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COVID INQUIRY

How covid-19 spreads: narratives, counter narratives, and social dramas

Trisha Greenhalgh and colleagues explore why inaccurate narratives about the mode of transmission of SARS-CoV-2 emerged early in the pandemic and shaped a flawed policy response, with tragic consequences

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Key messages

- A flawed narrative that SARS-CoV-2 was transmitted by droplets rather than being airborne became entrenched early in the pandemic
- Measures aimed at an assumed droplet pathogen (handwashing, surface cleansing, physical distancing) were over-emphasised
- Measures to reduce airborne transmission (improving indoor air quality, reducing indoor crowding and time spent indoors, and high-grade respiratory protection) were under-emphasised
- UK policy makers seemed to favour narratives from a narrow group of scientific advisers
- Consequences included care home deaths, mission critical delays in public masking, and avoidable infections of healthcare workers

The draft terms of reference for the UK covid-19 inquiry encompass not just what decisions were made but also how and why.[1] As Dyani Lewis has argued in *Nature*, the World Health Organization overlooked—and at times explicitly denied—airborne transmission of SARS-CoV-2 for over two years, despite early evidence indicating that this was an important, and perhaps the dominant, route of transmission.[2] UK policy makers likewise adhered to an assumed droplet mode of transmission and prioritised interventions accordingly, neglecting the key topic of indoor air quality.[3]

We consider how flawed narratives about SARS-CoV-2 transmission arose and became entrenched, leading to misplaced policies and avoidable deaths, focusing mainly on the UK. We invite the inquiry to consider not just those specific flawed decisions but also the culture of premature scientific conclusions and reluctance to engage with uncertainty.

Policy making as a struggle between narratives

Policy making involves competing narratives (about problems, how they arose, and how they will be resolved), institutions (especially government and its bureaucratic machinery), and interests (financial, political, ideological).[4] Policy might ideally "follow science," but whose science and why? Science shapes policy narratives through an "inside track" (such as official advisory committees) and, to a lesser extent, through an "outside track" (such as less mainstream scientists and citizen movements).[4] Pandemic policy making has been characterised not by clearly identified knowledge gaps that science obligingly fills but by toxic clashes between competing scientific and moral narratives.

Getting the mode of SARS-CoV-2 transmission right matters, because preventive strategies follow (box 1).[5 6] Being honest about scientific uncertainty also matters, because—among other reasons—it is hard to backtrack after declaring a policy to be "evidence based."[7]

Box 1: Droplet versus airborne transmission: implications for public health and healthcare worker protection

Droplet transmission

If an infectious pathogen spreads predominantly through large respiratory droplets that fall quickly, the most important public health measures are:

- respiratory hygiene (eg, sneezing into tissues)
- disinfecting surfaces and objects (fomites) onto which droplets might have fallen
- reducing direct contact (eg, do not shake hands with others or touch one's own face)
- staying physically apart from others at a distance that reflects the effect of gravity on droplets (1-2 m)
- wearing face masks within that droplet distance
- physical barriers (such as visors or plastic screens)
- providing respirator grade facial protection to healthcare staff who undertake "aerosol generating" procedures

These contact, droplet, and fomite precautions do not distinguish between indoor and outdoor settings, because a gravity driven mechanism for transmission would operate similarly in both.

Airborne transmission

If an infectious pathogen is mainly airborne, a person could be infected by inhaling aerosols emitted in the breath of an infected person. These aerosols might remain suspended in the air for many hours. Reducing airborne transmission requires measures to avoid inhalation of infectious aerosols, including:

- engineering controls in indoor spaces (ventilation, air filtration)
- reducing crowding (eg, by encouraging people to work from home if possible)
- reducing time spent indoors (eg, frequent breaks for school classes)
- maximising physical distance between people indoors (even beyond 2 m)

- wearing masks whenever indoors
- careful attention to mask quality (to maximise filtration) and fit (to avoid air getting in through gaps)
- taking particular care during indoor activities that generate aerosols (eg, speaking, singing, exercising)
- providing respirator grade facial protection to healthcare staff and others that work directly with patients

Competing narratives around transmission

"Covid is droplet, not airborne, spread"

At a press conference on 11 February 2020, WHO's director general announced that covid-19 was airborne.[8] After a prompt, he corrected himself and declared that the virus was transmitted by droplets (coughs, sneezes, and contaminated objects). The reasons for this hasty correction are not fully known but might have included a desire to prevent public panic and to avoid exacerbating a major supply chain issue with personal protective equipment[9] in the face of known international shortages.[10]

WHO's early public information campaign promoted droplet measures—handwashing, respiratory hygiene, and disinfection of surfaces and objects (box 1)—and firmly reassured the public that the virus was not airborne (fig 1). This stance reflected the dominance of infection prevention and control clinicians—whose day jobs included enforcing controls against droplet-borne infections in hospitals—on key committees.[11] Airborne precautions for airborne diseases are, of course, a legitimate component of infection prevention and control science, but in practice this professional group has focused historically on droplet precautions.[12]

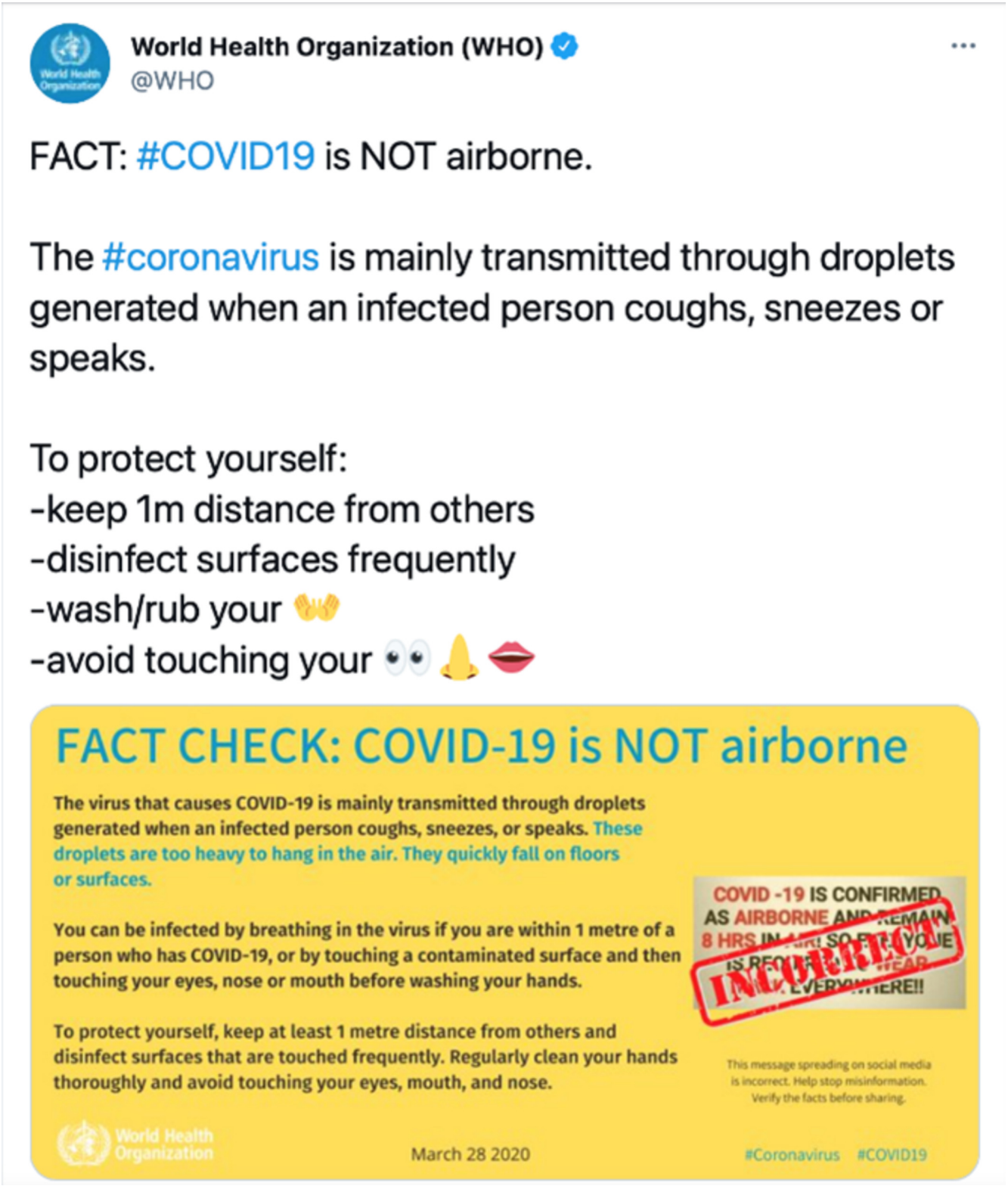

Fig 1 | Tweet from WHO on 28 March 2020 denying airborne transmission of SARS-CoV-2

The UK government's narrative (box 2) was similar to WHO's. It did not reflect nuanced discussions in the Scientific Advisory Group on Emergencies (SAGE), some members of which had raised the possibility of other transmission routes on 18 February 2020.[15] Rather, it reflected advice from a small group of infection prevention and control experts from Public Health England, Public Health Wales, NHS Scotland, and Public Health Agency Northern Ireland (see supplementary file on bmj.com) who favoured a droplet-but-not-airborne narrative.

Box 2: Contrasting early announcements about preventing transmission of SARS-CoV-2 from England and Japan

From Public Health England

"There are general principles you can follow to help prevent the spread of respiratory viruses, including:

- washing your hands more often—with soap and water for at least 20 seconds or use a hand sanitiser when you get home or into work, when you blow your nose, sneeze or cough, eat or handle food
- avoid touching your eyes, nose, and mouth with unwashed hands
- avoid close contact with people who have symptoms
- cover your cough or sneeze with a tissue, then throw the tissue in a bin and wash your hands
- clean and disinfect frequently touched objects and surfaces in the home"

Posted 3 March 2020, updated 30 March 2020, withdrawn 1 May 2020.[13]

This narrative assumes a droplet mode of transmission and implies a high level of certainty.

From the Japanese Prime Minister's office

"The locations where mass infections were confirmed so far are places where the following three conditions were met simultaneously: closed space with poor ventilation, crowded with many people, and conversations and vocalisation in close proximity (within arm's reach of one another). It is believed that more people were infected in such places. Therefore, we ask that you predict locations and settings where these three conditions could occur simultaneously and avoid them. We do not have enough scientific evidence yet on how significantly such actions can reduce the risk of spreading infection. However, since places with poor ventilation and crowded places are increasing infections, we ask that you take precautions even before scientific evidence for clear standards is found."

Posted 9 March 2020.[14]

This narrative assumes the possibility of airborne transmission and asks citizens to share the uncertainty and act in a precautionary way.

Box 3: 10 Streams of evidence that support airborne transmission of SARS-CoV-2

- Superspreading events: the virus is often transmitted at mass events from one or a few people to many people[20 21]
- Long range transmission: the virus spreads in shared air among people who have never physically met or touched any common surface[22]
- Asymptomatic and pre-symptomatic transmission: a high proportion of people who pass on the virus have no symptoms at the time[23]
- Indoor dominance: transmission is many times greater indoors than outdoors, and ventilation reduces transmission[24]
- Nosocomial infections occur despite strict contact and droplet precautions and reduce when airborne precautions are added[25]
- Although SARS-CoV-2 is difficult to isolate from air, viable SARS-CoV-2 was detected early in the pandemic in real world settings where infected people had been[26 -28]
- SARS-CoV-2 has been detected in air filters in building ducts[29]
- Transmission between animals has occurred when their cages are connected with air ducts[30]
- The virus exhibits overdispersion (one person with covid-19 might infect no-one; another might infect dozens)[31]
- Empirical evidence supporting droplet or fomite transmission is sparse[32 33]

Adapted from Greenhalgh et al.[34]

The droplet-but-not-airborne narrative emphasised randomised controlled trials (see supplementary file on bmj.com),[16] drawing implicitly on the hierarchy of evidence—a formalisation of the assumed superiority of randomised trials, which "typically serve[s] the needs and realities of clinical medicine, but not necessarily public policy."[17] It did not acknowledge the hierarchy of controls—a public health framework incorporating system level interventions to eliminate pathogens, environmental controls aimed at making air and water safe, and behavioural interventions.[18] This mindset seems to have led policy makers to reject a wealth of evidence on the science of how to optimise indoor air quality.[6]

"Covid is unequivocally airborne"

Aerosol scientists study how fluids and particles travel in the air. Some specialise in how respiratory pathogens—including tuberculosis, influenza, and other coronaviruses such as SARS and MERS—travel. They have shown, using laboratory studies, real world case studies, and computer modelling, that these pathogens are transmitted by aerosols and require airborne mitigation measures (box 1) and that coughs and sneezes generate turbulent gas clouds of different sized particles that can travel long distances.[19]

Since early 2020, evidence has accumulated from a range of study designs to support the hypothesis that, like most other respiratory pathogens and perhaps more so than other coronaviruses, SARS-CoV-2 is transmitted through the air (box 3).[5 34 -36]

Countries such as Japan,[14] where "inside track" aerosol scientists had the ear of government,[11] introduced airborne precautions early in the pandemic (box 2). But in most western countries the aerosol narrative initially fell on deaf policy ears. By July 2020, aerosol scientists were alarmed that official advice was based on oversimplistic and incorrect models of transmission (which had perpetuated for decades in the infection control literature[37]) and wrote an open letter to WHO offering to help.[5]

"Covid is 'situationally' airborne"

From the outset, WHO's guidance on protecting healthcare workers from covid-19 recommended a standard level of protection for most activities but a higher level for "aerosol generating" ones,[38] reflecting a long established (but flawed) medical research tradition. WHO's Infection Prevention and Control Research and Development Expert Group for Covid-19 did not initially include any aerosol scientists and seemed to ignore the offer of help. A new scientific brief was quickly published, reiterating the dominance of droplet transmission in most circumstances but acknowledging airborne transmission in certain situations—aerosol generating medical procedures and crowded, poorly ventilated indoor settings.[39]

Some parts of WHO subsequently welcomed the input of aerosol scientists and changed the guidance in December 2021 to recommend higher grade personal protective equipment (including N95 respirators) for all covid-19 patient care.[40] But the expert group dissented from this overall view, as noted in a footnote (page 1): "WHO provides this interim recommendation independent of the covid-19 infection prevention and control guidelines development group." That group continued to promote the "situationally airborne" narrative, which has persisted despite evidence against it and has far reaching implications. If aerosols transmit only when certain procedures are being performed, only a small fraction of healthcare staff need higher grade protection and only when performing particular procedures. If that assumption is incorrect,

staff (especially non-medical and less senior ones) and patients in most healthcare facilities are under protected.

"Everyone generates aerosols; everyone is vulnerable"

A systematic review found wide disagreement among guideline panels about which procedures and activities should count as aerosol generating (and hence earn respirator grade protection for the person doing them).[41] Many procedures, such as taking a nasopharyngeal swab, were inconsistently classified; some acts, such as coughing, were not procedures; and several procedures were classified as aerosol generating only because they induced coughing.[41] A review of the physiology and aerodynamics of respiratory acts concluded that coughing, sneezing, breathing (especially if laboured), speaking, and singing generated substantial amounts of aerosol and that well documented superspreading events for covid-19 involved a critical triad of poor ventilation, crowding, and loud vocalisation.[42]

These findings raise some paradigm challenging questions. Should respirator grade protection be worn by everyone—including other patients—whenever patients are coughing? Should more attention be paid to measures higher up the hierarchy of controls, such as ventilation or filtration of air or ensuring that fewer people share air and for shorter periods?

Social dramas

Droplet precautions became ritualised

The official droplet-but-not-airborne narrative materialised as artefacts (such as posters, disinfectant dispensers, and 2 metre distancing markers) and social practices (actions accepted and expected in particular contexts). Droplet directed practices became ubiquitous, as people washed hands and forearms assiduously for 20 seconds, quarantined and disinfected their post, and stayed a measured distance apart, and institutions installed and policed the various artefacts and practices.

These rituals of purification[43] powerfully reinforced the official narrative. "Clean" and "contaminated" came to be demarcated in terms of how recently and thoroughly hands had been sanitised and how far a droplet was assumed to travel (box 1). The same rituals served to downplay or obscure the narrative of aerosol transmission—which demarcated clean and contaminated in terms of air purity, with practices oriented to controlling indoor crowding and time spent indoors, ventilating or filtering air, and optimising quality and fit of masks (box 1). These material and enacted features of policy discourse served to silence further the narrative that SARS-CoV-2 is airborne.

Care home residents died in their thousands

On 23 March 2020, with up to 500 000 deaths and an overwhelmed NHS predicted, the UK's prime minister announced a national lockdown. Hospitals had switched into urgent discharge mode on 19 March, sending patients back to care homes without routine pre-discharge testing. Between March and June 2020, 18 104 deaths involving covid-19 and 11 169 additional deaths above the five year UK average occurred among care home residents.[44]

Amnesty International depicted the UK's care home crisis as a gross breach of human rights in which thousands of vulnerable people had been treated as expendable.[45] The crisis was largely avoidable. Public Health England's guidance for care homes emphasised a situationally airborne narrative.[46] Because aerosol generating procedures are rarely undertaken in care homes, these settings were low priority for personal protective equipment. Under-emphasis of the importance of ventilation and no routine use of masks are likely to have greatly amplified transmission between infectious residents and care home staff. In Hong Kong, by contrast, surgical masks were mandated for all care home staff by late January 2020, and no excess care home deaths occurred in the first wave of covid-19 (March to June 2020).[47]

Public masking became a libertarian lightning rod

Libertarianism is a political ideology that favours individual choice, freedom, and a retreat from state and institutional control. Libertarians resist imposed rules and like to do their own research rather than trust scientists or government. Uncertainty and conflict about the value and place of public masking allowed libertarian messages and practices to flourish.

At its 4 February 2020 meeting, SAGE advised masks for patients with symptomatic covid-19 to reduce transmission "if tolerated."[15] This group had acknowledged the potential for asymptomatic transmission of SARS-CoV-2 on 28 January 2020[15] but did not make the logical leap to recommend that asymptomatic people should wear masks as source control. In official meetings between January and April 2020, either public masking was not mentioned or arguments against it—lack of efficacy, harm, wastage—were tabled (see supplementary file on bmj.com).[15] Public announcements and professional videos[48] issued by Public Health England between February and June 2020 presented masking as ineffective and potentially harmful on the grounds that people might take compensatory risks or self-contaminate while putting on or removing their mask (the "donning" and "doffing" of infection control jargon). They provided no evidence to support these claims.

The confusion about masking in key decision making committees was due partly to confusion about mode of transmission. Asymptomatic transmission reflects a predominantly airborne route (because asymptomatic people are not coughing or sneezing), but the preoccupation with self-contamination and donning and doffing rituals reflected a predominantly droplet model (box 1). Wearing a cloth or surgical mask protects others (imperfectly) from transmission by droplets and (to some extent) aerosols; wearing a well fitting respirator grade mask also provides strong protection for the wearer against aerosol transmission.[49] A presumption of droplet transmission explains the limited attention paid to the type of mask and the excessive concern about self-contamination.

An influential inside track narrative seemed to conflate the absence of relevant randomised controlled trial evidence with evidence that masking was ineffective.[16] Outside track scientists argued for the precautionary principle, on the grounds that there was—as early as March 2020—indirect and mechanistic evidence (notably, around asymptomatic transmission) and strong theoretical arguments for public masking and huge potential risks associated with delay.[50] Mask mandates were finally introduced in England on 15 June (public transport) and 24 July 2020 (all public places). By then, public opinion was polarised, and many thought it was ineffective.[51] Most Asian countries had high public compliance with early masking policies and very low death rates; many western countries introduced masking late and had many more deaths, although causal links are complex and confounders many.[52]

Masking policies in the United States, and to a lesser extent the UK, were met with a strong libertarian backlash aligned with populist political leaders, right wing Christianity, anti-authoritarian social media groups, and, latterly, anti-vaccination groups.[53] In this context, masks came to symbolise pointless restriction of individual freedom, mindless compliance with authoritarian governments, and even blasphemy.[54]

Healthcare settings became occupational health battlegrounds

As documented in the 9 January minutes of the New and Emerging Respiratory Virus Threats Advisory Group (NERVTAG)—an expert committee of the Department of Health and Social Care that advises the UK government, SARS-CoV-2 was initially classified as an airborne high consequence infectious disease by the four nations' public health agencies.[55] Consequently, staff caring for patients with suspected or confirmed covid-19 required filtering facepiece respirators (FFP3) or equivalent. This reflected guidance from the UK Health Security Agency (previously Public Health England) and Health and Safety Executive on other coronaviruses and avian influenza and legal requirements for employers to protect their workers against airborne biohazards. The Health and Safety Executive had concluded in 2008 that surgical masks "should not be used in situations where close exposure to infectious aerosols is likely."[56]

NERVTAG minutes from 13 March 2020, however, show growing concern about shortages of respirator masks and the Department of Health and Social Care's request for "adapted" guidance that recommended surgical masks in most circumstances.[55] The deputy chief medical officer agreed to meet with the chair of the government's Advisory Committee on Dangerous Pathogens, whose members "were unanimous in supporting the declassification of covid-19 [as a high consequence infectious disease]."[55]

The declassification of covid-19 in early March 2020 had profound implications for the protection of healthcare workers. The following sentence, for example, was present in version 8.1 of Health Protection Scotland's guidance for clinicians on infectious pathogens (dated 5 March 2020): "The precautionary principle should be applied for all novel or emerging respiratory pathogens of high consequence when the mode of transmission is incompletely determined. Airborne precautions (including the use of correctly fitted FFP3 respirators) should be applied for all patients admitted with suspected or confirmed covid-19."[57]

But this entire paragraph was removed from version 9.0 of the guidance (dated 10 March 2020).[58] Notes in a marked-up version 8.1 obtained by us under the Freedom of Information Act reveal a comment against the paragraph as follows: "subject to change based on NERVTAG PPE decisions."

Although NERVTAG minutes from 6 March 2020 allude to severe shortages of respirator grade protective equipment, this was not made explicit in communications to either healthcare organisations or the public. A letter to UK healthcare organisations dated 28 March 2020 from NHS England and NHS Improvement, Public Health England, and the Academy of Medical Royal Colleges stated that, because of rising covid-19 cases and because "more was understood about the behaviour of the virus and its clinical outcomes,"[59] respirator grade protection would now be restricted to aerosol generating procedures.[59]

The number of UK health and care workers infected with SARS-CoV-2 at work is not officially documented. The secretary of state for health and social care reported that by mid-2021, around 1500 had died of covid-19 and 120 000 had developed long covid (some of whom remained on long term sick leave).[60] In April 2020, excess deaths were noted among healthcare staff (especially men and ethnic minority groups) working outside intensive care units, and this impression was confirmed in subsequent academic publications.[61] In early 2021, the British Medical Association and Royal College of Nursing demanded respirator grade protection for all staff working with patients with covid-19.

The latest guidance from the UK Health Security Agency, introduced in April 2022 but withdrawn in May 2022 when all jurisdictions were asked to revert to their respective national guidance, continued to promote a situationally airborne narrative and restrict respirator use to aerosol generating procedures.[62] It did not recommend respirator masks for all covid-19 patient care. But the document glossary states, "Airborne particles can be released when a person coughs or sneezes, and during [aerosol generating procedures]." There remains wide variation in infection control policies in different NHS trusts (perhaps because some interpret the guidance as mandatory); those that provide respirator grade protection seem to have much lower nosocomial infection rates for covid-19.[63]

Discussion

At the root of the UK's limited success in controlling transmission of SARS-CoV-2 lie flawed droplet-but-not-airborne and situationally airborne narratives. These narratives, and the false certainty with which they were conveyed, produced ineffective public health measures, contributed to shocking levels of care home deaths, exacerbated toxic discourse on masking, and justified withholding adequate protection from most health and care staff.

Why did the flawed narratives prevail? We consider four complementary hypotheses. The first is psychological. Social representation theory holds that people faced with new information show two tendencies: anchoring (grounding the new in an existing framework of concepts, ideas, and values) and concretisation (in which something abstract is made meaningful by making it physical and tangible).[64] People are unlikely to change their beliefs in light of complex and contravening evidence because this requires effort and causes aversion.[65] Policy makers are known to exhibit "satisficing"—meaning they narrow the parameters within which their decisions must make sense and be accountable, especially when threats are complex and urgent.[66] These well documented psychological tendencies might underpin the tendency for business and policy decisions to show what has been termed "escalation of commitment to a failing course of action."[7]

Our second hypothesis is scientific elitism. Scientists in infection control have amassed considerable scientific capital (influence, status, accolades); their favoured methods (randomised controlled trials) are greatly valued; and they have much to lose if they discard their long held droplet narrative and concede the importance of other kinds of evidence.[11] The inside track for pandemic policy making in the UK and WHO was narrow and partisan,[11 67] enabling an unusual degree of power to be wielded against outside track scientific voices, imposing a narrow and rigid set of acceptable scientific methods (what Danziger called "methodolatry"[68]), and precluding the kind of interdisciplinary deliberation that might have allowed a full and fair consideration of important competing narratives. The low status of aerosol science in policy circles was perhaps compounded by the relative youth of this scientific field and the inherent technical difficulties of isolating viable virus from the air (resulting in inconsistent findings in air sampling studies, especially when undertaken by non-experts).[35] The science of indoor air quality (for example, how and when to open windows, what kinds of filters to use) might be (wrongly) viewed as unsophisticated compared with much of modern biomedicine.[3]

Our third hypothesis is practical and logistical. As confirmed in official minutes, the national shortage of high grade respiratory protective equipment was a live discussion topic in UK policy advisory groups at the beginning of the pandemic. Although adherence to a droplet-but-not-airborne narrative was not

consciously undertaken purely because of this shortage, it certainly helped to make existing stocks go further.

Our fourth hypothesis is political. Droplet precautions are, at least to some extent, under the control of individuals and hence resonate with neoliberal discourses about individual freedom, personal responsibility, and restraint of the state (although the "choice" to distance physically, for example, presupposes sufficient space in which to do so). Airborne precautions require a paradigm shift in policy making, with strategic actions from those responsible for public safety; this approach aligns with a more socialist leaning political discourse and requires considerable up-front investment in the built environment whose benefits may take years to accrue.[6] WHO's tweet (fig 1) emphasises how to protect yourself rather than what to expect of your employer, your child's school, or your government. Relatedly, we hypothesise a role for populism, the modus operandi of which is cherry picking evidence that supports the policy drive and validating anti-science sentiment under the guise of bringing power to people.[69] Populism drew on public desires to return to normalcy and further marginalised aerosol science by depicting its recommended measures[6] as obscure, unaffordable, and an enemy of the public interest.

The narratives and dramas presented in this paper are not exhaustive. The framing of protection as a matter of individual responsibility, for example, also accommodates the current political narrative of "learning to live with covid-19," in which good citizens stoically accept the endemicity of a—hopefully attenuating—virus in exchange for greater individual freedoms.

The covid-19 pandemic can be framed as what Marcel Mauss (cited in Chaunlat[70]) calls a "total social fact," a phenomenon that affects all domains and layers of society (economic, legal, political, religious) and requires us to draw evidence from across multiple scientific and other fields. In such circumstances, the combination of the cognitive biases and satisficing behaviour of policy makers, scientists' desire to protect their interests, and politicians' alignment with individualist values and populist sentiment proved perilous.

As the pandemic continues to cause death and long term illness more than 30 months after the first case, airborne transmission of SARS-CoV-2 and the mitigations needed to tackle it (box 1) remain misunderstood and under-recognised. Extraordinarily, a recent UK inquiry into errors made in the pandemic did not mention masks or ventilation at all.[71] Although we acknowledge that solutions are always much more evident in retrospect, we think that the inquiry should ask hard questions about policy makers' accountability in relation to past and ongoing omissions in this regard. We have 10 specific questions for the inquiry (box 4).

Box 4: Questions for the inquiry

1. Why were early indications that this virus could be airborne overlooked by policy makers, resulting in public health measures that over-emphasised handwashing, surface cleansing, and 2 m distancing? What checks and balances might have helped policy makers keep a more open mind about mode of transmission rather than seeing it as a settled issue from an early stage?
2. Why did policy makers convey an unjustified level of scientific certainty about the mode of transmission and measures to prevent transmission, rather than sharing with the public that the mode was not yet known, as other countries did? How might the culture of UK policy bodies change to foster greater intellectual engagement with scientific uncertainty and how to handle it?
3. What were (and are) the membership and terms of reference of the UK's "infection prevention and control cell"? Who appoints them? Who checks their work? Does this group include any experts on airborne transmission and the delivery of safe indoor air? Why did (and does) this group have such a high degree of influence on policy? Why are its activities (at least partly) hidden from the public? Where are the minutes of its meetings?
4. Why did policy makers continue to de-emphasise the evidence base on the airborne mode of transmission for so long, even as strong and consistent empirical evidence was accumulating? To what extent were cognitive biases operating at either individual or group level? How might such biases have been minimised or overcome?
5. Why did policy makers continue to place so much emphasis on droplet precautions even after they had accepted that the virus was likely airborne? Why was indoor air quality given so little attention not just at the beginning of the pandemic but two years (and counting) into it?
6. To what extent were policy decisions adversely influenced (either consciously or unconsciously) by the shortage of high grade personal protective equipment? Who made these decisions and what is the chain of accountability?
7. To what extent was the limited public confidence in the efficacy of masks influenced by negative policy announcements on this subject early in the pandemic? Why were early statements that masks were likely ineffective and could be harmful not corrected as evidence to refute them accumulated? What lessons might specific public health leaders be encouraged to learn from this error?
8. Why are UK health and care workers still not fully protected against airborne infections in the workplace? Why is a premature and false narrative that the pandemic is over being used to justify not supplying workers with personal protective equipment designed to protect against airborne pathogens?
9. Are experts in aerosol science now adequately represented on all key science advisory bodies and are measures in place to ensure that their advice is sought and heeded?
10. Why have policy makers put prime responsibility for preventive measures on individuals given that many effective preventive measures for airborne transmission are located at institutional and national policy levels?

Bold action is now needed to ensure that the science of SARS-CoV-2 transmission is freed from the shackles of historical errors, scientific vested interests, ideological manipulation, and policy satisficing. Policy makers should actively seek to broaden the scientific inside track to support interdisciplinarity and pluralism as a route to better policies, greater accountability, and a reduction in the huge inequities that the pandemic has generated.

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Patient involvement: The article relates to a public health issue that affects everyone. As such, we are all potential patients. TG lost her mother to hospital acquired covid-19 so brings a user perspective on nosocomial transmission.

Competing interests: We have read and understood BMJ policy on declaration of interests and have the following interests to declare: in November 2020, DT contacted Public Health England, the chair of NERVTAG, the Department of Health and Social Care, and NHS England to request improved personal protective equipment for healthcare staff. In February 2021, TG added her signature to a letter from the Royal College of Nursing to the UK prime minister making a similar request. She is a member of Independent Sage. MO declares no conflicts of interest.

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