

Royal Statistical Society (RSS) COVID-19 Task Force Statement on how efficient statistical methods can glean greater intelligence from Test, Trace and Isolate (TTI), officially known as [Test & Trace](#)

Modelling for SAGE prior to May 2020 explored the possibility of swab-testing those quarantined within Test, Trace, Isolate (TTI) at 3 or 6 days into their isolation-period. Impact on the likely number of swab-tests (test-capacity) was a key consideration but can be managed by random sampling. Effectiveness of TTI depends on speed, compliance and monitoring¹.

The RSS COVID-19 Task Force commends the efficient use of two statistical methods (record-linkage; random sampling), by which to learn about patterns of transmission of SARS-CoV-2 infection and the effectiveness of quarantine for two types of high-risk contacts whom TTI asks to “stay at home” because they are at an increased risk of contracting the disease, namely:

- (a) household-members of a symptomatic index case;**
- (b) external close contacts, identified by a symptomatic index case, who are traced and asked to self-isolate.**

The RSS COVID-19 Task Force makes three key recommendations:

1. **Record-linkage:** Use record-linkage within TTI to count confirmed SARS-CoV-2 infections within the two high-risk groups (a) and (b) up to 2 days after the end of their 14-day quarantine. (*Two-day allowance is to ensure results from tests booked on the last day of quarantine are counted.*)

In this way, within each high-risk group, TTI can establish the number and demographic details of those who:

1.1 took a swab-test; and

1.2 tested RT-PCR positive for SARS-CoV-2 infection.

2. **Random sampling of households of symptomatic index cases:**

First, select a random sample of the households of symptomatic index cases (minimum 2,000 per week). Each selected household is then visited on a random-swab-day (or pair of days) and all household-members (other than the index case) are offered swab-testing plus a brief questionnaire about symptoms, usual occupation and demography. Thereby, we can monitor the proportion of high-risk group (a) household-members who test RT-PCR positive for SARS-CoV-2 infection, by sample-day during their 14-day quarantine, and whether (or not) they experienced symptoms in the previous 7 days.

Random-swab-days can be equally likely throughout the 14-day quarantine or differential, such as 50% chance shared by days 1-5 and 50% by days 6-14.

As a by-product of efficiently finding out about asymptomatic infections, the random-day visits also give information on “stay at home” adherence by high-risk group (a) household-members and by the symptomatic index case.

3. **Random sample of quarantined external close contacts of symptomatic index cases:**



Here, the random sampling might be designed differently – first, select symptomatic index cases with probability proportionate to how many external close contacts they had identified; then randomly select a fixed proportion of those identified external close contacts for random-visits. Each week, 30,000 to 40,000 high-risk group (b) external close contacts enter quarantine. Hence, we may wish to design our sampling scheme to visit around a third of them, or 10,000 individuals, each on a random-swab-day (or pair of days). The REACT-1 study² suggests that around 200 of the selected 10,000 may test RT-PCR positive for SARS-CoV-2 infection, of whom nearly 70% may have experienced no symptoms in the previous 7 days.

Implementing these recommendations within each of the high-risk groups (a) and (b) will enable TTI to learn efficiently about:

- i) Percentage of high-risk persons who developed one of three key symptoms and had a swab-test, and those who tested RT-PCR positive for SARS-CoV-2 infection (by record-linkage);
- ii) Percentage of high-risk persons who test RT-PCR positive for SARS-CoV-2 infection during days 1-5 versus during days 6-14 of their 14-day quarantine period (by random sampling);
- iii) Percentage of high-risk persons who adhered to self-isolation during days 1-5 versus during days 6-14 of their 14-day quarantine period (by the above random sampling);
- iv) Percentage of high-risk persons who developed at least one of three key symptoms during their 14-day quarantine, irrespective of whether swab-test was booked. (but only if tracers conduct randomly-selected off-quarantine telephone interviews).

Both **quarantined groups** are at higher-risk for testing RT-PCR positive for SARS-CoV-2 infection so that the percentages estimated in i) and ii) are likely to be substantially higher than reported by ONS Infection Survey³.

Intelligence gleaned efficiently

Statisticians at the Department of Health and Social Care (DHSC) have successfully de-duplicated TTI's test-records, which enables persons tested to be uniquely identified⁴. Swab-positive rates per 100,000 of population or per 100 tests can now be displayed by local health authority in weekly funnel plots^{5 6}; or tracked over time^{7 8}.

By re-deploying record-linkage techniques, DHSC statisticians will be able to capture additional information from TTI to address our first recommendation.

By expanding its study-design to incorporate random-sampling, TTI will, from then on, be able to learn with maximum efficiency what proportion of high-risk groups (a) and (b) test RT-PCR positive for SARS-CoV-2 infection without having experienced symptoms in the previous 7 days and about adherence to quarantine.

Random sampling delivers representativeness at affordable cost. Representative empirical findings from individuals in high-risk group (a) will improve knowledge about within household transmission, and risk factors associated with it (for example, how influential are age, gender, ethnicity of household-members; household size). If within households infection-rates are unacceptably high – for example, in respect of elderly members in larger high-risk households with a symptomatic index case – then public health consideration can be given to *shielding the household members at highest risk* either by removing them or the index case to a safer location

Separately, by using the expanded design, we shall also learn about the percentage of high-risk group (b) quarantined external close contacts who are swab-test positive, with or without prior symptoms; and their risk-factors for becoming infected.

Moreover, random-sampling of quarantined contacts (household-members of symptomatic index case; or external) allows - as a by-product - corroboration that, on the days during their quarantine-period when they were most likely to be infectious, quarantined contacts are indeed isolated-at-home: because they were present to be tested.

Finally, weekly comparison of new SARS-CoV-2 infection rates (symptomatic and asymptomatic) and transmission risk-factors between the ONS Infection Survey₃ and TTI's randomly-sampled high-risk groups (a) and (b) will be instructive. TTI can be powerfully informative about transmission-risks, as substantially more transmissions will occur among TTI's quarantined household-members and quarantined external close contacts. This is why we are recommending enhancing its design.

For further details, please see [Devil in the Detail Appendix](#).

References

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5. Spiegelhalter DJ. Funnel plots for comparing institutional performance. *Statistics in Medicine* 2005; 24: 1185-1202. Doi:10/1002/sim.1970. See also <https://qualitysafety.bmj.com/content/11/4/390.2.full>.
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8. Kendall M, Milsom L, Abeler-Domer L, Wyman C, Ferretti L, Briers M, Holmes C, Bonsall D, Aberer J, Fraser C. *COVID-19 incidence and R decreased on the Isle of Wight after the launch of the Test and Trace programme*. See pre-print <https://www.medrxiv.org/content/10.1101/2020.07.12.20151753v1.full.pdf>.