Response to Public Inquiry Questionnaire

Lorenzo Pellis
University of Manchester, 4/10/2022

Question 1

A brief overview of your qualifications, career history, professional expertise and major publications.

Qualifications:

PhD "Mathematical models for emerging infections in socially structured populations: the presence of households and workplaces", DIDE, Imperial College London, UK.	2005 – 2009
4-year undergraduate course in Mathematics (equivalent to UK BSc + MSc, with final thesis), awarded with distinction (110/110 cum laude), University of Trieste, Italy.	2000 – 2005

Appointments held:

30% secondment as Joint Chief Data Science Advisor, UKHSA.	Nov 2021 –
Sir Henry Dale Fellow and Reader, School of Mathematics, University of Manchester, UK.	Aug 2021 –
Sir Henry Dale Fellow and Senior Research Fellow, School of Mathematics, University of Manchester, UK.	Aug 2017 – Jul 2021
Sir Henry Dale Fellow, Department of Mathematics, University of Warwick, UK.	Oct 2016 – Jul 2017
Research Fellow, Complexity Centre, Department of Mathematics, University of Warwick, Coventry, UK. Member of the Warwick Infectious Disease Epidemiology Research (WIDER) group.	Mar 2012 – Sept 2016
Research Associate, MRC Centre for Outbreak Analysis and Modelling, Department of Infectious Disease Epidemiology (DIDE), Imperial College London, London, UK.	May 2009 – Feb 2012

Advisory roles and honorary appointments:

Turing Fellow, Alan Turing Institute, London, UK (renewed Oct 2021)	Aug 2018 –
Member of HMPPS National Review Panel for health advice	Mar 2022 –
Member of the Scientific Pandemic Influenza group on Modelling (SPI-M), since it became operational (SPI-M-O) on COVID	Mar 2020 – Mar 2022
Guest Editor of Philosophical Transactions of the Royal Society B special issue on COVID	Jul 2020 – Apr 2021

Major publications and preprints:

Cahuantzi, R., Lythgoe, K., Hall, I., House, T. A., & Pellis, L. (2022). Analysis and comprehensive lineage identification for SARS-CoV-2 genomes through scalable learning methods. *bioRxiv*.
Whitfield, C. A., Van Tongeren, M., Han, Y., Wei, H., Daniels, S. A., Regan, M., ... & Hall, I. (2022). Modelling the impact of non-pharmaceutical interventions on workplace transmission of SARS-CoV-2 in the home-delivery sector. *medRxiv*.
Wing, K., Grint, D. J., Mathur, R., Gibbs, H., Hickman, G., Nightingale, E., ... & Eggo, R. M. (2022). Association between household composition and severe COVID-19 outcomes in older people by ethnicity: an observational cohort study using the OpenSAFELY platform. *medRxiv*.
Overton, C. E., Webb, L., Datta, U., Fursman, M., Hardstaff, J., Hiironen, I., ... & Hall, I. (2022). Novel methods for estimating the instantaneous and overall COVID-19 case fatality risk among care home residents in England. *arXiv preprint arXiv:2202.07325*.
Brooks-Pollock, E., Northstone, K., Pellis, L., Scarabel, F., Thomas, A. C., Nixon, E. J., ... & Danon, L. (2022). Impact of voluntary risk-mitigation behaviour on transmission of the Omicron SARS-CoV-2 variant in England. *medRxiv*.
Keeling, M. J., Brooks-Pollock, E., Challen, R. J., Danon, L., Dyson, L., Gog, J. R., ... & Tildesley, M. (2021). Short-term Projections based on Early Omicron Variant Dynamics in England. *medRxiv*.
Ahmad, S., Brown, B., Charlett, A., Davies, E., House, T., Kirkman, B., ... & Overton, C. E. (2021). Early signals of Omicron severity in sentinel UK hospitals. *researchsquare preprint doi.org/10.21203/rs.3.rs-1203019/v1*
House, T., Pellis, L., Pritchard, E., McLean, A. R., & Walker, A. S. (2021). Total effect analysis of vaccination on household transmission in the Office for National Statistics COVID-19 infection survey. arXiv preprint arXiv:2107.06545.
House, T., Riley, H., Pellis, L., Pouwels, K. B., Bacon, S., Eidukas, A., ... & Sarah Walker, A. (2022). Inferring risks of coronavirus transmission from community household data. *Statistical Methods in Medical Research*, *31*(9), 1738-1756.
Funk, S., Abbott, S., Atkins, B. D., Baguelin, M., Baillie, J. K., Birrell, P., ... & ISARIC4C Investigators. (2020). Short-term forecasts to inform the response to the Covid-19 epidemic in the UK. *MedRxiv*.
Challen, R., Dyson, L., Overton, C. E., Guzman-Rincon, L. M., Hill, E. M., Stage, H. B., ... & Danon, L. (2021). Early epidemiological signatures of novel SARS-CoV-2 variants: establishment of B. 1.617. 2 in England. *MedRxiv*.
Pellis, L., Birrell, P. J., Blake, J., Overton, C. E., Scarabel, F., Stage, H. B., & Brooks-Pollock, E. (2021). Estimation of reproduction numbers in real time: conceptual and statistical challenges. *Journal of the Royal Statistical Society: Series A*.
*Overton, C. E., *Pellis, L., Stage, H. B., Scarabel, F., Burton, J., Fraser, C., ... & Lythgoe, K. A. (2022). EpiBeds: Data informed modelling of the COVID-19 hospital burden in England. *PLoS computational biology*, *18*(9), e1010406. [* joint first authorship]
Waites, W., Pearson, C. A., Gaskell, K. M., House, T., Pellis, L., Johnson, M., ... & Eggo, R. M. (2022). Transmission dynamics of SARS-CoV-2 in a strictly-Orthodox Jewish community in the UK. *Scientific Reports*, *12*(1), 1-12.
Shadbolt, N., Brett, A., Chen, M., Marion, G., McKendrick, I. J., Panovska-Griffiths, J., ... & Swallow, B. (2022). The challenges of data in future pandemics. *Epidemics*, 100612.

Swallow, B., Birrell, P., Blake, J., Burgman, M., Challenor, P., Coffeng, L. E., ... & Vernon, I. (2022). Challenges in estimation, uncertainty quantification and elicitation for pandemic modelling. *Epidemics*, *38*, 100547.
Marion, G., Hadley, L., Isham, V., Mollison, D., Panovska-Griffiths, J., Pellis, L., ... & Villela, D. (2022). Modelling: understanding pandemics and how to control them. *Epidemics*, 100588.
Kretzschmar, M. E., Ashby, B., Fearon, E., Overton, C. E., Panovska-Griffiths, J., Pellis, L., ... & Villela, D. (2022). Challenges for modelling interventions for future pandemics. *Epidemics*, *38*, 100546.
Hilton, J., Riley, H., Pellis, L., Aziza, R., Brand, S. P., K. Kombe, I., ... & House, T. (2022). A computational framework for modelling infectious disease policy based on age and household structure with applications to the COVID-19 pandemic. *PLoS computational biology*, *18*(9), e1010390.
Dyson, L., Hill, E. M., Moore, S., Curran-Sebastian, J., Tildesley, M. J., Lythgoe, K. A., ... & Keeling, M. J. (2021). Possible future waves of SARS-CoV-2 infection generated by variants of concern with a range of characteristics. *Nature communications*, *12*(1), 1-13.
Ward, T., Glaser, A., Johnsen, A., Xu, F., Hall, I., & Pellis, L. (2021). Growth, reproduction numbers and factors affecting the spread of SARS-CoV-2 novel variants of concern in the UK from October 2020 to July 2021: a modelling analysis. *BMJ open, 11(11)*, e056636.
Fearon, E., Buchan, I. E., Das, R., Davis, E. L., Fyles, M., Hall, I., ... & Wingfield, T. (2021). SARS-CoV-2 antigen testing: weighing the false positives against the costs of failing to control transmission. *The Lancet Respiratory Medicine*.
Brooks-Pollock, E., Danon, L., Jombart, T., & Pellis, L. (2021). Modelling that shaped the early COVID-19 pandemic response in the UK. *Philosophical Transactions of the Royal Society B*, *376*(1829), 20200267 – *Special Issue on COVID-19*
Fyles, M., Fearon, E., Overton, C., University of Manchester COVID-19 Modelling Group, Wingfield, T., Medley, G. F., ... & House, T. (2021). Using a household-structured branching process to analyse contact tracing in the SARS-CoV-2 pandemic. *Philosophical Transactions of the Royal Society B*, *376*(1829), 20200267 – *Special Issue on COVID-19*
Stage, H. B., Shingleton, J., Ghosh, S., Scarabel, F., Pellis, L., & Finnie, T. (2021). Shut and re-open: the role of schools in the spread of COVID-19 in Europe. *Philosophical Transactions of the Royal Society B*, *376*(1829), 20200277 – *Special Issue on COVID-19*
Hall, I., Lewkowicz, H., Webb, L., House, T., Pellis, L., Sedgwick, J., ... & University of Manchester COVID-19 Modelling Group and the Public Health England Modelling Team. (2021). Outbreaks in care homes may lead to substantial disease burden if not mitigated. *Philosophical Transactions of the Royal Society B*, *376*(1829), 20200269 – *Special Issue on COVID-19*
Pellis, L., Scarabel, F., Stage, H. B., Overton, C. E., Chappell, L. H., Fearon, E., ... & University of Manchester COVID-19 Modelling Group. (2021). Challenges in control of Covid-19: short doubling time and long delay to effect of interventions. *Philosophical Transactions of the Royal Society B*, *376*(1829), 20200264 – *Special Issue on COVID-19*
Scarabel, F., Pellis, L., Ogden, N. H., & Wu, J. (2021). A renewal equation model to assess roles and limitations of contact tracing for disease outbreak control. *Royal Society open science*, *8*(4), 202091.
Minter, A., Pellis, L., Medley, G. F., & Hollingsworth, T. D. (2021). What Can Modeling Tell Us About Sustainable End Points for Neglected Tropical Diseases?. *Clinical Infectious Diseases*, *72*(Supplement_3), S129-S133.

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Pellis, L., Cauchemez, S., Ferguson, N. M., & Fraser, C. (2020). Systematic selection between age and household structure for models aimed at emerging epidemic predictions. *Nature communications*, *11*(1), 1-11.
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Kinyanjui, T. M., Pellis, L., & House, T. (2016). Information content of household-stratified epidemics. *Epidemics*, *16*, 17-26.
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Heesterbeek, H., Anderson, R. M., Andreasen, V., Bansal, S., De Angelis, D., Dye, C., ... & Isaac Newton Institute IDD Collaboration. (2015). Modeling infectious disease dynamics in the complex landscape of global health. *Science*, *347*(6227), aaa4339.
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Pellis, L., Ball, F., & Trapman, P. (2012). Reproduction numbers for epidemic models with households and other social structures. I. Definition and calculation of R0. *Mathematical biosciences*, *235*(1), 85-97.
Shirreff, G., Pellis, L., Laeyendecker, O., & Fraser, C. (2011). Transmission selects for HIV-1 strains of intermediate virulence: a modelling approach. *PLoS computational biology*, *7*(10), e1002185.
Pellis, L., Ferguson, N. M., & Fraser, C. (2011). Epidemic growth rate and household reproduction number in communities of households, schools and workplaces. *Journal of mathematical biology*, *63*(4), 691-734.
Pellis, L., Ferguson, N. M., & Fraser, C. (2009). Threshold parameters for a model of epidemic spread among households and workplaces. *Journal of the Royal Society Interface*, *6*(40), 979-987.
Pellis, L., Ferguson, N. M., & Fraser, C. (2008). The relationship between real-time and discrete-generation models of epidemic spread. *Mathematical biosciences*, *216*(1), 63-70.

Question 2

A list of the groups (i.e. SAGE and/or any of its sub-groups) in which you have been a participant, and the relevant time periods.

- Scientific Pandemic Influenza Group on Modelling (SPI-M): regular (at least weekly) attendance. From 10/02/2020 till 23/03/2022.
- MTP: "Medium-term projections" meeting (formerly "short-term projections"), recurrent satellite meeting of SPI-M. From 01/04/2020 till present (taken over by UKHSA).
- PHE/UKHSA JMT: "Joint Modelling Team". Intermittent attendance. From 05/03/2020 until present.
- HMPPS: Her Majesty's Prison and Probation Services. I produced analyses for HMPPS and discussed them informally since 30/04/2020, but did not attend regular meetings. I only joined the National Review Panel (NRP) formally in March 2022.

Question 3

An overview of your involvement with those groups between January 2020 and February 2022, including:

a. When and how you came to be a participant;

- SPI-M: Questions were posed about potentially adopting school closure as a non-pharmaceutical intervention in early February 2020. I had done some analyses on the impact of school closure (unpublished) and had a model that could have possibly been used. Since then, I attended regularly. I formally joined on 23/03/2020.
- MTP: Immediately after the first lockdown, the Government asked SPI-M to provide estimates of R and hospital pressure. I coded up a model developed with colleagues at Oxford and started submitting projections from 08/04/2020. I still perform R estimates and medium-term projections (MTPs) now.
- PHE/UKHSA JMT: Email exchanges about the COVID situation in Italy started going around on 05/03/2020. Since then I only formally attended 3 meetings, but I provided numerous collaboration discussions throughout the pandemic.
- HMPPS: I was contacted directly by **NR** (HMPPS Public Health Advisor on COVID-19) and asked to produce analyses on risk of importation of COVID-19 in prisons, to be later integrated with modelling work from PHE. I performed 8 analyses in total until 25/02/2022.

b. The number of meetings you attended, and your contributions to those meetings;

- SPI-M: I attended 100 meetings out of 104. I joined from 10/02/2020 (the 3rd meeting after SPI-M became SPI-M-O, i.e. operational on COVID) and missed the

meetings on 25/8/2021 and 06/01/2022. My contribution consisted of bringing in some modelling analyses for discussion, listen to others' analyses, offer comments and opinions when relevant and agree on the consensus documents.

- MTP: I attended every meeting since 08/04/2020. Meetings have been weekly for most of the pandemic, though more frequent in the initial period after the first lockdown. My contribution involved submitting estimates of R and of hospital admissions, hospital beds occupied and ICU beds occupied under the assumption nothing changes in the coming weeks.
- PHE/UKHSA JMT: I only formally attended meetings on: growth rates (14/09/2020); household clustering (06/12/2021); and testing regimes (07/02/2022). The rest of the work involved contribution discussions, typically with modelling analyses or opinions on data trends. The most influential ones have been in: early meetings focussed on interpreting the state of the pandemic in Italy; and around Christmas 2020 on projection of hospital admissions and bed occupancy with the arrival of the Alpha variant.
- HMPPS: Numerous informal discussions, generally 1-to-1 with NR.

c. *Your role in providing research, information and advice.*

- SPI-M: I attended those meeting as an expert in mathematical modelling of infectious disease dynamics, bringing reports based on application of models developed to address questions, either commissioned by the SPI-M secretariat or that I or my colleagues considered relevant for the situation. Based on such analyses and those of other groups, a consensus statement was drafted after each meeting, which was then passed on to SAGE and used as basis for the advice to the Government.
- MTP: My role consisted in fitting a model developed in early April to NHS data about hospital admissions and daily deaths, plus hospital and ICU bed occupancy, to derive estimates of R and projection of pressure on hospitals for the weeks to come (assuming no change in transmission). Around the moments in time when a change in transmission was expected, the same model was used to explore scenarios of what to expect in terms of admissions and beds occupied for different values of R as realised by the intervention implemented (or lifted).
- PHE/UKHSA JMT: In addition to attending the occasional meeting, offering opinions when suitable, I have submitted weekly reports on situational awareness, both about hospitals with the same model used for the MTPs and about cases and deaths around Europe and selected countries worldwide, from WHO and then Johns Hopkins University data.
- HMPPS: I provided analyses as requested, on: risk of introduction in prisons, role of staff and visitors, compartmentalisation of staff and prison population, limitations expectations around testing and optimisation of test timing around work-shift patterns.

Question 4

A summary of any documents to which you contributed for the purpose of advising SAGE and/or its related subgroups on the Covid-19 pandemic. Please include links to those documents where possible.

MTP: I was submitting weekly estimates of R and model projections to the MTP group through the dedicated submission system, so that then estimates and projections from different groups could be combined by the dedicated team at DSTL (and then UKHSA). Combined estimates for R were published on the Govt website (https://www.gov.uk/guidance/the-r-number-in-the-uk), as were MTPs. An example of the combined MTPs can be seen here: https://www.gov.uk/government/publications/spi-m-o-medium-term-projections-16-december-2020. Around the time of major policy changes, in addition to projections under the no-transmission-change assumption, scenarios (example of dynamics we would expect to see for different future values of R) were also explored and published. An example is here: https://www.gov.uk/government/publications/spi-m-o-medium-term-projections-and-scenarios-28-october-2020. The model used is published in [P8] (see Question 5).

PHE/UKHSA JMT: The few times I was invited to attend a JMT meeting, I was typically presenting analyses that had already been submitted to SPI-M, so I will not report them again here. In addition, I was contributing to the JMT report weekly (not publicly available on the web but easily obtainable by UKHSA), with graphs about hospital projections obtained with the same model used for the MTPs and with estimates of the doubling time from European countries (plus selected countries worldwide, which changed as needed, e.g. with a focus on South-East Asian countries on Delta and a different one on Southern African countries with the arrival of Omicron). Additionally, the same code was used to estimate doubling time from Pillar 1 and Pillar 2 data in the UK, as well as the vaccine coverage once it became available. All outputs were sent to SPI-M too.

Papers to SPI-M, JMT, HMPPS and SAGE (in chronological order):

1	SPI-M: 9 Mar 2020	Epidemics in carehomes – impact of cocooning_v3.pdf	First quantitative analysis focussed specifically on care homes, highlighting the large potential hospital burden from residents alone. Attempt to quantify potential reductions in deaths and peak pressure on hospitals if we could lower the risk of introduction of COVID in care homes. I stress that I had no knowledge or control over the logistics involved in how to achieve this goal.
2	SPI-M: 16 Mar 2020; preliminary version,	Individual and household isolation - Lorenzo Pellis_v2.pdf	Isolating individuals upon symptoms and quarantining the household is more effective than other strategies examined, but costly in terms of person-days of

	SAGE: 10 Mar 2020		isolation. Please note: Epidemic control appeared achievable for very high compliance, but that was before we knew cases were doubling every 3 days (rather than the 5-6 days assumed in this analysis). This work forms part of [P20].
3	SPI-M: 20 Mar 2020	UK_predictions_fast_exp_growth.pdf	Epidemic shown to be progressing faster than previously thought, with cases doubling every 3 days, rather than the 5-6 days estimated from China and assumed in most of the other existing analyses considered by SPI-M. Published in [P16] (earliest preprint on 31 March 2020: https://arxiv.org/abs/2004.00117) and by SAGE [S12], and featuring in [I1]
4	SPI-M: 20 Mar 2020	UK_IT_interventions_comparison.pdf	Epidemic in the UK shown to be only 2 weeks behind the Italian one, and reiterating the faster speed of growth. Also, a projection is attempted of ICU admissions in the UK under the assumption the UK epidemic would mimic the Italian one also in terms of the impact of interventions already applied but the effects of which could not be seen yet. Published in [P16] (earliest preprint on 31 March 2020: https://arxiv.org/abs/2004.00117) and by SAGE [S12], and featuring in [I1]
5	SPI-M: 23 Mar 2020	Pellis_Household_second_gen.pdf	Clear evidence that the impact of interventions would not manifest in the available data streams until 9-10 days after their implementation, too little to see the impact of any control policy already implemented up to that point. In the worst-case scenario of such control policies being ineffective, even if all transmission were halted immediately, a 9-10-day delay, coupled with a 3-day doubling time, means infection would grow 8-fold, thus placing hospital and ICU bed projections higher than the target limits suggested by the NHS at the time. This work provided evidence of limited room for manoeuvre beyond the rapid implementation of a lockdown. Note also that, at the speed of growth estimated at the time, even doubling the bed availability would only buy 3 days of reprieve. Therefore, just a few days' delay

			could have led to significantly more infections and associated deaths, and likely added significant additional strain on the healthcare system. Published in [P16] (earliest preprint on 31 March 2020: https://arxiv.org/abs/2004.00117) and by SAGE [S12], and featuring in [I1]
6	Circulated by email: 25 Mar 2020	UK short term forecast[2].pdf	Evidence that numbers of confirmed cases were still growing exponentially after the lockdown, though from the third day they started indicating the impact, moderate as it may be, of interventions prior to the lockdown.
7	SPI-M: 2 Apr 2020	Comparing interventions in Italy and UK.pdf	Confirmation of a 2-week delay between the UK and Italian outbreaks was still approximately correct even as the impact of interventions were becoming visible. Published as [S1]
8	SPI-M: 17 Apr 2020	UK_IT_deaths_0416.png	Evidence of the still remarkably similar trend between the UK outbreak and Italian one translated by 2 weeks, even after the peak caused by the lockdown, which could be used to gage a likely future UK trend.
9	SPI-M: 24 Apr 2020	Manchester_LOS_TruncatedCHESS.docx	Estimates of Length of Stay (LoS) in hospital more realistic than those used initially by SPI-M
10	SPI-M: 24 Apr 2020	HospDelays.xlsx	Estimates of Length of Stay (LoS) in hospital more realistic than those used initially by SPI-M
11	SPI-M: 24 Apr 2020	Lorenzo Pellis - Mean lengths of stay and proportions in hospital.pdf	Early estimates of severity of disease outcome
12	HMPPS: 5 May 2020	Manchester - Risk of importation in prison.pdf	Preliminary analysis of risk of importation of COVID-19 in prisons from inflow of new inmates, members of staff and visitors, and projections for different reproduction numbers.
13	SPI-M:11 May 2020	Contact_Tracing.pdf	Evidence that Test, Trace and Isolate (TTI) is unlikely to keep the pandemic under control, without significant social distancing. Investigation of the role of household structure on contact tracing.
14	SAGE: 9 Jun 2020	Recommendations for Augmenting Contact Tracing in the UK: Learning from Other	Document co-authored through the Isaac Newton Institute (INI) Infectious Dynamics of Pandemics (IDP) meeting, Cambridge (online), UK. Available at:

		Diseases (same as [S2])	http://www.newton.ac.uk/files/preprints/ni20001.pdf
15	SPI-M: 17 Jun 2020; preliminary results on 10 Jun 2020	PHE_Manchester_School_reopening.pdf	Reopening secondary schools observed to be more likely to increase transmission rates in the general population than opening primary schools. This work supported subsequent SAGE advice that a staggered process of school re-opening, starting from younger pupils was an appropriate way forward. Work appears in [P14]
16	SPI-M: 24 Jun 2020	Manchester - Optimal work shift and testing pattern - SPI-M 200624.pdf	Suggestions concerning optimal shift patterns to minimise transmission, especially among health-care workers, and care home and prison staff
17	SPI-M: 26 Jun 2020; preliminary results on 12 Jun 2020	Manchester - Out of household isolation and quarantine.pdf	Isolation of confirmed cases outside of the household (e.g. in a hotel) is shown to occur too late in the infection cycle to have significant impact on within-household and community transmission. This analysis fed into SAGE's discussions, suggesting that the out-of-household isolation policy is unlikely to be cost-effective. However, though of minimal effect in reducing transmission rates in the general population, the analysis pointed at the direct health benefits of quarantining vulnerable household members outside the households to decrease their risk of hospitalisation and severe outcome.
18	HMPPS: 26 Jun 2020	Partial reverse cohorting in prison_corrected.pdf	Risk of introduction on COVID-19 in prisons through inflow of new inmates for different lengths of reverse cohorting (isolation before joining the rest of the prison community) and different background levels of prevalence in the population. Work appears in [P18]
19	SPI-M: 1 Jul 2020	Manchester estimates of hospitalisation and ICU rates.xlsx	New estimates of severity of disease outcome. Obtained with the MTP model, published in [P8]
20	SPI-M: 28 Jul 2020	DoublingTimeJuneJuly.pdf	Example of the weekly report performed between summer and winter 2020 to evidence that doubling times shorter than 2 weeks from other countries were not uncommon, thus indicating that the scenarios on what was expected for the second wave of the pandemic in the second

			half of 2020 prescribed to SPI-M members by the Cabinet Office at the end of July was too optimistic
21	SPI-M: 16 Sep 2020	Manchester - Summary Situational Awareness 200915.pdf	Example of the weekly analyses of the speed of growth in UK testing data and confirmed cases and death in Europe and selected countries worldwide. Valuable for situational awareness, it was produced since 29 July 2020, and in 2021 streamlined into a series of graphs added to the PHE/UKHSA JMT weekly report
22	SPI-M: 14 Oct 2020	infections_reported_vs_test_delays.docx	Recommendation that a large fraction of contacts should be traced for TTI to be effective. If enough tests are available, they should be done to all traced contacts rather than only those developing symptoms
23	SPI-M: 14 Oct 2020	TTI_high_low_prevalence_considerations.docx	Testing resources should not be all shifted where cases are growing fast, as this would leave uncovered those areas with less transmission, which are the ones where TTI can still maintain successful control
24	SPI-M: 14 Oct 2020	DelaySummary.docx	Evidence TTI delays vary geographically, but that the mean delay has increased between August and September 2020
25	SPI-M: 11 Nov 2020	Breakdown of contact tracing as capacity is exceeded_ A demonstration.docx	Considerations around the description of how demand exceeding capacity relates to the breakdown of contact tracing. As testing capacity is exceeded, contact tracing will experience an exponential decay in its efficacy, so to keep contact tracing effective for as long as possible prevalence of Covid and non-Covid-ILI must be kept low.
26	SPI-M: 11 Nov 2020	Manchester - Impact of reopening above and below testing capacity.docx	Evidence that a temporary disruption to an otherwise effective TTI process might allow cases to increase to the point of exceeding testing capacity, at which point TTI is unable to contain the epidemic anymore. Work published in [P17]
27	SPI-M: 11 Nov 2020	Spatiotemporal variations in testing delays across England.docx	Further monitoring of heterogeneity in delays in detection of traced cases, and further recommendation that shortening them is important for TTI to be more effective
28	SPI-M: 17 Nov 2020	Post-lockdown TTI scenarios.pdf	Tier 3 identified as most effective at controlling transmission. Tier 1 and 2 not enough, but time needed for cases to rebound can be made longer by ensuring

			cases are very low at the time of switching away from Tier 3
29	SPI-M: 17 Nov 2020	Testing_of_traced_contacts_5_7_10days.docx	Effectiveness of different testing policies, supporting a push for new technologies for faster testing
30	HMPPS: 19 Nov 2020	Incursion modelling Nov - v11.docx	Estimates of risk of importation of COVID-19 in prisons through visitors and members of staff. Testing is not a silver bullet to prevent introduction.
31	SPI-M: 25 Nov 2020	Testing_Allocation_Demonstration___Concise.pdf	Development of a framework for optimising testing allocation for a range of objective functions when demand for tests exceeds testing capacity
32	SPI-M: 25 Nov 2020	Age-varying testing.docx	Monitoring of the increase in test demand in 18-24 concomitantly to return to school and university
33	SPI-M: 25 Nov 2020	Manchester - group exposure estimation - Xmas and NY_v2.pdf	Analysis of the risks in transmission associated with forming bubbles, which contributed to SAGE's discussion on measures around Christmas 2020. Work appears in [P20]
34	SPI-M: 2 Dec 2020	Manchester - Timing of testing and infectiousness.pdf	Analysis on the limitations of testing in detecting infection in the early part of an individual's infectious period. This work provided a simple and intuitive explanation for why testing alone is unlikely to prevent the introduction of COVID-19 into prisons, care homes and any gatherings (e.g. Christmas). This work supported discussions around the use of point-of-care (i.e. results obtained on the spot) versus PCR testing (more accurate, but slower), a push for new technologies, more frequent testing and synchronisation of testing with work shift patterns, especially in prisons and care homes. Also presented to HMPPS [36]
35	SPI-M: 2 Dec 2020	Quarantine and testing strategies to prevent onwards infection from travellers returning to the UK from abroad.docx	Comparison of quarantine and testing strategies to prevent onwards infection from infected travellers returning to the UK from abroad
36	HMPPS: 4 Dec 2020	Manchester - Timing of testing and infectiousness.pdf	Same as [34], as presented to SPI-M on 2 Dec 2020.

37	SPI-M on 7 Dec 2020	Severity estimates template MFT.xlsx	Estimates of severity of disease outcome demonstrate that in-hospital treatment outcomes improved significantly between the first and second waves of the pandemic.
38	JMT: 20 Dec 2020	JMT Briefing 20-12-2020.docx	Overall PHE JMT situational awareness document, to which I contributed with estimates of R and projections of hospital admission and hospital/ICU bed occupancy. Obtained using model in [P8]
39	JMT: 3 Jan 2021	JMT Report 03-01-2021.docx	Overall PHE JMT situational awareness document, to which I contributed with estimates of R and projections of hospital admission and hospital/ICU bed occupancy. Obtained using model in [P8]
40	SPI-M: 27 Jan 2021	Manchester - Lockdown 3 school reopening 20210125_v2.pdf	Scenarios of what we might expect to see if schools re-open in February or in April 2021, for various values of impact of school mixing on transmission. Obtained using model in [P8]
41	SPI-M: 3 Feb 2021	Manchester - Lifting NPIs 20210202_v3.pdf	Scenarios of what we might expect to see if restrictions are lifted from the same initial to the same end point in amount of transmission, but in 3, 6 or 9 monthly steps (rapid to slow reopening). Obtained using model in [P8]
42	HMPPS: 25 Feb 2021	RCU Risk of Importation v2.docx	Reverse cohort units (RCUs) should ideally isolate individuals: if they are allowed to mix, RCUs can potentially amplify transmission rather than preventing it. Testing is helpful to control spread in RCUs and there only a relatively small difference between the range of strategies investigated.
43	HMPPS: 7 Apr 2021	Impact of vaccination in prisons_v3.docx	For prisoners aged 40+, hospitalisation and death rates are roughly in keeping with prisoners' age being increased by about 10 years. Only 16% of the prison is 50+, vaccinating by age in prison as in the general population is relatively inexpensive, but 1.5x more deaths, 2x more hospitalisations and 3x more cases than what observed up to now are expected. Vaccinating everyone immediately could substantially reduce health impact. Work appears in [S6].

44	SPI-M: 21 Apr 2021	JUNIPER_Vaccine Assumptions_updated .pdf	Investigation of available evidence about vaccine effectiveness to revisit assumptions in the Roadmap scenarios and allow understanding of difference between model predictions of different groups. Broadly, new evidence was not deviating from roadmap model assumptions, and differences were almost exclusively in assumptions about key parameters for which evidence was still very limited at the time of this work.
45	HMPPS: 26 Apr 2021	Impact of Vaccination in Prisons_2_LP.docx	Update of document sent on 7 Apr 2021, with simulations of expected outbreak dynamics in prison for various assumptions on R0 and vaccine efficacy
46	SPI-M: 26 Apr 2021	1f JUNIPER Options 26th April V1.pdf	Expert opinion on the impact of 2 sets of control policies (Option 1 and Option 2) suggested by the Cabinet Office, to choose the best one.
47	SPI-M: 4 May 2021	1e JUNIPER Options 4th May.pdf	Same as before, but with the additional comments concerning an Option 3
48	HMPPS: 8 May 2021	Update- risk of COVID-19 importation in prisons (staff only).docx	Update to document sent on 19 Nov 2020, given the lower incidence in both the general population and among members of staff, as well as weekly testing among staff but not residents
49	SPI-M: 18 May 2021	TTI % cases who were previously identified as contacts as a KPI.docx	Only 18% of cases notified as contacts later tested positive during their isolation window. How accurate is this percentage as an indicator of TTI effectiveness? The answer is that it would be helpful to accompany it with other indicators, such as the % of cases who were contacts notified either before or after testing positive, particularly as it changes over time, as well as the stratification of these percentages by household status of the contact
50	SPI-M: 19 May 2021	Targeted_vaccination _Manchester_v1.pdf	Targeting vaccination at areas with high prevalence of the new variant is almost always beneficial in practice
51	SPI-M: 25 May 2021	OvertonC_JUNIPER_InvestigatingAgeDistributionSgenepositiveEngland.pdf	Throughout May 2021, the age distribution of S-gene positive cases (proxy for emerging Delta variant) becomes more aligned with that of S-gene negative cases (proxy for well-established Alpha variant). This is suggestive of transition from majority of

			cases concentrated among travellers to widespread community transmission.
52	SPI-M: 2 Jun 2021	OvertonC_JUNIPER_demographic_trends.pdf	Patterns of ethnicity over time for S+/S- vary dramatically from place to place. In some regions (Bolton, Leicester, Birmingham, Blackburn, and Manchester), S+ cases have disproportionately affected individuals with an Asian ethnicity since early April. The ethnicity distributions are slowly converging back to that of S-.
53	SPI-M: 23 Jun 2021	6a. JUNIPER shifting ages for SPIM 23rd June 2021.pdf	Shift in age distribution of cases, admission and hospitalisation-case ratio partially but not completely explained by mixing and vaccination by age groups.
54	SPI-M: 23 Jun 2021	OvertonC_JUNIPER_Post admission for SPI-M.pdf	No observed change in length of stay (LoS), though recent estimates (involving Delta) are very uncertain due to small numbers. The analysis also estimates the hospital fatality rate and its changes over time.
55	SPI-M: 1 Jul 2021	notes.pdf	Overall direct estimation of total effect of vaccination on transmission from the ONS COVID-19 Infection Survey. Work appears in [P4]
56	SPI-M: 6 Jul 2021	2d. Bristol roadmap_20210706.pdf	Transitioning from non-pharmaceutical interventions to vaccination to control COVID-19 transmission. Alternative calculation of the impact of lifting interventions in a partially vaccinated populations that makes simplifying assumptions from the modelling side but employs behavioural data collected through a survey. The goal was to offer a different modelling approach to cross-check the projections from the three main roadmap models. Work published by SAGE [S7], and the same method is used in [S8,S11,P2]
57	SPI-M: 30 Nov 2021	UKHSA_UoM_high_Delta_proportion_in_SGTF.pdf	Potential biases in estimating Omicron growth rates as Delta cases spotted among S-gene negative recorded cases
58	SPI-M: 1 Dec 2021	Using LFTs at arrival or for TTI.pdf	The “day 2” PCR test might fail to stop some of the importations from international arrivals, and it can be complemented with daily LFT for improved effectiveness. Similarly, daily LFTs enhance the effectiveness of contact tracing. Work extended in [59]

59	SPI-M: 8 Dec 2021	Using LFTs at arrival - version 2.pdf	The "day 2" PCR test might fail to stop some of the importations from international arrivals, and it can be complemented with daily LFT for improved effectiveness. The advantage is particularly evident if further within-household transmission risks going unnoticed when the index case is missed. Extension of work in [58]
60	SPI-M: 15 Dec 2021	Email: Request for comments/review on travel testing policy DfT modelling	Email discussion on revisions of the modelling framework in use by the Department of Transport.
61	SPI-M: 15 Dec 2021	Manchester and UKHSA -Back of the envelope calculations on age-based lockdown.pdf	Omicron is so infectious that shielding the elderlies in the population is very difficult and even if done at high levels of effectiveness the reduction in the number of cases is limited. Work included [S10] with [63]
62	SPI-M: 21 Dec 2021	Manchester - Care home shielding omicron.pdf	Reducing transmission in care homes, even if possible, would have very limited effect. Shielding care homes from the general population can be helpful, but reduction in cases, hospitalisations and deaths is still limited even with high levels of shielding. Available as part of a SAGE paper
63	SPI-M: 22 Dec 2021	Manchester Age-based NPIs - Simple model insight 20211220.pdf	Assuming a different form of immunity in the population does not alter the previous result [61]. Omicron is still so infection that the reduction in the number of cases achievable with an age-based lockdown is limited. Work published by SAGE [S10]
64	HMPPS: 25 Feb 2022	Omi health outcomes v2 Feb22_LP.docx	Expected ranges of deaths after a full Omicron wave under current estimates of vaccine efficacy

SPI-M outputs as published by SAGE (numbers refer to SPI-M table above):

S1	1 Apr 2020	Comparing interventions in Italy and UK. I found looking two weeks ahead at the pandemic in Italy to be a good guide of what we might expect in the UK. This has been helpful and remarkably accurate (see [3,4,5,7,8])	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/893534/S0097_SAGE22_20200401_Comparing_Interventions_in_Italy_and_UK.pdf
S2	9 Jun 2020	"Recommendations for Augmenting Contact Tracing in the UK: Learning from Other Diseases", Isaac Newton Institute	http://www.newton.ac.uk/files/preprints/ni20001.pdf

		(INI) Infectious Dynamics of Pandemics (IDP) meeting, Cambridge (online), UK. Same as [14]	
S3	15 Nov 2020	LSHTM, University of Manchester and Alan Turing Institute: On the use of lateral flow antigen tests in contact tracing - preliminary findings. The use of daily LFTs on traced contacts may offer an improvement over the current contact tracing strategy.	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/950771/s0897-testing-of-traced-contacts.pdf
S4	1 Dec 2020	LSHTM and the University of Manchester/the Alan Turing Institute: Comparison of quarantine and testing strategies to prevent onwards infection from infected travellers returning to the UK from abroad.	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/950772/s0943-tti-modelling-group-quarantine-testing-strategies.pdf
S5	15 Jan 2021	EMG/SPI-B/SPI-M: Reducing within- and between-household transmission in light of new variant SARS-CoV-2. Recommendation that precautions within the households are still helpful at limiting transmission and protecting the vulnerable ones even among households' members, and even if Alpha has higher transmissibility.	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/952799/s1020-Reducing-within-between-household-transmission.pdf
S6	25 Mar 2021	EMG Transmission Group: COVID-19 transmission in prison settings. Contains work in [43]	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/979807/S1166_EMG_transmission_in_prisons.pdf
S7	7 Jul 2021	JUNIPER: Transitioning from non-pharmaceutical interventions to vaccination to control COVID-19 transmission. Alternative calculation of the impact of lifting interventions in a partially vaccinated populations that makes simplifying assumptions from the modelling side but employs behavioural data collected through a survey. The	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1001156/S1305_JUNIPER_Transitioning_from_non-pharmaceutical_interventions_to_vaccination_to_control_COVID-19_transmission.pdf

		goal was to offer a different modelling approach to cross-check the projections from the three main roadmap models. Work based on [56] and the same method is used in [P2]	
S8	12 Oct 2021	University of Bristol: Trade-off between population immunity and return-to-work for COVID-19 control, autumn and winter 2021 scenarios. Using the same method as the previous analysis [56,S7], scenarios are explored for various values of R and vaccine efficacy	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1027886/S1387_Bristol_Autumn_and_Winter_scenarios.pdf
S9	21 Dec 2021	University of Manchester: Impact of shielding on care homes during wave 2: Considerations for Omicron. Reducing transmission in care homes, even if possible, would have very limited effect. Shielding care homes from the general population can be helpful, but reduction in cases, hospitalisations and deaths is still limited even with high levels of shielding.	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1044998/S1471_Manchester_-_Care_home_shielding_omicron.pdf
S10	21 Dec 2021	University of Manchester: Age-based NPIs, simple model insight. Omicron is so infectious that shielding the elderlies in the population is very difficult and even if done at high levels of effectiveness the reduction in the number of cases is limited. Contains work in [61,63]	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1044565/s1465-age-based-npis-simple-model-insight.pdf
S11	11 Jan 2021	University of Bristol: Impact of voluntary risk-mitigation behaviour on the magnitude of a COVID-19 Omicron variant wave in England. Again using the method of previous analyses [56,S7,S8], the impact of a large wave of Omicron is projected under assumption of behaviour based on a new survey. Voluntary risk reduction measure could	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1048350/SAGE103_S1492_RR_Omicron.pdf

		reduce deaths by a quarter, but results are uncertain mainly due to assumptions on vaccine efficacy against Omicron and severity of Omicron	
S12	23 Mar 2020	University of Manchester: UK COVID-19 predictions. Published later, this document reflects the document presented at SPI-M on Fri 20 Mar 2020 [3] on the 3-days doubling time, which was then considered by SAGE on Mon 23 Mar 2020.	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1067374/S0081_UK_predictions_for_SAGE.pdf

Question 5

A summary of any articles you have written, interviews and/or evidence you have given regarding the work of the above-mentioned groups and/or the UK's response to the Covid-19 pandemic. Please include links to those documents where possible.

Interviews on COVID-19:

I1	Aired: 19 Nov 2020	Interviewed as part of the BBC2 programme "Lockdown 1.0 – Following the Science?", filmed on 7 Jul 2020 and mostly focussing on [3,5,S12]	https://www.bbc.co.uk/programmes/m000pjr1 (about 46 mins in)

Popular science interviews and articles:

I2	5 Jun 2020	"COVID-19: FSE report" from The Buzz, University of Manchester podcast, mostly focussing on [3,5,S12]	https://www.mub.eps.manchester.ac.uk/science-engineering/2020/06/05/covid0-19-fse-report/
I3	10 Dec 2020	Interview at "Homecoming", a meeting presenting 4 stories-of-success for my home University in Trieste, Italy	Slides available on request
I4	10 Jan 2022	Popular science article published through JUNIPER on the Plus Magazine	https://plus.maths.org/content/so-whats-waning

Scientific seminars/presentations:

I5	8 May 2020	"AI, Stats & COVID-19", University of Trieste, Italy (online), mostly focussing on [3,5,S12]	Slides available on request
I6	22 Jun 2020	Online conference "Modellistica e Covid-19", mostly focussing on [3,5,S12] and model in [P8]	Slides available on request

I7	7 Apr 2021	Presentation at the British Applied Mathematics Colloquium (BAMC), Glasgow (online). Presenting model in [P8]	Slides available on request
I8	9-11 Jun 2021	Royal Statistical Society "Special Topic Meeting on R". Online conference on selected submissions, which are then published on Journal of the Royal Statistical Society A [P7]	Slides available on request
I9	30 Nov – 3 Dec 2021	E-poster presentation at Epidemics8 conference (online) on model published in [P8]	Poster available on request

Scientific publications following work for SPI-M:

P1	Whitfield, C. A., Van Tongeren, M., Han, Y., Wei, H., Daniels, S. A., Regan, M., ... & Hall, I. (2022). Modelling the impact of non-pharmaceutical interventions on workplace transmission of SARS-CoV-2 in the home-delivery sector. *medRxiv*.	Lots of overlap with work on optimal testing strategies, e.g. [16,34,35,42, 48,58,59]
P2	Brooks-Pollock, E., Northstone, K., Pellis, L., Scarabel, F., Thomas, A. C., Nixon, E. J., ... & Danon, L. (2022). Impact of voluntary risk-mitigation behaviour on transmission of the Omicron SARS-CoV-2 variant in England. *medRxiv*.	Work in [S11], with the same methods as [56,S7,S8]
P3	Ahmad, S., Brown, B., Charlett, A., Davies, E., House, T., Kirkman, B., ... & Overton, C. E. (2021). Early signals of Omicron severity in sentinel UK hospitals. *researchsquare preprint doi.org/10.21203/rs.3.rs-1203019/v1*	
P4	House, T., Pellis, L., Pritchard, E., McLean, A. R., & Walker, A. S. (2021). Total effect analysis of vaccination on household transmission in the Office for National Statistics COVID-19 infection survey. arXiv preprint arXiv:2107.06545.	Work of [55]
P5	House, T., Riley, H., Pellis, L., Pouwels, K. B., Bacon, S., Eidukas, A., ... & Sarah Walker, A. (2022). Inferring risks of coronavirus transmission from community household data. *Statistical Methods in Medical Research*, *31*(9), 1738-1756.	
P6	Funk, S., Abbott, S., Atkins, B. D., Baguelin, M., Baillie, J. K., Birrell, P., ... & ISARIC4C Investigators. (2020). Short-term forecasts to inform the response to the Covid-19 epidemic in the UK. *MedRxiv*.	
P7	Pellis, L., Birrell, P. J., Blake, J., Overton, C. E., Scarabel, F., Stage, H. B., & Brooks-Pollock, E. (2021). Estimation of reproduction numbers in real time: conceptual and statistical challenges. *Journal of the Royal Statistical Society: Series A*.	Work presented at conference [I8]. Proper journal article to appear soon
P8	*Overton, C. E., *Pellis, L., Stage, H. B., Scarabel, F., Burton, J., Fraser, C., ... & Lythgoe, K. A. (2022). EpiBeds: Data informed	Contains work in [P19,P38, P39]

	modelling of the COVID-19 hospital burden in England. *PLoS computational biology*, *18*(9), e1010406.	
P9	Hilton, J., Riley, H., Pellis, L., Aziza, R., Brand, S. P., K. Kombe, I., ... & House, T. (2022). A computational framework for modelling infectious disease policy based on age and household structure with applications to the COVID-19 pandemic. *PLoS computational biology*, *18*(9), e1010390.	
P10	Ward, T., Glaser, A., Johnsen, A., Xu, F., Hall, I., & Pellis, L. (2021). Growth, reproduction numbers and factors affecting the spread of SARS-CoV-2 novel variants of concern in the UK from October 2020 to July 2021: a modelling analysis. *BMJ open, 11(11)*, e056636.	
P11	Fearon, E., Buchan, I. E., Das, R., Davis, E. L., Fyles, M., Hall, I., ... & Wingfield, T. (2021). SARS-CoV-2 antigen testing: weighing the false positives against the costs of failing to control transmission. *The Lancet Respiratory Medicine*.	
P12	Brooks-Pollock, E., Danon, L., Jombart, T., & Pellis, L. (2021). Modelling that shaped the early COVID-19 pandemic response in the UK. *Philosophical Transactions of the Royal Society B*, *376*(1829), 20200267 – *Special Issue on COVID-19*	Introduction paper to the Special Issue containing [P13,P14,P15, P16]
P13	Fyles, M., Fearon, E., Overton, C., University of Manchester COVID-19 Modelling Group, Wingfield, T., Medley, G. F., ... & House, T. (2021). Using a household-structured branching process to analyse contact tracing in the SARS-CoV-2 pandemic. *Philosophical Transactions of the Royal Society B*, *376*(1829), 20200267 – *Special Issue on COVID-19*	Contains work in [11,17,22,23]
P14	Stage, H. B., Shingleton, J., Ghosh, S., Scarabel, F., Pellis, L., & Finnie, T. (2021). Shut and re-open: the role of schools in the spread of COVID-19 in Europe. *Philosophical Transactions of the Royal Society B*, *376*(1829), 20200277 – *Special Issue on COVID-19*	Contains work in [15]
P15	Hall, I., Lewkowicz, H., Webb, L., House, T., Pellis, L., Sedgwick, J., ... & University of Manchester COVID-19 Modelling Group and the Public Health England Modelling Team. (2021). Outbreaks in care homes may lead to substantial disease burden if not mitigated. *Philosophical Transactions of the Royal Society B*, *376*(1829), 20200269 – *Special Issue on COVID-19*	
P16	Pellis, L., Scarabel, F., Stage, H. B., Overton, C. E., Chappell, L. H., Fearon, E., ... & University of Manchester COVID-19 Modelling Group. (2021). Challenges in control of Covid-19: short doubling time and long delay to effect of interventions. *Philosophical Transactions of the Royal Society B*, *376*(1829), 20200264 – *Special Issue on COVID-19*	First preprint on 31 March 2020. Contains work in [3,4,5] and [S12]
P17	Scarabel, F., Pellis, L., Ogden, N. H., & Wu, J. (2021). A renewal equation model to assess roles and limitations of contact tracing	Contains work in [26]

	for disease outbreak control. *Royal Society open science*, *8*(4), 202091.	
P18	Bays, D., Williams, H., Pellis, L., Curran-Sebastian, J., O'Mara, O., Team, P. J. M., & Finnie, T. (2021). Insights gained from early modelling of COVID-19 to inform the management of outbreaks in UK prisons. *International Journal of Prisoner Health*.	Contains work in [18]
P19	Vekaria, B., Overton, C., Wiśniowski, A., Ahmad, S., Aparicio-Castro, A., Curran-Sebastian, J., ... & Elliot, M. J. (2021). Hospital length of stay for COVID-19 patients: Data-driven methods for forward planning. *BMC Infectious Diseases*, 21(1), 1-15.	Contains work in [9,10]
P20	*Overton, C., *Stage, H. et al. (2020). Using statistics and mathematical modelling to understand infectious disease outbreaks: COVID-19 as an example. *Infectious Disease Modelling*.	Contains work in [2,33]

Question 6

Your views as to whether the work of the above-mentioned groups in responding to the Covid-19 pandemic (or the UK's response more generally) succeeded in its aims. This may include, but is not limited to, your views on:

I am an experienced mathematical modeller, but I have worked essentially at the most mathematical end of the field until the pandemic. The pandemic was one of the first times when I actually worked with real data, and certainly the first experience for me in providing policy advice. Therefore, my views should be read in light of my experience of being suddenly projected in this policy advice world, which was extremely hectic in particular in the run up to the first lockdown.

I find it hard to provide a unique answer that applies to the entire pandemic period because both my experience and the groups' composition/aims/roles/limitations changed significantly throughout the course of the pandemic. However, the most useful temporal distinction I can think of is to split answers in two periods: during the pandemic "early response" (ER: prior and during the first lockdown; roughly Feb-May 2020) and "late response", i.e. after the first lockdown (LR: roughly June 2020 onwards).

a. The composition of the groups and/or their diversity of expertise;

- The composition of SPI-M has always appeared balanced to me, with a suitable diversity of expertise, both when I first joined it and when it rapidly grew in size throughout the ER phase.
- However, especially in the LR phase, I wonder whether the additional presence of experts on economic matters (health economics or more general economic and social aspects) would have helped. Although suggested on multiple occasions by various members to the SPI-M secretariat and co-chairs (Graham Medley and Angela

McLean), the answer I recall was that economic evaluations go beyond the remit of SPI-M and that social and economic aspects would be accounted for in SAGE, or directly in Government.
- I have always been impressed with the competence and efficiency of the SPI-M secretariat, SPI-M's academic co-chairs and generally all civil servants I interacted with.
- The JMT and the NRP also had diverse and appropriate compositions, and competent members.

b. The way in which the groups were commissioned to work on the relevant issues;

- This aspect also seemed appropriate. In SPI-M, we were tasked with questions coming from "above", through the secretariat and chairs. However, I never felt prevented from bringing in either alternative analyses or potential opinions on non-commissioned issues, if we academics felt they were somewhat more relevant to the current or long-term situation than those directly commissioned.
- The hierarchical structure also allowed a very constructive cycle between policy requests and modelling response, which would in turn stimulate amended policy asks. This has also come up repeatedly in discussions with scientists outside of SPI-M as one of the most important elements for science to provide useful policy advice.
- About the other groups, I have too limited understanding on the way PHE/UKHSA and HMPPS were commissioned to work on relevant issues to comment knowledgeably.

c. The resources and support that were available;

- Resources and support available was somewhat appropriate, especially in the LR phase, but small groups still struggled.
- Unsurprisingly, the ER phase suffered from standard issues expected when a system is caught by surprise and has to adapt quickly, so we academics relied largely on the University reallocating our teaching load to other members of staff. Plan to avoid that for the next emergency should be put in place. In the LR phase, financial contributions were awarded to the Universities for the time we academics invested in activities related to SAGE and its subgroups, so that the University could cover the cost of other staff taking on our admin and teaching commitments. However, I believe Universities did not know they would have been compensated financially until Autumn 2020 and the funding did not arrive until one year into the pandemic.
- Although the funding to the Universities was generally an appropriate repayment for the time directly invested in the activities of SAGE and its subgroups, the cost of maintaining a full research group, with expert post-doctoral researchers (which have proved essential to generate a significant part of the analyses) still fell on us academic, either through previously awarded grants that were then repurposed, or by applying for more funding throughout the emergency. This was much easier for larger groups (e.g. Imperial College and the London School for Hygiene and Tropical Medicine – LSHTM), which had enough admin and research personnel to share the

workload, and in certain cases were even given direct funding (e.g. from MRC, if I remember correctly) for the emergency response.

- In some cases, early access to data from some groups but not others made it harder to have multiple groups independently validate particular analyses, particularly in the ER phase (see [3,4,5,S12,P16]). This issue was later addressed by centralised data sharing agreements and robust confidence in results (and hence advice) only when multiple groups would independently agree on similar results.

d. The advice given and/or recommendations that were made;

- The advice and recommendations were always given to the best of our abilities, based on the evidence considered and the analyses discussed
- However, the ER phase was obviously particularly critical, given the novelty of the context and the limited data available.
- One of the most useful contributions I was involved with was the correction of early estimates of the doubling time, revising original values down from 5-6 to 3 [3,4,S12], and estimating a 9-day delay between intervention and seeing its effect on hospital data (the only reliable data in March 2020), just prior to the first lockdown [5,P16]. At that point work relying on SAGE's previous estimates became rapidly outdated, as focussed on scenarios and parameter ranges corresponding to an unrealistically slow epidemic.
- As a personal opinion, I found it challenging to give advice or recommendations without knowing the rough "cost" of the consequences of some epidemiology-driven choices: for example, although all-round costs are hard to quantify in practice, I could offer a model-based assessment of the increased risk of introduction of the infection in a closed environment (e.g. a prison), but without knowing how expensive it is to control an outbreak in that environment, it is hard to formulate a recommendation. For this reason, there might have been a potential risk for advice and recommendations from scientists to be tilted towards the side of tighter control (due to the lack of "costs" attached to it). However, I am confident this potential bias was accounted for in SAGE, if nothing else due to the plurality of expertise there (not only epidemic modelling).

e. The extent to which the groups worked effectively together;

- The groups worked generally very well together, with respectful and constructive interactions the vast majority of times. The stressful conditions naturally led to some tensions, but they were generally managed and addressed appropriately.
- An unavoidable London/non-London divide did sometimes emerge from discussions. This is partially due to the geographical heterogeneity of the pandemic (e.g. London typically hit sooner and harder than the rest of the UK), but partially also due to the two largest modelling groups being based in London. The sheer size, past experience in emergency response, and larger availability of tools, funding and personnel meant results and opinions shared were sometimes not always uniformly balanced. This was more of a risk in the ER phase, in conditions of stress and limited data.
- This unbalance is often perfectly natural: I myself would be more likely to trust a more tested model, from someone with more experience and who has thought

more about it than the results I might obtain with a new model, in a condition of stress. However, when the collegial advisory role clashes with the competitive world of academic success (e.g. first and typically higher impact publications), there is a realistic risk that the voice and estimates of smaller groups carry less weight that those of larger groups. Of the two London-based group, I generally perceived the London School of Hygiene and Tropical Medicine to take a more collaborative and less competitive approach than Imperial College.

f. The extent to which applicable structures and policies were utilised and/or complied with and their effectiveness.

- Sitting in SPI-M but not SAGE, it is not possible for me to comment on the way the generated advice and consensus was moving up the advisory structure and informing final decisions.
- However, it is possible (and natural) that results/opinions formulated in SPI-M by research group led by members who are also in SAGE were overrepresented or had more influence in the decisions taken. This was more likely in the ER phase, with a smaller group and more hectic times. Steps to limit that, with a larger SPI-M, more robust group structure, and the additional presence of Angela McLean to support Graham Medley as academic co-chair of SPI-M, were taken, and I felt have been effective. Paradoxically, though, a larger SPI-M could also be generating a plurality of analyses, with a potential risk that policy makers, with so many different analyses would just ask one or two top scientists' opinion and ignore the rest. Again, I trust the SPI-M secretariat and co-chairs ensured that was generally not the case.
- Ultimately, I never had the feeling that a message I deemed important and that I wanted to be heard was not given due attention. Multiple channels involved in policy advice (SPI-M, PHE/UKHSA, NHS, etc.) also contributed to add to plurality of opinions influencing the final decision.
- There have been occasions where the policy decisions went against the advice SPI-M provided, confirming that our role was to give advice, not to make decisions.

Question 7

Your views as to any lessons that can be learned from the UK's response to the Covid-19 pandemic, in particular relating to the work of the above-mentioned groups. Please describe any changes that have already been made, and set out any recommendations for further changes that you think the Inquiry should consider making.

- As hinted at above, policy advice and scientific publication rewarding system are often at friction with each other. Many of these have been highlighted very carefully in the in-context page at the end of [P16], and are by no means restricted to our experience. In particular:

- Early estimates are more likely to lead to high impact publication, no matter how accurate they are, and subsequent refinements, though essential for the policy response, are not rewarded in the scientific peer review process.
- Inaccurate estimates might continue to be used just because they appear on high impact journal, and the more the citations, the more they are cited.
- Work on policy advice documents is often either not scientifically careful enough because done at pace, or scientifically solid but not methodologically innovative. As a result, much of the policy advice reports are not publishable, and even when made public, not useable as part of the Research Excellence Framework.
- Data sharing, rather than being encouraged and facilitated, is generally difficult, time consuming and hard to incentivise, as arguably detrimental to a group's academic success rather than rewarding. This is more likely to happen in the early stages of the pandemic response, which is also when wrong estimates are more dangerous for public health response.
- Negative peer reviews based on subjective evaluation of importance of the work or the estimate provided can effectively delay publication of useful results for long enough to make them irrelevant. Coupled with a need for immediate transparency, this can become a time sink for academics that hinders, rather than strengthening, their advisory role.

Progress: I personally do not feel much progress has been made to address this problem during the pandemic, although I do agree an emergency might not be the right time to solve this issue. The risk remains that academic career priorities (high impact publications and academic funding) interfere with the robustness and accuracy of the response or the collegial nature of the advisory process. Vice versa, the policy advice system risks not providing enough rewards in terms of academic career.

- A devolved health care system is particularly frail in coordinated response, as needed in the context of emergency. Data collection, sharing, and monitoring in a consistent manner is also hindered by lack of central control. This made data on hospital admission at the beginning of the pandemic very delayed in the UK, and the lack of international sharing (Italy was the only European country making its hospital data publicly available in March 2020) meant every country had to look at their own hospital data and likely acted late (or at least risked that) in their early response because they could not reliably act on data from countries that were far ahead in their epidemic curve. Even later, estimates of vaccine effectiveness of protecting from hospitalisation was challenging to estimate as hospitalisation data was anonymised in the NHS and vaccination data was anonymised in PHE/UKHSA, resulting in the inability to usefully link the two datasets.
  Progress: Communication and coordination improved throughout the pandemic, but issues of data inconsistencies between devolved administrations remain. Being able to re-establish the same level of communication and coordination rapidly in a new emergency is the real issue.
- Data access to key datasets, e.g. about hospitals, is essential in an emergency, but is often prevented by lack of data sharing agreements, which are hard to work on in a hurry. This should be kept in mind for the next emergency, both nationally and internationally.

Progress: Agreements were put in place during the pandemic. Again, the real question is whether data can be spun up immediately at the next emergency. There is a general hope that the data structures put in place during the COVID-19 pandemic will be kept, but there is a distinct possibility this might not be the case as the memory of the pandemic fades. My experience with Monkeypox leads me to think that the data issues that emerged during Covid are not solved effectively.

- Plurality is helpful for increased robustness.
  Progress: SPI-M rapidly expanded to address this issue during the pandemic. More importantly, the new version of SPI-M (of which I am not a member) has reduced to a smaller size while attempting to maintain the same level of plurality.
- Although this was not the case in SPI-M, other decision-makers were often perceiving models as a substitute for data. In many cases, excessively complex model requests were expected in a hurry, only to have "numbers" to use for decision makers to devolve responsibility even in the case of simple decisions based on common sense. Despite the warnings that numbers in result tables heavily depend on assumptions, especially in the absence of data, the perception was often that a number was needed, irrespective of how reliable that estimate was.
  Progress: communication between policy makers (or close advisors) and academics has improved this aspect, though such communication is time consuming and better established in non-emergency times.
- If plurality is desired, then in future emergencies, funding should be guaranteed or at least facilitated, bearing in mind that smaller groups are disproportionately affected by funding shortages.
  Progress: compensation became available, and Universities and funders were understanding of the situation in general, but again whether mechanisms are in place for the next emergency is the real challenge.
- More discussion between SPI-M and SPI-B, or economic presence in SPI-M, might have been useful, but this was likely happening already enough in SAGE (and I just did not see it as only member of SPI-M)

Question 8

A brief description of documentation relating to these matters that you hold (including soft copy material held electronically). Please retain all such material. I am not asking for you to provide us with this material at this stage, but I may request that you do so in due course.

All material described above is either publicly available or I hold an electronic copy on my laptop and as email attachments. All email conversations have been preserved.