**Briefing on Mass Testing Technologies**

A critical part of the measures to control Covid-19 are the use of new testing technologies and innovations, deployed in ways that will have the most impact in protecting people at risk, finding the virus and enabling life to get back to as normal as possible. These novel and new technologies are being bought into use at pace; piloting their use is a vital part in rolling out and scaling up.

**Purpose of Piloting?**

* Piloting these technologies will help understanding where to best use these technologies and how they can be operationalised in the real world; to protect those at high risk, find the virus and help enable us to go back to as normal a way of life as possible.

* They will also form the foundations to delivering mass testing - testing large numbers of people in a short period of time, with test results made available quickly, so that people in environments such as hospitals, schools, universities and workplaces can be reassured more quickly that they are not infected or isolate themselves more quickly if they are.

**The key principles behind mass testing pilots are to:**

1. Protect those at highest risk, including NHS staff and people who live and work in care homes.
2. Find more positive cases to prevent and reduce transmission. NHS Test and Trace is already testing hundreds of thousands of people a day, but as new technologies are developed, they can be used to find more positive cases.
3. Enable economic and social activity, such as helping schools, universities and critical workplaces to remain open or re-open. This will enable key activities in society to go ahead. **Local areas such as the South West will vary in their different needs and this will be key to informing how tests are deployed.**

PCR is the current routine testing method for COVID-19 as it is highly sensitive and highly specific. PCR testing uses temperature cycles and various reagents to replicate the number of COVID-19 genetic material (RNA). Due to the amount of cycles required these tests take a longer time to complete. In addition, due to the nature of the sample preparation process and the reagents required in qRT-PCR, these tests are expensive and also require a skilled laboratory team.

**Definition of terms used for technology performance:**

**Sensitivity**: the ability of a test to correctly identify samples with COVID-19. For example, a test with 100% sensitivity correctly identifies all patients **with** the disease, whereas a test with 90% sensitivity correctly detects 90% of subjects as positive and 10% of subjects with COVID-19 are not detected (false negatives).

**Specificity**: the ability of a test to correctly identify samples without COVID-19. For example, a test with 100% specificity correctly identifies all patients **without** the disease, whereas a test with 90% specificity correctly identifies 90% of subjects as negative and 10% of subjects incorrectly test positive (false positives).

**Turnaround time**: this is the approximate time required for a result to be generated once the sample has been received.

**Key Technologies Being Piloted:**

1. **LAMP (e.g. Optigene, Genie HT Platform)**

Loop-mediated isothermal amplification (LAMP) amplifies and measures the amount of COVID-19 RNA in a similar way to PCR. However, LAMP testing removes the need for thermal cycles that is required for PCR. This means that the turnaround time is significantly reduced when compared to PCR-based testing and there is no requirement for a highly-skilled laboratory team to run the PCR equipment and analyse the results. LAMP testing can either be direct (testing the sample directly) or indirect (this requires another step to extract RNA from samples before beginning the LAMP test).

[**Direct LAMP coronavirus saliva test**](https://www.gov.uk/government/news/new-saliva-test-for-coronavirus-piloted-in-southampton) **is currently being rolled out for Asymptomatic NHS staff members** . Direct RT-LAMP has an overall Technical Sensitivity of 79.74% when considering the full dynamic range of “positive” samples (RT-qPCR of CT <45).This improves to 96.61% in the cohort with a higher viral load (RT-qPCR of CT <25) on saliva samples, making it important for detecting individuals in the infectious stage rather than when the virus is being degraded and cleared by the individual.

The direct LAMP tests will allow the identification of asymptomatic NHS staff, ensuring frontline staff can self-isolate and reduce the risk of onward infection.Importantly it can detect the virus directly from saliva samples which are easy to collect and simple for the person to provide.

LAMP provides the ability to deliver significant volumes of tests (in excess of 2000 tests per machine a day) potentially adding to the NHS testing capacity.

1. **LamPORE (e.g. Oxford Nanopore GridION)**

LamPORE is an isothermal test produced by Oxford Nanopore consisting of two key stages

* Reverse Transcription Loop Mediated Isothermal Amplification (RT LAMP) to amplify the original RNA virus
* Nanopore sequencing of the viral RNA fragments for precise analysis

LamPORE combines LAMP with nanopore sequencing. Following LAMP, COVID-19 genetic material has amplified and is then detected using a sequencer. If COVID-19 is detected the sequencer returns this result to the user.

LamPORE can be deployed in two versions:

* **GridION**–high throughput desktop sequencer capable of processing up to 10,000 samples in a 12 hour shift
* **MinION**2–portable pocket sized sequencer suitable for rapid-response analyses capable of processing up to 1,000 samples per 12 hour shift

LamPORE is a precise, rapid and highly scalable assay, can be done manually or automated and requires relatively simple pipetting steps. It can be performed on both swabs and saliva – CE-marking is for swabs, but saliva has been validated and CE-marking will be updated accordingly. It performs with high sensitivity and specificity –equivalent to or greater than RT-qPCR.

LamPORE is designed to be deployed at scale for a lower cost per test than RT-qPCR to provide diagnostic testing of symptomatic individuals.

There is also a multi-respiratory panel in development, which involves no change in process or capacity when using the multi-virus assay on the same GridION.

The assay includes an internal control that distinguishes between poorly collected samples and true negatives.

1. **Lateral Flow Test (e.g. Innova Assay)**

The Lateral flow assay is a clinically validated swab antigen test that does not require a laboratory for processing and can turnaround rapid results within an hour at the location of the test. Pilots are taking place in a number of universities and schools, adult social care settings and in other high-risk workplaces and at some of the existing test centres.

Using lateral flow tests can enable the identification of infectious people who are asymptomatic, ensuring that they can isolate and prevent onwards infection. They may be able to be used to help reduce restrictions for those who test negative, in turn supporting the economy and wider society to return to a more normal way of life.

Lateral Flow Antigen testing detects the presence of viral antigen from a sample. The testis administered by handheld devices producing results in 20 – 30 mins. Lateral flow antigen testing has a lower sensitivity compared to qRT-PCR, but studies to date suggest that these tests are better at returning positive results for individuals who are infectious rather than those who may have had COVID-19 recently and are no longer infectious.

Lateral flow antigen tests are likely to be used in Population Case Detection; Care Homes, Schools, Universities and Food processing plants, or areas where DPH have identified a need in outbreak control.

1. **End Point PCR testing (e.g. e-PCR (LGC))**

The e-PCR assay design, process workflow and analytical pipeline is similar to existing qPCR workflows, the machines it is operated on are unique and operate on miniaturised qPCR like reactions making the process quicker, with greater scalability than qPCR at a very much reduced cost. The e-PCR workstream efficiently delivers at the same sensitivity and specificity as qPCR. E-PCR may be used to test high risk cases producing results in just 2 – 8 hours. Potential utilisation: NHS, Care Homes, Outbreaks.

**Whole City Testing in Liverpool:**

Everyone living or working in Liverpool are now being offered COVID-19 testing, whether they have symptoms or not, in the first pilot of whole city testing in England, made possible by the dramatic increase in testing capacity and new technologies.

The aim of whole city testing is to help support the local area to find even more people with coronavirus to control the spread of the virus and gain more data on the number of cases across the city, which are already among the highest per 100,000 in the UK. Testing began last week. Tracing is being carried out, with advice to self-isolate on positive results.

Residents and workers will be tested using a combination of existing swab tests, as well as new lateral flow tests, which can rapidly turn around results within an hour without the need to be processed in a lab. Existing test sites will be used, in addition to home testing kits, and new additional test sites will be deployed.

The pilot will help to inform a blueprint for how mass testing can be achieved and how fast and reliable COVID-19 testing can be delivered at scale.