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Contemporary Social Science

Journal of the Academy of Social Sciences

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/rsoc21

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To cite this article: Susan Michie, Philip Ball, James Wilsdon & Robert West (2022): Lessons from the UK's handling of Covid-19 for the future of scientific advice to government: a contribution to the UK Covid-19 Public Inquiry, Contemporary Social Science, DOI: 10.1080/21582041.2022.2150284

To link to this article: https://doi.org/10.1080/21582041.2022.2150284

Published online: 11 Dec 2022.

CONTEMPORARY SOCIAL SCIENCE
https://doi.org/10.1080/21582041.2022.2150284

ACADEMY of SOCIAL SCIENCES
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Lessons from the UK's handling of Covid-19 for the future of scientific advice to government: a contribution to the UK Covid-19 Public Inquiry

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ABSTRACT

Despite strong expertise and a sophisticated scientific advisory system, the UK's response to the Covid-19 pandemic has been, and continues to be, weak in terms of preventing death and illness, and damage to the economy. This article argues that an important reason for this failure has been that the policies of the UK government have at critical times failed to take adequate account of scientific evidence, while at the same time attempts have been made to blame scientists for resulting policy failures. This paper analyses the role of scientific advice in addressing Covid-19 in the UK and draws three lessons for how such expertise can be better deployed in the future. It argues that: (1) Government scientific advisors and advisory bodies should be more independent of political influence and interference; (2) Government scientific advisors should be empowered to challenge misrepresentation and misuse by decision-makers of the scientific evidence, and undermining of public-health policies; and (3) Government scientific advice should be more transparent and advisors should engage more proactively with the public. Acting on these lessons will be important for ongoing handling of the current crisis, for the current UK Covid-19 Public Inquiry, and for the UK's preparedness for future crises.

ARTICLE HISTORY
Received 13 November 2022
Accepted 13 November 2022

KEYWORDS
Scientific advice; COVID-19; UK COVID-19 Public Inquiry; science policy; evidence-informed policymaking

A plague on both their houses? Politicians and scientific advisers at the start of the pandemic

Since the outbreak of the Covid-19 pandemic, structures and processes of scientific advice, and those who contribute to them, have arguably been more visible, valued, contested and criticised than at any time since those structures emerged in their modern form (Allen et al., 2020; Pearce, 2020). In the UK, the principal government advisory mechanism, the Scientific Advisory Group for Emergencies (SAGE), was large and complex, involving a shifting cast and multiple subgroups (House of Commons Science and Technology [HoC S&T]

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Committee, 2021). Subgroups and expert bodies informing SAGE included: the New and Emerging Respiratory Virus Threats Advisory Group (NERVTAG); the Scientific Pandemic Influenza Group on Modelling (SPI-M); and the Scientific Pandemic Insights Group on Behaviours (SPI-B); COVID-19 Genomics UK (COG-UK); and Health Data Research UK (HDR UK). Evidence and advice were also supplied by other bodies, including Public Health England, the Joint Biosecurity Centre, the Office of National Statistics and the Joint Committee on Vaccination and Immunisation (JCVI) (Department of Health and Social Care, 2021). This article discusses the workings of this scientific advisory system in the UK government and offers preliminary recommendations for how it could be improved.

From the moment the Prime Minister, Boris Johnson, first appeared at a Downing Street emergency press conference on 12th March 2020, flanked on one side by Professor Sir Patrick Vallance as Government Chief Scientific Adviser (GCSA) and on the other by Professor Chris Whitty as Chief Medical Officer (CMO), anyone familiar with the performance of expert advice, with most of the action normally taking place backstage, could see this was a very different, big box-office production (Hilgartner, 2000; Morgan, 2020).

For a time, these press conferences attracted large audiences and offered a public gripped by fear and uncertainty a simple and compelling storyline. They were told that decisions were being 'led by the science' (Ball, 2020), as assembled and synthesised by SAGE, and filtered through the GCSA and CMO to ministers.

Soon, however, this storyline started to crumble. Scathing criticisms started to appear both of politicians and scientific advisors, and rifts became apparentwith and between politicians and scientists (Cairney, 2021; Conn et al., 2020; Horton, 2020; Pearce, 2020; Woodcock, 2020).

As a response to concerns over SAGE's initial secrecy, an informal body of experts called Independent SAGE was launched by a former Government Chief Scientific Advisor, Sir David King. The aim was to encourage scientists to communicate directly with the public (Costello, 2020; Davis, 2020; Sample, 2020). At the same time, alternative narratives developed, such as the 'herd immunity' vision of the Great Barrington Declaration, and these began to attract their own vocal and competing audiences among UK politicians and media (Lenzer, 2020; Merrick, 2020). By April 2020, the editor of *The Lancet*, Richard Horton, characterised the outcome of the advisory process as 'the biggest failure of UK science policy in a generation' (Ahuja, 2020).

As the UK entered the autumn of 2020, and a lethal second wave of the pandemic hit, many experts (including members of SAGE) were openly questioning whether the Government, which remained resistant to a second lockdown, and its scientific advisers were still aligned: a situation that persisted after the introduction of vaccines in early 2021 (BBC News, 2020; Farrar, 2020; Farrar & Ahuja, 2021; SAGE, 2020).

In the summer of 2020, the message from Sir Patrick Vallance was that 'lessons will be learned' (HoC, 2020; Sky News, 2021) and that 'the science system across government and across agencies needs to be robust' and 'we need to think about resilience of that system' (Inge, 2020). SAGE minutes were belatedly published (Government Office for Science and SAGE, 2020), and Vallance acknowledged that initial secrecy surrounding the process was unhelpful: 'I think we definitely made a mistake early on by not getting the SAGE minutes and papers out quickly' (House of Lords Science and Technology Committee, 2020).

In 2021, a joint inquiry by the House of Commons Health and Social Care Committee and Science and Technology Committee concluded that the decisions on lockdowns and social distancing during the early weeks of the pandemic, and the advice that informed

them, represented 'one of the most important public health failures the UK has ever experienced', with the result that the UK performed 'significantly worse' than comparator countries in terms of Covid-19 related deaths and hospitalisations (HoC, 2021). The inquiry pointed to 'groupthink', a 'slow and gradualist' approach, and assumptions of national exceptionalism as contributing to these failures. Further 'deficiencies in the machinery of government' included scientific advice being impaired by a resistance to transparency, low levels of input from international experts, and a lack of meaningful challenge to official advice from a wider range of experts and public-health practitioners (HoC, 2021).

Vaccine rollout in the second phase of the pandemic

A successful Covid-19 vaccine rollout in 2021 then created a generalised positive impression, or 'halo effect' (Nisbett & Wilson, 1977), about the way the pandemic had been handled (Landler & Castle, 2021; McTague, 2021). This appeared to allow the main players – both political and scientific – to recast the performance of expert advice as a broad success.

By the time the pandemic had reached its two-year mark, poor decision-making in the early months and any shortcomings in advisory processes were being downplayed, or excused by the unique scale and urgency of the challenge at that time. Scientific advice entered a zone of self-justification where, as per the title of an influential study by Carol Tavris and Elliot Aronson (2007), 'mistakes were made (but not by me)'.

So with a few tweaks and some gentle mid-course correction, the UK's scientific advisory system was presented as having worked largely as intended (Thomas, 2022). Then, despite continuing high levels of Covid-19 transmission, SAGE and its subgroups were stood down in Spring 2022 as government ministers declared the pandemic effectively over in the UK.

Learning lessons and the COVID-19 enquiry

With hindsight, it is of course easier to spot where mistakes were made. Our point in any case is not to single out individuals for criticism. But organised hindsight – as well as foresight – is a recognised asset of an effective advisory system (Wilsdon, 2014). So it is important to shine a light back on an advisory system that conveniently appears to have concluded that, bar a few early hiccups, it performed remarkably well under difficult circumstances.

Scientific advice, like other parts of the UK's unwritten rules of government, has long relied on leading figures in the scientific community doing their bit in the national interest (Doubleday & Wilsdon, 2013; Jasanoff, 2007). Following controversies in the late 1980s and the 1990s over an outbreak of bovine spongiform encephalopathy (BSE) and the safety of genetically-modified crops, there were signs of this system reappraising its operating assumptions.

Notably, the 16-volume UK public inquiry into the BSE crisis, chaired by Lord Phillips, highlighted multiple flaws in the modelling of the disease, and in expert assumptions about the public response (BSE Inquiry, 2000). These uncertainties were exacerbated by scientific advisers who failed to understand the realities of agriculture. Ministers told the public that beef was 'perfectly safe' to eat because they were afraid of causing a panic among a public they regarded as 'irrational and ill-informed' (Millstone & van Zwanenberg, 2001). Policy failures around BSE sparked a form of 'civic dislocation' (Jasanoff,

1997), in which citizens and consumers lost faith in the institutions supposed to protect them.

So the UK advisory system could start by reminding itself what it previously knew but appeared to forget in the heat of a crisis (Ballo, Pearce, Stilgoe, & Wilsdon, 2022). Despite the stakes of decisions over Covid-19 being higher than those over BSE, the response from within the advisory system, and the wider UK scientific community, has to date been 'muted and deferential', or largely self-absolving, rather than engaging in more open institutional soul-searching (Ball, 2022).

In this context, it was surprising that formal scrutiny of scientific advice was not more prominent in the initial terms of reference of the UK Covid-19 Inquiry, the independent public inquiry led by Baroness Hallett, which is now underway (UK COVID-19 Inquiry, 2022). An early choice not to include the advisory system within the scope of the inquiry was criticised by Independent SAGE, other experts, and by groups representing families of those who died with Covid-19, as a 'serious omission' (Inge, 2022a).

In May 2022, Baroness Hallett responded to these points with a proposal to ensure the Inquiry's coverage of 'the availability and use of data, research and expert evidence' (Hallett, 2022). And indeed in its final terms of reference, published at the end of June 2022, the Inquiry's remithad expanded further to include 'how decisions were made, communicated, recorded, and implemented' and 'the availability and use of data, research and expert evidence' (UK Covid-19 Inquiry, 2022).

As the Inquiry begins its work, it is important to consider what are the most important lessons to be drawn for structures and cultures of scientific advice in the UK. Much has already been said and written on these questions (Ball, 2021; Ball, 2022; Horton, 2021; HoC S&T Committee, 2021; McKee, 2021; Pearce, 2020; Sasse, Haddon, & Nice, 2020). There is no doubt that aspects of the advisory response were a success, particularly the volume and speed of evidence and analysis generated and synthesised, involving many hundreds of experts and officials across the research community and in government. But the crisis has also exposed weaknesses, blind spots and 'flaws in how ministers understand and use science advice' (Sasse et al., 2020).

Pillay and King (2021) have argued that 'a wholesale review of the structures, oversight and governance of government scientific advice is needed to regain the priorities of independence, trust, transparency, and freedom to speak directly to the public.' To contribute to such a review, we draw on academic, media and other reports and critiques of these processes: as participants in formal and informal advisory processes throughout the pandemic (Michie and West); as a veteran science journalist, author and commentator on the relationship between science and politics (Ball); and as a researcher of science policy, with inside experience of the UK advisory system from within the UK's national academy of sciences (Wilsdon).

Lesson 1: government scientific advisers need to have greater independence from political influence and interference, and to adopt a more sophisticated definition of their roles and responsibilities

Former British Prime Minister Margaret Thatcher's view that 'advisors advise and ministers decide' was referenced frequently during the pandemic in support of the idea that scientific advisers had a limited democratic mandate to comment on policy, and should only

speak in public regarding their narrow area of expertise (Farrar & Ahuja, 2021; Financial Times, 2020; Vallance, 2021). The statistician David Spiegelhalter, a participant in SAGE, offered a version of this view: 'My role is not to say what the policy should be. I'm a statistician, how do I know what policy should be when there's so many things to be taken into account when you decide on a policy?' (Baker, 2021).

It is of course entirely legitimate for some scientists to choose to restrict their interventions to their defined subject area, and to avoid engaging more widely. But this is only one model of expertise, which, when presented as the norm, can lead to scientists being told to 'stay in their tramlines' (Inge, 2022b). It also fails to reflect the interdisciplinary nature of public health, pandemic management and team science (Egede et al., 2021; Jenkinson, 2021).

Many would resist the notion that a clean separation between science and politics is even possible in complex, contested situations (Funtowicz & Ravetz, 1993; Jasanoff & Jasanoff, 1990; Sarewitz, 2004) or that scientific advice can always be supplied in a neutral, apolitical manner. In one influential account, Roger Pielke Jr distinguishes between four roles that researchers often play in advisory processes: the 'pure scientist'; the 'science arbiter''; the 'issue advocate' and the 'honest broker' (Pielke, 2007). These are ideal types, and individual advisers may end up playing each role at different points (sometimes on the same issue). Such a typology encourages greater reflexivity and transparency among advisers when they are moving between different roles. Implementation science is another source of insights here: as noted in a recent editorial on Covid-19, merely disseminating information is never sufficient for changing behaviour, organisations, and systems to reflect scientific thinking (Wensing, Sales, Armstrong, & Wilson, 2020).

Given the extensive literatures on advisory systems, uses of evidence in policy, and the social responsibilities of scientists, the narrow attitudes of some scientific advisers on their responsibilities during the pandemic were surprising. As science writer Ed Yong, who won a Pulitzer prize for his coverage of the pandemic in the United States, observes,

> The naive desire for science to remain above politics meant that many researchers were unprepared to cope with a global crisis that was both scientific and political to its core. Science is undoubtedly political, whether scientists want it to be or not, because it is an inextricably human enterprise. (Yong, 2021)

To what extent did scientific advice during the pandemic maintain its supposed objectivity? For all that the responsibilities of the GCSA, CMO and SAGE are regularly described in idealised and romantic terms as 'speaking truth to power' (Neate, 2021; Sky News, 2020; Vallance, 2021), there are several high-profile episodes where the framing of options, or responses to actions, appeared to be led by politics, rather than 'led by the science' (Ball, 2020).

It was, for example, an accepted, even self-evident 'truth' that the prime minister shaking hands in a Covid-19 ward in March 2020 was ill advised, as an example to the public and in its own right. It was clear that the flouting of lockdown rules in March 2020 by the PM's then chief adviser Dominic Cummings was likely to undermine public compliance with lockdown rules when it subsequently became known to the media – as indeed proved to be the case (Fancourt, Steptoe, & Wright, 2020). It was equally evident in November 2021 that the PM sitting next to a 95-year-old man (Sir David

Attenborough) in an indoor space at the COP26 climate summit without wearing a mask, or visiting a hospital without doing so, or the refusal of (mostly Conservative) ministers to wear masks in parliament, undermined public messaging on mask-wearing at a time when the formal government position was that 'we expect and recommend that members of the public continue to wear face coverings in crowded and enclosed spaces', as well as such actions posing hazards in their own right. It was clear that assertions by the Leader of the HoC that mask-wearing was unnecessary among those who know each other if they have a 'convivial fraternal spirit' were blatant misinformation. But on none of these occasions did the GCSA or CMO feel able or willing to issue any public clarification, corrective or criticism.

The silence of chief scientists concerning the revelations about the Downing Street parties during lockdowns was also notable. The GCSA's brief admission during one interview that this behaviour was 'disappointing' does scarce justice to the damage that 'partygate' did to the entire system of public-health messaging and to the efforts of scientists, health professionals and others to deliver it. The same might be said for suggestions by ministers and ex-ministers after the summer of 2021 that the UK had 'exited from the pandemic' before other countries, and that SARS-CoV-2 had now transitioned to an endemic virus. Such claims, amounting to disinformation, appear to have gone publicly unchallenged by chief scientists.

The GCSA has said that part of the scientific adviser's role is 'to make it clear to a decision maker what options there are' (Vallance, 2021). This was not, it seems, always how SAGE worked in practice. Rather, its experts were asked to evaluate the consequences of the policy options presented to them: working in reactive mode, they were not allowed to address questions that had not been posed to them by the Government.

So despite the lockdown policies that had been adopted in east Asia and Italy by March 2020, SPI-M did not model that option for the UK, seemingly because they did not consider it was a policy on the table. As John Edmunds, a SAGE modeller, said, the initial Coronavirus Action Plan, published in early March 2020 – which said that 'for the vast majority of the people of this country, we should be going about our business as usual' – was devised by politicians, and 'our job was to make it work.' (Farrar & Ahuja, 2021, p. 98). Another modeller on SAGE, Neil Ferguson, has said that 'There seemed to be a disconnect between all the effort being put into analysing these policy options and any understanding of what it would actually look like if that sort of thing happened.' (Farrar & Ahuja, 2021, p. 102). Try as they might, the modellers could not find plausible scenarios presented to them at that early stage of the pandemic that did not end in deaths running into six figures.

Such realism came only after a crucial period in which the GCSA, CMO and others participating in SAGE advocated robustly for 'flattening the curve' rather than the alternative policy being pursued by countries such as South Korea, China and New Zealand of 'elimination' or 'zero Covid'. The former was a policy option with a questionable scientific basis, and over time, it became clear that countries following the latter route achieved better health and economic outcomes than those that adopted the UK's approach. (Ongoing difficulties and restrictions in China are more the result of shortcomings of the vaccination programme than of the policy of aggressively suppressing the spread of the virus.)

Scientists might now usefully reflect on why they were so ready to rule out a policy option that was deployed effectively in other countries, and which would have been

consistent with the advice from the World Health Organization to take swift and decisive action. Were they acting on their own objective judgement, or responding to the preferences of the politicians?

A similar tailoring of scientific advice to fit with pre-existing policy decisions was evident in the full relaxation of restrictions on 19 July 2021. SPI-M presented predictions of the course of the infections based on assumptions about how people would behave when the rules were relaxed. What they did not provide was what a scientist would generally expect to see in such an 'experiment': an indication of how the situation might develop if *no* change were made, meaning that the remaining restrictions were kept in place (as some scientists considered they should be). This was apparently because the modellers were not asked to model that situation, nor were behavioural scientists asked to comment on it (Ghani, 2021).

Again, it was not a policy option on the table. Policy advice cannot be reliable or comprehensive if politicians are the only ones allowed to set the parameters of the options. When the evidence was not of interest to or not supportive of policies preferred or pursued by the Government, the mantra 'following the science' was replaced by 'what we are seeing is within the parameters we set'. The scientific advice in these situations needed to be more free to decide the bounds of what needs to be asked and modelled, in accordance with good research practice.

Scientific advisers need to enjoy the confidence of ministers and other decision-makers. But their obligations also extend to the wider public, to whom they have a responsibility to uphold the integrity of the advisory system. This must surely mean speaking out and being critical of government decisions or actions if and when circumstances and evidence require, or at least stating explicitly when policy decisions diverge from the scientific advice. Otherwise, as former SAGE member Jeremy Farrar has asked, 'Does staying in an advisory role mean being complicit in the outcomes of bad decisions?' (Farrar & Ahuja, 2021).

There are established models for this more critical and independent approach in other areas of evidence-informed policymaking. Economic advisory bodies like the Bank of England's Monetary Policy Committee (BoE MPC) and the Office for Budget Responsibility (OBR) operate with formal independence, in support of an overall framework of government policy objectives (de Haan, Bodea, Hicks, & Eijffinger, 2018). The MPC also communicates directly with the public and is open about divergent interpretations and uncertainties in the evidence underpinning its deliberations on interest rates (Haldane & McMahon, 2018).

Thus, we argue that the GCSA and CMO should be able to address the press and the public directly, without being chaperoned by ministers (who during Covid-19 intervened on several occasions to deflect questions being put to their scientific advisers). These roles of course carry a responsibility to advise and support ministers, but this should not extend to an obligation to ignore their misstatements, rule-bending or rule violations. And while policy must of course ultimately be determined by elected representatives, scientific advisers have a right and obligation to ask, if their advice does not appear to be reflected in policy, why this is the case – and, if appropriate, to explain this to the public.

We believe that the government's 'Guidelines on the Use of Scientific and Engineering Advice in Policy Making', originally drafted in 1997 by former GCSA Lord May, in the aftermath of the BSE crisis, and last revised in 2010 by Sir John Beddington (Government Office

for Science, 2010), need to be revisited and overhauled in light of lessons from Covid-19. Expanded freedoms and responsibilities must be encoded in the terms of engagement of the GCSA, CMO, departmental CSAs and advisory bodies like SAGE. Without greater and more visible independence, public confidence in the scientific advisory system will be further eroded.

Lesson 2: government scientific advisers need to be free to criticise misrepresentations or undermining of scientific evidence by politicians

Throughout the pandemic, scientific evidence and advice were misrepresented and misused to justify bad policy decisions. An infamous example where policy was influenced by science that was questionable at best was in the introduction of the idea of 'behavioural fatigue'. This was simply not a recognised scientific concept. It was introduced into SAGE discussions as a reason for delaying lockdown, despite never having been taken to or discussed by SAGE's behavioural advisory group. The CMO even told the public: 'There is a risk that if we go too early, people will understandably get fatigued and it will be difficult to sustain this over time' (Harvey, 2020). We now know that delaying that first lockdown almost certainly cost many thousands of lives.

No-one has admitted to having introduced this term. When asked by a Commons Select Committee about its emergence, David Halpern of the Behavioural Insights Team, who attended SAGE, said he could not remember (Harvey, 2020). Behavioural scientists were quick to disown the term, with 600 of them signing an open letter calling on the government to share its analysis of the evidence (UK Behavioural Scientists, 2020). Michie and colleagues, writing in the BMJ, stated 'Instead of using the concept of 'fatigue' to understand a lack of adherence to Covid-19 rules, we should focus on, and tackle, people's capability, opportunity, and motivation' (Michie, West, & Harvey, 2020). The accompanying editorial was entitled 'Behavioural fatigue: a flawed idea central to a flawed pandemic response' (Abbasi, 2020).

This misuse of science also caused harm to behavioural science, with former Downing Street adviser Dominic Cummings in his evidence to Parliament's Science and Technology committee referring to behavioural scientists as 'charlatans' (HoC S&T Committee, 2021). Given that human behaviour and its scientific understanding are central to effective pandemic management (UK Behavioural Scientists, 2020), this episode is likely to have caused harm over the short and long term.

The emerging narrative, encouraged by Cummings' testimony and implied in the resulting report (HoC S&T Committee, 2021), is that the failure of ministers was in not pushing back hard enough on the science advice by advocating lockdown. This seems to be a retrospective story constructed for the convenience of the policy makers, which aims to shift blame onto the scientific advisers. The government – in particular the PM – showed great resistance to lockdowns, which were in conflict with their libertarian views. Some cabinet ministers, and indeed the current Prime Minister Rishi Sunak, have now openly questioned the value of lockdowns (Wilcock, 2022). But the question is rather why the scientific case for restrictions was not advocated more strongly, or why, particularly later on, in the winter of 2020, it did not appear to exert sufficient influence on policy.

It appears that government policy was also influenced by a small group of scientists whose views lay outside the range of mainstream opinion. In September 2020, some of

the scientists who were shortly to launch the Great Barrington Declaration were invited to meet with Boris Johnson to advise on the course of action as the second wave of infection grew (Sunday Times, 2020). Their advice against a 'circuit breaker' lockdown has been said to have influenced Johnson's decision not to heed that option as SAGE had recommended (Farrar & Ahuja, 2021), again most probably causing many avoidable deaths. This seems to be an example of unofficial 'science advice' cherry-picked to fit a pre-existing policy preference – a situation that chief science advisers may have been powerless to prevent, but about which they must be allowed (perhaps obliged) to express dismay and disapproval.

Lesson 3. Scientific advice should be more transparent and advisors should engage more proactively with the public

As noted above, the need for transparency and engagement was a central finding of the Phillips Inquiry in 2000 (BSE Inquiry, 2000). Soon afterwards, Sir David King was clear during his tenure as GCSA that scientific advisers must act as bridges between the scientific and political systems, but that their role is also to engage and inform the public. Serving under two Prime Ministers, he regularly spoke directly to the public and media without being accompanied by politicians (King, 2020)

Such hard-won insights seem to have been lost in the early stages of pandemic response. It was concern about the lack of transparency in the SAGE process that initially prompted the formation of Independent SAGE in April 2020. Although that situation improved with the subsequent publication of SAGE minutes, it has not always been clear how accurately these minutes – often rather general, and timid in their recommendations – reflect what was discussed. This point is reinforced by Jeremy Farrar's account of his time on SAGE (Farrar & Ahuja, 2021).

Attending SAGE were large numbers of Whitehall officials, advisers and government scientists in addition to independent university-based scientists, and an increasing number of subgroups. All were deemed 'participants' rather than 'members', meaning that accountability was diffuse and opaque. In reviewing the use of scientific advice, the House of Commons Science and Technology Committee noted that scientists giving advice on social impacts were 'less visible than epidemiological modelling advisers; and their role in decision making opaque' (HoC S&T Committee, 2021). Without transparency, there can be neither accountability nor scrutiny nor learning from what has gone well and what not so well.

The case for transparency extends beyond SAGE. Other advisory bodies to the government have been subject to far less scrutiny, yet seem to have exerted great influence. For example, the Joint Committee on Vaccination and Immunisation (JCVI) failed for most of 2021 to follow its own Terms of Reference by publishing minutes within six weeks. This was important given its controversial decision, in the light of escalating transmission, illness and school absence amongst children, not to recommend a vaccination programme for 12–15-year-olds and then 5–11-year-olds, for months after other countries were doing so.

When the JCVI's minutes were eventually published, they were hard to interpret, and rendered more so by pronouncements by the committee at the time. That process was, indeed, an example of how *not* to feed scientific advice into policy making: it did make a

policy recommendation (to not offer vaccination to this age group), even though by the committee's own admission the range of considerations included in the assessment was far too narrow to justify it and subsequent evidence showed that the recommendation was made despite benefit being recognised (Gurdasani et al., 2021). The result – health ministers ignoring the recommendation not to vaccinate – can only have helped to fuel vaccine hesitancy.

The value of having an independent source of scientific advice is demonstrated in the levels of engagement by Member of Parliaments, city mayors, local government, Non-Governmental Organisations and the wider public in the work of Independent SAGE (2022). Up to 20,000 people watch its weekly briefings, which were started when the Prime Minister abandoned the Number 10 briefings. Some have criticised Independent SAGE for the confusion created by its use of the same acronym, with the potential implication that SAGE itself is compromised (Clarke, 2021; Smallman, 2020); others are very positive about its impact (McKee et al., 2022; Woodruff, 2021). On the other hand, 'official' SAGE and Independent SAGE have rarely diverged significantly in their advice, and there has been some overlap of personnel between them. Indeed, some would argue that science is better served by a diversity of voices in the advice it offers to policy (Sarewitz, 2011). In contrast to the often tightly choreographed and controlled government briefings, Independent SAGE has made public engagement an explicit goal of its operation, with the public, policymakers, scientists and NGO representatives able to raise questions at its weekly briefings (McKee et al., 2022).

Nonetheless, the fact that a group of prominent scientists felt it necessary to establish a separate, unofficial body to formulate scientific advice for policymakers suggests that something is broken in the existing system. SAGE was never designed to work as a body that provides advice for two years, all of it in the public eye. It would, moreover, be unrealistic and unwise to overlook the character of the government it, and other scientific bodies, have been advising. Science advice must of course be non-partisan, but that cannot and must not mean overlooking the political realities in which it operates. The UK government has, during the course of the pandemic, repeatedly demonstrated a readiness to break national and international laws (Melo Araujo, 2022 Parker, Payne, Foster, & Pickard, 2020;) as well as parliamentary and indeed social norms, ignored or subverted the machinery that upholds public and legal standards (Allegretti & Stewart, 2021), been judged by the courts to have flouted the law in awarding contracts to medical providers during the pandemic (BBC News, 2022), and procrastinated on policy decisions in ways that, in the view of many scientists, cost thousands of lives. Such an administration poses challenges to the mechanisms of science policy that it was never designed to handle. It would be foolhardy not now to try to 'future-proof' the science advisory process against such challenges.

Building on the 2000 BSE Inquiry, the UK Covid-19 Inquiry should examine how scientific advisory bodies can be empowered and encouraged to engage in regular dialogue and engagement with the public. This responsibility also needs to be made more explicit in the role descriptions of the GCSA and other government scientific advisers. The guiding principle here needs to be the maintenance of public trust, which has repeatedly proven to be essential to the effective handling of a crisis. The encouraging news is that public trust in science and scientists appears to have remained robust through the pandemic (Wellcome Trust, 2021; Skinner, Garrett, & Navin Shah, 2020). But trust in government

decision making has been severely tested, with longer-term risks for public health and wellbeing. Acting now to open up scientific advisory structures and build strong cultures of public engagement could be a crucial part of future pandemic preparedness, and ensuring greater resilience to the climate emergency and other challenges.

Conclusion

It is important to acknowledge the shifting, complex and relentless landscape of challenges that scientific advisers (including the GCSA and CMO) faced throughout the pandemic. This article is intended to be a constructive reflection at a system level, rather than blaming or criticising particular individuals.

Although some on both the political and scientific sides of these debates may prefer to draw a veil over what went on, and at times went wrong, the UK Covid-19 Inquiry has a vital opportunity to shine fresh light on what worked or what did not, and recommend ways in which the advisory system can be improved.

There has arguably been too much collusion between scientific advisers and government, and there are risks of more. The government's talismanic celebration of the vaccine rollout, for example, might be seen by scientists as a justification for more funding of basic science, even though it has inflated and exaggerated the importance of vaccinations at the cost of obscuring the importance of other measures and considerations – and of underlying problems of social inequality, long Covid, and underfunding of the National Health Service.

The UK Covid-19 Inquiry will be a stringent test of the scientific community's ability to reflect and criticise in an open and objective manner. Some of the expertise needed to do that will have to come from the social and behavioural sciences as well as from experts in public-health policy and in science studies, where there is often a more nuanced view of how science and wider culture interact. Beyond the Inquiry, there is a strong case for scientific institutions to conduct their own self-examination and reflection (ideally with independent oversight), rather than passively waiting to see which aspects of structure, conduct and performance fall within the purview and recommendations of the official inquiry. Sir Patrick Vallance's announcement that he intends to stand down in April 2023, at the end of his five-year term as GCSA, also creates a natural opportunity for his successor to take stock and identify priorities for strengthening the robustness, resilience and independence of the scientific advisory system (Government Office for Science, 2022).

Disclosure statement

No potential conflict of interest was reported by the author(s).

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