V-KEMS Report

Test Trace and Isolate for Epidemic Control

Lessons learnt from COVID-19 in the UK and preparing for future pandemics

Contributors:

The meeting was organised by Elizabeth Fearon (LSHTM). The write up was co-ordinated by Guy Marshall (Manchester). The contribution of speakers, facilitators, organisers and breakout room participants is gratefully acknowledged.

Sangeeta Bharia (Imperial) Hikaru Bolt (LSHTM) Fergus Cumming (UKHSA) Ciara Dangerfield (Juniper) Emma Davis (Oxford) Elizabeth Fearon (LSHTM) Martin Fyles (Manchester) Deirdre Hollingsworth (Oxford) Caroline Jay (Manchester) Maha Kaouri (Newton Gateway) Guy Marshall (Manchester) Billy Quilty (LSHTM) Francesca Scarabel (Manchester) Miguel Silva (Manchester) Rigina Skeva (Manchester) Jordan Skittrall (Cambridge) Dawn Wasley (ICMS, Edinburgh) Carl Whitfield (Manchester)

"An analytical framework for test, trace and isolate in the United Kingdom for SARS-CoV-2 control" was funded by UK Research and Innovation (UKRI) Medical Research Council and National Institute for Health Research (NIHR) as a COVID-19 Rapid Response project 2020-2021 (MR/V028618/1).

This event is being organised in collaboration with the Joint UNIversities Pandemic and Epidemiology Research (Joint UNIversities Pandemic and Epidemiology Research (JUNIPER)) consortium, which is a consortium of epidemiology modelling and statistics groups from across eight universities in the UK. COVID-19 rapid response grant (MR/V038613/1)

WARNING: this report contains preliminary findings that have not been peer reviewed. The findings are intended to provoke further study and policy discussion and should not be treated as definitive scientific advice in response to the SARS-CoV-2 epidemic.

Whilst we expect these principles to help others formulate coherent and consistent guidelines, time has prevented any quantitative study of their effectiveness. This could be undertaken, but would require real data and time to build more detailed simulation tools. Thus, we are not able to make specific recommendations from the principles, e.g. we cannot infer that it is safe to do X if you follow principle Y.

Additionally, this report has been assembled in a short time frame, we have made every effort to ensure references and links are present. Where this is not the case, we apologies for the unintentional oversight.

Contents

List of Acronyms

COVID-19 Coronavirus disease 19

HIV Human Immunodeficiency Virus

JUNIPER Joint UNIversities Pandemic and Epidemiology Research

KPI Key Performance Indicator

LFD Lateral Flow Device

LSHTM London School of Hygiene and Tropical Medicine

LTLAs Lower-tier local authorities

NIHR National Institute for Health Research

OU University of Oxford

PCR Polymerase Chain Reaction

SARS-CoV-2 Severe Acute Respiratory Syndrome Coronavirus 2

TTI Test Trace and Isolate

UKHSA United Kingdom Health Security Agency

UKRI UK Research and Innovation

UoM University of Manchester

VoC Variant of Concern

1 Background

Testing, contact tracing and isolation (TTI) strategies have been utilised in many settings as part of efforts to manage the COVID-19 pandemic through reducing, or as far as possible preventing, transmission of SARS-CoV-2. Test Trace and Isolate (TTI) approaches and goals have differed depending on the epidemic phase, particular challenges and overall epidemic management strategy, e.g. between those countries aiming for zero or near zero transmission within their borders versus those framing their objectives, explicitly or implicitly, around keeping cases to a level not devastating to healthcare system capacity. Unlike untargeted transmission control interventions that require the whole, or large sections of society to dra-

matically reduce their social contacts, which governments have tried to achieve via school, leisure, home-working or stringent limits on private gatherings, TTI interventions aim to specifically target individuals who are known (or suspected) to have been exposed to the virus, and prevent contacts between the identified infected individuals and those still susceptible. Identified cases are asked to isolate in order to prevent further transmission; contacts they have had while potentially infectious are traced and asked preemptively to quarantine away from others whom they could infect, should they have been exposed.

This half-day workshop convened front-line healthcare researchers, academic modellers, and policy makers in December 2021 to consider:

1. What have we learned about TTI for control of COVID-19 since January 2020?
2. How should TTI be considered as part of managing the epidemic in the UK for the next 6 months, and going forward?
3. What learnings about TTI could be applied to future epidemic management of other diseases?

Pandemics are fast-moving emergency situations, in which top-priority policy questions, including those relating to TTI, can shift quickly depending on the current status of the epidemic. This situation was illustrated very well across the time frame for the planning, hosting and documentation of this workshop. Workshop planning occurred over early Autumn 2021, when in the UK, there was concern about to what extent infections during the ongoing Delta variant wave would translate into cases requiring hospital care, serious morbidity and mortality, particularly at a time when the NHS was trying to catch up on the backlog of treatment displaced over the previous 18 months. There was a high level of concern also about the economic, social and educational trade-offs of more stringent transmission control measures, and isolation for double-vaccinated and child contacts of cases had been ended in August 2021.

In the two weeks preceding the workshop, the rapid identification and wave of Omicron infections observed in late November in South Africa quickly shifted concerns about COVID-19 control in the UK, with much faster growth suddenly anticipated, alongside uncertainty around the implications for serious outcomes and hospital capacity. TTI policy, particularly as it pertained to international arrivals, what could be expected of TTI in the face of rapid epidemic growth, and the use of testing to prevent exposures to vulnerable individuals came to the fore again.

Writing as of April 2022 when the Omicron wave fortunately did not lead to some of the more severe potential scenarios in the UK, and legal mandation for case isolation has been ended,

along with access to free testing for most of the population, the epidemic context, and political context has shifted again.

However, it has been apparent to those involved in the epidemic response, that the same questions about TTI policy can tend to re-surface. Concerns about delaying the spread of new variants via arrivals policy are re-visited upon the emergence of new variants. Concerns about mitigating against the severe outcomes of a rapid rise in infections could become pertinent again due to waning immunity, particularly amongst those most vulnerable to severe disease, seasonal dynamics and potential viral evolution. The long-term dynamics of SARS CoV-2 are not yet known, so considering what TTI tools in which setting will be effective, but also proportionate, for a range of scenarios remains important.

It is also critical that we translate learnings about TTI for control and management of the COVID-19 pandemic to future epidemic threats. Valuable early work highlighted likely difficulties with some forms of TTI for control of an infection with the epidemiological profile of SARS CoV-2: pre-symptomatic transmission, wholly asymptomatic or pauci-symptomatic infections, short generation times, and high transmissibility. Approaches including backwards tracing or focused cluster detection and fast electronic tracing have been used to mitigate some of these challenges. However, experiences have also highlighted the social context in which infections are concentrated and TTI is to take place, as critical to its effectiveness. More work could be done to build on previous work to develop a framework for assessing TTI effectiveness for control of novel infections.

This half-day workshop involved four short talks, with brief Q&A, followed by two facilitated breakout sessions, which were documented using Mural and are reported in this paper. Attendees were all involved in TTI-based pandemic analysis in the UK, and included front-line healthcare researchers, academic modellers, and policy makers. Reporting is organised into the three central questions above posed and discussed at the workshop, with both presentations and workshop discussions reported (questions 1 and 2 discussed together), and key recommendations highlighted.

2 What have we learned about TTI for control of SARS-CoV-2?

This section summarises the four presentations which immediately preceded the two workshop groups. Each presentation was 10 minutes. Elizabeth Fearon, London School of Hygiene and Tropical Medicine (LSHTM), led the design of the workshop, and introduced and led the sessions.

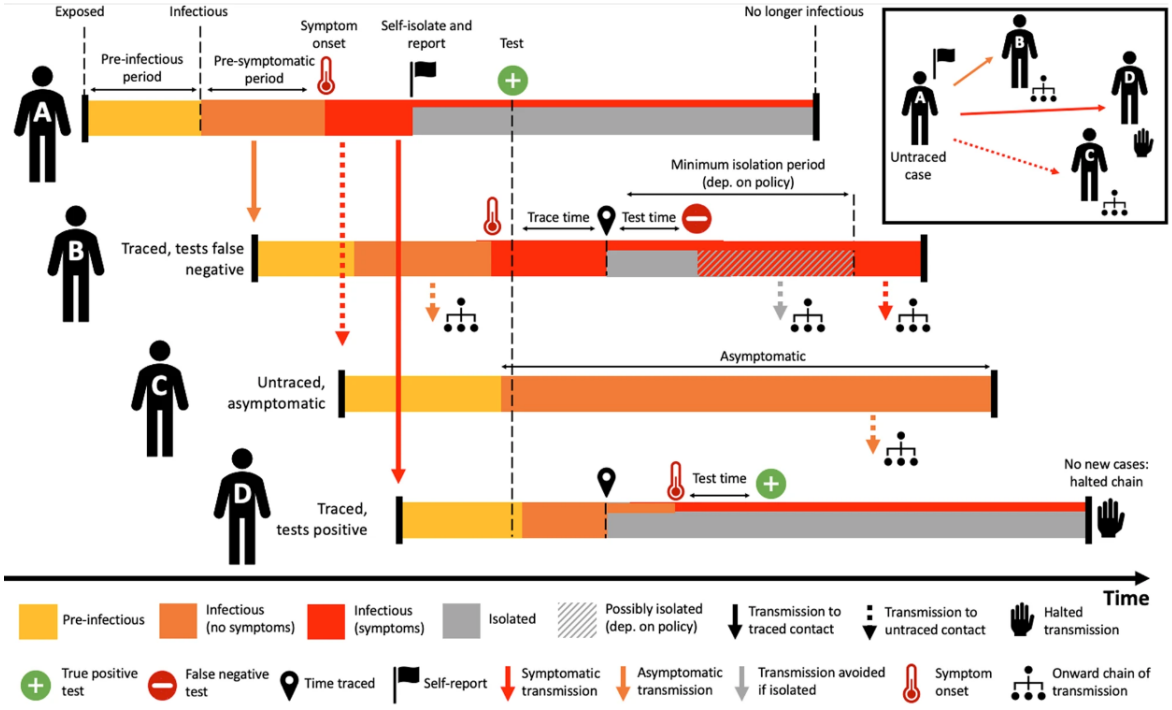

Figure 1: Overview of a contact tracing process implemented in modelling. Reproduced from "*Contact tracing is an imperfect tool for controlling COVID-19 transmission and relies on population adherence*" (Davis et al., 2021) under CC-BY 4.0

Beginning the workshop, Emma Davis, researcher at the University of Oxford Big Data Institute, presented a summary of key points that we had learned about making TTI effective for controlling SARS-CoV-2 University of Oxford (OU) *What did we learn about effective TTI in the early-mid epidemic phase?*. She reviewed early work indicating the need for speed to prevent onwards infection from exposed contacts, which helped to motivate digital tracing. As experience and numerous modelling studies have indicated, TTI alone cannot be relied upon to reduce transmission alone, but could be useful applied alongside other measures. The talk also highlighted approaches to improve efficiency, such as taking advantage of household structure and other clusters, backwards tracing to find infectors and their infectees and underscored to importance of identifying a high number of index cases. Figure 1 shows an example of a contact tracing process implemented in modelling. Davis also addressed the importance of considering perverse outcomes in the interaction between presence of disease-related restrictions and reporting of disease if policies to legally mandate isolation were to reduce reporting. Behavioural factors were discussed, including both the difficulty of modelling these factors and their variability over time. The talk then moved to considering the aims and utility of modelling. During an evolving pandemic, one of the major challenges is that pertinent questions, and priorities, can change at very short notice. This can result in a trade-off between generating models useful in the short-term, versus taking time to refine these models. Utility of near-real-time modelling can be impacted by access to data streams.

3 What factors will be important in considering the use of TTI in the UK's COVID-19 response over Winter 21/22 and in the medium term?

Following Davis' summary of what we had learned so far, Fergus Cumming, United Kingdom Health Security Agency (UKHSA) *What are important considerations/applications of TTI in the medium term (next 6 months) in the UK?* considered priorities and challenges moving forward from a policy information perspective. This talk started by considering the impact of TTI on transmission in the various pandemic phases to date. An assessment of NHS Test and Trace shows that it had contributed significantly to the reduction in transmission. Analysis of the mass asymptomatic testing evaluation carried out in Liverpool, while highlighting differences in uptake across the population, did show evidence for having reduced hospitalisations (link). Longer term questions, such as is (expensive) testing providing good value, and how should the wider TTI landscape (such as the app, contact tracing, self-isolation, symptoms communication) evolve through time, were highlighted and briefly considered. An increased evidence

base was advocated, such as around testing to treat (e.g. complementing with antivirals), to protect in high transmission or high risk settings, and for surveillance (e.g. wastewater). The talk concluded with comments on challenges posed by the Omicron variant, especially for decision-makers translating research into practice.

Guy Marshall, University of Manchester (UoM) addressed *Why should we, and how can we, involve the public in pandemic response research such as the TTI project?* This talk described results of a qualitative study and subsequent modeller input, sharing insights from engaging with the public about modelling assumptions. Key results focused on impacts for modelling, and included suggestions to incorporate clustering and heterogeneities across the population, time-based behavioural changes, and identifying research priorities to support personal risk management strategies, e.g. Pre-contact testing, Informal tracing, Supporting personal cost-benefit trade-offs. It was noted that qualitative studies such as this are useful for challenging assumptions used in modelling.

4 Workshop Group 1 Discussions: Past and Present

A discussion group considered past and present challenges for TTI control of SARS CoV-2 jointly. Several challenges were highlighted, along the theme of it being challenging to know what interventions work, particularly in terms of uptake, adherence and compliance. Ecological approaches to assessing effectiveness are fraught with problems of confounding.

4.1 Evaluating TTI

The group discussed difficulties in the post-hoc evaluation of TTI policies. The various English Lower-tier local authorities (LTLAs) differed in their approach to pandemic management and employed a suite of interventions to control transmission. The simultaneous deployment of multiple interventions makes it challenging to disentangle the effect of individual measures or interventions. There were international variations in TTI (e.g., UK vs. Australia), TTI was did not appear to work well as well in UK, needing resource and uptake. However comparisons between countries are challenging due to different overall objectives, accompanying policies, and different epidemiological contexts and populations.

The group also highlighted key aspects of policy implementation whose evaluation could have assisted with efforts to understand likely effectiveness, including modelling-based analyses. For instance, possible trade-offs for the public in self-swabbing were discussed. It was noted

that self-swabbing has been shown to be as effective as healthcare workers performing the swabs (link). However, some people are taking the tests incorrectly, causing pain. Participants also noted the need to account for stress of frequent tests.

RECOMMENDATION: Modellers need more studies like the longitudinal "Assessment of Transmission And Contagiousness of COVID-19 in Contacts" (ATACCC, link), which daily swab highly-at-risk individuals (e.g. contacts of cases) as soon as possible after exposure and Polymerase Chain Reaction (PCR) test to get contact tracing values. A particularly useful research would be to conduct daily Lateral Flow Devices (LFDs) to compare, and collect symptom diaries, and link to contact tracing data to make inferences about secondary attack rates. These studies should be ongoing to ensure we can stratify by age, past infection, vaccination status.

RECOMMENDATION: As second-best to the above recommendation, examination could be undertaken across more repeat-testing data streams, ideally linking with contact tracing data.

A major limiting factor in evaluating TTI in the UK has been understanding how many people use LFDs. The difficulty in assessing issues with logging tests (especially negative) was noted. Participants felt this omission could warrant a questionnaire, potentially as part of the CoMix Study or the ONS Community Infection Survey.

RECOMMENDATION: Consider adding a test logging difficulty question to CoMix or SIS studies.

4.2 NHS App

In schools, positive cases in a class are sometimes not reported to the school, with parents relying on the app instead. This leads to a question: Is reliance on the app desirable? In schools, it may be that reverting to the 'old way' where bubbles test is sensible. It was also noted that some schools are doing their own contact tracing programme, which is not centrally captured.

Many people have uninstalled the NHS app as they have lost confidence. The app would potentially be useful if people found it usable, but not very likely that they'd want to. The drop in use of NHS app after the 'Pingdemic', when there was a spike in the 20-34 age group following the Euro 2020 football tournament held in June-July 2021, was felt irredeemable.

4.3 Other Questions

The questions here are listed as potential future research topics which may be useful for improved TTI modelling and effectiveness.

- How does the infection period interact with TTI; how does the timing of infectiousness correlate with different tests' sensitivities?
- For new variants, especially Variant of Concern (VoC)s: How does the infectious period change, how does this relate to changes in test sensitivity over the course of infection and how does this change relative to characteristics and timing of symptoms? (included in this question is also generation time, which should be a result of viral load trajectories and measures to control transmission?). Note that social care data has good sample size and reliable data for Contact Tracing, which can be used for viral load. Relevant studies include Kissler et al., and premier league testing (link).
- What kind of informal contact tracing have people been doing (e.g. using messaging services such as WhatsApp) and how effective might this be? Further, could we document and assess this as part of future public engagement?
- Can we decrease our reliance on symptoms to initiate contact tracing?
- What is the potential (theoretical and practical) for a mass synchronised testing event in slowing a fast-growing epidemic - e.g. get everyone to test on the same day. This could be akin to Slovakia's test-to-be-released-from-lockdown approach in Autumn 2020 that analysis found to have a large effect.
- How should we consider TTI for Rapid Treatment? For example, the antiviral molnupiravir needs to be administered relatively early in the disease lifecycle to be effective, and it is therefore important to identify cases among more vulnerable individuals quickly. However, there are possible issues in interactions with other drugs which may make this approach less useful in settings with vulnerable individuals who may be on other medication.

4.4 Ideas

Several other ideas were discussed, reflecting the context of the workshop (early December, with Omicron emerging and with a wide range of possible scenarios regarding hospitalisations and death considered plausible). They are not necessarily recommendations, but

were presented as ideas perhaps worth exploring for this and similar contexts to slow a fast-growing variant of unclear epidemiological impact:

- Encourage informal contact tracing and testing.
- Daily testing of contacts could be useful.
- A synchronised testing intervention could be useful to reduce transmission, whereby the public are all advised, through media, to take a test. This could be similar to surge testing, but on a national level.
- Send tests (box or single test) to every home. There was concern about cost and availability of tests.
- Making more use of employers: There is potentially a big role for workplaces to play in TTI. For example, people may be more likely to comply if recommended to test regularly by employer, and employers hold lots of relevant contact information which could aid in contact tracing.
- Review TTI strategy during previous VoC: Learning from control of earlier VoC in the UK in the Spring 2021 (e.g. Beta, Gamma) is challenging at present because the measures that were employed were (understandably) heterogeneous. We have not yet attempted to document what happened in different circumstances.

RECOMMENDATION: Assess whether it might be feasible and useful to conduct more thorough investigations into the effectiveness of Beta and Gamma VoC control interventions. This could be challenging due to documentation, and the extent to which findings would be transferable given the restrictions on social contacts at the time. However, any investigation might help researchers to understand more about the process.

RECOMMENDATION: A systematic review of different contact tracing protocols for Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) from around the world could be conducted, covering how systems were set up, different Key Performance Indicator (KPI)s, and effectiveness studies.

5 Looking to the future: a framework for considering what factors determine the effectiveness of TTI in controlling an epidemic

Towards applying learnings from TTI for COVID-19 control to future epidemics of unknown pathogens, Francesca Scarabel, UoM considered *How might we think about what characteristics affect the likely success of TTI in controlling an epidemic*? Infection characteristics, timing, and societal structure were highlighted as key considerations in modelling used to inform TTI strategies. Actions were recommended to prepare, such as to: (i) Set up surveillance protocols to collect the necessary information quickly, efficiently and as exhaustively as possible (e.g. FF100 for early influenza cases, see link) (ii) Understand society: behaviour, core groups, movement and contacts, socio-economic status (iii) Understand technology: how quickly and broadly can we communicate with the public and build up trust (iv) Develop models that can answer the questions we might expect from policy makers, such heterogeneous contacts, clustered society, enclosed settings, or core groups. For further reading, see link.

6 Workshop Group 2 Discussion: Future epidemics

6.1 Topics

The topics discussed were broad ranging, and mostly “system level”. Topics included modellers’ needs for access to data for research, the composition and capabilities required in future modelling teams, and the need to better understand behavioural aspects. Also discussed was the opportunity to use findings from this experience to inform interventions and modelling of other diseases.

6.2 Access to Data for Research

There was a lengthy discussion about data access. Modellers would like access to real time data, ideally as a stream, and at a granular level, to be able to answer a range of questions. It was noted that second-order effects, such as benefits of interventions, are hard to measure. Richer and more granular data could help with this.

More broadly, participants argued for better data collection, make data open by default to al-

low researchers to think about what else is needed, and what can be done with what is available. It was noted by some participants that the UK is perceived by many as having relatively good data accuracy and availability, compared to other countries. It was also suggested to design projects to follow data from point of generation to where it translates into policy (see Section 6.3). There was a need expressed for real time metrics about the current state of the pandemic. The discussion noted potential bias, and risk of relying on Key Performance Indicators KPIs. It was also commented that any existing KPIs may also reduce willingness to incorporate new information, so a method for updating KPIs based on the situation would also be recommended to reduce this potential limitation.

RECOMMENDATION: Explore options for creating data infrastructure for researchers to access anonymised data relating to the pandemic, including contact tracing and test results, at the most granular level feasible (in both time and location).

6.3 Modelling Team Composition and Capabilities

Teams should have interdisciplinary skills and diversity. This is especially relevant when making decisions or assumptions about behaviours of members of the public. In terms of building capability of modellers, it was suggested to ensure modellers have access to the experience of those on the healthcare front-line, with the aim of improving their understanding of the system as quickly as possible. In addition to building social connections between different expert domains, this could help inform modelling assumptions and potential issues by increasing the front-line domain knowledge of the modellers.

There was also discussion about “problems no-one owns”, those that fall within gaps in the process. Of particular concern was the lack of visibility, including resolution of any issues. A suggestion was to “follow the data” from creation through to policy decision, which could aid in identifying unknown gaps.

RECOMMENDATION: Give modellers exposure to those engaged in healthcare settings regularly, and foster inter-disciplinary relations by facilitating more interdisciplinary workshops (targeting academics, public health practitioners and officials) etc.

RECOMMENDATION: Ensure teams are diverse. This is a generally good practice and particularly relevant where it is necessary to make assumptions about behaviours of the public, as in modelling pandemics.

6.4 Behavioural Science

As with the other workshop group, behavioural aspects were discussed as being a key aspect of TTI, both for modelling but also for the effectiveness of TTI interventions.

RECOMMENDATION: Fund research into priority topics to understand:

- Adherence to government policies
- Management of policy changes through time. There is a balance between having flexibility to respond to change, and causing confusion by having policy changing. It was noted that, once set on a course, it is hard to change initial policy without impacting trust.
- Gaps in data and processes. For example, tracking the process of data being generated through to policy decision-making, to identify gaps and assign ownership as required.

6.5 Other Infections and Diseases

A further topic arising in discussion was "what can contact tracing for COVID-19 teach us about other infections/diseases?", and especially use of digital contact tracing for other diseases. Parallels with Human Immunodeficiency Virus (HIV) were discussed. Several participants had previous experience in HIV interventions, and suggested looking at earlier stage discussions about HIV testing.

RECOMMENDATION: Investigate using learnings about TTI for COVID-19 to inform strategies for digital contact tracing to support control of other diseases such as HIV.

7 Reflections on TTI at Different Pandemic Stages

One of the main themes arising through the session was how TTI differed in the various stages of the pandemic. This is reflected both in the presentations and the workshops. **RECOMMENDATION:** Consider the effectiveness of TTI interventions in context, and plan an adaptive approach.

8 Recommendations Summary

The workshop can perhaps be summarised in three recommendations.

RECOMMENDATION: Improve understanding of behaviours. This relates to having relevant research, rich data about the public and means for their engagement, and good monitoring of (and reflection on) interventions. Further research is required, especially examining previous interventions and encompassing other potential data sources such as informal contact tracing.

RECOMMENDATION: Improve researcher access to data. This includes design of data collection studies around DIY contact tracing, and commissioning studies to understand these important but centrally undocumented aspects of TTI. Whilst the UK has good quality data, workshop attendees advocate for sustained investment in public health data infrastructure, and in processes to allow researchers to safely access this.

RECOMMENDATION: Improve inter-disciplinary collaboration and communication. This includes between researchers and those implementing policy, and also between researchers and the public, and researchers and front-line workers. Researchers and policy makers also could benefit from improved ways of working, to help researchers anticipate the needs of policy makers, enabling rapid and policy-relevant research. Workshops, secondments, interdisciplinary projects, and encouraging diverse teams (in terms of demographics and expertise) may support this.

9 Concluding Remarks

This document captures the discussions in a workshop reflecting on TTI during the COVID-19 pandemic, attended by TTI specialists involved in UK pandemic response. Capturing lessons learned is important, not just for the ongoing pandemic but also for future pandemics. Key challenges have been identified which, particularly if undertaken in advance, could improve the effectiveness of TTI in the management of future pandemics.

ICMS
The Bayes Centre,
47 Potterrow
Edinburgh, EH8 9BT

Email: knowledge.exchange@icms.org.uk
icms.org.uk
@ICMS_Edinburgh

Contact Person
Dawn Wasley
knowledge.exchange@icms.org.uk