Reference: M2/SAGE/01/JXR
Dr Jonathan M Read, Lancaster University
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Please find below my answers to the questions provided in your email dated 2 September 2022.

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

I have a degree in Biology (York University, 1991) and a PhD in Ecology (Stirling University, 1996). I have been working on infectious disease epidemiology since 2000, initially developing theoretical models of pathogen evolution (University of Cambridge & University of Warwick), but since 2008 working on more applied epidemiological studies, a mixture of secondary data analysis and designing and conducting epidemiological field studies (University of Liverpool & Lancaster University). Applications include influenza, Ebola, anti-microbial resistance, and SARS-CoV-2. I also have expertise in the quantification and description of social contact patterns relevant to the transmission of respiratory infections.
Selected publications:

- Read JM, Keeling MJ. Disease evolution on networks: the role of contact structure. Proceedings of the Royal Society, B. 2003; 270:699–708.
- Read JM, Eames KTD, Edmunds WJ. Dynamic social networks and the implications for the spread of infectious disease. Journal of the Royal Society Interface. 2008; 5(26):957–1118.
- Lessler J, Riley S, Read JM, et al. Evidence for Antigenic Seniority in Influenza A (H3N2) Antibody Responses in Southern China. PLoS Pathogens. 2012; 8:e1002802.
- Danon L, Read JM, House TA, Vernon MC, Keeling MJ. Social encounter networks: characterising Great Britain. Proceedings of the Royal Society, B. 2013; 280:1765 20131037.
- Read JM, Diggle PJ, Chirombo J, Solomon T, Baylis M. Effectiveness of screening for Ebola at airports. Lancet. 2015; 385(9962):23-24.
- Docherty AB, Harrison EM, ..., Read JM, et al. Features of 20 133 UK patients in hospital with covid-19 using the ISARIC WHO Clinical Characterisation Protocol: prospective observational cohort study. BMJ. 2020;369:m1985.
- Challen R, Brooks-Pollock E, Read JM, et al. Risk of mortality in patients infected with SARS-CoV-2 variant of concern 202012/1: matched cohort study. BMJ. 2021 Mar 10;372.
- Read JM, et al. Hospital-acquired SARS-CoV-2 infection in the UK's first COVID-19 pandemic wave. The Lancet. 2021 Sep 18;398(10305):1037-8.
- Read JM, Bridgen JR, Cummings DA, Ho A, Jewell CP. Novel coronavirus 2019-nCoV (COVID-19): early estimation of epidemiological parameters and epidemic size estimates. Philosophical Transactions of the Royal Society B. 2021 Jul 19;376(1829):20200265.
- Meslé MMI, ..., Read JM. Estimating the potential for global dissemination of pandemic pathogens using the global airline network and healthcare development indices. Scientific Reports 12, 3070 (2022).

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.

SPI-M-O; 27 January 2020 to January 2022.

SPI-M subgroup Nowcasts and Medium-term Projections (July 2021 to December 2021)
SAGE/SPI-M subgroup on Children (called various names at different times according to my Outlook invitations: Children's Task & Finish Group; Sub-group on Children and Schools; subgroup on children and young people); April 2020 to December 2020.

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;
b. The number of meetings you attended, and your contributions to those meetings;
c. Your role in providing research, information and advice.

SPI-M-0. I was asked to present analysis of pandemic potential of the novel coronavirus to SPI-M on 27 Jan 2020, and shortly afterwards was asked to join the operational group. I attended most meetings (generally weekly meetings, but more often in the early stages of the pandemic). For the period Jan-Mar 2020, I did not attend the meetings dated 02 Mar 2020, 09 Mar 2020, 16 Mar 2020. My contributions would be in general discussion and critique of presented work, provision of national and regional R estimates, specific requested analyses (e.g., within hospital transmission, social contact patterns). Where possible (given time and data availability, and expertise), I would respond to specific requests for analysis, often in a collaborative manner with other SPI-M-O members. My key contributions are described under question 4.

SPI-M subgroup Nowcasts and Medium-term Projections. This group was established to provide focussed discussion on the weekly reproduction number estimates and medium-term projections being provided by various academic groups. As I was one of those providing estimates of reproduction numbers, I was asked to join. I attended most of the meetings from mid-2020 onwards, where other commitments permitted. I provided weekly national and regional estimates of reproduction numbers, and contributed to general discussion.

S**AGE/SPI-M subgroup on children**. My experience in conducting a study in USA looking at influenza infection among schoolchildren was deemed relevant, and I was invited to join occasional meetings. I'm afraid I do not have access to minutes from these meetings and do not have a record of my own attendance. My contribution was mostly through discussion, and centred around known social mixing patterns of children, how to measure these effectively, and possible transmission routes of SARS-CoV-2 within school (based on my earlier influenza research).

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.

Documents where I was the leading/corresponding author are listed below. I assume that the documents to which I made a minor contribution (but was not the lead or corresponding author) will be provided by the relevant lead. Some of these would have been submitted to SPI-M through official channels; others (due to time constraints) were presented at SPI-M meetings. I have copies of all the following documents unless specified.

- Estimates of the pandemic potential and scale of the epidemic within China for the novel coronavirus. This work provided early (Jan 2020) epidemiological assessment of the emerging situation in China.
    - "*Novel coronavirus 2019-nCoV: early estimation of epidemiological parameters and epidemic predictions*". Original MedRxiv paper: https://www.medrxiv.org/content/10.1101/2020.01.23.20018549v2. Peer-reviewed version: https://royalsocietypublishing.org/doi/10.1098/rstb.2020.0265
- Modelling of the importation risk into UK posed by an uncontrolled epidemic in China
    - "*2019-nCoV epidemic forecasts and importation risks*" 09 Feb 2020
- Modelling study examining when epidemics may peak within different regions of England, February 2020. There was a general question within SPI-M as to how much regional variation there may for an uncontrolled epidemic; this study focussed on the timings of epidemic peaks.
    - "*Distribution of epidemic peak timings across major English metropolitan areas*" 29 February 2020.
- Analysis of covid-19 patient data
    - "*COVID-19 UK patients – Interval from symptom onset to hospital admittance*" 27 March 2020
    - "*Characteristics of COVID-19 UK patients and risk factors associated with requiring ventilation and death*" 05 April 2020
    - "*COCIN study – selective update*" 09 December 2020.
- Estimation of hospital acquired infections (HAI, or nosocomial infections) throughout the first epidemic wave in UK, and occasional analyses for subsequent waves of infection. Analysis of the first wave data was published in The Lancet: https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(21)01786-4/fulltext
    - "*Modelling the daily rate of nosocomial infections in UK hospitals using CO-CIN data*" 10 April 2020
    - "*Investigating nosocomial infections using CO-CIN COVID-19 patient data*" 12 April 2020
    - "*Modelling the daily rate of nosocomial infections in UK hospitals using CO-CIN data*" 17 April 2020
    - "*Investigating nosocomial infections using CO-CIN COVID-19 patient data*" 23 April 2020
    - "*Investigating nosocomial infections using CO-CIN COVID-19 patient data –version 4*" 30 April 2020
    - "*Modelling the daily rate of nosocomial infections in UK hospitals using CO-CIN data*" 18 May 2020
    - "*Nosocomial infection trends using COCIN COVID-19 patient data*" 10 November 2020
    - "*COCIN HAI quick report*" 10 Feb 2021
    - I conducted similar analysis weekly throughout the autumn 2020 and into 2021, which were presented during SPI-M online meetings, but no formal documents were provided to SPI-M.
- Analysis of covid-19 symptom presentation in children in comparison to adults.
    - "*Clinical aspects of COVID-19 in children: symptoms at admission among CO-CIN participants*" 12 April 2020.
- Analysis of social contact patterns

    - "*Estimating the potential for social contact reduction in the UK*" 11 March 2020. Using previously collected social contact data, this analysis examined how much social mixing could be reduced by limiting contact to home and school/work settings.
    - "*Social contact patterns in the UK: CoCoNet survey preliminary findings*" 11 August 2020. https://www.medrxiv.org/content/10.1101/2021.10.22.21265371v1
    - "*CoCoNet Report 2: the survey before Christmas.*" 01 December 2020.
    - "*Social mixing patterns in the UK following relaxation of COVID-19 pandemic restrictions: a cross-sectional online survey*" 30 June 2021. Examined working from home and potential reduction in contacts.
- Factors influencing influenza transmission within schools
    - "*Role of schools in influenza transmission and the effect of half-day attendance: key findings from the SMART study of influenza transmission in US schools*" 13 April 2020
- Work related to use of testing of those in isolation or quarantine.
    - "*Optimising the swab test regimen of contacts to minimise the risk of releasing falsely negative SARS-CoV-2 individuals from traveller quarantine or isolation following tracing*" 16 June 2020.
- Effect of tiers and control options
    - "*Epidemic growth within LTLAs and control tiers using pillar 2 data.*" 25 November 2020.
    - "*Control Options for Mitigating a Rapid Rise in Infections.*" 12 October 2021
- Reproduction number estimation (methodological, not estimates)
    - Edits to "*Extract of methods document to confirm with modellers*". 15 March 2021
- Novel variant analysis
    - "*Rt estimates for new and old variants, by region*" 13 January 2021

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.

Media interviews I have been involved with related to the work above are:

- BBC inside science features the early China pandemic analysis, July 2020: https://www.bbc.co.uk/programmes/m000l267
- I was interviewed by BBC Panorama for a programme aired in November 2020 (https://www.bbc.co.uk/programmes/m000pjr1), but no footage from my interview was broadcast.
- Selected co-authors and I gave a media briefing on the hospital-acquired infections Lancet publication on 12 August 2021, through the Science Media Centre.

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:
a. The composition of the groups and/or their diversity of expertise;
b. The way in which the groups were commissioned to work on the relevant issues;
c. The resources and support that were available;

d. The advice given and/or recommendations that were made;
e. The extent to which the groups worked effectively together;
f. The extent to which applicable structures and policies were utilised and/or complied with and their effectiveness.

As far as I am aware the aim of SPI-M-O was not formally specified to us, but understanding is the aim of the group was to provide epidemic analysis and advice to support SAGE in advising the government on responding to the covid pandemic. This included providing situational awareness information (i.e., epidemiologically relevant measures such as the growth rate and reproduction number estimates). The group increased in size during the course of pandemic, as additional expertise developed and was sought. The majority of the group were epidemic modellers, but there was also representation from clinicians and immunologists. While the main expertise of the group was epidemic modelling, members collectively had a broad experience of epidemiology and public health responses to epidemics, as well as experience in analysing and conducting operational research during previous pandemics and important outbreaks (including SARS in 2001 and Ebola in 2014/15).

There was considerable willingness from the secretariat to support the committee as much as possible, and I think their effort and hard work should be recognised. In particular, in the early stages the secretariat liaised effectively across government to secure rapid access to important data (such as travel statistics and bespoke ONS analysis from the previous census). There was also very good collaboration and engagement between SPI-M-O and the Department for Education. Data availability was very good, generally, though there were exceptions (notably national-level detailed hospital admission data, particularly in relation to new variants).

More and better integration between the behavioural scientists and members of SPI-M-O would have benefited the response; I think this would ideally be initiated by chairs and secretariat, rather than relying on the scientists themselves to initiate, though some links between modellers and behavioural scientists had been established prior to the pandemic. I believe that integration of economic modelling with epidemic modelling would have led to the identification of more nuanced but effective control policies that more holistically balanced the economic impact of social distancing with the public health and epidemic impact. Inclusion of economic experts and advisors (perhaps from the Treasury?) would have been helpful in this regard, particularly if they could have been embedded within and worked directly with the academic epidemic modelling groups.

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.

The imposition of a stay-at-home lockdown presented challenges for the modelling groups. A key question for modelling in late February 2020 was: would a lockdown work in reducing the reproduction number below 1 (and cause the number of new cases to substantially reduce)? To answer this, models need to be able to model transmission and the effect of an intervention on that transmission. As epidemic modellers, we tend to attempt to include a mechanistic representation of

transmission of infections between people. However, there are important structural differences in the way different models used by different groups represent interactions between people and opportunities for transmission. For example, most models used in epidemic modelling in the response – and indeed across epidemic modelling -- are what are termed age-structured models. That is, they model the population as a set of sub-populations, each with a different age, and it is explicitly assumed (informed by previously collected social contact information) how much social interaction happens between each age group. This type of model was commonly used by teams at Warwick, LSHTM and Cambridge/PHE prior to the pandemic. This approach contrasts with a more detailed individual-based network model, such as used by Prof Neil Ferguson (Imperial). The UK's first lockdown -- where individuals were required to stay at home for a prolonged duration, except for those working in 'essential services' or with specific reasons, presented a very difficult challenge to modelling. To the best of my knowledge, it had never been considered as a population scale response to a pandemic prior to 2020, and so there had been no explicit modelling of the effects of such a public health measure within the epidemic modelling literature. The only model capable of exploring the impact of such a control measure on the progression of the pandemic was Prof Ferguson's model, because it had sufficient complexity including structure of households within the model. This left the UK's response critically dependent on a single model from a single academic group. While I believe Prof Ferguson's model worked correctly, there are a large number of structural and parametric assumptions that went into that model which may well have been different had other modelling groups developed equivalently more detailed and socially realistic models. A consensus from multiple groups' modelled output for the same scenario has great strength. Future pandemics would be better served by the academic community having a wider range of models available with multiple levels of complexity, so important policy questions are not reliant on the output of a single group or model. I believe this can only be established through dedicated pandemic preparedness funding. I understand that Prof Ferguson's model was developed originally to model smallpox outbreaks, funded by dedicated funding around the epidemic threat posed by bioterrorist smallpox release; this was in light of the 9/11 attacks and anthrax bioterrorism in the USA. There is also a specific need to improve epidemic models to serve the requirements of policy better, and this would, in my opinion, also include better integration with behavioural and economic expertise.

Epidemic modelling is critically dependent on the ability quantify and model behaviour; epidemics are driven by human behaviour. This includes normal every-day behaviour that permits the spread of infections, but equally important is the how individuals and a population collectively responds to an epidemic threat and how this may be affected or moderated by government and media messages. The ability to forecast the progression of an epidemic is highly sensitive to future behaviour. An important knowledge gap in modelling is the ability to predict behavioural changes, particularly in response to interventions (and the lifting of interventions). There is much willingness among academics for interdisciplinary collaboration, but I believe a significant limiting factor is dedicated pandemic preparedness funding.

In the autumn of 2020, localised tiered control was implemented within England; each tier representing a different set of control interventions. Unfortunately, due to the way these were implemented it was statistically challenging (if not impossible) to differential the effect of different interventions on the epidemic. In future pandemics, it would be valuable to consider a more sophisticated implementation of different interventions to better identify the effect of each, something akin to traditional block structures in experimental study design. There may, of course, be

overriding public health imperatives, but designing the implementation of controls to maximise knowledge of the efficacy of the controls should be considered.

One final comment on research for pandemic preparedness. I believe there is a real danger that we may move too quickly into the neglect phase of the fund-neglect cycle that has hindered pandemic preparedness research. There is much to be learnt from last 2 years of the pandemic, in particular how to better improve the epidemic modelling analysis to benefit policy decisions. While I appreciate much research funding has been diverted away from traditional areas to fund rapid pandemic research, there is a risk that without dedicated funding, the knowledge that has been built up (often simple information such as what was implemented where and when) and importantly the data collected, will be lost and improvements in preparedness will be minimal. I also recommend that much of the data collected and key to understand the pandemic (e.g., CoCin study. CoMix social mixing data, Home Office border and travel data. PHE/UKHSA CTAS contact tracing data, COG genomic data, NHS patient and staff data and vaccination data) are archived and treated as a national research resource (with linkages between data sets wherever possible) and available for appropriate research use, to maximise understanding and therefore preparedness for future outbreaks and pandemics.

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.

I have electronic copies of the documents listed above, and associated email correspondence.