UK Health Security Agency

Supplementary paper – modelling the impact of daily testing for contacts of COVID-19 cases (DTCC)

Project lead	Stephen Finer
Contact testing programme	Nick Sharp
Evaluation and Social Research	Ashley Goddard, Toby Nonnenmacher, Jack Hulmes, Matt Barnard, Marcus Ward, Emily Wolstenholme
Customer, Communications and Innovation	Gill Hayes, Georgiana Brown, Rose Hadden, Cheryl Hart
Advanced Analytics	Luke Hounsome
Public Health and Clinical Oversight	Tom Fowler, Sarah Tunkel
Specialist advice for impact analysis	Tim Peto

Contents

Executive summary

The policy

Daily Testing for Contacts of COVID-19 (DTCC) was launched on 14 December 2021 as part of the response to the emergence and rapid transmission of the Omicron variant of coronavirus (COVID-19). The policy ended on 25 February 2022 when formal contact tracing ceased as part of the UK government's Living with COVID-19 strategy.

The DTCC policy applied to close contacts who were not legally required to self-isolate (predominantly those adults who were fully vaccinated or children between the ages of 5 and 18). It took the form of non-mandatory guidance for this group to take daily lateral flow device (LFD) tests:

- every day for 7 days or
- until 10 days since last contact with the person who tested positive for COVID-19

If they tested positive, they were required to follow the self-isolation policy for COVID-19 cases.

This report

This report is a supplementary technical annex to the full DTCC evaluation report. It describes a theoretical model that provides a means by which the impact of the DTCC policy can be estimated.

The model is based on a representation of the real-life implementation of the policy and incorporates the findings from other elements of the evaluation. However, by necessity it includes a number of approximations and assumptions.

As well as providing an assessment of this policy, it also sets out a mechanism for modelling that could be used to assess (perhaps prior to policy launch) the impact of similar testing regimes in the future.

Impact of DTCC

The model indicates that DTCC may reduce onwards infection from close contacts by 2.5% compared to the PCR testing of close contacts policy that was in place prior to the launch of DTCC. This suggests that, if the costs and capacities of the 2 testing policies were equal, DTCC would be the better policy to enact in order to achieve maximum reduction in disease transmission and best value for money. Compared to a theoretical no testing scenario DTCC was estimated to lead a 12.3% reduction in onwards infections.

Sensitivity analysis

The analysis showed that DTCC remains more impactful in terms of reducing transmission than PCR testing of close contacts if LFD sensitivity is as low as approximately 60%. Therefore, if LFD testing were also cheaper to implement than PCR testing, DTCC would remain the better option under these circumstances.

However, if LFD sensitivity were to fall below 60%, either uptake of DTCC would need to be improved to have an equivalent impact compared to PCR testing of close contacts, or a balanced decision would need to be made weighing up difference in the cost of operating an at home LFD testing service compared to a wider PCR testing service.

The sensitivity analysis has also demonstrated the importance of quick contact tracing, with DTCC shown to be most effective when occurring on days 2 to 8 relative to the contact event. This finding remained consistent various LFD sensitivity scenarios.

1. Introduction

The Daily Testing for Contacts of COVID-19 (DTCC) policy ran from December 2021 to February 2022 and consisted of guidance for close contacts to test daily with lateral flow devices (LFDs) for a period of 7 days. The DTCC evaluation covers 3 main topic areas: testing demand, uptake of the testing and impact (in terms of transmission). While it is possible to directly measure some aspects of impact in terms of cases detected, it is harder to directly measure the quantity and impact of broken chains of transmission (that is cases that have been prevented from occurring). We have therefore developed a theoretical model that provides a means by which the impact of the DTCC policy can be estimated, relative to other contact testing policies. This report details that model in full and is a technical annex to the full DTCC evaluation report (which draws upon the model findings in its conclusions).

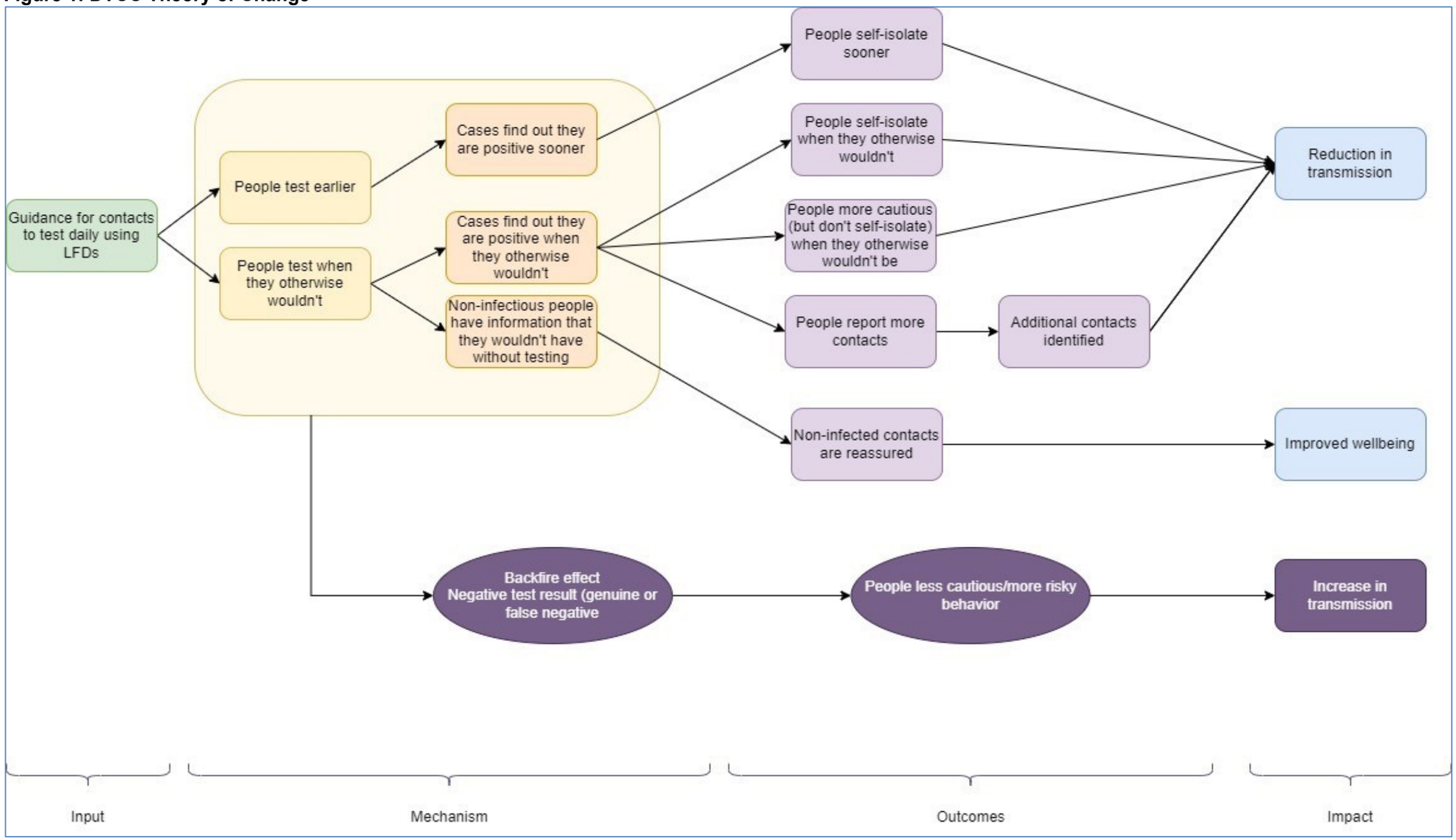
The model is based on a representation of the real-life implementation of the policy and aims as far as possible to incorporate the learnings from other aspects of the evaluation. However, by necessity the model includes a number of approximations and assumptions, either due to lack of data availability or for ease of development and interpretation. In this respect, it provides a less accurate assessment of impact than an experimental or quasi-experimental approach. But, given the real-world circumstances under which the policy was introduced, it provides a reasonable quantification of the impact the policy has. Perhaps more importantly, it also provides a mechanism for modelling that could be implemented to assess (perhaps prior to policy launch) the impact of similar testing regimes in any future pandemic.

2. Modelling methodology

2.1 Theory of change

In order to fully understand the DTCC policy, and the mechanism through which its impact brings about the desired outcomes, we have developed a theory of change (which is presented in Figure 1). This shows primary positive outcomes of reduction in transmission and improved wellbeing, and a potential 'backfire' effect that may lead to an increase in transmission.

Figure 1: DTCC Theory of Change



Text explanation of Figure 1

The model follows the flow: Input leads to a Mechanism, producing an Outcome and a resulting Impact.

The Input for the Theory of change model is the guidance for contacts to test daily using LFDs. This results in 2 alternate Mechanism options: the first being that people test earlier and cases find out they are positive sooner than they would have, the Outcome being that people self-isolate sooner, leading to the Impact of a reduction in transmission.

The second Mechanism is that people test when they otherwise would not, allowing cases to find out they are positive when they otherwise would not, and non-infectious people have information they would not have had without testing.

The Outcome for positive cases is that they will either self-isolate or behave more cautiously (but not self-isolating) when they otherwise would not have. The Impact of both is in a reduction in transmission. A further Outcome of Cases testing positive is that they may report and identify more contacts, also with the Impact of a reduction in transmission.

The Outcome of non-infectious people testing and having this information, that they would not have without testing, is that non-infected contacts are reassured, with the Impact of improved wellbeing.

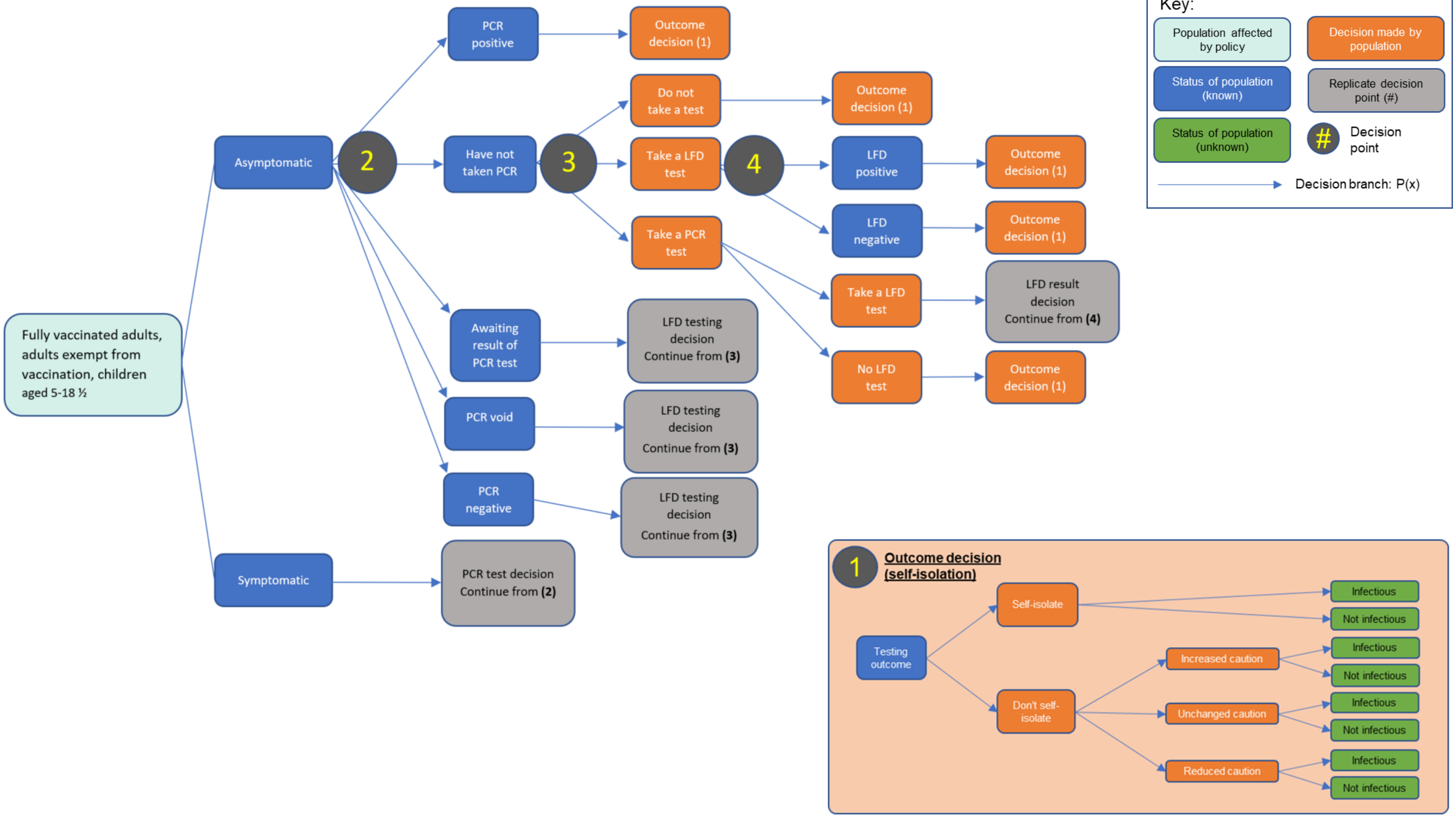
A further possible Mechanism people following the DTCC guidance is the ‘backfire’ effect of negative test results (whether these are genuine or false negatives); the Outcome of this is people exhibiting less cautious/more risky behaviour and the ultimately Impact is an increase in transmission.

2.2 Decision tree

The theory of change considers the overall impacts of the DTCC policy. In reality, the success or otherwise of the policy depends on the decisions taken by an individual on a daily basis, based on the information they have about their infection status, as whether or not to self-isolate.

Expanding on the theory of change, we have derived a detailed decision tree that describes potential testing scenarios and consequential decisions that must be taken by a user each day, resulting in compliance or non-compliance with the DTCC policy guidance (Figure 2). A user would ‘move’ through this tree and eventually reach the end where a decision is made to self-isolate or act with more/less/unchanged caution, the likelihood of each action being a direct consequence of the information acquired early in the decision tree, principally symptom status and test result(s). The consequence of the full set of decisions is then determined by whether someone is infectious or not (that is whether they have COVID-19 and are in the infectious period).

Figure 2: Full decision tree



Text explanation of Figure 2

The full decision tree sets out that the guidance applies to fully vaccinated adults, those adults exempt from vaccination and children aged between 5 and 18.5 years. It considers a single day and the various permutations of being symptomatic or not, whether (or not) to take an LFD or PCR test and the decision on how to act on the results of the test. The ultimate aim of the tree is to set out the decisions and action that individuals can take, whether they are infectious or not.

The decision tree steps through a number of decisions.

Outcome Decision Point 1 is described in a separate frame and referred to repeatedly throughout the decision tree, with all decisions being made by individuals who are either infectious or not infectious. A testing outcome leads to a decision to either self-isolate or not. Those who self-isolate are either infectious or not infectious. Those who do not self-isolate may either act with increased caution, unchanged caution or reduced caution. People following all 3 of these routes are either infectious, or non-infectious – the end-points of the model.

At the start of the decision tree participants are either asymptomatic or symptomatic.

Asymptomatic people start at Decision Point 2 which has 5 options that apply to them on that day:

- PCR positive result received – then stepping to Outcome Decision Point 1 (previously described)
- Not taken a PCR test – this leads to Decision Point 3
- Awaiting result of PCR test – this leads to Decision Point 3
- PCR void result – this leads to Decision Point 3
- PCR negative result – this leads to Decision Point 3

Decision Point 3 has 3 options:

- Do not take a test – leading to Outcome Decision Point 1 (previously described)
- Take an LFD test – the LFD result will be either positive or negative, both options leading to Outcome Decision Point 1 (previously described)
- Take a PCR test. (As the PCR result is not immediate) the participant also then decides whether or not to take an LFD test – the result will be either positive or negative, both options leading to Outcome Decision Point 1 (previously described). If they decide not to do an LFD test, they then move directly to Outcome Decision Point 1 (previously described)

Symptomatic people start the decision tree by deciding whether (or not) to take a PCR test. They then face the same decisions and alternate courses of actions as asymptomatic people, from Decision Point 2 described above.

(End of text explanation)

Our desired modelling approach is to capture the impact of daily decisions, and how the influencing factors change over the course of time when an individual is a contact and taking action as a result of being a contact. This full decision tree has too much complexity to incorporate into a model. There are a number of branches which would be relevant for only a very small proportion of participants and a significant amount of repetition and redundancy between branches which can be aggregated and simplified.

To produce a final model, complexity is reduced by:

- considering the decisions of only those individuals who are infectious (the output measure is onward infections, which cannot be caused by uninfected/non-infectious individuals)
- not considering the potential for void PCR results (which are relatively rare, typically less than 5% of all PCR tests taken[1])
- not considering the time it takes for a PCR test to be processed and the result returned (that is no differentiation between having no PCR tests and awaiting a PCR test)
- assuming that if both a PCR and LFD test is taken, the PCR test takes precedence in decision making and the onward decisions are the same as those if just a PCR is taken (that is no added information from the additional LFD)

In addition, because neither DTCC, nor the PCR testing of close contacts policy to which DTCC is compared, required self-isolation of close contacts, we do not need to include the impact of self-isolation.

2.3 Model design

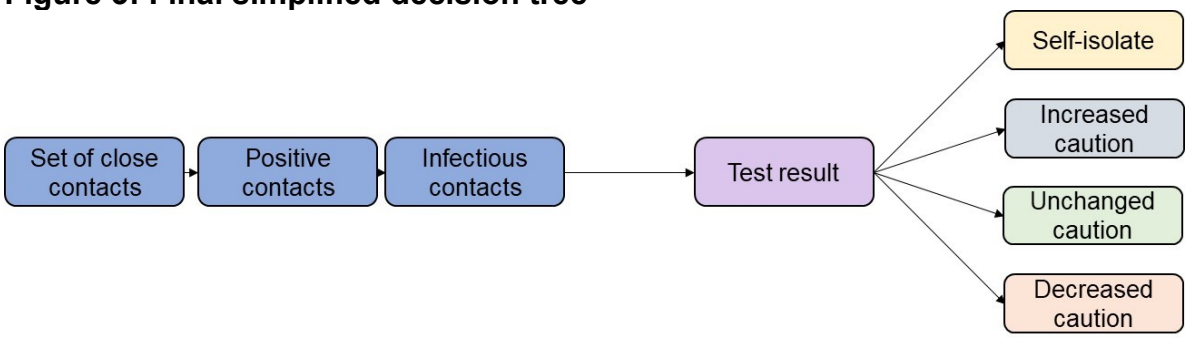
The final simplified model is presented in Figure 3. The starting point is the total contact population, from which a number of those who are infectious is derived from a given prevalence and progression of infectiousness. The group of infectious contacts are then split into different groups, first by symptom status and then by test type and result to determine what status individuals will be in (on a particular day). From there the model determines the number of individuals in each groups whose behaviour falls into one of 4 categories: self-isolation, behaving with increased caution (compared to their standard behaviour), behaving with decreased caution and no change in behaviour.

The number of likely onwards transmissions is then calculated using the number of individuals displaying each behaviour and the reproduction (R) rate of COVID-19 (which is adjusted to

[1] Weekly statistics for NHS Test and Trace (England): 5 to 18 May 2022 Tests reported: 28 May 2020 to 18 May 2022. Viewed on 30 May 2022

reflect the risk of each behaviour). The final output is the sum of the total number of onwards transmissions for each day within the period being considered.

Figure 3: Final simplified decision tree



Text explanation of Figure 3

The decision tree moves through the following steps:

1. Set of close contacts, leading to
2. Positive contacts, leading to
3. Infectious contacts
4. Following the guidance to take a test will produce a test result. Depending on the test result, one of the following actions is taken:

- self-isolate
- increased caution
- unchanged caution
- decreased caution

(End of text explanation)

A key factor in the implementation and success of DTCC is that the daily testing regime may happen at different times for different people, due both to the variability in the time it takes for successful contact tracing, and also due to variation in the incubation of disease and subsequent infectiousness. As a result, there are 2 overlapping and interacting timelines for any individual who could participate in DTCC (the disease onset timeline and the contact tracing and testing timeline).

Our model covers the entirety of the 14-day period from the day of exposure to the last day on which an individual might be infectious. It would therefore cover any infections that may occur prior to contact tracing, and the likely full period of 10-days of isolation or 7-days of testing. The model can be adapted to assess the likely benefits of a variety of contact testing policies and target populations. In this analysis we build 2 distinct versions of the model: one for the DTCC policy, and one for the PCR testing of close contacts policy, which was the policy in operation immediately prior to DTCC. The different models are achieved by varying the input parameters within the same model structure, primarily those related to taking PCR/LFD tests

and their subsequent results. The outputs are then used to provide a comparative estimate of the effectiveness of the 2 policies in terms of onwards transmissions.

2.4 Time period

The modelling approach is to assess the difference between the 2 contact testing policies of DTCC and PCR testing of close contacts (which immediately preceded DTCC) if they were applied to a constant set of close contacts with a defined set of characteristics.

The model parameters for PCR testing of close contacts are derived from real world data from November 2021, which was the last full month that this policy was in place. The data used for DTCC is from January and February 2022, the latter half of the time period for when this policy was live.

It is important to emphasize the modelling does not attempt to estimate the number of onwards transmissions that did occur during November 2021 and January/February 2022. These 2 time periods had very different characteristics, for example different COVID-19 prevalence, different predominant strain, different contact reporting and so on, which would strongly influence any attempt to accurately model the real-life scenario and making it difficult to assess directly the impact of the contact-tracing policies.

3. Model parameters

The model is based on a decision tree, where each branch of the model represents a probability. Running the model converts an input number of close contacts, and splits these into one of 4 behaviours according to the probabilities supplied by the model.

There are broadly 3 sets of parameters used in the model which are:

- static parameters – these are not impacted by contact tracing policy (for example the probability of self-isolating on receipt of a positive test result) and are used in both versions of the model
- PCR testing of close contacts parameters – these are used to represent the testing policy in place from March to December 2021, where close contacts were offered a PCR test regardless of symptom status
- DTCC parameters – these are used to represent the daily testing of close contacts policy in place from December 2021 to February 2022

3.1 Static parameters

These input parameters are kept consistent between both the PCR testing of close contacts and the DTCC model and are broadly those that relate to the population of close contacts being modelled. They determine how many close contacts will be considered by the model, the infectious profile of these contacts and their actions on receipt of certain test results.

3.1.1 Contact population parameters

These are the basic input parameters to the model. For ease of interpretation of the outputs we start with a population of one million close contacts. For an idea of scale, at the height of the Omicron wave in January 2022 there was a peak of 1,077,182 close contacts transferred to the contact tracing system in a single week, approximately four times the weekly number from November 2021[2].

Wider findings from the evaluation suggest close contact positivity rates of 15 to 20% (14% of fully vaccinated contacts in the ONS self-isolation compliance contacts survey reported testing positive for COVID-19, asymptomatic positivity of contacts reached by contact tracers was consistently between 10 to 20% between March and August 2021). Therefore we assume a baseline positivity rate of close contacts of 20%.

[2] Weekly Statistics for NHS Test and Trace (England): 3 to 9 February 2022. NHS Test and Trace statistics 28 May 9 February 2022: data tables. Viewed on 31 May 2022.

Table 1: Model input parameters – contact population

Parameter	Baseline value	Source
The number of close contacts identified	1,000,000	CTAS
Positivity rate of close contacts?	20%	ONS self-isolation compliance contacts survey, UKHSA data analysis

3.1.2 COVID-19-safe behaviours parameters

These parameters determine the proportion of contacts in the model that will behave in a certain way given the presence or absence of a test result; for example the proportion of people who will isolate if they have a positive test result. We make an assumption that final behaviour is determined by test result alone (that is no adjustment is made for the presence or absence of COVID-19 symptoms or test type).

Table 2: Model input parameters – behaviours on positive/negative/no test result

Parameter	…positive test result	…negative test result	…no test result
What proportion of contacts self-isolate with a …	75%*	3%*	3%*
What proportion of contacts show increased caution with a …	12.5%	47%*	50%
What proportion of contacts show unchanged caution with a …	12.5%	44%*	47%
What proportion of contacts show decreased caution with a …	0%	6%*	0%*

*Source: ONS self-isolation compliance contacts survey

Likelihood of self-isolating

To estimate the proportion of people who will self-isolate on receipt of a positive test we use the ONS self-isolation compliance case survey[3]. Repeated waves of this survey throughout the latter half of 2021 showed a broadly consistent level of adherence to the requirement to self-isolate following a positive test result (78% in September, 75% in November and 74% in December). Therefore, for our baseline model we will assume that 75% of contacts who test positive for COVID-19 will self-isolate.

In the ONS self-isolation compliance contacts survey (wave 3)[4], a total of 18% of respondents reported they were self-isolating, of whom 83% said this was because they had tested positive, suggesting a background level of self-isolation among the contact population. Using the value of

[3] Coronavirus and self-isolation after testing positive in England – Office for National Statistics (ons.gov.uk)
[4] Coronavirus and behaviour of the vaccinated population after being in contact with a positive case in England – Office for National Statistics (ons.gov.uk)

the remaining 17% self-isolating regardless of test result we estimate that 3% of contacts will self-isolate with a negative test result, or if they have not got a test result (0.18 x 0.17 = ~0.03).

Level of caution shown in non-isolation behaviour

The ONS self-isolation compliance contacts survey asked respondents: "since day 1 of undertaking daily rapid lateral flow testing and having tested negative, how often have you..." to understand how the knowledge of having a negative test impacted on daily behaviours such as wearing face masks and using public transport. While there was slight variation between activities, the results generally showed that people acted with increased or unchanged caution (likely under the knowledge that they were a close contact). Very few acted with decreased caution – the negative test result did not lead to a substantial reduction in COVID-19-safe behaviours.

In more detail, the results showed that:

- up to 6% of contacts acted in a more-risky manner (ranging from 0% of people wearing face masks less often to 6% visiting crowded places more regularly)
- at least 47% of contacts did not change their behaviour on receipt of a negative test result (ranging from 47% of people meeting friends and family the same amount to 86% wearing a face mask in shops the same amount)
- up to 49% of people act in a more cautious manner (ranging from 12% of people wearing a face mask more often to 49% of people meeting friends and family less often)

We use these findings, alongside the baseline level of self-isolation (3%), to estimate the proportion of contacts exhibiting each behaviour on receipt of a positive/negative test result or having taken no test. For the purposes of modelling we aim to derive most likely estimates for each behaviour.

Level of caution shown with no test results

For estimating these parameters we interpret the findings of the self-isolation compliance contacts survey as the impact of the test result and knowledge of being a close contact on behaviour compared to not being a close contact. For unchanged behaviour with no test result (that is just the knowledge of being a close contact) we can take the lowest value from the questions asked, therefore we assume 47% of contacts will show unchanged caution on when knowing they are a close contact (this can be considered most likely as it leaves a significant amount who will act with increased caution given their knowledge of being a contact). It would be reasonable to assume that the knowledge of being a close contact does not lead to a decrease in caution, therefore the remaining 53% is split between self-isolation and showing increased caution. We have already determined that 3% of people will self-isolate regardless, therefore the remaining 50% of contacts will show increased caution with no test result.

In summary:

- 3% of contacts will self-isolate with no test result
- 0% of contacts will show decreased caution with no test result
- 47% of contacts will show unchanged caution with no test result
- 50% of contacts show increased caution with no test result

Level of caution shown with negative test result

The results from the self-isolation compliance contacts survey indicated a small proportion of people act with decreased caution with a negative test result. Using those results, we therefore assume that 6% of contacts will show decreased caution with a negative test result. In the absence of better data we assume that this 6% is drawn equally from the unchanged caution and increased caution groups. Therefore, we assume 44% of contacts will show unchanged caution on receipt of a negative test and 47% of contacts will show increased caution on receipt of a negative test.

In summary:

- 3% of contacts will self-isolate with no test result
- 6% of contacts will show decreased caution with no test result
- 44% of contacts will show unchanged caution with no test result
- 47% of contacts show increased caution with no test result

Level of caution shown with positive test result

We have no data on the behaviour of positive contacts who have elected to not self-isolate. However, it would be a reasonable assumption that contacts would not behave in a more risky manner with the knowledge they are positive. Therefore, we assume those not self-isolating would be evenly split between acting with unchanged caution and acting with increased caution:

- 75% of contacts will self-isolate with a positive test result (as above)
- 0% of contacts will show decreased caution with a positive test result
- 12.5% of contacts will show unchanged caution with a positive test result
- 12.5% of contacts show increased caution with a positive test result

3.1.3 Transmission parameters

These parameters determine how many onwards infections are caused by the infectious contacts within the model based on the behaviour they are estimated to be following. From December 2021 to February 2022 the average lower bound for the R-rate in England was 0.9 and the average upper bound was 1.1[5]. To reflect that close contacts may be riskier in terms of transmission prior to contact notification or a test result we assume a baseline R-rate of 1.1.

[5] The R value and growth rate - GOV.UK (www.gov.uk). Viewed on 31 May 2022

Prior to the lifting of COVID-19 restrictions, the guidance for those with COVID-19 was that they could leave self-isolation after a minimum of 5 full days[6]. We therefore assume a baseline value of 5 days for which a positive case is infectious.

Table 3: Model input parameters – COVID-19 R-rate and infection period

Parameter	Baseline value	Source
The reproduction rate (R-rate); that is the average number of new infections caused by someone with COVID-19	1.1	GOV.UK
The proportion of all COVID-19 transmissions that are within the same household (as the index case)	45%	Expert estimate
The total number of days on which a positive case is infectious	5 days	GOV.UK

The numbers in the table above can be used to derive the daily number of new infections caused by each contact within the model. For someone not self-isolating and showing unchanged caution, the number of onwards infections per day is estimated as the R-rate divided by the number of days that someone is infectious. That is:

$$Onward\ infections\ per\ day = \frac{R\ rate}{Infectious\ period} = \frac{1.1}{5} = 0.22$$

For those self-isolating the onwards infections are assumed to be those caused by someone not self-isolating, scaled according to proportion of household infections (on the assumption that household infections are not mitigated for by self-isolation). That is:

$$Onward\ infections\ per\ day\ during\ self-isolation = \frac{R\ rate}{Infectious\ period} \times Proportion\ infections\ in\ household = \frac{1.1}{5} \times 45\% = 0.099$$

There is limited evidence with which to quantify the impact on onwards transmission of increased or decreased caution, therefore we must make some reasonable estimates. For someone acting with increased caution it is assumed that this R-rate will be between that of someone self-isolating and someone acting with unchanged caution. In the absence of any firm data, we assume that this will be the mid-point of the 2 previous estimates. That is:

$$Onward\ infections\ per\ day\ (increased\ caution) = \frac{0.099 + 0.22}{2} = 0.16$$

[6] Self-isolation for those with COVID-19 can end after 5 full days following 2 negative LFD tests – GOV.UK (www.gov.uk) Viewed on 31 May 2022

For someone acting with decreased caution, the increase in transmission is assumed to be the same as the decrease caused by someone showing increased caution. That is:

$$Onward\ infections\ per\ day\ (decreased\ caution) = 0.22 + \left(0.22 - \left(\frac{0.099 + 0.22}{2}\right)\right) = 0.28$$

The onwards transmission values are summarised in Table 4.

Table 4: Model input parameters – transmission from infected close contacts

Parameter	Baseline value
The number of onwards infections caused by someone self-isolating (per day)	0.099
The number of onwards infections caused by someone showing unchanged caution (per day)	0.22
The number of onwards infections caused by someone showing increased caution (per day)	0.16
The number of onwards infections caused by someone showing decreased caution (per day)	0.28

3.1.4 Infectiousness of positive contacts

In the model the proportion of contacts who are infectious on any given day after contact with an index case is used to estimate the proportion of contacts who are at risk of causing onwards transmission. We have derived an estimate for this using data drawn from UKHSA systems. We use a data set of positive LFD test results reported by close contacts of COVID-19 cases in November 2021. LFD tests are matched to close contacts using personally identifiable information (surname, postcode, date of birth) provided as part of both the contact tracing and test reporting services. Only exact matches are counted. From the management information collected through these processes we can derive the date, relative to the contact event, on which the positive test was taken.

We use November 2021 as the time frame for this data set as it was a time of relatively high LFD usage within the population, but prior to the guidance to repeat test with LFDs (through either DTCC or the later advice to leave self-isolation early on the provision of 2 consecutive negative LFD tests). The final data set contains 52,825 positive test results. For the purposes of this model, we assume that this data set is representative of all close contacts (despite LFD data being known to be limited by a significant amount of under-reporting).

We assume that each test represents the first time someone has tested positive, and that they will be infectious for a constant period of time following that test (5 days, see above).

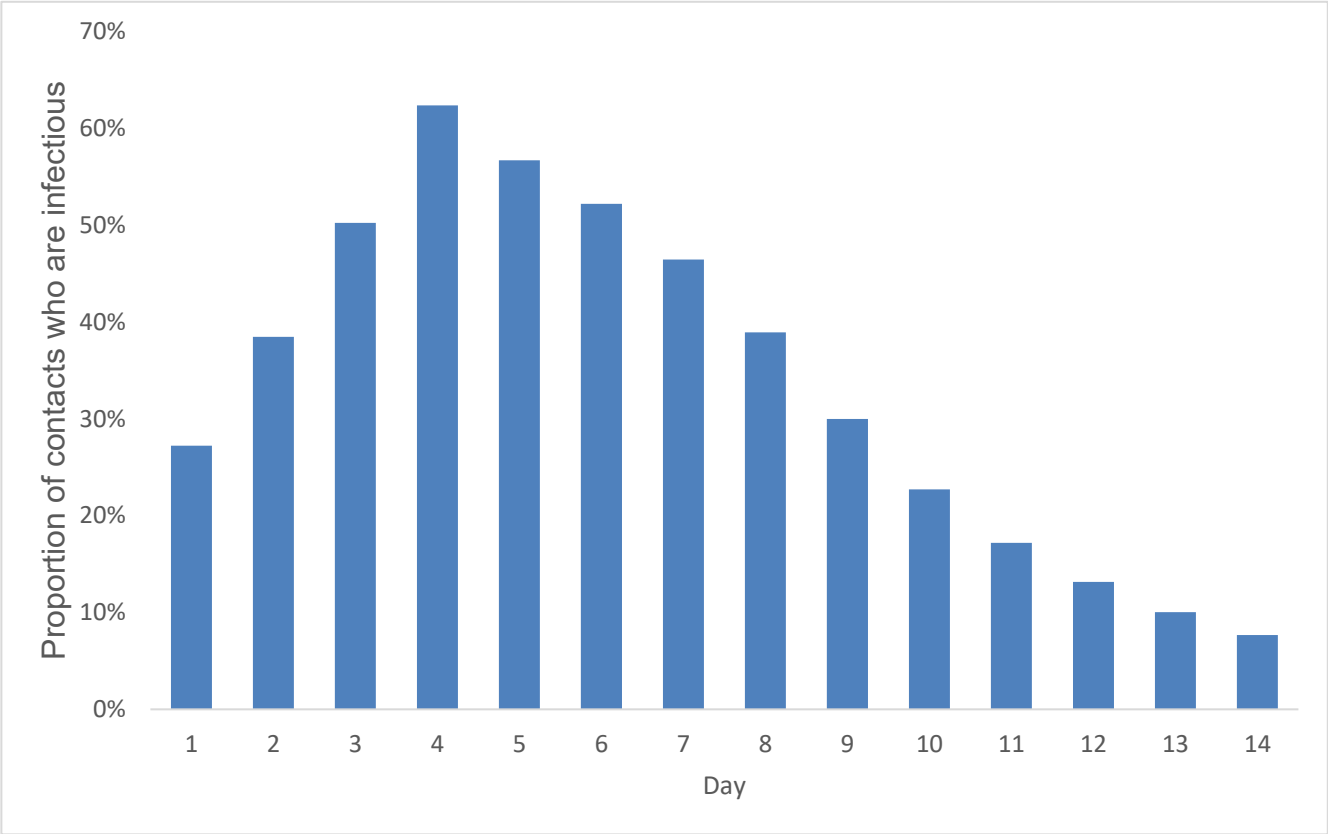
Therefore, for example, the number of contacts who are infectious on day 7 relative to contact tracing is the total number of contacts who have tested positive up to that point minus the number that originally tested positive on or prior to day 2.

Table 5: Model input parameters – proportion of infected close contacts who are infectious on each day post contact tracing

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Proportion infectious	27%	38%	50%	62%	57%	52%	46%	39%	30%	23%	17%	13%	10%	8%

The distribution of infectiousness amongst close contacts in shown in Figure 4 and Table 5. This peaks on day 4 at 62%; that is on day 4 after the contact event 62% of close contacts are infectious, and therefore at risk of transmitting COVID-19 to a susceptible individual. For the purposes of the modelling we assume infectiousness is a binary variable; someone is either infectious and at risk of passing on disease or they are not (that is we do not attempt to model for example a lower level of infectiousness when someone is close to recovery).

Figure 4: Proportion of infected close contacts who are infectious on each day post contact tracing



3.1.5 Test performance parameters

For our baseline scenario we assume that PCR testing has a sensitivity for infectious individuals of 100%; that is no infectious people receive a false-negative PCR result. LFD tests are known to have lower sensitivity. A systematic evaluation of LFD sensitivity reported a sensitivity of 78.8%[7]. We therefore use a value of 80% for LFD sensitivity of infectious individuals in our baseline model. We consider the impact of different levels of LFD test performance in the sensitivity analysis.

Because the model considers only infectious people, we do not incorporate an estimate of test specificity; that is no consideration is given COVID-19 negative people who may be given a false-positive result, as by definition these individuals would be incapable of causing onwards transmission of COVID-19.

[7] COVID-19: Rapid antigen detection for SARS-CoV-2 by lateral flow assay: A national systematic evaluation of sensitivity and specificity for mass-testing – eClinicalMedicine (thelancet.com)

Table 6: Model input parameters – test sensitivity of infectious individuals

Parameter	Baseline value
PCR test sensitivity	100%
LFD test sensitivity	80%

3.2 PCR testing of close contacts parameters

This section details the model inputs used to represent the PCR testing of close contacts policy (that is the policy that was in place prior to DTCC). The impact of the policy is incorporated by estimating over the course of the contact tracing period, from the group of contacts who are infectious, the proportion of which have:

- tested positive on PCR during the contact tracing period
- tested negative on PCR during the contact tracing period
- tested positive on LFD that day
- tested negative on LFD that day
- no relevant test result

The first 4 of these are estimated using a combination of data and reasonable assumptions, with the residual being those contacts who have no test result (and therefore act accordingly). We assume that a PCR result will define the actions over the entire contact tracing period (as typically individuals would take only one or a small number of PCR tests and carry this information to a number of daily decisions), whereas an LFD result is specific to the actions on the day it is taken (as LFDs are advised to be used for regular, repeat testing). A distinction is made between symptomatic and asymptomatic contacts, as symptom status is assumed to be an influencing factor on the likelihood of testing positive.

When interpreting the data to put values on these parameters, we assume that on any given day, the group of infectious contacts is representative of all contacts identified (regardless of their positivity). For example, if X% of all contacts test on day 1, we assume X% of infectious contacts test on day 1.

3.2.1 Summary

Table 7: Model input parameters – proportion of infectious individuals by test result, PCR testing of close contacts

Result	Test type	Symptom status	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10	Day 11	Day 12	Day 13	Day 14
Positive	PCR	S	4%	7%	10%	13%	17%	20%	22%	24%	25%	26%	26%	27%	27%	28%
		A	2%	4%	6%	9%	11%	13%	15%	15%	16%	17%	17%	17%	17%	17%
	LFD	S	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
		A	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Negative	PCR	S	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
		A	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	LFD	S	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
		A	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
No test			94%	89%	83%	77%	72%	67%	63%	61%	59%	58%	57%	56%	55%	55%

3.3.2 Proportion of contacts testing positive on PCR (in the contact tracing period)

These parameters are the proportion of contacts who have tested positive on PCR up to and including the day of interest in the model. To derive these estimates, we use a data set of PCR results from known contacts extracted from UKHSA systems. This data set covers individuals who were reached by contact tracing services between 1 November 2021 and 28 November 2021.

From a total of 1,752,883 contacts, we were able to identify 825,753 PCR results. Of these a total of 283,980 were positive (174,571 symptomatic and 109,409 asymptomatic), matched using personally identifiable data (surname, date of birth, postcode). This gives a positivity rate of 36%.

Assuming that the positivity rate of 36% also applied to those contacts that didn't test, we can estimate that there were a total of 622,989 contacts in that population (of 1,752,883 contacts,) who were positive for COVID-19. Note: this is likely an overestimate the number of positive contacts due to a likely selection bias in those choosing to PCR test (that is those contacts most at risk are more likely to test).

To derive the input value for the model were take the number of test positive tests up to and including the day of interest and divide by the total positive population of 622,989. In other words, for the number of contacts who have tested positive by day we sum the number of positive tests taken up to and including day 2 and divide by 622,989. This method implicitly includes both uptake of PCR testing within the contact population, and the different in testing uptake between symptomatic and asymptomatic contacts.

In this method, having received a positive PCR result takes precedence over taking an LFT. In the table below, the proportion of contacts testing is cumulative over the 14 day period.

Table 8: Model input parameters – proportion of infected contacts who have received a positive PCR test up to and including day X, PCR testing of close contacts

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Symptomatic	4%	7%	10%	13%	17%	20%	22%	24%	25%	26%	26%	27%	27%	28%
Asymptomatic	2%	4%	6%	9%	11%	13%	15%	15%	16%	17%	17%	17%	17%	17%

3.2.3 Proportion of contacts testing negative on PCR (in the contact tracing period)

For the purposes of our baseline model, we assume that PCR test sensitivity is 100%, and therefore no infectious individuals will receive a negative PCR test.

Table 9: Model input parameters – proportion of infected contacts who have received a negative PCR test up to and including day X, PCR testing of close contacts

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Symptomatic	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Asymptomatic	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

3.2.4 Proportion of contacts testing positive on LFD (each day)

We know that, due to the availability of LFD testing during the PCR testing of close contacts policy, that some contacts may have chosen to test with an LFD rather than a PCR. In other words, there would be a background level of LFD testing. The model can be adjusted to accommodate this, but for the baseline scenario we assume no background LFD testing. Therefore no infectious contacts will be assumed to have received a positive LFD result.

Table 10: Model input parameters – proportion of infected contacts who have received a positive LFD on day X, PCR testing of close contacts

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Symptomatic	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Asymptomatic	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

3.2.5 Proportion of contacts testing negative on LFD (each day)

Similarly, the baseline model assumes no contacts will have received a negative LFD result. As per PCR testing, these inputs could also be interpreted as an assumed LFD sensitivity of 100%.

Table 11: Model input parameters – proportion of infected contacts who have received a negative LFD on day X, PCR testing of close contacts

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Symptomatic	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Asymptomatic	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

3.2.6 Proportion of contacts not testing

The proportion of contacts not testing is estimated as anyone not falling into the above 4 categories. In other words, proportion not testing equals 100% minus (sum of those testing positive/negative on PCR and those testing positive/negative on LFD).

Table 12: Model input parameters – proportion of infected contacts who have no test result on day X, PCR testing of close contacts

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Proportion not testing	94%	89%	83%	77%	72%	67%	63%	61%	59%	58%	57%	56%	55%	55%

3.3 Daily testing of close contacts

This section details the model inputs used to represent the daily testing of close contacts (DTCC) policy. The model logic is broadly similar to that used for PCR testing of close contacts. However, for DTCC there is the added complexity of a high proportion of contacts testing daily with LFDs, on top of routine PCR testing. Again, the impact of the policy is modelled by using data to work out for the group of infectious contacts who have:

- tested positive on PCR during the contact tracing period
- tested negative on PCR during the contact tracing period
- tested positive on LFD that day
- tested negative on LFD that day
- no relevant test result

We assume the 7-day testing period for DTCC falls on days 5 to 11 of the 14-day contact tracing period, incorporating the time it takes for contact tracing to complete. For days one to 4, and 12 onwards, the calculations are the same as those discussed for the PCR testing of close contacts policy.

To estimate the daily parameters for DTCC, we start with an estimate of the proportion of contacts who have not received any test result (taken from survey data). According to the policy guidance, the remainder of contacts would be taking daily LFD tests. However, we know that some proportion will take a PCR test. Therefore, we use a similar estimate for the proportion of contacts who have tested positive on PCR during their contact period as the PCR testing of close contacts estimates, with the remaining contacts assuming to be testing on LFD. These calculations are used for days 5 to 11 of the model only.

3.3.1 Summary

Table 13: Model input parameters – proportion of infectious individuals by test result, daily testing of close contacts

Result	Test type	Symptom status	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10	Day 11	Day 12	Day 13	Day 14
Positive	PCR	S	2%	3%	5%	7%	8%	9%	10%	10%	11%	11%	11%	12%	12%	12%
		A	0%	1%	2%	2%	2%	3%	3%	3%	3%	3%	3%	3%	3%	3%
	LFD	S	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
		A	0%	0%	0%	0%	48%	47%	46%	45%	45%	44%	44%	0%	0%	0%
Negative	PCR	S	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
		A	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	LFD	S	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
		A	0%	0%	0%	0%	12%	12%	11%	11%	11%	11%	11%	0%	0%	0%
No test			98%	96%	93%	91%	30%	30%	30%	30%	30%	30%	30%	85%	85%	85%

3.3.2 Proportion of contacts not testing

Chapter 2 of the DTCC evaluation considered the uptake rate of DTCC amongst close contacts. The evidence from the most reliable source on this was that the DTCC guidance was followed in full by between 64 to 75% of eligible contacts. For our model, we will use 70% as a baseline value. Therefore, for each day from days 5 to 11 inclusive, we will assume a baseline value of 30% of contacts not taking part in DTCC (and having no test result). Days 1 to 4 and 12 onwards are calculated in manner described for the PCR testing of close contacts policy.

Table 14: Model input parameters – proportion of infected contacts who have no test result on day X, daily testing of close contacts

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Proportion not testing	98%	96%	93%	91%	30%	30%	30%	30%	30%	30%	30%	85%	85%	85%

3.3.3 Proportion of contacts testing positive on PCR (in the contact tracing period)

The proportion of contacts taking a positive PCR is calculated in the same way as in section 2.2.2, but on a different dataset corresponding to the time period. This data set covers individuals who were reached by contact tracing services between 17 January and 13 February 2022. In this case, number of contacts (2,581,521) multiplied by the positivity (53%) calculated based on those taking PCRs is likely to be a larger overestimate, as the self-selection bias of those choosing to take PCRs is likely to have a bigger impact when PCR testing is less routine.

Table 15: Model input parameters – proportion of infected contacts who have received a positive PCR test up to and including day X, daily testing of close contacts

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Symptomatic	2%	3%	5%	7%	8%	9%	10%	10%	11%	11%	11%	12%	12%	12%
Asymptomatic	0%	1%	2%	2%	2%	3%	3%	3%	3%	3%	3%	3%	3%	3%

3.3.4 Proportion of contacts testing negative on PCR (in the contact tracing period)

As with the PCR testing of close contacts policy, we assume that PCR sensitivity is 100%, and therefore no infectious individuals will receive a negative PCR test.

Table 16: Model input parameters – proportion of infected contacts who have received a negative PCR test up to and including day X, daily testing of close contacts

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Symptomatic	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Asymptomatic	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

3.3.5 Proportion of contacts testing positive on LFD (each day)

So far for the DTCC policy we have derived estimates for the proportion of contacts who are not testing, and the proportion of the those testing who have a PCR test result. By definition, the remainder are taking daily LFDs. Therefore, the proportion of contacts testing on LFD is derived as anyone not falling into the above categories. In other words, proportion testing on LFD equals 100% minus (sum of those not testing, those testing positive/negative on PCR). The proportion of those testing on LFD who test positive is then calculated using the baseline estimate of LFD sensitivity.

For the purposes of this model, we will assume that all symptomatic contacts are captured by the PCR testing. Therefore, all LFDs are assumed to be for asymptomatic individuals (which is in line with the DTCC policy).

We have avoided using LFD data within UKHSA systems to directly quantify the parameters in the model due to known high levels of under-reporting of LFD test results by users.

Table 17: Model input parameters – proportion of infected contacts who have received a positive LFD on day X, daily testing of close contacts

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Symptomatic	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Asymptomatic	0%	0%	0%	0%	48%	47%	46%	45%	45%	44%	44%	0%	0%	0%

3.3.6 Proportion of contacts testing negative on LFD (each day)

Similarly, the proportion of individuals with a negative LFD result is calculated from the proportion testing on LFD and the baseline LFD sensitivity (80%).

Table 18: Model input parameters – proportion of infected contacts who have received a negative LFD on day X, daily testing of close contacts

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Symptomatic	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Asymptomatic	0%	0%	0%	0%	12%	12%	11%	11%	11%	11%	11%	0%	0%	0%

3.4 Sensitivity analysis

We carried out a sensitivity analysis to understand the impact of various input parameters on the final results, and also the interaction between different aspects of the model. The sensitivity analysis focuses on 3 key inputs to the model:

Adherence to self-isolation on receipt of positive test

These scenarios explore the impact of better or worse adherence to self-isolation on the effectiveness of the policies (either side of the 75% used in the baseline scenario). As with the baseline scenario, the proportion of people not self-isolating is split evenly between acting with increased/unchanged caution.

Adherence to the testing policy

These scenarios explore the impact of increasing/decreasing compliance with the required testing policy. This is implemented by adjusting the proportion of individuals taking the relevant test (PCR testing for PCR testing of close contacts and LFD testing for DTCC), and re-calculating other relevant parameters as necessary. For example on day 5 of the baseline DTCC model the estimated proportion of individuals taking a daily LFD is 60%, with a further 30% of individuals not testing (the remaining 10% are assumed to have received a PCR test). In a scenario where policy uptake is increased by 10%, the proportion of individuals on day 5 taking a test would be 66%, with 24% taking no test (the PCR testing proportion is unaffected).

Effectiveness of the tests used (PCR/LFD)

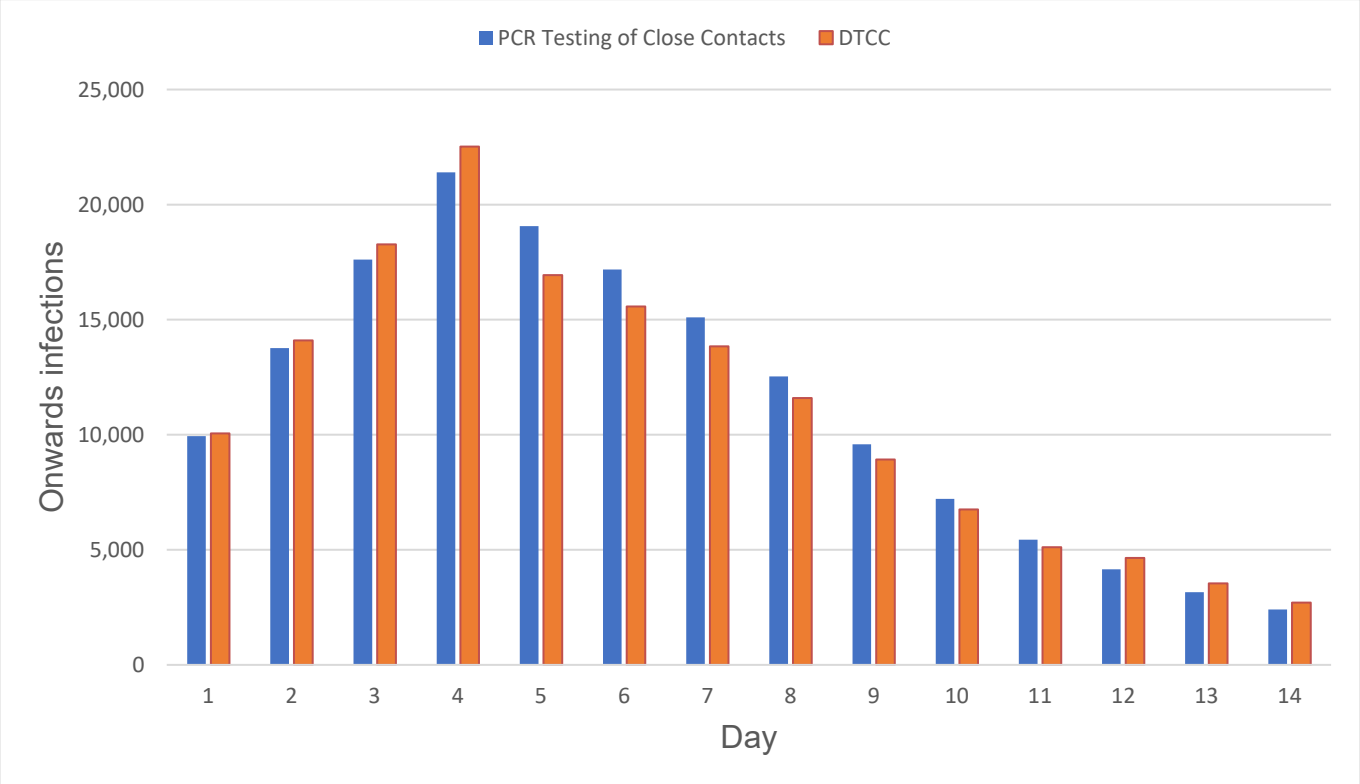
These scenarios explore the impact of false-negative test results on the onwards transmission of COVID-19. This is explored by adjusting the proportion of individuals taking a positive result, allocating this proportion instead to those having a negative result. For example, on day 6 of the baseline PCR testing of close contacts model 20% of individuals are assumed to have had a positive PCR test. With a PCR test sensitivity of 90% this would change to 18% having had a positive PCR test and 2% having a negative test.

4 Results

4.1 Baseline scenario

In the baseline scenario of 1,000,000 close contacts (with a prevalence of 20%) the model estimates that an implementation of the PCR testing of close contacts policy would lead to 158,559 onwards infections. From the same set of contacts an implementation of the daily testing of close contacts (DTCC) policy leads to an estimated 154,597 onwards infections. This equates to a 2.5% relative effect size[8] of DTCC compared to PCR testing of close contacts (that is a 2.5% reduction in onwards infections from the introduction of DTCC).

Figure 4: Onwards infections per day, baseline scenario



The number of onwards infections per day is shown in Figure 4. This shows that prior to and after the window in which daily tests are taken (days 5 to 11) there is a higher number of onwards infections when the DTCC policy is in place. This is likely due to the reduced PCR testing in these periods under the DTCC policy. However during the 7-day window there is a reduction in onwards infections for DTCC, that is there is a benefit in terms of onwards transmission from the daily testing with LFDs. Considering these 2 findings together, the

[8] Relatively effect size is calculated as: 1- (onwards infections from DTCC / onwards infections from PCR testing of close contacts)

increase in transmission outside the 7-day testing is outweighed by the increased case finding and thus reduced onwards transmission by testing daily with LFDs.

4.2 Sensitivity analysis

We have conducted a sensitivity analysis to investigate the relative impact of various input parameters and how they interact with the testing policies being investigated. The findings will help inform future policy development.

4.2.1 Comparison with a no testing scenario

An important counter-factual in this modelling work is to understand the level of onwards transmission that would occur should no contact testing take place. In reality a no test scenario would be influenced by numerous other factors; including the level of knowledge of a disease in the population, level of social mixing / lockdown restrictions and contact tracing from cases. However, we can adjust the model to remove all testing, but with all other parameters unchanged, to give an indication of how each testing policy is performing relative to a no test scenario.

In a no test scenario the model estimates a value of 176,172 onwards infections. This is an effective R-rate of 0.88 compared to the 200,000 infectious contacts used as input to the model. This is lower than the R-rate of 1.1 used as input to the model, which is an overall rate from all cases. We would expect the output from the model to show a lower R-rate than that used as input as the model makes a number of assumptions about COVID-19-safe behaviours from a close contact given their knowledge of their higher than usual risk status.

Compared to the no test scenario the baseline model suggests a reduction in onwards transmission of 10.0% for the PCR testing of close contacts policy (158,559 vs. 176,172) and 12.3% for the daily testing for contacts of COVID-19 policy (154,579 vs. 176,172).

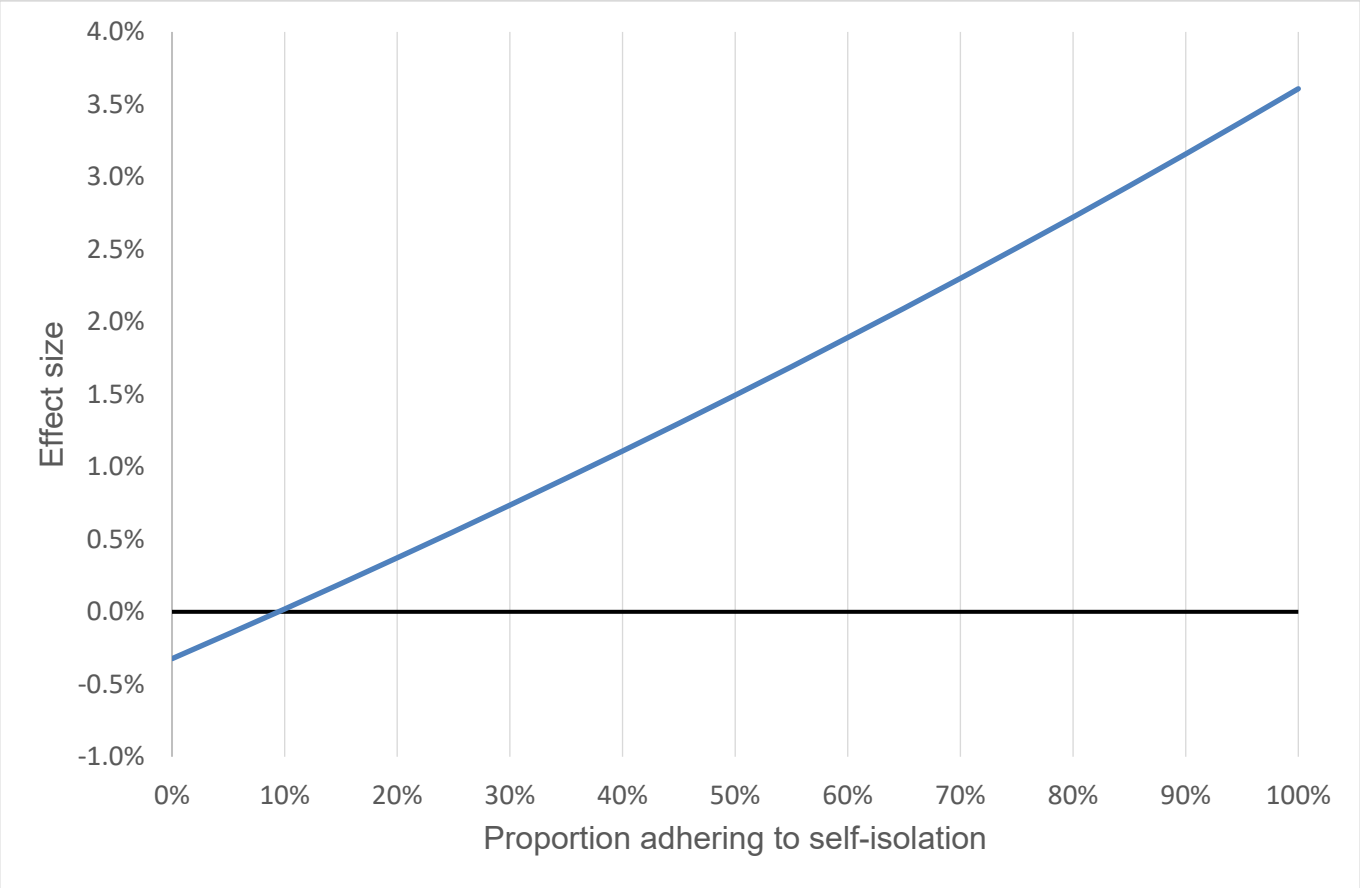
4.2.2 Compliance with self-isolation on a receipt of a positive test

The baseline model assumes 75% of people will effectively self-isolate on receipt of a positive test result. A sensitivity analysis investigating the impact of varying this parameter is show in Figure 5.

As would be expected, this shows that as compliance with self-isolation increases, the effect size of DTCC compared to PCR testing of close contacts increases. This is likely to be due to DTCC picking up more infectious individuals, and therefore proportionally more onwards infections are prevented. Similarly at very low levels of self-isolation the effect size decreases, with DTCC showing a slight negative effect size at very low compliance levels (self-isolation levels of <10%). Note in these scenarios individuals with positive results are estimated to be

behaving in a ‘more risky manner’ than those with a negative result, which is unrealistic, so these scenarios should not be strongly considered when interpreting the results of this model.

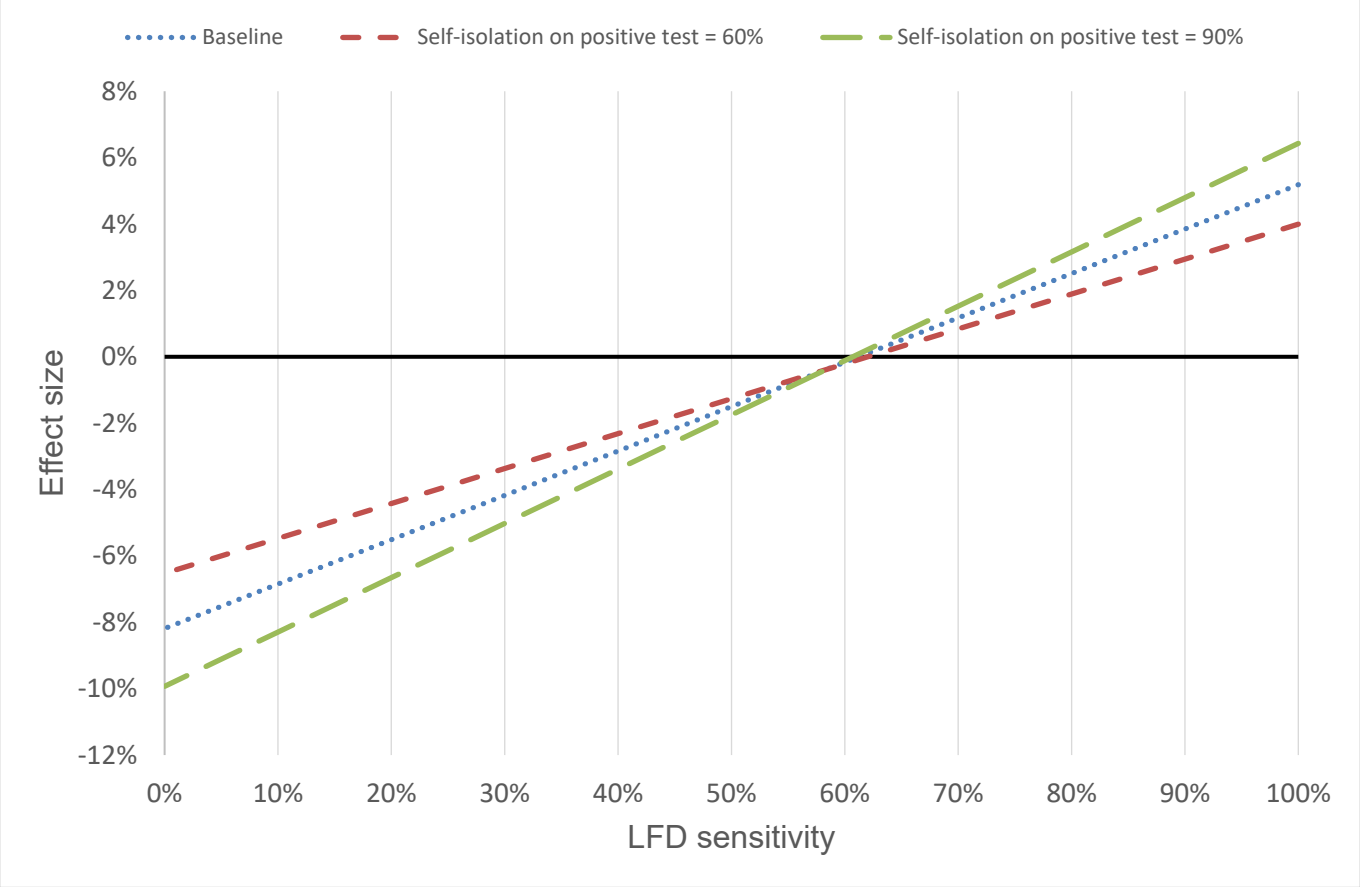
Figure 5: Sensitivity analysis – impact on the effect size of DTCC compared to PCR testing of close contacts when the varying the proportion of individuals adhering to self-isolation on receipt of a positive result. All other parameters at baseline values



4.2.3 LFD sensitivity

The baseline model assumes 80% sensitivity of LFD. A sensitivity analysis investigating the impact of varying LFD sensitivity, alongside different levels of adherence to self-isolation on receipt of a positive test, is show in Figure 6. As expected, when LFD sensitivity increases the effect size of DTCC increases. However, at LFD sensitivities around 62%, the model suggests that impact of DTCC is equal to that of the PCR testing of close contacts policy (effect size of 0%). Similarly at an LFD sensitivity of around 58%, the effect size between all 3 scenarios is equal (the lines intersect) the effect size of DTCC is the same as that of PCR testing of close contacts.

Figure 6: Sensitivity analysis – impact on the effect size of DTCC compared to PCR testing of close contacts when varying LFD sensitivity, under 3 different scenarios for the likelihood on self-isolating on receipt of a positive test (75% (baseline), 60% and 90%). All other parameters at baseline values



4.2.4 Policy uptake

For both the PCR testing of close contacts and DTCC baseline models the baseline parameters incorporate our best estimate of policy uptake utilising data analysis and findings from the wider evaluation. Figure 7 and Figure 8 show the impact of varying uptake levels of each policy compared to the baseline scenario in the other. These show that the model estimates that, in a PCR testing of close contacts scenario, uptake of PCR testing amongst contacts would need to improve by around 22% in order to achieve and equal effect size to the baseline DTCC policy. Similarly, under the baseline scenario of 80% LFD sensitivity, the effect size remains greater than zero while the uptake of LFD testing remains within approximately 25% of the baseline uptake.

Figure 8 shows how these findings vary with different assumptions around LFD sensitivity. With an LFD sensitivity of 60% the effect of both policies is similar (effect size ~0%) and therefore the uptake of LFD testing would need to improve for DTCC to have a positive impact compared to PCR testing of close contacts. This is consistent with the findings shown in Figure 6.

For increased LFD sensitivity (LFD sensitivity = 100%) the uptake of LFD testing can fall by greater than 40% and still retain a positive effect size. Conversely, with a low LFD sensitivity (LFD sensitivity = 40%) the effect size remains negative even with a 50% increase in uptake of LFD testing.

Figure 7: Sensitivity analysis – impact on the effect size of DTCC compared to PCR testing of close contacts when varying the uptake rate of PCR testing of close contacts. All other parameters at baseline values

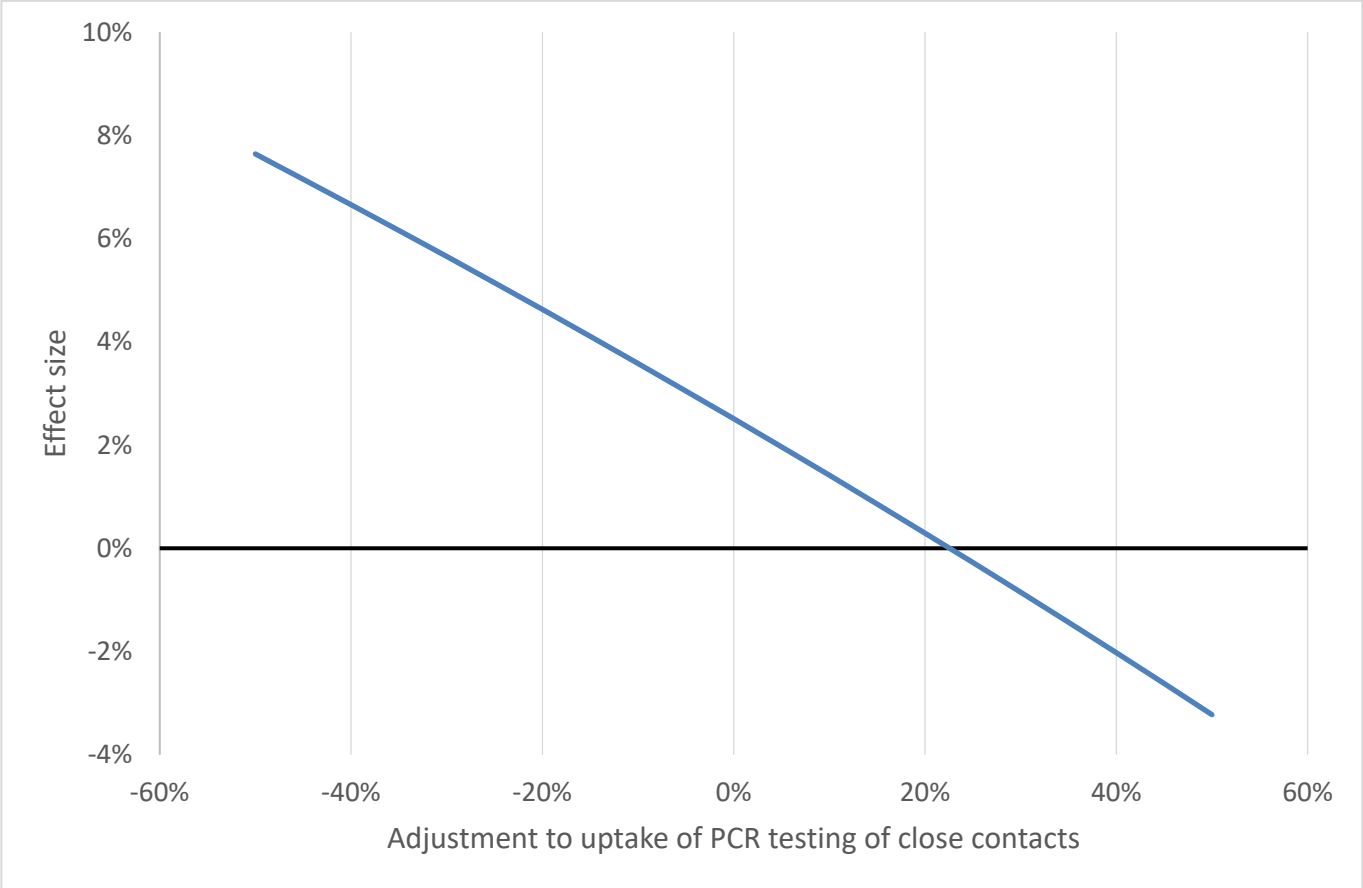
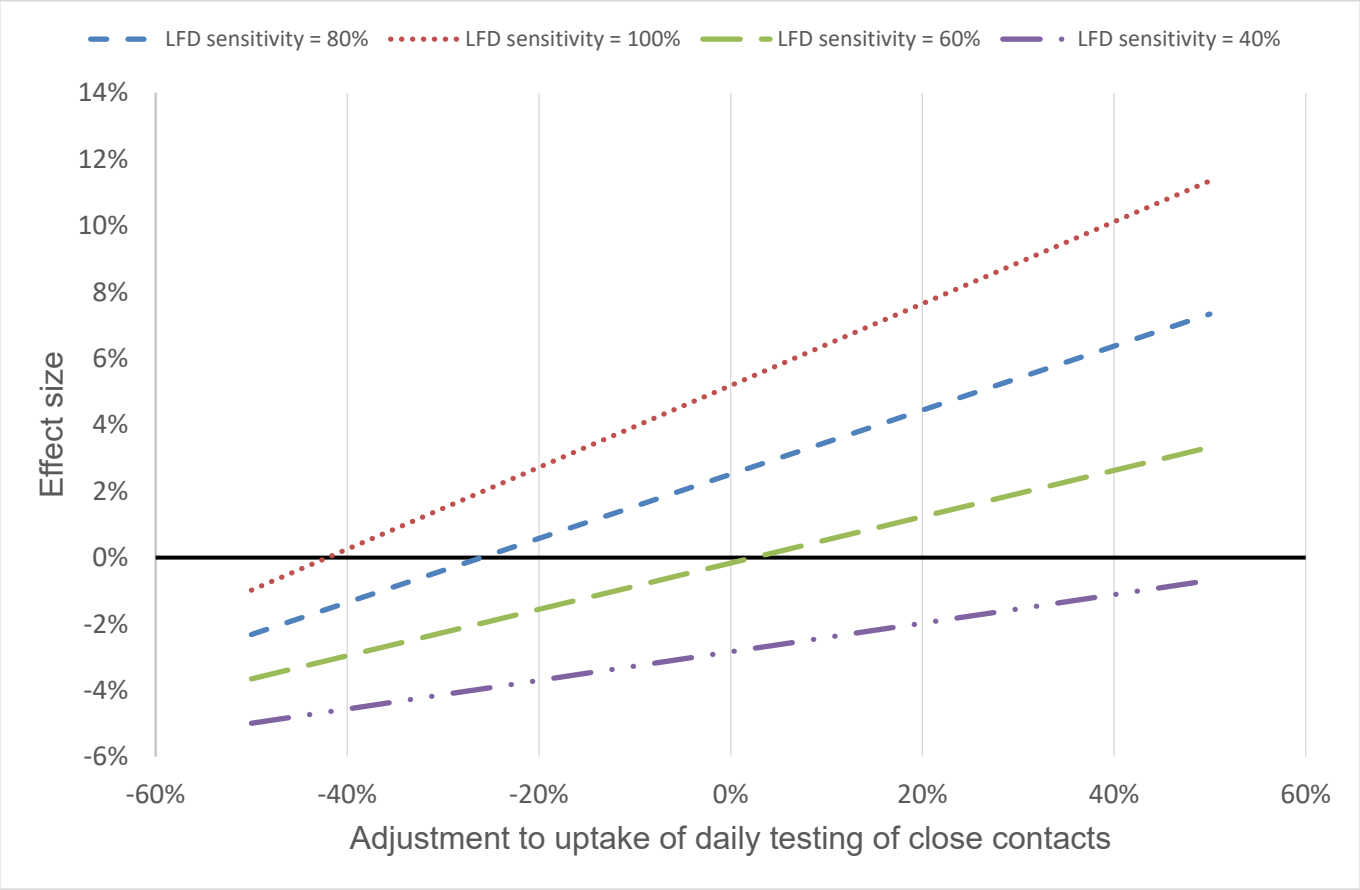


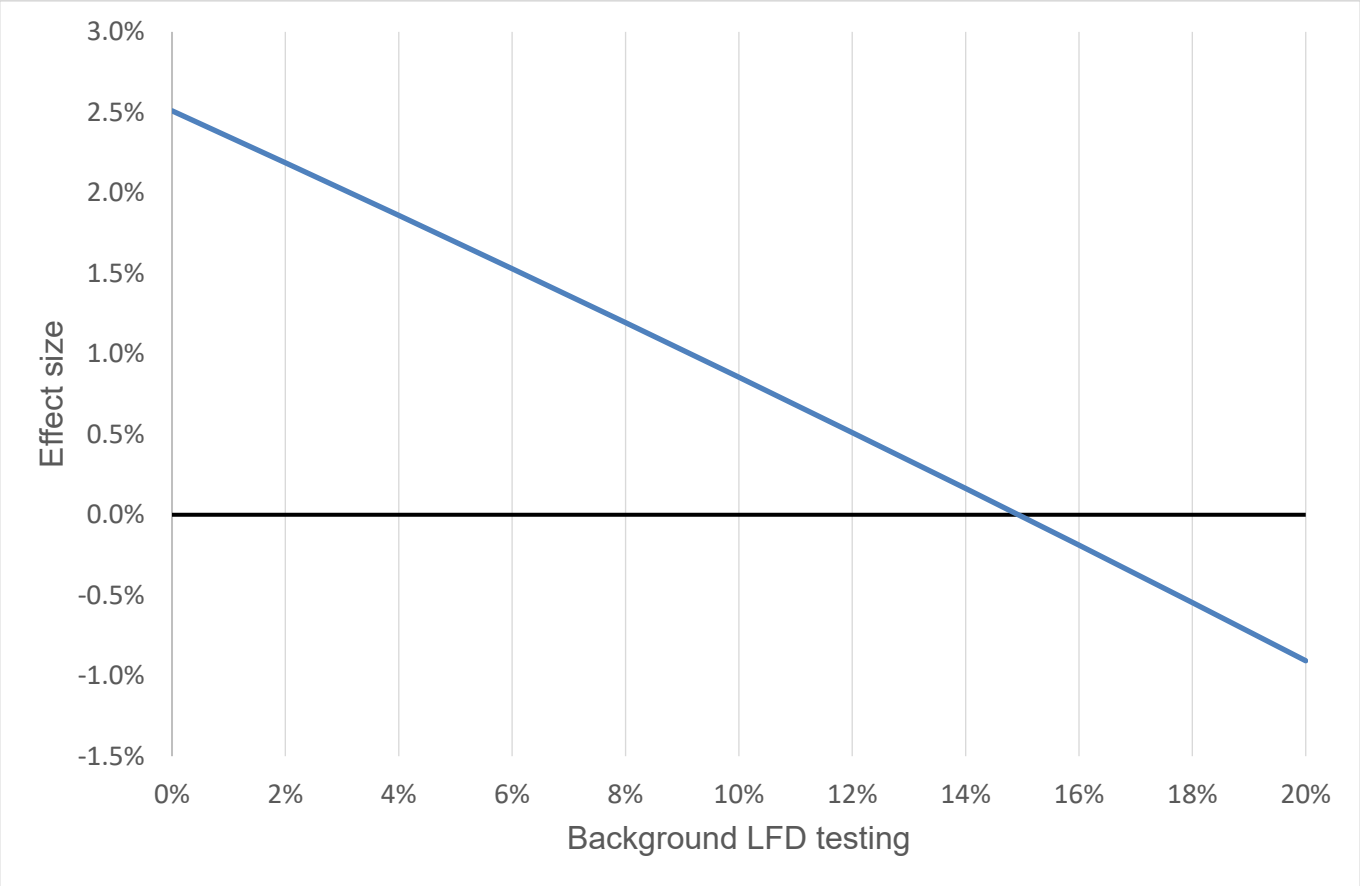
Figure 8: Sensitivity analysis – impact on the effect size of DTCC compared to PCR testing of close contacts when of varying the uptake rate of daily testing of close contacts, under 4 different scenarios for LFD sensitivity (baseline: 80%, 100%, 60% and 40%). All other parameters at baseline values



4.2.5 Background levels of LFD testing

As detailed in Section 0, the model incorporates a functionality for including a level of background testing within the population. This background testing is assumed to occur on all days except those within the 7-day testing window for DTCC. As shown in Figure 9, increasing the amount of background LFD testing reduces the effect size of DTCC compared to PCR testing of close contacts (as would be expected). However, routine background LFD testing needs to reach 15% before a negative effect size is seen.

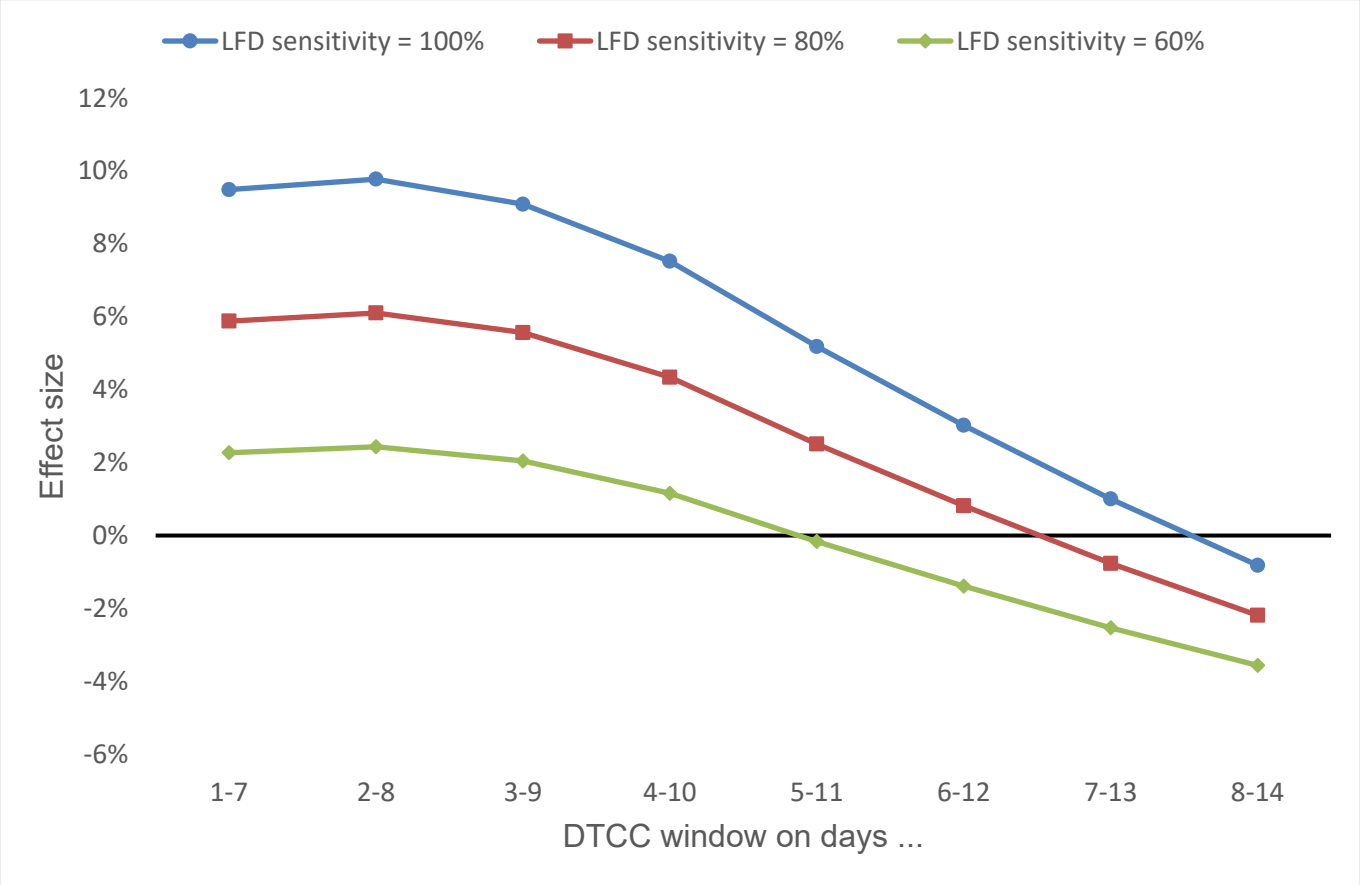
Figure 9: Sensitivity analysis – impact on the effect size of DTCC compared to PCR testing of close contacts when varying the level of background LFD testing. All other parameters at baseline values



4.2.6 Daily testing window

The baseline model assumes that all contacts do their seven days of from days 5 to 11 relative to the contact event. For this sensitivity analysis the model was restructured to vary the window for daily testing from days 1 to 7 through to days 8-14. The results of this analysis are shown in Figure 11. These suggest that the effect size is generally higher the earlier the testing window is; that is DTCC is more effective the earlier the daily testing can take place relative to the contact event, with days 2 to 8 being the most effective 7-day window. Under the baseline scenario (LFD sensitivity = 80%) DTCC is still estimated have a positive effect size when the 7-day testing window begins on day 6 (that is when contact tracing takes almost a week), and only falls below the effectiveness of PCR testing of close contacts when the 7-day window starts on day 7. Reducing the LFD sensitivity to 60% reduces the effect size, and the daily testing must start on or before day 4 to achieve a positive effect size. These results emphasize the importance of rapid contact tracing in breaking the chains of transmission.

Figure 10: Sensitivity analysis – impact on the effect size of DTCC compared to PCR testing of close contacts when of varying the 7-day window for daily testing in DTCC. All other parameters at baseline values



5 Discussion

In this report, we have described the structure and outputs of a model developed to form part of the Daily Testing for Contacts of COVID-19 (DTCC) policy evaluation. This model was based on a decision tree approach and is constructed using parameters from the wider findings of the evaluation, and where necessary specific data analyses and research from relevant literature. The model was designed to assess the theoretical difference between the 2 policies, and as such should not be considered an empirical assessment of the actual impact of the policies.

In our baseline scenario, the model estimates DTCC a 2.5% relative effect size of DTCC compared to PCR testing of close contacts (154,597 onwards infections compared to 158,559 onwards infections). This suggests that, if the costs and capacities of the 2 testing policies were equal, DTCC would be the better policy to enact in order to achieve maximum reduction in disease transmission and best value for money.

In addition to the main findings from the baseline model, the approach taken allows us to investigate the interaction between different parameters in a sensitivity analysis. These findings are likely more informative for future policy making than the single point estimates from the baseline scenario.

This analysis showed that DTCC remains more impactful in terms of reducing transmission than PCR testing of close contacts if LFD sensitivity for infectious people is as low as approximately 62%. Therefore, even if LFD sensitivity for infectious people in reality was around 60%, if LFD testing was also cheaper to implement than PCR testing, then DTCC remains the better option for controlling onwards transmission from close contacts.

However, if LFD sensitivity falls below 60%, either uptake of DTCC would need to be improved to have an equivalent impact compared to PCR testing of close contacts, or a balanced decision would need to be made weighing up difference in the cost of operating an at home LFD testing service compared to a wider PCR testing service.

The sensitivity analysis has also demonstrated the importance of quick contact tracing, with DTCC shown to be most effective when occurring on days 2 to 8 relative to the contact event. This finding remained consistent various LFD sensitivity scenarios.

This model works at an aggregate level, considering a population of close contacts and the likely onwards transmission from sub-groups of these contacts. We have not attempted to model the true complexity of the group of contacts and the variation that will occur between individuals. For example the course of infectiousness is likely to vary between people, and the window in which daily testing takes place will also vary depending on the speed and mechanism by which contact tracing takes place. These factors are likely to strongly impact the effectiveness of contact testing policies, and as such the exclusion of these from the modelling

may limit the extent to which the absolute outputs can be considered a true reflection of the likely onwards transmission of COVID-19 from close contacts.

Furthermore, the data used to parameterise the model was drawn from both operational systems and the findings of customer surveys and questionnaires. These data sources are known to be imperfect (for example there is known under-reporting of LFD test results, and survey results often show survey bias; for instance unrealistically high compliance in responses) and therefore the model results may be impacted by some of the lower quality data inputs. Where possible we have tried to explore this in the sensitivity analysis.

Despite these limitations we believe this model provides an effective tool for exploring the impact of different contact testing strategies. While in this instance we have used this modelling to estimate the impact of existing and historical testing polices, the decision tree modelling approach is likely better utilised pre-policy launch to explore the benefits of proposed policies and inform any future roll out. For example if the modelling demonstrated a certain level of uptake was required to achieve the required benefits, it could inform how much resource an organisation should expend on pro-active communications. Therefore we would recommend that pro-active modelling and evaluation should be considered an essential part of the design for any future contact testing strategy.

About the UK Health Security Agency

UKHSA is responsible for protecting every member of every community from the impact of infectious diseases, chemical, biological, radiological and nuclear incidents and other health threats. We provide intellectual, scientific and operational leadership at national and local level, as well as on the global stage, to make the nation health secure.

UKHSA is an executive agency, sponsored by the Department of Health and Social Care.

Published: December 2022
Publishing reference: GOV-13465