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Citation for final published version:

Evans, Robert 2022. SAGE advice and political decision-making: 'following the science' in times of epistemic uncertainty. *Social Studies of Science* 52 (1) , pp. 53-78. 10.1177/03063127211062586

Publishers page: <https://doi.org/10.1177/03063127211062586>

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To be published in
Social Studies of Science

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Author

Robert Evans

Centre for the Study of Knowledge, Expertise and Science (KES)
School of Social Sciences
Cardiff University

Publication History

Original submission to journal: 19 November 2020
Revised version submitted: 25 May 2021
This version accepted: 13 August 2021

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Abstract

This paper presents a preliminary analysis of the advice provided by the UK government’s Scientific Advisory Group for Emergencies (SAGE) held between 22 January and 23 March 2020 in response to the emerging coronavirus pandemic. Drawing on the published minutes of the group’s meetings, the paper examines what was known and not known, the assumptions and working practices that shaped their work, and how this knowledge was reflected in the decisions made by the government. In doing so, the paper critically examines what it means for policy making to be ‘led by the science’ when the best available science is provisional and uncertain. Using ideas of ‘externality’ and ‘evidential significance’, the paper argues that the apparent desire for high levels of certainty by both scientists and political decision-makers made early action impossible as the data needed was not, and could not, be available in time. This leads to an argument for changes to the institutions that provide scientific advice based on more sociologically informed expectations of science in which expert judgement plays a more significant role.

Introduction

On Monday 23 March 2020, Prime Minister Boris Johnson informed everyone living in the UK that, due to the rapidly rising number of coronavirus cases, they were only permitted to leave their home for one of four ‘very limited purposes’.¹ By the end of April, just five weeks later, the number of confirmed covid-19 cases in the UK had increased from 6,650 to 171,253, whilst the number of deaths attributed to the virus had increased from 359 to 26,771. By the end of June, at which point the first wave of the epidemic had peaked and case numbers had fallen back below 1000 new cases per day, these figures had increased to 313,483 confirmed cases and 43,730 deaths.²

Given the scale and speed of this tragedy, questions have inevitably been asked about the scientific advice given to the government and whether the lockdown initiated on 23 March should have been implemented sooner. The nature and quality of this advice is important as the claim to be ‘following the science’ was used repeatedly by the UK Government to explain the policies it was introducing and to justify not acting in other ways. Whilst this respect for science can be seen as a positive change given recent debates about ‘post-truth’ politics (in this journal see, for example, Collins et al., 2017; Jasanoff and Simmet, 2017; Sismondo, 2017a, 2017b), it does pose the question about

¹ The four reasons were:

- Shopping for basic necessities, as infrequently as possible
- One form of exercise a day - for example a run, walk, or cycle - alone or with members of your household;
- Any medical need, to provide care or to help a vulnerable person; and
- Travelling to and from work, but only where this is absolutely necessary and cannot be done from home

The speech is available at: <https://www.bbc.co.uk/news/uk-52011928>

² Source: <http://www.statistica.com>; data downloaded August 2020. The figure for June includes some duplication as the total for 2 July is 283,757, approximately 30,000 lower. That said, it should also be noted that, at the time of writing (November 2020) the UK government website shows higher numbers of cases and deaths – 12,657 on 23 March and 177,496 on 30 April for cases and 939 and 28,470 for deaths – which suggests some under-reporting in the early period of the pandemic. In what follows, I use statistica.com figures as published in August 2020 to give a more accurate representation of what was known at the time. For a more detailed discussion of the presentation of coronavirus statistics in the UK see Billig (2021).

whether, and to what extent, the failure of the UK to contain the pandemic was a failure of scientific advice rather than of political decision-making.

In the remainder of this paper, I summarise some of the ways in which the relationship between science and policy has been discussed within the STS literature and argue that, despite the success of the co-production approach, a distinction between the 'technical' and 'political' aspects of decision-making remains useful. I then track the developing scientific understanding of covid-19, as recorded in the minutes of the UK government's Scientific Advisory Group for Emergencies (SAGE), and cross-reference this to the policies announced by the Prime Minister and others. This analysis documents how the uncertainties and limitations of scientific knowledge were made explicit by SAGE and how the political choices made by the UK government responded to these difficulties. The key argument is that both the government and the members of SAGE appear to have set the bar for 'usable' knowledge at a very high level and that this delayed the implementation of policies to contain the pandemic. Following this, I reflect on the possible solutions to the problem and suggest that a more sociologically informed understanding of science provides a means to recognise the limits of science whilst also supporting its use as a source of expert advice.

Scientific Advice in Policy-Making

Soliciting scientific advice for policy-making implies a distinction between the 'technical' and the 'political' that STS has done much to undercut (e.g. Jasanoff, 2007). As numerous case studies have shown, these boundaries are routinely crossed as scientific advisers make judgements about acceptable risks, reliable evidence and desirable outcomes (Hilgartner, 2000; Irwin, 1995). Technical advice is, therefore, interlaced with value-judgements and this, in turn, leads to calls for more participatory and democratic forms of advice-giving in which expert values and assumptions can be (con)tested more effectively. Examples of STS work in this vein include: constructive technology assessment (Grin, J. et al., 1997; Rip et al., 1995) post-normal science (Funtowicz and Ravetz, 1993), socially robust knowledge (Nowotny et al., 2001), the deconstruction of quantified risk into qualitatively different types of uncertainty (Wynne, 1992b), the critique of value-free science (Douglas, 2009), and feminist and post-colonial philosophies of science (Harding, 2006; Longino, 1990). Well-known studies that support this perspective include Wynne's study of Cumbrian sheep farmers (Wynne, 1992a), Epstein's study of AIDS treatment activists (Epstein, 1996), and Ottinger's study of fenceline communities (Ottinger, 2013). The influence of these ideas can be seen in national events like the UK's GM Nation? debate (Horlick-Jones et al., 2007) and the increasing popularity of participatory research (Brown, 1987, 1992) and citizen science methods (Irwin, 1995; Wylie et al., 2017). There has also been some impact on policy making, with the report of the House of Lords science and technology committee in the UK (House of Lords, 2000) often seen as a landmark moment.

Despite this, however, the expectation that policy decisions should be informed by the best available expert advice persists (Science Advice for Policy by European Academies, 2019). Indeed, even STS scholars who have been highly critical of the way scientific advice has been sourced, understood and used in the past still believe in the value of scientific advice. As Brian Wynne put it in an interview for the *Nordic Journal of Science and Technology Studies*:

Meanings and concerns should arise within democratic settings articulated through democratic political processes. They should be informed by science, of course, but this is not the same as allowing science to define those public concerns and meanings. There is no reason why something that is democratic and political shouldn't be informed by science.

The challenge then is how to make sense of this distinction between the domains of ‘science’ and ‘politics’ given what STS has said about their inseparability. The case against separation is usually made via examples of regulatory science (Jasanoff, 1994; Weinberg, 1972), in which hybrid institutions commission research, evaluate evidence and formulate regulatory rules and policies. In such settings, the same actors are involved at all stages and it does, indeed, appear that that science and politics become merged. If this is the case, however, then the idea that ‘something that is political’ can, and should, be ‘informed by science’ makes little sense; if the technical is always and already political how can there be two separate activities in play?³

One way to make this distinction between ‘democratic settings’ and ‘science’ work is to follow Collins and Evans (2002) and distinguish between the political and technical ‘phases’ of decision-making. The terms are sometimes miss-understood as implying a return to the fact-value distinction or support for technocracy (Jasanoff, 2003; Wynne, 2003) but neither view is correct, as the original and subsequent publications explain (Collins et al., 2010, 2020; Collins and Evans, 2002, 2003, 2007, 2017; Evans and Plows, 2007). Instead, the terms refer to aspects of decision-making that are characterised by different norms and priorities such that there is a clear sociological difference between the two. The technical phase refers to institutional settings and moments where the intention is (or should be) to act ‘scientifically’; the political phase refers to those settings and moments where the intention is (or should be) to act in accordance with democratic principles.⁴ In this way, the activities are distinguished by what participants are trying to achieve and the means that they have at their disposal to reach those goals in ways that would be seen as legitimate by their peers. There is no suggestion that the technical phase is value-free, nor that it must precede the political phase; indeed, the most likely scenario that both kinds of work occur in parallel with each informing and responding to the other.⁵

UK Scientific Advice and Covid-19

The work of advisory committees such as SAGE lies in what has just been described as the technical phase. The technical phase can be constituted in many ways but the formation of an expert committee is typical of the UK’s approach (Jasanoff, 2005, 2007) and precedent suggests that this approach faces a particular challenge when confronted with an emergent problem, such as the coronavirus pandemic, about which little is known. The most well-known example of this is probably the ‘mad cow disease’ (BSE) fiasco of the 1980s and 90s, where it is now widely accepted that the early scientific advice downplayed the dangers and policy-decisions were taken slowly and reluctantly.⁶

³ Proponents of actor-network theory would, presumably, agree with this concern but draw the opposite conclusion, namely that there is just one kind of activity in play with nature and society, science and politics, being the *explanandum* and not the *explanus*. This merits of actor network theory have been much debated in the literature and the position taken in this paper follows that found in Collins and Yearley (1992) and Bloor (1999).

⁴ In the case of hybrid institutions the argument is that both phases are contained within the same institution, and even the same individual, as the same participants orientate to different priorities at different times (Collins et al., 2010).

⁵ Although not especially important for this paper, it should also be noted that Collins and Evans are also clear that participation in the technical phase is not restricted to scientific experts and that anyone with relevant experience would be qualified to take part.

⁶ Irwin (1995) provides a summary of the main themes, with the government inquiry, published as Phillips et al (2000), providing the most comprehensive account.

Focussing on SAGE as an element of the technical phase highlights the distinctive feature of the way the members of SAGE provide advice, namely that they are, and should be, expected by government, public and STS scholars to act 'scientifically'. Under the interpretation offered here, this means that epistemic and non-epistemic values associated with scientific work are exercised within the context of meeting the government's need for reliable information about, for example, the prevalence, spread, prevention and treatment of the new virus. In more practical terms, it means scientists on SAGE must make scientific judgements about when something is 'known' and with what degree of certainty and that these judgements should not be influenced by explicit political or other non-scientific preferences.

Pinch (1985) shows that there are two aspects to scientific judgements about the conclusions the available data can support: the 'evidential context' of the observation and the degree of 'externality' it requires. In the paper that sets out the framework, Pinch uses the case of solar neutrinos to show how the same data could be interpreted as meaning either that a radioactive isotope of Argon (Ar^{37}) had been observed or that solar neutrinos had been observed. The second statement has a higher degree of 'externality' as it corroborates the theory about the nature of the sun by claiming that solar neutrinos have caused Ar^{37} to be present in the detector. In contrast, the first statement makes no such theoretical claim and simply says that Ar^{37} was present. Claims with a low degree of externality typically attract little controversy because they do not say very much of significance. In contrast, bolder claims that draw in a wider range of concepts, methods and actors have a higher degree of externality and higher evidential significance, but this enlarged context also increases the degree of scrutiny needed to accept them.

Applying these concepts to the advice given by SAGE about the likely path of an unfolding, global pandemic allows us to ask what sort of science is required in order to inform policy-makers. On the one hand, it seems likely that a high degree of externality and evidential significance will be required given the need to extend the interpretation from simply reporting new cases to providing advice about how the virus is likely to spread across different demographic groups and with what effect. On the other hand, making such claims with a high degree of confidence is likely to mean an extensive period of scientific work through which the necessary certainty can be developed, something which the emergency setting, where advice is needed quickly, seems to preclude.

In exploring how these choices were made in the UK, the analysis takes a different approach to two recent publications papers that focus on scientific advice during the pandemic and, in particular, the role of epidemiological modelling. Saltelli et al (2020) do not address the UK situation directly but draw on the idea of post normal science to provide a more general manifesto for the use of models that repeats many of the standard themes from the STS literature, such as the need for wider scrutiny of assumptions and data, and concludes with a call for the scrutiny of mathematical models to be a 'social activity' (Saltelli et al., 2020: 484). Pearce (2020) focuses more directly on the UK and uses the certainty trough metaphor (MacKenzie, 1990) to argue that SAGE scientists were caught between competing role demands and that this led them to downplay the uncertainty around the estimation of a key epidemiological parameter. Both papers imply that the failure in the UK was a failure of science in the sense that SAGE failed to convey the limitations and uncertainties of epidemiological knowledge properly.

In what follows, I argue that much of what policy-makers needed to know about the limitations of expert knowledge was available and accessible to them. As a result, I argue that the failure was primarily a political one. To make this argument, I now turn to the minutes of the meetings, summarising them in chronological order, highlighting issues of interest and concern as they arise and tracking the inexorable rise in case numbers that came to dominate news coverage at the time.

In presenting the data this way I hope to convey both the uncertainty of the period and the sense of urgency and anxiety that accompanied it.

Data and Methods

What follows is based on two main sets of documents:

1. Minutes and other papers relating to the 18 meetings of the SAGE group that were held between 22 January and 23 March 2020. Minutes are available from UK government website⁷, though Professor Paul Cairny at the University of Stirling has included them in a much larger set of documents available via dropbox.⁸
2. Transcripts and supplementary information relating to the 10 press conferences and briefings given by the UK government during the same period.

Where appropriate, additional information has been included to contextualise these documents. Examples of this additional material include: press reports; research or briefing papers produced by members of SAGE; biographic information about members of SAGE; the timeline for the emergence of coronavirus published by the World Health Organisation;⁹ and data on coronavirus cases.¹⁰

No interviews were conducted with members of SAGE or the UK government. This is for two reasons. First, at the time the paper was being written (late autumn in 2020) the UK was entering what would turn out to be its second, and most severe, wave of the pandemic during which another 70,000 people would lose their lives. Asking members of SAGE to give up valuable time during this crisis seemed morally indefensible. Second, given that the analysis depends only on the time elapsed between SAGE making a knowledge claim and the government acting on that knowledge, the public minutes provide the most conservative estimate of that gap. Whilst it is possible that the same information might have been communicated informally before it appeared in the minutes, and so was available earlier, there can be no doubt that information in the published minutes was available to the government.

Emerging Knowledge of Covid-19

Throughout the pandemic, the UK government's principal source of scientific advice has been the Scientific Advisory Group for Emergencies (SAGE).¹¹ As the pandemic is a medical emergency, the group is co chaired by Sir Patrick Vallance, the UK's Chief Scientific Advisor (CSA), and Professor Chris Whitty, the UK's Chief Medical Officer (CMO), both of whom brief the government on behalf of SAGE. The expert members of the group (there are also observers and a secretariat) include academic researchers, many of whom also serve on more specialist advisory committees, as well members of relevant public agencies and the chief scientific advisers to individual government departments. The guidance issued to SAGE defines their role as providing 'coordinated, timely scientific and/or technical advice' through the review and analysis of existing data, the assessment of existing research and, if necessary, the commissioning of new research.¹²

⁷ See <https://www.gov.uk/government/organisations/scientific-advisory-group-for-emergencies/about>

⁸ See <https://www.dropbox.com/sh/9mtmp55yhczewv/AABC2pLCFAQSZ52lAxdBSuZ8a?dl=0>

⁹ Available at: <https://www.who.int/news-room/detail/29-06-2020-covidtimeline>

¹⁰ Data source: <https://www-statista-com>. For the UK, official data is available from <https://coronavirus.data.gov.uk/>.

¹¹ Pearce (2020) provides a useful overview of the wider committee structure.

¹² Source: Enhanced Sage Guidance, available from: <https://www.gov.uk/government/organisations/scientific-advisory-group-for-emergencies/about>

In what follows, I divide the description and analysis into two time periods. The first covers the time up to 13 March 2020 and includes:

- The emergence of the novel coronavirus and the formation, on 22 January, of the SAGE group that would advise the government
- The first Prime Ministerial press conference on 3 March setting out the UK's strategy to contain, delay and mitigate the effects of the pandemic
- Advice from SAGE on 13 March that there were no scientific grounds to delay the introduction of social distancing policies that would begin the 'delay' phase of the response

The second covers the period between 16 and 23 March 2020, and includes:

- The publication of a report, based on epidemiological modelling, that showed the NHS would be overwhelmed unless the policy approach is changed from containment and delay to suppression
- Three SAGE meetings, six government press conferences, and a televised address to the nation by the Prime Minister, in which the social and economic policies needed to suppress the virus were introduced.

Questions of whether action to delay or suppress transmission should have been taken earlier hinge on what was known, or could have been known, before 13 March, whilst questions of whether scientific advice was followed are addressed in the period after 16 March.

Waiting for the science

The meetings up to and including 13 March are primarily concerned with developing an understanding of the coronavirus pandemic, setting out what is needed to monitor the spread of the virus within the UK, and providing advice to the government about what kinds of interventions should be introduced.

22 January 2020: SAGE Meeting 1

The first SAGE meeting took place 13 days after the World Health Organisation (WHO) had confirmed a 'novel coronavirus' as the cause of what was previously a cluster of 'pneumonia of unknown cause' in Wuhan, a city of about 10 million people and the capital of China's Hubei province. At the time of the meeting, there were a total of 547 confirmed cases in China, 1 reported case in Thailand (13 Jan), 1 in Japan (16 Jan), 1 in Korea and 1 in USA (both 21 Jan). Around the same time, the WHO decided against classifying the outbreak a Public Health Emergency of International Concern (22-23 Jan).

The minutes are headed 'Precautionary SAGE meeting on Wuhan Coronavirus (WN-CoV)' and the discussion reflects the limited information available. Case numbers are 'almost certainly' (para 4) higher than reported but how much higher is not known. Human-to-human transmission seems likely but how far, how fast and for how long is unknown. The incubation period is unclear and there is, as yet, no evidence about asymptomatic transmission. The minutes conclude with the statement that SAGE members are 'unable to say at this stage whether [they] might be required to reconvene' (para 30).

28 January 2020: SAGE Meeting 2

SAGE did, in fact, meet six days later. By this point, Wuhan had gone into lockdown (23 Jan) and the number of confirmed cases in China had increased tenfold to 6000. Further cases had been reported in France (WHO, 24 Jan) and the WHO was calling on countries in South East Asia 'to remain vigilant' (WHO, 27 Jan).

The second meeting marks a shift to a longer-term perspective. First, the parameters by which the pandemic will be measured are set out: case fatality rate (lower than SARS but still uncertain); reproduction number, aka 'R' (between 2 and 3 in China but uncertain);¹³ doubling rate (3-4 days); symptoms (cough, fever, pneumonia but uncertain); incubation period (average of 5 days but considerable variation); duration of infectivity (unknown, estimate 14 days); asymptomatic transmission (limited evidence but likely).

Second, the meeting sees the incorporation of the Scientific Pandemic Influenza Group on Modelling (SPI-M) as a formal sub-group of SAGE. This puts epidemiological modelling at the heart of the process, with epidemiologists making up a substantial proportion of the experts present and model outputs becoming the key means of producing knowledge and justifying recommendations. In contrast, despite noting that SAGE participants are mindful of the 'importance of behavioural science in informing policy', the minutes state that no separate sub-group on behavioural science will be set up at this stage (para 31-32). There is also a very limited role for public health experts, with what little representation there is coming via institutional roles (e.g. Public Health England, Deputy Chief Medical Officer).

Third, the meeting adopts the planning guidance for pandemic flu as the basis of a 'reasonable worst case scenario' (RWCS). Although not quantified in the SAGE minutes, this means that a significant number of deaths are possible as the planning guidance document for pandemic flu states that:

up to one half of the population may become infected and between 20,000 and 750,000 additional deaths (that is deaths that would not have happened over the same period of time had a pandemic not taken place) may have occurred by the end of a pandemic in the UK.¹⁴

3 February 2020: SAGE Meeting 3

When SAGE reconvened by teleconference 6 days later, there were 2 confirmed cases in the UK, the total number of confirmed cases in China had increased to 19,700 and the WHO (30 Jan) had formally declared the coronavirus outbreak a Public Health Emergency of International Concern.

If the previous meeting was significant for introducing the criteria by which the virus will be understood, this one was important for introducing the metric against which interventions will be measured: a one month delay in the onset of the epidemic that will allow the National Health Service (NHS) to prepare and push the peak of the epidemic 'out of the usual winter respiratory season' (para 2). This is important for two reasons. First, it allows policy options to be evaluated. Second, and more importantly, it says that there will be a significant epidemic in the UK.

4 February 2020: SAGE Meeting 4

Official case numbers in China are now 23,700, though believed by SAGE to be about 10 times that number. Confirmed cases in the UK remain at 2.

The 'meeting summary' reaffirms the discussion of the previous day, with the final item capturing both the reliance on modelling and the sense of inevitability about the epidemic:

¹³ This is sometimes reported as R_0 , but in the UK it is generally referred to as 'R'. See e.g.: <https://www.gov.uk/guidance/the-r-number-in-the-uk>

¹⁴ <https://www.gov.uk/guidance/pandemic-flu#pandemic-flu-description-of-the-risk>

Modelling group SPI-M to produce projections of *when* the epidemic will peak, as well as other issues, including the impact of closing schools in different outbreak scenarios. (para 7, emphasis added)

There is no further information about the scenarios being considered but some details of the modelling work are given in the 'consensus statement' produced by SPI-M on 3 February 2020 and published with the meeting summary. The document begins by repeating information and assumptions about key parameters before moving on to 'operational considerations', about which it says:

Preliminary forecasts and accurate estimates of epidemiological parameters will likely be available in the order of weeks and not days following widespread outbreaks in the UK (or a similar country). While some estimates may be available before this time their accuracy will be much more limited.

The UK hospitalisation rate and CFR [case fatality ratio] will be very important for operational planning and will be estimated over a similar timeframe. They may take longer depending on the availability of data.

(paras 18 and 19)

This suggestion that conclusions with high degrees of externality – i.e. model outputs that accurately represent what is happening in the real world – will not be available until some weeks after widespread outbreaks in the UK are underway poses some serious questions for policy-makers. Assuming SAGE is correct, the past two weeks have seen cases in China grow from the 326 officially recorded on 21 January to approximately 250,000. If exponential growth of a similar rate occurs in the UK, then a delay of 'weeks' rather than 'days' before action is taken risks a substantial increase in the number of cases, hospital admissions and deaths compared to a more precautionary approach in which action is taken sooner. In other words, the choice to wait for the science to become more certain is not without costs.

6 February 2020: SAGE Meeting 5

There is now a third confirmed case in the UK and confirmed cases in China have increased to 30,600. The minutes note that there is now evidence of human-to-human transmission outside China.

11 February 2020: SAGE Meeting 6

The number of confirmed cases in the UK has increased to 8, with the number in China now standing at 44,300. The meeting marks the stabilisation of some knowledge about covid-19, with the parameters listed on 28 January confirmed with the remark that 'SAGE will not discuss these key variables again unless and until there is ... significant new data' (para 15).

The bulk of the minutes focus on three areas. The first is data availability, with paragraphs 16-26 identifying areas where more information would be useful. The second is the outbreak in Wuhan, which the modellers expect to peak in the next 1 – 3 weeks, approximately 2.5 months after it began. The peak in the rest of China is expected to be a further 1-2 months after this (paras 28-29).

These estimates inform the third area of discussion, namely what can be expected in the UK. No estimate of the scale of the epidemic is given but it is assumed that the UK will follow the same pattern with the epidemic peaking 'around 2 to 3 months following the establishment of widespread transmission' (para 31).

The meeting also marks the beginning of the end for any early optimism about testing as a means of tracking and controlling the spread of the virus. On 3 February 2020, paragraph 7 of the SPI-M consensus paper began with the statement that it was 'unclear whether outbreaks can be contained by isolation and contact tracing'. On 10 February, paragraph 7 of the updated document states that:

It is a realistic probability that outbreaks outside China cannot be contained by isolation and contact tracing. If a high proportion of asymptomatic cases are infectious, then containment is unlikely via these policies.

Additional measures to delay the spread of the virus, such as the school closures mentioned a week earlier (meeting 4) are, therefore, likely to be needed, raising obvious questions about what those measures should be and when they should be implemented.

13 February 2020: SAGE Meeting 7

Confirmed cases in the UK have increased to 9; the equivalent figure for China is now 59,800.

The meeting sees the creation of a formal sub-group on behavioural science (SPI-B) but, as with earlier meetings, most of the action points (4 out of 5) fall to SPI-M and its collaborators. This makes sense if the primary task is seen as developing the science needed to how coronavirus spreads. It is less clear, however, how far this emphasis on underpinning knowledge addresses the more immediate problems of identifying potential solutions or evaluating policy options such that the situation that is developing in China is not repeated in the UK. Both tasks are listed in the SAGE guidance, which also stresses the need for timely advice, but the minutes suggest that developing the science is seen as the foundation upon which all other tasks depend.

18 February 2020: SAGE Meeting 8

Confirmed cases in the UK remain unchanged at 9. Confirmed cases in China have increased to 74,100 and 3 have been confirmed in Italy.

The discussion concerns the transition from the current 'contain' phase, in which the outbreak is managed via identifying cases and their close contacts, to a 'delay' phase, in which additional measures are needed. SAGE recommend that, 'early warning surveillance systems ... need to feed into trigger points for decisions on when the current monitoring and contact tracing approach is no longer working' (para 8). There is, however, no explicit discussion of whether the data needed for such a strategy will be available in time to reliably estimate the models or to identify the proposed 'trigger points' in real-time.

20 February 2020: SAGE Meeting 9

Confirmed UK cases remain at 9, there is one new case in Italy and cases in China are said to be 75,500.

The minutes are mainly concerned with when the shift from 'containing' the virus through 'test and trace' measures to 'delaying' its spread through additional measures should happen. The SPI-M consensus paper (dated 17 February 2020) that accompanies the minutes reports that:

There were differing views within the group about the likelihood of sustained transmission in the UK both currently and in the near future. Some believe it is a realistic possibility that sustained transmission in the UK will become established in the coming weeks while others believe this likelihood is higher and that there may already be sustained transmission. (para 16)

The emphasis in the minutes, however, appears to be on reaching a consensus position and developing scientific certainty:

Before consideration of measures to reduce spread is undertaken, it is essential to understand the ability of surveillance methods to pick up evidence of an epidemic (and how those methods might be improved), understand when evidence will become available, and – from that surveillance – the likely trajectory of an epidemic. (Para 1)

In other words, the evidential context in which SAGE appears to be operating is one in which concerns with externality and evidential significance remain the priority. Whilst this undoubtedly reflects the prevailing norms of scientific advice-giving in the UK, it is also the case that the evidential context could be changed by SAGE prioritising different aspects of their remit or policy-makers choosing to ask for different kinds of advice.

25 February 2020: SAGE Meeting 10

Confirmed UK cases have increased from 9 to 13. Cases in China continue to rise slowly, suggesting the epidemic has reached its peak. In contrast, the number of confirmed cases recorded in Italy has increased substantially, from 4 on 20 Feb to 323 just 5 days later.

The meeting sees the first official consideration of ‘non-pharmaceutical’ measures – university and school closures, home isolation, household quarantine and social distancing – designed to slow the spread of infection. The SPI-M paper that presents the analysis concludes that these measures could be effective if implemented for a significant duration but also warns that models provide only weak evidence for policy decisions:

Although current confidence in SPI-M modelling conclusions is low, and further review is needed, SAGE agreed that further work is unlikely to generate different conclusions in the short term and that policy decisions would need to be based on the currently available modelling outcomes and the experience from other countries – Singapore, China etc. (para 15)

The choice for policy-makers seems clear: if model outputs provide weak evidence, how should they be used given that this situation unlikely to change in the near future? Is a precautionary approach that acts quickly preferable to the alternative in which action is delayed until stronger evidence is available (c.f. meeting 4 held on 4 February)?

27 February 2020: SAGE Meeting 11

Confirmed cases in the UK remain unchanged at 13 but cases in Italy have doubled to 655; cases in China continue to increase slowly and the official total now stands at 78,500.

The meeting reviews the pandemic planning assumptions, suggesting that a realistic worst case scenario could see 80% of the population affected, with a fatality rate of 1%. As these rates are not translated into absolute values, it is left to the reader to do the arithmetic: given a UK population of approximately 60M, the 80% figure translates into 48M cases and, if 1% of these die, then the virus will kill 480,000 people.

Within this context, the meeting examines the ‘non-pharmaceutical interventions’ identified in the previous meeting. Their conclusions make bleak reading: none of the measures is seen as likely to contain an outbreak on its own; only social distancing will delay the peak by more than 3 weeks and only social distancing has the potential to reduce the peak of an outbreak substantially (i.e. by 50%, the others offer reductions of around 20%). Of equal significance to this conclusion is the preamble in which the choices facing the government are set out:

A combination of measures would be expected to have a greater impact [and] combining all four measures, as a long-term policy, might [reduce] the reproduction number to around 1. However, this would result in a large second epidemic once measures were lifted...

It is a political decision to consider whether it is preferable to enact stricter measures at first, lifting them gradually as required, or to start with fewer measures and add further measures if required...

Three things seem to follow from this. First, it is now unambiguously a case of 'when' not 'if' there is an epidemic in the UK. Second, the realistic worst case suggests 480,000 people will die and the four measures considered thus far are unlikely to reduce the peak by more than 50%. Third, the government has some important choices to make, with the possibility of 'suppression' (or something like it) now on the table in the form of 'stricter measures at first'.

3 March 2020: SAGE Meeting 12

There has been a sharp rise in the number of confirmed cases in the UK. When SAGE met on 27 Feb, there were 13 cases in the UK with no new cases reported in the previous 3 days. Now, confirmed cases have more than doubled to 51. In Italy, the number of confirmed cases has quadrupled in the same five days from 655 to 2,502. This may be behind the changes to consensus statement provided by SPI-M, which now begins:

It is highly likely that there is sustained transmission of COVID-19 in the UK at present. It is almost certain that there will be sustained transmission in the UK in the coming weeks. (para 1)

Despite this, there is no change to the projections of the pandemic in the UK. Instead, the main topic of discussion is the 'non-pharmaceutical interventions', now referred to as 'behavioural and social interventions' or 'non-clinical interventions.' Continuing with the preference for high standards of proof, the minutes note that 'PHE have implemented a surveillance and monitoring plan as per previous SAGE discussions' (para 3) and that SPI-M is to advance this work by providing 'timings for when interventions should be implemented' by the next meeting (March 5)' with PHE 'drafting public guidance on potential interventions' (page 3).

There is, therefore, a clear sense that the group believes additional measures will be needed but also that they are not recommending they be implemented immediately.

3 March 2020: PM Press conference 1

The purpose of this, the first covid-19 press conference, is to launch the government's Coronavirus Action Plan. The event is clearly intended to be reassuring with the Prime Minister saying:

We're committed to doing everything possible based on the advice of our world leading scientific experts to prepare for all eventualities ... The plan does not set out what the government will do, it sets out the steps we could take at the right time ... our country remains extremely well prepared ... for the vast majority of the people of this country, we should be going about our business as usual.

In framing the action plan around ideas of prediction and control, the government has clearly taken a view on the choice offered to it on 27 Feb and decided that interventions will be introduced gradually. The detailed reasoning behind this decision is not available but the position taken, and the rhetoric of 'following the science', is clearly consistent with placing a high value on well-supported statements with a high degree of externality.

5 March 2020: SAGE Meeting 13

Confirmed cases in the UK have risen once again, doubling in two days to stand at 114, with confirmed cases in Italy increasing from 2,502 to 3,858.

The question of when to move from 'contain' to 'delay' is moving up the agenda but, in another example of the emphasis on evidence and externality, the meeting summary states that there are 'currently *no scientific grounds* for moving away from containment' (para 1, emphasis added). There is, however:

epidemiological and modelling data to support implementation – within 1-2 weeks – of individual home isolation (symptomatic individuals to stay at home for 14 days) and whole family isolation (fellow household members of symptomatic individuals to stay at home for 14 days after last family member becomes unwell) to delay Covid-19 spread, modify the epidemic peak and reduce mortality rates.

In addition, there is scientific data to support implementation – roughly 2 weeks later – of social isolation (cocooning) for those over 65 or with underlying medical conditions to delay spread, modify the epidemic peak and reduce mortality rates.

(paras 2 and 3)

9 March 2020: PM Press Conference 2

UK confirmed cases are now 271, up from 51 at the press conference held six days earlier. The Prime Minister states that 'containment is extremely unlikely to work on its own' but also that very few changes will be implemented immediately as 'it's absolutely critical ... that we take the right decisions at the right time, based on the latest and best evidence'.

10 March 2020: SAGE Meeting 14

In Italy, confirmed cases have more than doubled to reach 10,149. In the UK, confirmed cases have tripled in the previous 5 days, though the minutes suggest that official data is under-reporting cases by a factor of at least 10 and possibly 25:

Based on surveillance ... the UK likely has thousands of cases – as many as 5,000 to 10,000 – which are geographically spread nationally.

Transmission is underway in community and nosocomial (i.e. hospital) settings.

(paras 5 and 6)

The same 'situation update' reports that data are 'accruing fast' (para 7) and that PHE and SPI-M will meet to 'discuss how to make surveillance data more useful for modelling purposes' (para 10). Despite these concerns, SAGE considers the UK to be '4-5 weeks behind Italy', albeit on a 'similar curve' (para 12). There is no sense that an epidemic can be avoided though a delay of 2-3 weeks can be created 'if interventions are applied' (para 12).

The meeting papers also include an updated version of the paper evaluating behavioural and social interventions that was discussed on 27 February. There is relatively little change in the assessment of each measure, but the document is more directive than the earlier version, stating that adopting the most stringent set of measures at the outset is *not* the recommended strategy. This is illustrated by a diagram (see Figure 1) that, perhaps significantly, has no scale on the y-axis

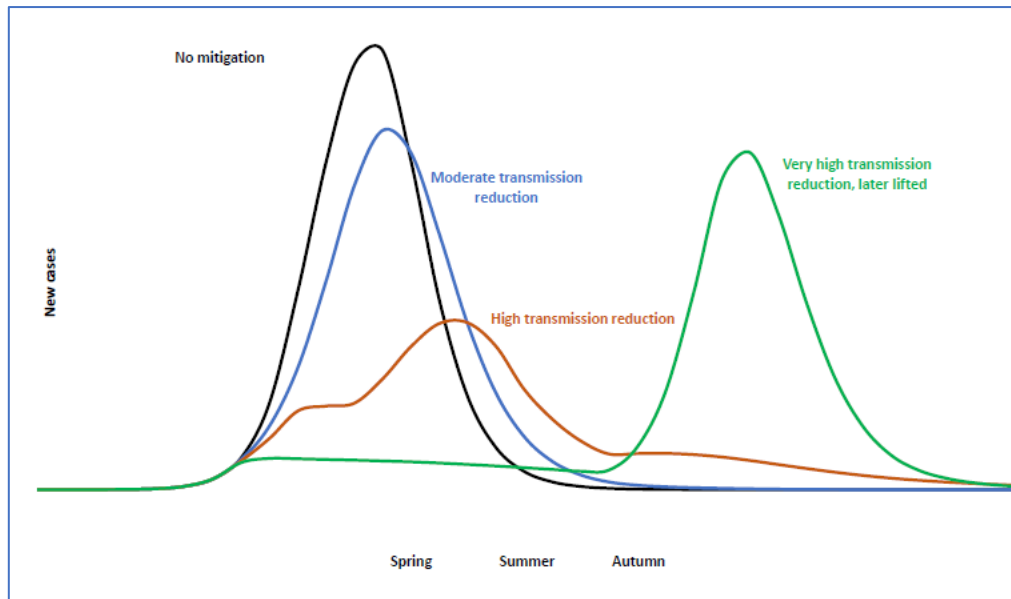


Figure 1: Illustrative impact of behavioural and social interventions lasting several months on a reasonable worst-case epidemic

and which is explained as follows:

A combination of these measures is expected to have a greater impact: implementing a subset of measures would be ideal. Whilst this would have a more moderate impact it would be much less likely to result in a second wave. In comparison, combining stringent social distancing measures, school closures and quarantining cases ... could result in a large second epidemic wave once the measures were lifted. (para 13)

It does seem, therefore, that the political decision to introduce measures gradually is consistent with the advice given by SAGE. As before, however, the precision needed to identify the ideal combination and sequence of measures cannot be achieved in practice, leaving open the question of how to balance the risks of an intervention that is either too early or too late:

The timing of the interventions would be critical. It will not be possible to time their starting date optimally or identify the areas which will be most impacted first (para 14)

12 March 2020: PM Press conference 3

Confirmed cases in the UK are now at 590 and have reached 15,113 in Italy. The press conference is led by the Prime Minister and announces the switch to the 'delay' phase of the response. The tone is serious, with the Prime Minister's opening remarks acknowledging that the virus is spreading, that people have already died of covid-19, and that many more will do so:

... the number of cases will rise sharply and indeed the true number of cases is higher - perhaps much higher - than the number of cases we have so far confirmed with tests...

it's going to spread further and I must level with you, level with the British public, many more families are going to lose loved ones before their time.

The strategy continues to focus on making interventions at the right time, but the timetable is speeding up as SAGE becomes increasingly willing to make bolder statements with higher degrees of externality. Self-isolation for those with symptoms, a policy described just three days earlier as being

10-14 days away, is now announced with ‘immediate effect’. The change is limited though, with the extension of this to include household isolation for symptomatic cases described as likely in ‘the next few weeks’.

13 March 2020: SAGE Meeting 15

Confirmed cases in the UK have doubled in the 3 days from the group’s last meeting, up from 373 to 797, whilst confirmed cases in Italy have increased from just over 10,000 to 17,660.

There are now more cases in the UK than had been expected but the discrepancy is not enough to cause a significant change in the committee’s understanding of the situation:

Owing to a 5-7 day lag in data provision for modelling, SAGE now believes there are more cases in the UK than SAGE previously expected at this point, and we may therefore be further ahead on the epidemic curve, but the UK remains on broadly the same epidemic trajectory and time to peak. (para 1)

The sense that the situation might be more serious than expected, and that stronger claims can now be made, is reflected in the suggestion that policies described the previous day as being introduced in few weeks should now be implemented as soon as possible:

There are *no strong scientific grounds* to hasten or delay implementation of either household isolation or social distancing of the elderly or the vulnerable in order to manage the epidemiological curve compared to previous advice.

However, there will be some minor gains from going early and ... *there is scientific evidence* to support household isolation being implemented as soon as practically possible.

(para 14, 15-16, emphasis added)

This change in rhetoric marks a change in approach brought about by the data. In earlier meetings, concerns about externality and evidential significance functioned as a reason for not acting: confidence was too low and models too uncertain. Now, the absence of a clear signal from models – no strong evidence for or against – has become a reason for acting sooner rather than later. The question we are left with is whether this kind of reasoning could have been deployed earlier, e.g. on 3 March (meeting 12) when it was acknowledged that sustained transmission was underway. Whilst data was more limited at that time it was also known – e.g. meeting 10 on 25 Feb – that additional modelling work was unlikely to produce different results.

Following the Science

This change of approach is confirmed on 16 March. Although the evidential context has not changed, it appears that the data and models are now more trusted, meaning SAGE are now willing to make stronger claims about the scale of the pandemic and the necessary policy response. The critical question now is the extent to which this advice is reflected in policy decisions.

16 March 2020: SAGE Meeting 16

Confirmed cases in the UK have doubled from 797 to 1,543 in the three days since the previous meeting. Confirmed cases in Italy have also continued to rise, increasing by 10,000 to 27,980 in the same three days.

The meeting confirms a significant shift in understanding and advice:

On the basis of accumulating data, including on NHS critical care capacity, the advice from SAGE has *changed* regarding the speed of implementation of additional interventions ...

there is *clear evidence* to support additional social distancing measures be *introduced as soon as possible*.

(paras 1 and 2, emphasis added)

The reason for this change is given in the updated consensus view of the SPI-M sub-group, which now believes that the current suite of options is 'very unlikely to prevent critical care facilities being overwhelmed' (para 1) and, moreover, that it was 'unclear' whether adding general social distancing to the mix would be sufficient to 'curtail the epidemic by reducing the reproduction number to less than 1' (para 2). The SPI-M group thus recommend that more radical measures need to be implemented 'as soon as practical' (para 3).

The same paper also introduces a significant change to the timescale over which any intervention would be applied. Earlier charts showed a single peak with case numbers falling by the end of the summer. In contrast, the recommendation that stringent measures be introduced immediately means that the SPI-M consensus report now states:

It was agreed that a policy of alternating between periods of more and less strict social distancing measures could plausibly be effective at keeping the number of critical care cases within capacity. These would need to be in place for at least most of a year. Under such a policy, at least half of the year would be spent under the stricter social distancing measure. (para 4)

Whilst the consensus statement is relative brief – just five paragraphs – it draws on a much longer paper published by the modelling team at Imperial led by Professor Neil Ferguson (Ferguson et al., 2020). The report explains why mitigation can no longer be the preferred approach:

We find that that optimal mitigation policies ... might reduce peak healthcare demand by 2/3 and deaths by half. However, the resulting mitigated epidemic would still likely result in hundreds of thousands of deaths and health systems (most notably intensive care units) being overwhelmed many times over. For countries able to achieve it, this leaves suppression as the preferred policy option. (Ferguson et al., 2020: 1)

16 March 2020: PM Press conference 4

The Prime Minister's opening remarks are designed to convey the seriousness of the situation and position the introduction of new restrictions as based on the 'best scientific advice':

As we said last week, our objective is to delay and flatten the peak of the epidemic by bringing forward the right measures at the right time....

Last week we asked everyone to stay at home if you had one of two key symptoms: a high temperature or a new and continuous cough.

Today, we need to go further, because according to SAGE it looks as though we're now approaching the fast growth part of the upward curve.

Two specific measures were announced. First, the household isolation that was described just 4 days earlier as being necessary within the 'next few weeks' is to be introduced immediately. Second, the policy of shielding – initially called cocooning – will come into effect over the weekend and remain in place for approximately 3 months.

The press conference introduced other measures, not mentioned in SAGE minutes, but which are intended to reduce social contacts. These included:

- stopping all non-essential contact with others
- stopping all unnecessary travel
- working from home where possible
- avoiding pubs clubs, theatres and other social venues:

17 March 2020: PM Press conference 5

Confirmed case numbers in the UK have increased by just over 400 in 24 hours and now stand at 1,959; confirmed cases in Italy are now 31,506.

The main focus of the press conference is the package of economic measures introduced by the Chancellor of the Exchequer, Rishi Sunak. The Chancellor's statement reinforced the seriousness of the situation, claiming that the steps already announced are 'unprecedented since World War 2', but also warned that the government 'may well have to go further and faster in the coming days to protect lives and the NHS'.¹⁵

18 March 2020: SAGE Meeting 17

The official case numbers in the UK now stand at 2,626 and cases in Italy have risen to 35,713.

The sense of urgency remains, as does the newfound confidence in the data, with SAGE reporting that the modelling work done since the previous meeting 'now supports school closures on a national level and that the effect would be greatest if instituted early' (para 24).

18 March 2020: PM Press conference 6

As per the advice given by SAGE earlier in the day, schools and nurseries will be closed to all but the children of key workers.

19 March 2020: PM Press Conference 7

Confirmed case numbers in the UK have doubled in the 3 days since Monday 15 March to stand at 3,269. Confirmed cases in Italy have passed 41,000.

No new policy measures are announced. The aim is both to recognise the scale of the effort required and to acknowledge 'huge efforts that the country is making to comply with the advice that [has] been given'. With this in mind, the Prime Minister seems concerned about whether this compliance will be maintained and there is a clear attempt to frame the current measures as a temporary situation with a clear end date:

I am conscious as the days have gone by that people will want to know how long we are expecting them to keep it up ...

I do think, looking at it all, that we can turn the tide within the next 12 weeks

A charitable interpretation would be that a tide always comes back in and the Prime Minister does not guarantee there will be no return of the virus and hence the restrictions. It is, however, clearly at odds with scientific advice that has consistently stated that attempting to suppress the pandemic through stringent measures will create a second peak when the measures are lifted.

20 March 2020: PM Press Conference 8

Confirmed cases in the UK have increased by another 700 in 24 hours to reach 3,083. Confirmed cases in Italy have gone up by 7,000 in the same 24 hours to 47,021.

¹⁵ Full transcript at: <https://www.gov.uk/government/speeches/chancellor-of-the-exchequer-rishi-sunak-on-covid19-response>

Until this point, there has been no requirement that bars or restaurants should close, with people merely advised to 'avoid' them. This changes with the announcement that:

[based] on scientific advice and following our plan ... we are collectively telling, telling cafes, pubs, bars, restaurants to close tonight as soon as they reasonably can, and not to open tomorrow ... We're also telling nightclubs, theatres, cinemas, gyms and leisure centres to close on the same timescale.

22 March 2020: PM Press Conference 9

Confirmed cases in the UK have quadrupled since the start of the week and are now 5,683, an increase of over 4,000 since the press conference on Monday 16 March. Confirmed cases in Italy have doubled in the same period to reach 59,138. The press conference announces the implementation of the 'shielding' programme first mentioned on 16 March and ends with an exhortation to be vigilant in order to maximise the collective benefit of each individual sacrifice:

Always remember that ... you are doing your bit in following this advice to slow the spread of this disease. The more we collectively slow the spread, the more time we give the NHS to prepare, the more lives we will save, the faster we will get through this.

23 March 2020: SAGE Meeting 18

Official case numbers for the UK now stand at 6,650 whilst, in Italy, the number has increased to 63,927.

The SAGE minutes do not contain anything like the radical change of the previous week, though they do suggest that what has been announced may still not be enough:

Key areas for improvement include reducing contact with friends and family outside the household, and contact in shops and other areas. (para 24)

There is also sense that the pandemic will have long-term and wide-ranging consequences and that, 'given the clear links between poverty and long-term ill-health, health impacts associated with the interventions need to be investigated' (para 4). Other topics discussed include the increasing availability of clinical data, the evaluation of treatment options, and the importance of increasing testing capacity.

23 March 2020: PM Press conference 10

This statement took the form of a televised 'address to the nation' delivered straight to camera. The speech marked a significant increase in the restrictions that can be summed up by the instruction 'stay at home'. Whereas previous restrictions and advice had allowed some degree of interpretation, the new policy appears designed to achieve the 'improvement' demanded by SAGE by reducing social contact to the bare minimum. Leaving your home was now only permitted for one of four reasons:

- shopping for basic necessities, as infrequently as possible
- one form of exercise a day, either alone or with members of your household;
- any medical need, to provide care or to help a vulnerable person; and
- travelling to and from work, but only where this is absolutely necessary

The police were given powers to enforce these rules and a swathe of additional measures were introduced, including:

- the closure of all shops selling non-essential goods

- the closure of public spaces including libraries, playgrounds and places of worship
- the banning of all gatherings of more than two people from different households
- the stopping of all social events and ceremonies except funerals.

The speech ended with the phrase that was to become the mantra of the government response in the UK: ‘stay at home, protect our NHS and save lives.’

Science and Politics

It is now generally accepted that the UK went into lockdown too late, something that is often justified by reference to the relatively high per capita rates of infection and death experienced by its citizens. This outcome also accounts for the inclusion, in a recent comparative analysis of policy responses to covid-19, of the UK in a group of countries (the US, Brazil, India and Italy are the others) characterised by ‘political division and inaction or incoherent action’ (Jasanoff et al., 2021: 24). Viewed over the longer term, there is certainly some element of this UK’s response but, at least in the early stages, there was very little political or expert controversy.¹⁶ Likewise, as the summary just provided makes clear, once SAGE did make clear recommendations – from 16 March onwards – the government did move quickly with new restrictions being announced daily. The key question is, therefore, why did it take until this point for significant measures to be introduced?

One explanation for this has been provided by scientists on the SAGE committee themselves, some of whom have gone on record to say that limitations in the data meant their ‘situational awareness [was] really quite poor’.¹⁷ Whilst such honesty is certainly to be commended, and helps explain why advice changed from 16 March onwards, it does not tell the whole story.

Recent analysis by Warren Pearce also acknowledges that the paucity of data made modelling work difficult, but argues that the uncertainty this created was ‘downplayed in both the advice provided by SAGE and public comments by SAGE participants’ (Pearce, 2020: 2). Whilst there is an element ‘predict and control’ rhetoric in both the SAGE minutes and the government’s Action Plan, it would be unfair to say that SAGE did not address either the stakes involved or the uncertainties that surrounded their work:

- the pandemic flu guidance used as the basis for the realistic worst case planning scenario (28 January,) clearly states that several hundred thousand deaths are possible and the examples given in the Coronavirus Action plan (3 March) show that previous flu pandemics have led to tens, if not hundreds, of thousands of excess deaths
- the need for more accurate and/or up-to-date data is highlighted in several of the meetings (3 February, 20 February, 3 March) with SAGE noting that official data are underestimating the number of cases in the UK by a factor of 12-25 (10 March)
- the limitation of models is noted at several points, with meetings and consensus statements noting that key parameters cannot be estimated until after transmission has been established and that identifying the optimal timing for interventions will not be possible (4 February, 11 February, 20 February, 25 February, 27 February, 3 March, 10 March)
- the need for political choices about when and how to introduce interventions is made clear on 27 February and resolved with the publication of the Coronavirus Action Plan on 3 March,

¹⁶ The Independent SAGE group that was set up to provide a source of counter expertise to the official SAGE group examined here was not formed until 4 May 2020.

¹⁷ John Edmunds, quoted in <https://www.theguardian.com/world/2020/jun/07/uk-failure-to-lock-down-earlier-cost-many-uk-lives-top-scientist-says>

which makes clear that the government is pursuing a strategy of ‘contain and delay’ rather than suppression.

If this is the case, then perhaps the problem lies not with the science or the scientists but with the questions SAGE was tasked with answering in the first place. The official guidance document for SAGE states that it is expected to provide advice on matters such as:

- the scientific and technical concepts and processes that are key to understanding the evolving situation and potential impacts;
- how the emergency might develop and the potential implications of this ...
- possible ways to improve, monitoring, forecasting and assessment in the short to medium term;
- potential scientific and/or technical solutions that can remove or mitigate the risks and/or manage the impacts, and the pros and cons of these...;
- the scientific and/or technical pros and cons of policy options identified by others;
- the degree of consensus (e.g. all, the majority, most, some or few experts agree);
- differences in opinion (i.e. are there differences in scientific / technical opinion and what are the sources of disagreements?); and
- the degree and cause of uncertainty (e.g. confidence levels, margins of error and the reasons for not being more certain).

(paras 16-18)¹⁸

Reviewing the developing understanding recorded in the minutes of the first 18 meetings of SAGE, a crucial element seems to be the framing of the evidential context, accepted by both scientists and politicians, as one that produces scientific knowledge – point 1 in the list of possible topic areas – rather than one that responds to policy-questions or provides advice about policy-options – points 2, 4 and 5. This is not to say that efforts to develop a robust and scientific understanding of coronavirus have no relevance but that there is a risk, demonstrated quite clearly in this case, that making this a priority fails to recognise the different speeds at which science and politics move in times of emergency.

Working in a way that gave greater priority to providing advice on the other areas identified as possible topics for SAGE would not require a huge change to the personnel used and nor would it require a ‘blurring’ of the distinction between technical advice and political decision-making. Instead, by distinguishing between ‘technical’ and ‘political’ phases, we can identify three possible points of intervention. First, within the political phase, the framing of the problem that SAGE is tasked with solving, and hence the evidential context in which they operate, could and should have been specified differently. For example, if the over-arching aim was to avoid hospitals being overwhelmed, then the government could have directed SAGE to prioritise estimating the trajectory for case numbers under different scenarios and the risks associated with each given the difficulty on knowing exactly which ‘path’ the UK was on. Whilst SAGE could, perhaps, have re-set the framing by, for example, choosing to focus on the public health aspects of the pandemic and directing its work to this end, it remains the case that political leaders have primary responsibility for the topics on which they seek advice.

Second, within the technical phase – i.e. the SAGE meetings – this re-framing might have led to some diversification of experts – e.g. more public health specialists and a broader range of social science

expertise – but it would not have required them to act less scientifically; the values and norms that guide their actions would remain the same, only the question would change. Specialist expertise would, therefore, remain essential for understanding what was known or not known about these new questions, but discussion and outputs would be directed less at achieving high levels of externality by rigorously connecting the available data to observable events and more at identifying the risks associated with different kinds of error and uncertainty.

Finally, this difficulty of providing certain knowledge under conditions of endemic uncertainty, requires a different mode of public communication about science in general and the science of the pandemic in particular. Rather than persisting with the much criticised idea that the public requires certainty, political decision making and public health policies in the early stages of the pandemic would need to have been justified against the backdrop of a science that was too uncertain to provide a solid and unambiguous case for action. Crucially, this depends on scientists, policy-makers and others making an argument for scientific advice that does not blend science into politics but, instead, stresses the distinctive normative commitments of each. By distinguishing between a technical and political phase it is possible to delineate a space in which giving more weight to the views of those who know what they are talking about – i.e. those with expertise – can be defended even when the degree of certainty that everyone would prefer is impossible to achieve. In other words, non-epistemic reasons are needed for relying on one kind of advice rather than another and those reasons should include a preference for advice that is based on sustained observation and calculation carried out with integrity, that is, advice generated by following the norms of scientific practice (Collins et al., 2020; Collins and Evans, 2017)

Conclusions

This paper has argued that the UK's failure to implement lockdown policies when case numbers were lower is due, at least in part, to its political decision to 'follow the science'. By deciding to wait until a high degree of scientific certainty was reached – certainty which their own advisors told them would not be available for several weeks after widespread transmission had been established – the UK government effectively ruled out a more precautionary strategy. As it was, by choosing to 'follow the science' – itself an important statement of what kind of knowledge should matter – the Government, implicitly or explicitly, encouraged its advisors to put a high value on externality and, as a result, ended up unable or unwilling to act until the evidence was overwhelming.

Whilst both scientists and policy-makers must take some responsibility for the failure to act sooner, this should not be shared equally. Scientists could have provided clearer warnings, and it is possible that the CSA and CMO did just that as they briefed the UK government, but this seems relatively minor in comparison to the failure of the government to ask for the right kind of advice in the first place. By allowing SAGE to continue to interpret the terms of reference in ways that prioritised consensus and certainty, rather than requiring advice that set out the range of views available, the confidence with which each was held, and the consequences of accepting different views for the development of the pandemic the UK government created a situation in which the advice it needed could never be provided in the time available. If we are to act on scientific advice in a more timely way, we have to be realistic about what it can achieve within the timescale imposed by an emergency and not allow the quest for the perfect to be the enemy of the good.

Acknowledgements

I am grateful to the anonymous referees, the journal editors, members of the Cardiff Centre for the Study of Knowledge Expertise and Science (KES) and participants at the virtual SEESHOP meetings held during the summer of 2020 for comments on earlier drafts of this paper. Whilst it is it

sometimes unfair to single out individuals, I do want to record my appreciation for the comments provided by the two referees: the focus and structure of the argument are much clearer thanks to their careful reading and constructive advice.

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