appendix 4 sets out what this might look like, describing the agencies involved and their responsibilities and lines of accountability.

## 2.9 Learning from other countries

We have used learning from other countries to develop our recommendations above. For a detailed review of the latest academic evidence of the successful components of an FTTIS system please see the separate document from Dr Sheng-Chia Chung and team at University College London<sup>4</sup>, including a detailed description of the response in Taiwan and the extensive database of measures adopted in European countries in the European Observatory on Health Systems and Policies COVID Response Monitor<sup>5</sup>.

### 3 Building acceptability, engagement and support for those asked to isolate

Although the FTTIS system has the potential to prevent a second wave and lock-down, as now demonstrated in other countries, the system being developed has attracted a range of concerns from diverse communities and voices. Drawing on an understanding of the behavioural science evidence (Appendix 5), six areas of concern are:

#### 3.1 Knowledge

There are two key components. First people need to know why the FTTIS is crucial and how it fits into an overall anti-pandemic strategy. It is important to avoid language of ‘easing’ or ‘relaxing’ restrictions. Rather, it is important to understand how we have moved into a new phase of controlling the pandemic in which, in return for changing some restrictions on movement, greater vigilance is needed in other ways, of which adherence to FTTIS is a key element.

Second, people need to know exactly when they should be tested and what is required of them if they test positive – or are informed they are a contact of someone who has tested positive.

#### 3.2 Trust

With a background of the public’s decreasing confidence in the Government’s management of the pandemic, trust in the current “Test and Trace” system is critical and impacts on all stages of the system: willingness to be tested, willingness to report all ones contacts, willingness to self-isolate if informed one is a contact of an infected individual. Trust will be variable and may be particularly low in particular groups such as young men and BAME people. It will be undermined by:

- Inaccurate and excessive claims about the functionality of the system and about the numbers being tested along with the lack of a transparent monitoring and evaluation strategy
- Inadequate explanation of the test, particularly with regard to possible inaccuracies - with an estimated 20-30% false negative rate in the face of inadequate swabbing
- Concerns about confidentiality and security of the data, especially given data are held centrally and data breaches have occurred, including sending personal details to private companies. These concerns are especially the case for the smartphone app component of the system which uses Bluetooth technology to share data across phones and has been developed and will be implemented by a private provider. There is a concern that there may be fraudulent use of the system given it is not being carried out by local, familiar and trusted services.
- No public consultation or community engagement in the development of “Test and Trace”. Delivery of the system is by centralized, impersonal systems run by private companies with mixed track-records, as opposed to the use of familiar and trusted local people such as GPs, health visitors and community nurses.
- Hasty roll-out of the system with inadequate preparation and inadequately trained staff.

**“The current TTI system has been put in place without any risk assessments being carried out, and without proper privacy notices as to what is going to happen to the data collected for the app” - Ravi Naik, data and tech legal expert**

### 3.3 Practicality

The willingness and ability to adhere to the various stages of the system will be heavily affected by practical considerations, notably – but not only - financial. Those suffering from mental or physical disease may face difficulties in obtaining care and the process of isolation can have profound implications for those with mental health problems, as well as other vulnerable groups such as those experiencing domestic abuse

Right from the start, the willingness of people to report symptoms, especially at an early stage, will be affected by the practical implications of doing so and people will be deterred by any penalties they might thereby incur. Equally, people will be less willing to provide names of contacts if they fear that these will be disadvantaged in terms of employment, housing or immigration issues. However, the greatest problems are likely to be at the stage where contacts are asked to self-isolate, particularly as they will likely be feeling physically well.

We therefore recommend that a strategy should be developed to ensure that those in isolation receive support that is appropriate and acceptable and which addresses the particular needs of specific groups (such as parents, those who suffer from technological and other forms of poverty, those living in multi-generational households, the homeless). At a minimum this should ensure no detriment to those who self-isolate. However, there are strong arguments for providing positive incentives to those who act for the collective good. Moreover, such a strategy should mobilise not only the Government but also the private sector and support groups in the community.

## 4 Quality assurance

A system is needed to ensure the quality of the testing programme, including technical aspects including the quality of taking samples, the performance of the tests, the speed of response, and the acceptability to those being tested. This should consider not just the aggregate figures but also the extent to which measures of quality vary for groups within the population. For example, does the organisation of the testing system disadvantage certain groups, such as those who do not have English as a first language or who live in remote rural areas? To this end ***we recommend that a set of key performance indicators should be reported weekly, including data that are timely, relevant, and useful to key stakeholders, at a sufficient level of granularity to support local decision-making.***

We propose a set of key indicators for which data is needed so that it can be determined if a FTTIS system is capable of identifying and isolating suspected cases and contacts within 48 hours: for each local authority area in England and Northern Ireland and for each Health board in Wales and Scotland

### Suspected cases and deaths

- How many suspected cases are reported to PHE daily?
- How many suspected deaths are notified each week?
- Proportion of weekly suspected cases subsequently tested and of those tested proportion of confirmed cases?
- Proportion of suspected deaths tested and of those tested proportion of deaths confirmed COVID?

### Tests

- What percentage of tests results are returned within 24h?
- Changes in locality based testing rates, including for high risk settings such as care homes?

### Contacts

- What percentage of people with a positive test are successfully contacted within 24h to find contacts?
- What percentage of people share their close contacts with the call centre?
- What percentage of named contacts are contacted within the next 24 hours?

### Isolation

- What percentage of contacts comply with isolation?

### Support

- What percentage of cases in isolation require/request support?
- What percentage of these receive support during isolation?
- What percentage of contacts in quarantine require/request support?
- What percentage of these receive support during quarantine?

These key indicators should be complemented with regular exercises to collect and report on the following questions:

- What percentage of tests on suspected cases are completed in NHS labs, PHE labs, Lighthouse Laboratories, private laboratories or other scientific laboratories?
- If someone with symptoms has a test that is negative and symptoms persist, how quickly do they receive another test?
- How are the results of all tests communicated with the patient's GP? Who else has access to the data, and for how long? What is the destruction policy?
- How are participants guaranteed that calls are genuine?
- Are GPs and local authority public health directors empowered and resourced to set up a test and trace hub in every primary care network?



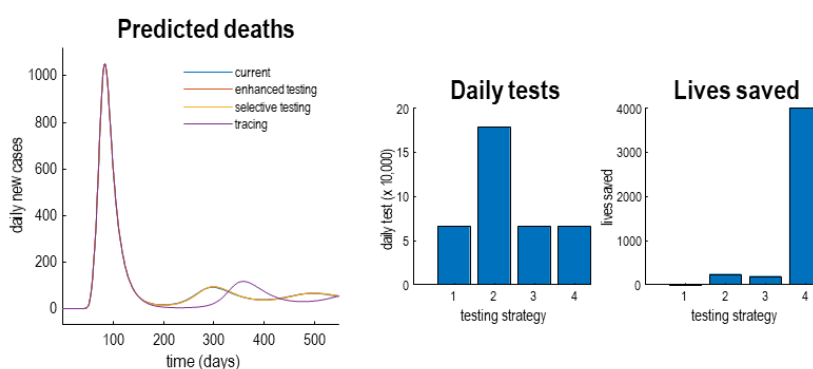
## Appendix 1. The role of modelling

Modelling may have a more nuanced role in shaping FTTI policies than might be imagined. This follows from the common-sense observation that **an efficacious FTTI protocol will save lives**; irrespective of the mechanisms or attending uncertainty about unknown quantities. Modelling does however provide a clear motivation to maximise the efficacy of FTTI and offers an understanding of the underlying mechanisms and timescales.

There are many modelling initiatives addressing the effects of unlocking and, in particular, FTTI interventions (please see main text for a brief survey). Here, we focus on systemic (i.e. dynamic causal) models that embed conventional epidemiological models within a larger system of clinical and behavioural responses to infection. This allows one to model the mechanisms—and efficacy—of tracking and tracing as part of the epidemiological dynamics. When fitting these models to available data (here, test rates, positive cases, deaths, serology, and PCR data from the ONS) the following picture emerges:

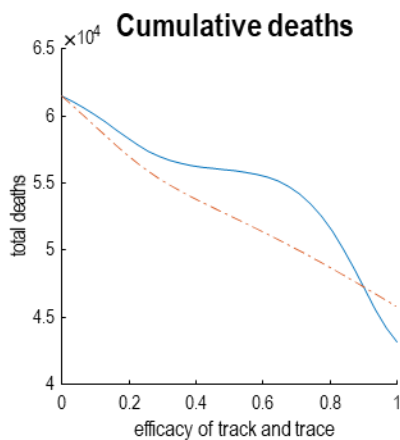
- A maintained decline in the prevalence of infection across the UK depends upon a gradual relaxation of lockdown policies—based on the prevalence of infection. The reproduction rate is currently at its lowest and infection levels will continue to decline for a few months.
- If population immunity is lost over the ensuing months to years, the reproduction rate will drift slowly towards one and a second wave is possible in several months (e.g., after Christmas).
- **As the efficacy of FTTI increases, the second wave is progressively deferred or delayed.** Under the assumption that therapeutic advances or an effective vaccination programme can be introduced within a year or so, FTTI could render the second wave innocuous.

The delay of the second wave is illustrated in the figure below for a fictive scenario in which one in four people who are infected but asymptomatic self-isolate. Crucially, just changing the way that we test people has no effect: one has to identify people who are infected but asymptomatic to change the course of the epidemic.



This figure illustrates the benefits of tracing and tracking. The curves in the left panel show the predicted death rates since the onset of the outbreak under four different ways of deploying testing (current testing practices; increasing overall tests rates; increasing the selectivity of testing—in terms of the proportion of people tested who are infected—and implementing FTTI). Only the track and trace intervention has a material effect. This effect is to defer a second peak (purple line). As the efficacy of the tracking and tracing increases, the second peak is deferred further and further into the future. Here the efficacy was increased from 0 to 25%. The right panels show the number of daily tests (in 10,000s) under the four interventions (left panel) and the putative number of lives saved under this model (right panel).<sup>6</sup> Please see [here](#) for details.

The figure below shows the number of lives that can be saved as a function of the efficacy of FTTI, and this model of how people quarantine themselves—having been identified as potentially infected.



This graphic illustrates the number of lives that could be saved as a function of increasing the efficacy of tracking and tracing. The solid line reflects what would happen if we introduced tracking and tracing now; from zero to complete efficacy. The broken line shows the corresponding curve had tracking and tracing been maintained during the first pick. Note that this would not have been practically feasible because it would have meant that 1 million or more people would have had to have been identified. Please see [here](#) for details.

The key point here is that increasing the efficacy of FTTI, increases the number of lives that may be saved. Here, efficacy is simply the probability that “if I am asymptomatic but infected, I will isolate myself for a period of 14 days”. The way in which FTTI works is to preclude the spread of infection by identifying people before they become contagious. This begs a question of **why is testing needed?**

In principle, the efficacy of FTTI, could be assured by **tracking and tracing** the contacts of anybody who had symptoms of coronavirus and asking them to self-isolate. This would not require any testing. In turn, this suggests the role of testing is to minimise unnecessary self-isolation (where self-isolation is feasible) and the disruption to people's lives. In short, testing might allow you to come out of self-isolation if you were negative. The problem with this is that you could still be infected if the test did not have a high sensitivity. This may be especially problematic if you are tested at the early stages of an infection.

Furthermore, to use testing to trace previous contacts — in time to prevent them infecting other people — the test results have to be available within hours to days (not days to weeks). This puts pressure on a fast turnaround and local availability of PCR tests. In summary, it is almost self-evident **that track and trace** is mandated at this point in time. The question of how PCR testing (e.g., **test and trace**) should be deployed is less clear:

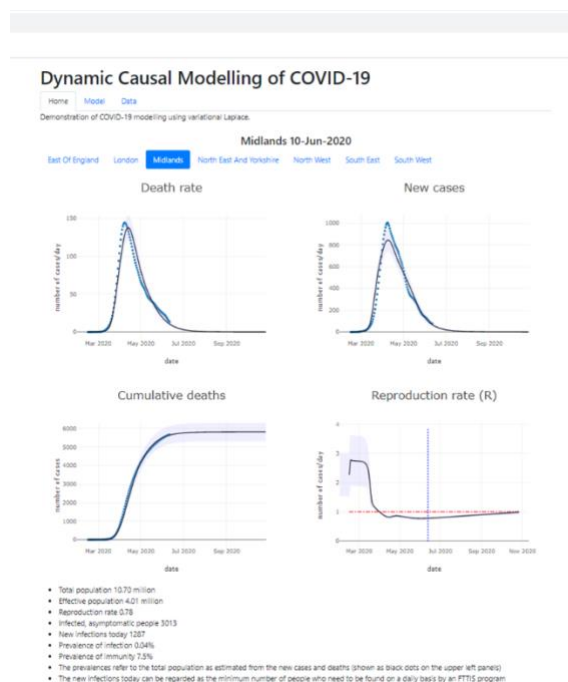
Should it be used for clinical management—and prescribed at the discretion of the general practitioner or responsible medical officer?

Should it be used for screening – and if so why? In other words, how will screening change anything, if an effective tracking and tracing policy is in place and regional outbreaks or clusters are contained?

Should it be an integral part of a FTTI program and, if so, why? In other words, is testing licensed by allowing people to stop or avoid self-isolating?

### Regional statistics and targets:

The dashboard at the following site: <https://www.fil.ion.ucl.ac.uk/spm/COVID-19/dashboard/> illustrates real-time estimates that may be useful for FTTIS planning:



This dashboard – based upon the dynamic causal modelling above – provides an indication of prevalence of infection and the expected number of new, asymptomatic, infection cases per day at a regional level (**New infections today** in the above dashboard). This can be taken as a rough guide to the minimum number of people that need to be identified for suppression.

**Notes:** The estimates of the reproduction rate and associated prevalence of infection in each region are based on a dynamic causal model of the coronavirus outbreak. This kind of modelling is distinct from conventional epidemiological modelling because the dynamic causal model incorporates things like self-isolation, social distancing, the probability of being tested and waiting for test results. This allows us to use regional reports of COVID-19 related deaths and new cases to model regional outbreaks.

In brief, the model assumes each region experiences an epidemic with similar characteristics but with different parameters, such as the number of contacts at home or work. And different mixtures of people who are more or less likely to catch (or transmit) the virus. These parameters are estimated from regional data and are then used to nowcast and forecast the evolution of the outbreak in terms of underlying or latent causes (such as the prevalence of infection). The effective population size is the number of people who are caught up in the outbreak, some of whom will be resistant to catching the virus. Of those that are not, some will become contagious and infect other people. From these estimates it is possible to evaluate the effective reproduction ratio at any point in time during the course of the outbreak, in addition to other quantitative estimates, such

as the number of people currently infected or new cases of infection every day (that may or may not be identified).

The ensuing predictions complement equivalent estimates from epidemiological modelling based upon the history of outcomes observed so far. See <https://www.mrc-bsu.cam.ac.uk/now-casting/> for a state-of-the-art transmission model. In principle, it is possible to compare the quality of dynamic causal and epidemiological models in terms of their model evidence or marginal likelihood. However, at the present time, it is difficult to estimate the evidence for epidemiological models; thereby precluding (Bayesian) model comparison. Technical details about the dynamic causal model used here can be found at <https://www.fil.ion.ucl.ac.uk/spm/COVID-19/>.

## ***Appendix 2. A systems approach to FTTIS***

FTTIS is an example of a “soft system”.<sup>3</sup> To succeed, it depends on the actions of a number of subsystems, some of which are inside the health system and others outside it, each involved in transformations, for example the collection, processing, and transmission of information to other systems. Each of these subsystems involve human agency, in that those involved must act in certain ways if the system is to work as intended. Whether or not they do so is influenced by a number of factors, including their immediate and wider environment and their vision of the world, for example their trust in authority. Soft systems are complex, in that an apparently small disturbance could have either no or a major impact, their performance is shaped powerfully by path dependency, whereby the conditions that apply when they begin can constrain how they develop in the future, and in the presence of positive and negative feedback loops. There are increasing examples of how soft systems methods have been applied in health systems research, for example in understanding the operation of cancer screening<sup>7</sup> or immunisation programs.<sup>8</sup> It has been especially helpful when used in co-production, using qualitative research to capture a “rich picture” of a situation where the perceptions of those involved are important, as in a recent study of an IT system used in a childhood obesity programme,<sup>9</sup> something that has certain parallels with FTTIS, which is also dependent on IT systems. Another recent example of relevance to FTTIS involved coproduction with patients experiencing severe asthma who were reluctant to attend emergency departments,<sup>10</sup> a situation that has parallels with potential concerns about being tested. It was also used in design of vocational rehabilitation services for patients with strokes,<sup>11</sup> a situation described by the authors as disorganised and patchy provision .... patients can fall through the net and receive little or no support”, a concern that also applies to those in isolation. As one recent review noted it “is particularly suited for tackling real world problems that are difficult to define and where stakeholders may have divergent views on the situation and the objectives of change”.<sup>12</sup>

The Test and Trace system, as implemented in England is especially complex because of the large number of organisations involved, even before looking at the Find, Isolate, and Support systems that will need to be in place. The existence of multiple test providers has the advantage of improving access, but it also creates major challenges for coordination and, in particular, information flow and accounts in the media indicate that these challenges are far from being resolved.

At this point, it is appropriate to step back to identify the sub-systems that are required for FTTIS to work. A non-exhaustive list includes:

- a system to ensure that the entire population is aware of the procedures to be followed, taking account of language and literacy barriers.
- a system to ensure that those who are aware of the need to take action on developing symptoms are able to do so, taking account of differential access to telephones, the Internet, as well as the incentives for those in certain circumstances, such as the gig economy, to avoid providing this information.
- a system that enables those who are able and willing to identify themselves to do so. In the current system in England, this is provided by the call centres that are at the core of the FTTI programme.
- a system to ensure that those who are suspected of having COVID-19 can obtain a test within 24 hours, return it at once, and have the result within another 24 hours. This is a major logistic and distributional challenge, given that many people may be unable to access drive through testing sites and may face postal delays. This has been addressed in other countries by the widespread availability of tests and pharmacies.
- A system to conduct testing at scale and pace, with appropriate sensitivity and specificity.

- A system to ensure the quality of the testing programme, including technical aspects including the quality of taking samples, the performance of the tests, the speed of response, and the acceptability to those being tested. This should consider not just the aggregate figures but also the extent to which measures of quality vary for groups within the population. For example, does the organisation of the testing system disadvantage certain groups, such as those who do not have English as a first language or who live in remote rural areas?
- A system to identify the contacts of those known to have COVID-19 or suspected as such, and to contact them to advise them to isolate. Again this is a core part of the existing contact tracing system but it depends on the ability of the index case to know who they have been in contact with, a function that was intended to operate via the app, and to have sufficient details to contact them, something that may be problematic.
- A system to synthesise the emerging data, providing geographical identifiers for each case, which can then be provided in real time to those who require this knowledge, in particular local authority directors of public health and primary care teams.
- A system to ensure that necessary action, such as temporary restrictions on movement or on opening of facilities, can be implemented. This will require a rapid assessment of the powers of local authorities, and where necessary emergency legislation.
- A system of oversight, to ensure that the different elements of the system are working together in an optimal manner and achieving the results intended. This should be supported by a programme of continuing evaluation and, where necessary, rapid targeted research, for example to understand why problems are arising, either in general or for particular groups within the population.

In each of these systems, it will be necessary to identify the key elements. In soft systems science, these are the following, conventionally referred to by the mnemonic CATWOE.

- Customers - the beneficiaries of the subsystem. For example, the primary beneficiaries of the testing sub-system are those being tested but also those who must act on the information obtained. In the data synthesis subsystem, the beneficiaries are groups such as directors of public health.
- Actors - those who do things necessary to make the transformation at the heart of the subsystem. For example, this is the laboratory scientists in the testing subsystem.
- Transformation - the act being undertaken. For example, in the contact tracing subsystem, this is the action of identifying all contacts of the index case and making contact with them.
- Weltanschauung - a German word, translated as the vision of the world necessary for the system to work. In this case, it will be necessary to have a high degree of trust. This is an area where there will be a need for substantial input from anthropologists, sociologists, and behavioural scientists, possibly supported by regular polling data. For example, it is abundantly clear that the Dominic Cummings affair seriously damaged trust in the government's response.
- Owners - those who have the ability to initiate or close the subsystem. Put another way, this asks who is in charge? Within each subsystem, who can actually make the decisions that are needed to make it work? This can be extremely difficult, for example in ensuring that those who should identify themselves actually do so it may be necessary to mobilise appropriate support from social services and others to encourage them to do so, addressing the potentially major disincentives that they may face.
- Environment - this relates to the situation in which people involved in the system, as customers, actors, or owners, find themselves. This may mean that aspects of subsystems need to be tailored to

particular needs, including the challenges faced by people isolating in homes in multiple occupancy, or people living in remote rural areas.

A comprehensive systems analysis will ensure that all of these subsystems are identified and mapped, with a clear understanding of the different elements of each subsystem, the links between them, including flows of people, information, and finances, and the lines of accountability.

### ***Appendix 3. FTTIS programmes for socioeconomically deprived and black and minority ethnic populations***

The UK was the first country to report on the association of ethnicity and socioeconomic deprivation with the SARS-CoV-2 pandemic. People from socioeconomic deprived areas and those from black and minority ethnic (BAME) and deprived populations have been affected disproportionately with increased hospitalisation and mortality. The reasons for this are complex and not completely elucidated but have been seen in other epidemics such as tuberculosis and HIV. What is clear is that we must ensure such disparities are not present in implementation of a national testing, contact tracing and isolation (TTI) programme. This has however not always been guaranteed. For example, past evidence suggests that BAME populations in the UK have not engaged in screening programmes for other infectious diseases and for cancer screening.<sup>13,14</sup> This has also been mirrored in uptake among BAME communities in research studies.<sup>15</sup> From current ongoing work within the Clinical Research Network regarding BAME engagement and recruitment to Covid-19-related studies, it is clear that there is a significant gap in culturally-tailored and appropriate public health information for individuals from ethnic minority populations. There has also been recent media and public criticism that public health messaging concerning Covid-19 prevention has not been culturally tailored to at-risk BAME populations. Additionally, work with the public have recently highlighted that BAME individuals have reported that there is a need to "make Covid-19 information more accessible and bespoke to different BAME communities and faith groups, including those who are not online and those who have English as a second language".

The reasons for poor engagement in screening are complex and include beliefs and attitudes, language barriers, stigma, fear, lack of knowledge and awareness, barriers to access and potential gender differences.<sup>13,14</sup> For example, limiting any TTI material to English would mean over 30 - 40% of certain south Asians not understanding the material if self-testing is implemented, which may lead to poor uptake. Even when there is adequate uptake, there may be inadequacies in completion of tests due to poor understanding, especially if self-testing is introduced.<sup>16</sup>

So what can be done to ensure such disparities are not widened in a national TTI programme? There have been recent calls for policy planners to ensure that access and uptake of COVID testing is equitable across all social and economic gradients.<sup>17</sup> This would include multidisciplinary working with social scientists, anthropologists, leaders of marginalised communities, and experts in local social determinants of health in health policy.<sup>17</sup>

Previous research has shown that multifaceted and media interventions can improve uptake of screening in BAME populations.<sup>18</sup> These include use of lay health workers and navigators, working with community organisation including faith groups, and raising awareness of benefits of screening in the community.<sup>18-20</sup> Unless the TTI programme has been planned with these issues in mind, it may have limited efficacy within certain groups including the BAME community and in other hard to reach groups.

Another key area will be to ensure digital app solutions for testing and contact tracing are developed to meet the needs for those already disproportionately affected by COVID including the deprived and BAME populations and the elderly. If not carefully planned, there is a risk for further widening inequalities in these populations. We suggest all apps are developed and urgently pilot tested in these populations. In addition careful monitoring of uptake, engagement and effectiveness will need to be embedded with a view to service level modifications if required.

For BAME and deprived communities to engage in a TTI programme, implementation groups will need to ensure a locality embedded infrastructure with involvement of public health and infectious disease specialists,



primary care, schools, community and religious groups and a network of locally based volunteer sector organisations. These groups have the local knowledge of their populations. These locally based groups will also benefit from education and training in managing and controlling local outbreaks. Locally based teams will need to ensure there is enough capacity to manage a TTI programme particularly in case of a local outbreak. These groups will need to ensure responsiveness of communication through the local channels mentioned above. A major limitation currently is the closure of local religious and community centres, as these organisations in the past have played a pivotal role in increasing community awareness programmes. However, many community groups are continuing to be active virtually including local radio stations and religious activities through social media. Local pharmacists with the relevant language skills have also played major roles in preventative strategies in local communities.

A number of factors will need to be factored in a testing and tracing programme. As previous research has shown multifaceted approaches are more likely to increase uptake of a TTI programme, many factors will need to be taken into consideration:

- Diversity in the BAME population: BAME communities are a heterogeneous group and implementation of a TTI programme will need to be relevant to each individual community
- Cultural competency: local communities have the understanding and respect for different cultural perspectives, and this has been shown to improve the accessibility and effectiveness of health care services for people from BAME backgrounds. It is essential that TTI is embedded within local structures and networks.
- Awareness raising: Through volunteer groups, religious and community leaders, local businesses groups including primary care, community pharmacies and social media.
- Culturally sensitive approaches: This needs to include material in the right language including simple instructions on self-testing. These materials will need to be developed and piloted with local volunteer groups
- Tailored information: Information for TTI programme will need to be co-developed with the local community teams which will include culturally tailored resources (e.g. infographics, multimedia) translated into different languages to support the uptake and adherence of a TTI strategy.
- Contact tracing: Contact tracing will need to be undertaken using the approaches outlined above and will need to be accessible by all (including those without smartphones or those unable to read or write English) and acceptable. Those conducting contact tracing will need to have training to ensure the conversations occur in a culturally sensitive and in the appropriate languages.
- Provision for isolation: Many BAME and deprived families live in multigenerational families. These families need to be supported and provision for alternative accommodation should be made available for multigenerational families, key workers and those who are homeless. This will also need to include provision for food and essential amenities. If individuals are to comply with isolation, employers will also need to ensure that those isolating are paid during isolation and do not suffer financial hardship.

BAME communities and those living in socioeconomically deprived areas have been disproportionately and severely affected by COVID-19 and policy makers need to urgently ensure these disparities are addressed for the TTI programme including gaining trust of the local populations. Unless a TTI programme is implemented with these proviso's, we are likely to see even further widening of disparities.

#### **Appendix 4. Legal Notification system (England, Wales, Scotland and N Ireland)**

COVID was made a notifiable disease in England on March 5<sup>th</sup> – this means there is a legal requirement placed on registered medical practitioners to report suspected cases and deaths from COVID. This system when it is working enables local data flows and is fundamental for effective contact tracing. Each of the four nations has a variation of the legal requirement based on local health systems for CDC- all rely on close cooperation between GPs, local labs and health services and public health. (see figure for England and table for all four countries )

**Suspected cases** In all four countries the system begins with the patient who usually reports symptoms to their doctor. The legislation in England, as set out in the Health Protection (Notification) Regulations 2010,<sup>21</sup> requires that a doctor who suspects COVID s/he must notify the proper officer of the local authority who must then notify PHE. In practice, however, the situation has changed so that notification is now made to one of PHE's Health Protection Teams.<sup>22</sup> This is set out in the 2018 Framework Agreement between the Department of Health and Social Care and Public Health England<sup>23</sup> which gives responsibility to PHE to *"Fulfil the Secretary of State's duty to protect the public's health from infectious diseases and other public health hazards, working with the NHS, local government and other partners in England, and also working with the devolved administrations and globally where appropriate. This means providing the national infrastructure for health protection including: an integrated surveillance system"*. However, we were unable to identify the legal or regulatory basis for this change. The patient can obtain a test through the various mechanisms set out elsewhere in this report.

**Test** The laboratory has the legal obligation to notify PHE of the test result but since 2010 the local authority is no longer entitled to receive test results which makes it harder to monitor the outcome of both suspected and confirmed cases locally.

**Suspected death** A post-mortem test specimen should be taken and sent to the laboratory: positive results are notified to PHE, not to the local proper officer.

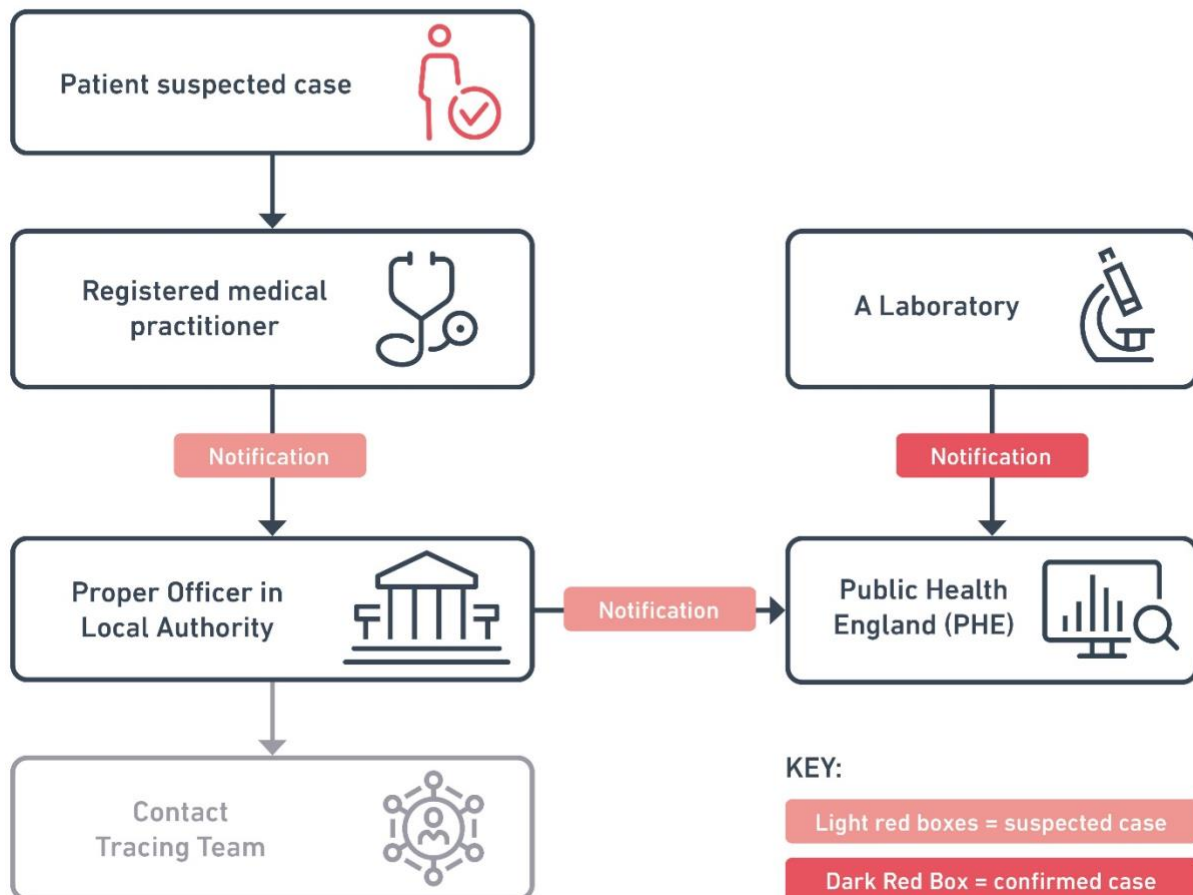
Similar systems which requires close cooperation between the registered medical practitioner (RMP) in the community or hospital health services, labs and local public health departments is the basis for contact tracing in many European countries.

For a suspected case, the RMP advises the patient to self-isolate if well enough, and ideally would provide community support and monitoring. This might include community health services support and provision of home monitoring kits, thermometer and oxygen saturation meters which can be sterilized and recycled.

**Data flows** If the established system were working detailed information on suspected cases would flow to the proper officer in public health departments who then informs PHE. Since 2010 test data flow directly to PHE not local authorities.

**Why data on community prevalence are lacking in this epidemic** Since March patients with COVID symptoms have been advised to stay at home and not contact their GPs, or to contact NHS 111 initially,<sup>24</sup> and thereafter to contact NHS 111 online. The management of COVID has been through a new vertical programme which bypasses GPs and the legal notification system for reporting suspected cases. This means suspected cases have not been reported or supported and tests are not being returned to GPs.

## FIND: the legal system for reporting notifiable diseases (COVID-19) in England, and how data flows



*Summary of the legal requirements for notifying notifiable diseases in England, Scotland, Wales and Northern Ireland*

<b>Data type</b>	<b>Notifier</b>	<b>Notified</b>	<b>Timescale</b>
<b>England</b>			
Suspected cases and deaths	Registered medical practitioner	Proper office of local authority... ...who then informs Public Health England (see text above for de facto situation)	3 days (written), or, if urgent, orally as soon as reasonably practicable  3 days (written), or, if urgent, orally as soon as reasonably practicable
Confirmed cases and deaths	Operator of a diagnostic laboratory	Public Health England	7 days (written), or, if urgent, orally as soon as reasonably practicable
<b>Scotland</b>			
Suspected cases and deaths	Registered medical practitioner	Health board...  ...which then informs the Common Services Agency and Public Health Scotland	3 days (written), of, if urgent, orally as soon as reasonably practicable no later than the end of the week in which the information is received, or if not practicable, as soon as practicable afterwards
Confirmed cases and deaths	Director of a diagnostic laboratory	Health board in whose area the laboratory is situated the Common Services Agency, and Public Health Scotland	10 days (written), or, if urgent, orally as soon as reasonably practicable
<b>Wales</b>			
Suspected cases and deaths	Registered medical practitioner	Proper officer of local authority... ...who then informs Public Health Wales	3 days (written), of, if urgent, orally as soon as reasonably practicable  3 days (written), or, if urgent, orally as soon as reasonably practicable
Confirmed cases and deaths	Operator of a diagnostic laboratory	Proper officer of local authority... ...who then informs Public Health Wales	7 days (written), or, if urgent, orally as soon as reasonably practicable  3 days (written), or, if urgent, orally as soon as reasonably practicable
<b>Northern Ireland</b>			
Suspected and confirmed cases and deaths	Medical practitioner	Director of Public Health for Northern Ireland	As soon as suspected or confirmed

*Summary of the legal requirements for notifying notifiable diseases in England, Scotland, Wales and Northern Ireland*  
*Sources: England: The Health Protection (Notification) Regulations 2010, Regulations 2, 3, 4 and 6; Scotland: Public Health etc. (Scotland) Act 2008, sections 13, 15 and 16, as amended; Wales: The Health Protection (Notification) (Wales) Regulations 2010, Regulations 2, 3, 4 and 6; Northern Ireland: Public Health Act (Northern Ireland) 1967, section 2, as amended.*

## **Appendix 5 Behavioural Issues Underpinning an Effective FTTIS System**

The effectiveness of any FTTIS system depends upon maximising the proportion of infected people and of their contacts who self-isolate. This is made difficult by the fact that there is potential for 'leakage' at every stage of the system. Leakage can occur in the proportion of people who 1) are found and get tested quickly, 2) provide contacts, 3) are contacted, and 4) self-isolate.

There are general principles required for adherence in any system such as this. These include:

- Clarity and transparency as to why the system is so important and exactly what people are being asked to do.
- Trust in the system which in turn depends upon openness, honesty about achievements and limitations, and, above all full involvement of the public at all stages of the process (particularly the development and preparation of the system).
- Practical and material support so that people can do what is being asked of them.

Additionally, there are principles that apply to each stage in the process. These include:

- *Find*: It is critical that people volunteer for a test as early as possible when they begin to have symptoms. This requires combating social norms that you show grit and commitment by 'soldiering on' when 'under the weather'. It is necessary to build a '*new commitment*' which means, if in doubt, stay home and get tested.
- *Test*: The likelihood of people putting themselves forward for testing will be influenced by their confidence in its predictive accuracy so this needs to be communicated clearly.
- *Trace*: It is critical that people are willing to reveal all their contacts to tracers. This raises issues of trust, especially for groups alienated from authority, and makes it all the more important that the system is promoted and delivered by known and trusted local organisations. *Trace* also violates strong norms amongst such groups of not informing on other members. Again, norms need to be reconfigured. The '*new loyalty*' means protecting your community from infection.
- *Isolate*: This phase is particularly difficult because it means that people must isolate even when feeling well, when others are going out and when there is no personal advantage in doing so. Given that the purpose is to protect others from infection, the system depends on a strong 'we' focus – motivating collective action to protect the community. It also depends on having the accommodation, financial means and practical support needed to stay at home.
- *Support*: Ensuring that people feel confident that they will have adequate support is key to the success of the whole system, from willingness to acknowledge symptoms and get an early test to self-isolation. Given the demands on those asked to isolate, support may well need to go beyond a promise of no detriment and involve positive incentives. Moreover, the type of support provided has to be tailored to the particular circumstances of different sections of the community: the homeless, multi-generational households, crowded households, single-parents, gig economy workers etc. A bold and imaginative support system, involving all sections of society – government, mutual aid community groups, and the private sector, is key to the success of FTTIS.

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Public health physician and urban epidemiologist, MRC Epidemiology unit, University of Cambridge

**With contributions from Independent Sage's Behavioural Advisory Group:**

**Imran Awan** is Professor of Criminology at Birmingham City University and a leading expert on Islamophobia and countering extremism. He is a participant in the UK government's SPI-B group.

**Val Curtis** is Professor of Hygiene and Director of the Environmental Health Group at the London School of Hygiene and Tropical Medicine. She is an evolutionary anthropologist specialising in hygiene behaviour globally. She is a participant in SPI-B.

**John Drury** is Professor of Psychology at the University of Sussex specialising in research on collective behaviour including behaviour in emergencies. He is a participant in SPI-B.

**Susan Michie** is Professor of Health Psychology and Director of the Centre for Behaviour Change, University College London. Her research focuses on behaviour change in relation to health and the environment. She is a participant in SPI-B and advises the World Health Organization on behavioural science in relation to Covid-19.

**Ann Phoenix** is Professor of Psychosocial Studies at the Thomas Coram Research Unit, UCL Institute of Education. Her research focusses on racialised and gendered identities, family lives and home, migration and transnational families.

**Stephen Reicher** is Professor of Psychology at the University of St. Andrews. His work addresses group processes, with special emphasis on processes of leadership, influence and collective action. He is a participant in SPI-B and in the Advisory Group to the Scottish Chief Medical Officer on Covid-19.

**Elizabeth Stokoe** is Professor of Social Interaction at Loughborough University. She is an expert in conversation analysis. She is a consultant for SPI-B.

**Robert West** is Emeritus Professor of Health Psychology at University College London and Editor-in-Chief of the journal *Addiction*. He specialises in addiction and behaviour change. He acts as advisor to Public Health England on tobacco control and behaviour change. He is a participant in SPI-B.

**Laura Bear** is Professor of Anthropology at the London School of Economics. Her current research focusses on the impact of the Covid-19 pandemic on vulnerable communities. She is a participant in SPI-B.



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