COVID19 pandemic: uncertainties, and the challenges of science communications

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Abstract

Objectivity, fairness and balance are the three critical, classic buzzwords of journalism ethics. Objective journalism asks the journalists to eschew bias and present the story with a balance. Accuracy needs 'fact check' and balanced story demand presenting all sides of the story, and fairness implies that the journalist should strive for accuracy and truth in reporting and not lead the readers towards a reporter's desired conclusion. Balanced reporting is imperative for the media to play the role of the fourth estate in democracy. Nonetheless, in the paper, we present three case studies related to the COVID pandemic that adhere to the journalistic norms of fact-check, balance and news values yet are a misrepresentation. All these stories are related to uncertainties in science and conflating one type into another in the media framing leads to disseminating this misinformation. Showing fact check and balance are necessary but are not sufficient to eliminate misinformation stemming from a mix-up of various types of uncertainties, and some suggestions are made to the journalist as to how to deal with uncertainness in science while reporting them.

Introduction

In India, the southern state of Kerala reported the first case of Coronavirus disease 2019 (COVID-19) on January 27, 2020. Heeding the alarm raised by the World Health Organisation that the COVID19 is pandemic, the Indian Government imposed an unprecedented nationwide lockdown on the night of March 23, 2020.

The initial lockdown was extended three times, and the unlock process, that is, relaxation of lockdown conductions, gradually commenced from June 1, 2020. The active cases began to swell since June 2020, peaking in October 2020 and tapering off by December 2020. The 'second wave' mounted from February 2021 was, in comparison, swift, intense, and catastrophic. A lot more deaths are reported to have taken place during the second wave, and the health infrastructure was overwhelmed, creating a condition of chaos, gloom, and despondency.

As the World Health Organisation noted, the COVID pandemic was accompanied by an infodemic(W.H.O, 2020). Misinformation, disinformation, and malinformation were part of this infodemic. While some fake news raised hopes that the Government would disburse cash to every citizen, some were mischievous, claiming steam inhalation would cure the COVID. Others promoted enmity, hate and exacerbated anxiety and social tension.

Media resorted to 'fact check' and its related journalistic practices such as hoax busting and 'fake news' debunking to tide over the infodemic. Nevertheless, in this paper, we argue that 'fact check' and related journalistic practices are necessary but insufficient to meet various 'information disorders' resulting from science uncertainties.

The first section of the paper outlines the scholarly perspective on uncertainties in science and how media frames them. In the second section, we introduce the landscape of fact check and fake news in the wake of the COVID infodemic in India. In the third section, we present a snapshot of three exemplar stories on the COVID pandemic, stemming from the uncertainties that are characteristic of science. These stories were carried prominently in Indian media to demonstrate that 'fact check' alone is insufficient to arrest the information disorder. In the discussion section, we argue that how these media misrepresentations were created by everyday journalist practice such as fact check, balance and news value. These information disorders escaped facts check protocols. Further, taking a cue from studies on reporting patient autonomy in medical settings to climate change, we make some suggestions for journalists to deal with uncertainties in the science.

Science and uncertainties

Science is endemic to many varieties of uncertainties (Gooding, 1990; Pickering, 1995). The inherent variability and randomness of nature result in *objective* uncertainties. This is supplemented by *epistemic* uncertainties that result from our current lack of knowledge (known unknown). Our real experience is limited by the tools, techniques, and technology of the times (without radio telescopes, pulsars would have remained unknown-unknown) and the scientific models (and theories) we use to frame our understanding. Even though these models are complex and sophisticated, they essentially short of the real, resulting in prediction uncertainty. There is *ontological* uncertainty that comes from unknown-unknowns. Our knowledge of exotic objects such as neutron stars, supermassive black holes, dark matter, and dark energy are recent. A few decades ago, we hardly had any inkling of even their existence. Fourthly, the evidence available at hand may not be compelling to decide between two competing theories or models, resulting in *judgemental* uncertainty.

Manifestly the constitutional contingent nature of scientific knowledge presents an inherent tension in the communication of uncertainty in science. In the face of uncertainty, scholarship notes two extremes in journalistic practices; the first is total concealment of uncertainty in science. Premised on the assumption that the public prefers unambiguous, 'one armed' advice (David, 1975), the paternalistic strategy eschews all uncertainties and presents science as an authority that settles matters once and for all. As (Ebeling, 2008, p. 336) observes in media coverage, "uncertainty is stripped out of the discourse, and certainties about future expectations of a scientific discovery or a resulting technology are inserted and emphasised". The second response of media in the face of uncertainty in science is to reduce all uncertainties as a case of 'controversy'

or 'conflict'. Interestingly both responses naively view science as certitude (Stocking, 1999).

How do journalists and media handle scientific uncertainty if they choose to 'frame' it? Communications scholars see 'uncertainty in science' as a continuum that ranges from inexactness to lack of observations/ measurements, practically immeasurable, conflicting evidence, reducible ignorance, indeterminacy, and irreducible ignorance (van Asselt & Rotmans, 2002, pp. 80–81)value diversity, technological surprise, ignorance and indeterminacy. – Uncertainty is usually treated as a marginal issue, as an additional physical variable, as a mathematical artifact. The current methods merely involve evaluation of the impacts of `certain uncertainties', i.e. uncertainties for which estimates or probability distributions are available.– Current methods give no indication of the magnitude and sources of the various underlying uncertainties and the aggregated uncertainty measures are difficult to understand to decision-makers and other audiences.The threat of climate change, challenges from emerging technoscience such as nanotechnology and the conceptual, methodological, and ethical problems these entails has spurred the recent scholarship on the communication of scientific uncertainty (Guenther, Froehlich, & Ruhrmann, 2015; Gustafson & Rice, 2019, 2020; Han, 2013; Kandlikar, Risbey, & Dessai, 2005; Morgan, 2009; Rabinovich & Morton, 2012; Rice, Gustafson, & Hoffman, 2018; Schneider, 2016; van der Bles et al., 2019). The evidence appears mixed regarding whether portraying uncertainty in science communication has positive or negative effects. Examining the extant empirical research, Gustafson, A., & Rice, R. E. (Gustafson & Rice, 2019) delineate four different types (deficient, technical, scientific, and consensus uncertainty) framing uncertainty in contemporary media practice.

The *deficient uncertainty* media frame foregrounds a general lack of knowledge (a 'known unknown'). This frame is communicated by showing a known 'gap in knowledge' or 'shortcomings of the research' (Gustafson & Rice, 2020, p. 618). Measurement error, approximations used in the modelling and other scientific methodological practices limit the scientific claims. These quantified errors, called *technical uncertainty,* is communicated by the media by including projected ranges, confidence intervals, and probabilities (Gustafson & Rice, 2020, p. 618).

The Intergovernmental Panel on Climate Change (IPCC) uses a set of seven verbal descriptions of uncertainty, such as *unlikely* and *very likely,* to convey the underlying imprecision of its forecasts and conclusions. The frames of *scientific uncertainty*, 'unknown unknowns', is often communicated by emphasising 'deficient in our knowledge is an inherent feature of the scientific process or that further research may uncover unknown errors in our current understandings (Gustafson & Rice, 2019, p. 682). It may be noted that scientific uncertainty is distinct from technical uncertainty, which is a "known, identifiable shortcoming in a specific area while the former is a general epistemological philosophy of unknown unknowns" (Gustafson & Rice, 2019, p. 682).

Consensus uncertainty, is portrayed as disagreement among two sets of experts, experts and public or as uncertainty within the body of evidence itself is presented in the frame of 'disagreement,' 'conflict,' or 'controversy'(Gustafson & Rice, 2020, p. 618).

In addition to the above, one of the critical challenges for media is the motivated '*manufactured uncertainty* based on 'junk science', giving rise to non-existent 'controversy'. Since the 1990s, scholars have unravelled how industry-funded 'research' construct a 'contested expertise', with a motivated intention to confuse the audience with contradictory claims and seed doubts. The motivated propaganda uses public relations tactics to attack reasonable scientific evidence as 'inconclusive' to argue against regulation on issues ranging from tobacco (Barnes, 1998), sugar (Kearns, Schmidt, & Glantz, 2016), pharmaceuticals (Fugh-Berman, 2013) and climate change (Oreskes & Conway, 2012). As Tuchman (1972) notes, adhering to the "strategic ritual of objectivity", journalists unwittingly sow doubts about claims that are nonetheless backed by considerable evidence and expert consensus.

With a view to 'balance', the media often provide 'equal time' to "claims-makers who offer contrary views however outrageous ...because their inclusion reinforces the impression of journalistic objectivity"(Stocking & Holstein, 2009, p. 28). These are framed as consensus uncertainty, and the claim is unwittingly presented as 'unsettled science' as is the case with climate science and tobacco research (Oreskes & Conway, 2012).

Landscape of infodemic in India

As was the case elsewhere, the pandemic in India was accompanied by intensive infodemic. Analysing the infodemic circulating in the social media during January to May 2020, a report by BOOM FactCheck, India (Sutaria, 2020) identified 178 'fake news' that were either medical misinformation or wedge driving mes-

sages, exacerbating "existing tensions in the country, particularly long-standing rifts between the country's Muslim minority and Hindu populations".

A study conducted by the author (to be published elsewhere) catalogued 2,119 'fake news' circulating in India related to COVID19 between January 2020 and July 2021. Of this, 598 were 'wishful thinking' (UV rays from the Sun will kill the virus; gargling with hot water will prevent the virus from taking foothold), 803 were dread rumours (contracting the virus is sure death; lockdown would be extended; mosquito and housefly can transmit the virus and spread the infection) 637 were wedge driving (blaming cultural habits of specific communities for the origin of the pandemic and spread of the infection) and 81 anticipatory (with the lockdown the ozone hole has healed; peacocks roaming on the streets).

Interestingly 678 (nearly 32%) of these were during the January-March of 2020, when COVID19 hardly impacted India. The tide of certain rumours seems to have ebbed by the time the active cases increased and spread across the nation. Jamuna Prasad (1935), studying the spread of rumours after an earthquake in Bihar, India, in 1934, perceptively observed that "widespread emotional disturbance which persists over a more or less extended period, prepare the soil for the growth and spread of rumours"(Prasad, 1935, p. 6) and with "the return of emotional stability, rumours practically ceased to grow" (Prasad, 1935, p. 6).

In the Information Disorder report for Council of Europe, Claire Wardle and Hossein Derakhshan (2017) identify mis-, dis-, and malinformation as three types of bad- information contaminating the journalistic norm of 'truth telling'. They argue that flaws can occur at all the three phases of communication: creation, (re)production, distribution, and all the three stakeholders, agent, message, interpreter, contribute to the information disorder. Fact check is seen as a panacea to arrest the information disorder at the site of its creation (media) by the agent (journalists). No wonder the media in India too took recourse to 'fact check' to tide over the infodemic threat.

Since the founding of the first fact check group in the US (FactCheck.org in 2003), according to a report by Duke Reporter's Lab, as of August 2021, there are 348 active (and 113 inactive) fact check organisations worldwide. Relying on verifiable information from experts, academia, governments agencies, ex-post fact-checking examines the claims of public relevance circulating in legacy media and social media trends. The fact-check agencies have evolved a code initiated by The International Fact-Checking Network (IFCN) [Available at https://www.poynter.org/international-fact-checking-network-fact-checkers-code-principles.] 'Fact Check' and its related journalistic activities such as 'hoax busting', 'debunking' were deployed in the media in response to the challenges arising from the COVID-infodemic.

In the emergence of hybrid media, hoax busting, and fact-checking have emerged into a new genre of reporting in the legacy media, occupying significant column space and airtime. The Government too initiated to disseminate 'fact check' information through its official press release channel, Press Information Bureau(https://pib.gov.in/factcheck.aspx). A large number of scientists, science communicators and designers came together into a voluntary platform 'Indian Scientists Response to COVID 19' (ISRC) (www.indscicov.in) and as one of their activities undertook 'hoax busting'; which critically examined many of the mis, dis and mal information circulating in the public sphere in India at that time.

Insofar as journalism is a 'discipline of verification', 'fact check' is not new. The ex-ante fact check is now supplemented by an ex-post fact check that goes beyond 'two sides' but adjugated the claim's veracity in the worrisome context of post-truth and explosion of user-generated content in social media. A subset of this ex-post 'fact-check' is 'debunking' of fake news and viral hoaxes, using a specific set of skills that are in common with 'verification' (Mantzarlis, 2018).

Scientific uncertainty and misinformation

True to the journalistic dictum of educating and informing, the media presented the facts and figures related to the scale and extent of the infection and deaths and communicated the pandemic protocols to be followed by the citizens for their safety and protection. Novel coronavirus, SARS-CoV-2, had most likely spilled over to humans around October- November 2019. Various characteristics of the pathogen such as life cycle, pathogenicity, its routes and modes of transmission, clinical manifestation, mutation rate and immune response were all unknown- unknowns or known-unknowns. Our knowledge about the nature of the virus, modes of transmission, ways of detection, discriminating symptoms, clinical manifestation and efficacious treatment is still evolving even after two-plus years since the onset of the pandemic (Cao, 2020; Shi et al., 2020). Along with *epistemic* and *ontological* uncertainty, our knowledge was also handicapped by *technical*

uncertainty. As this unprecedented global disaster unfolded, the knowledge and consequently our response was evolving. Thus, it was unclear if masking in public as a public health measure should be mandated at the early stage of the pandemic (Peeples, 2020). In these ambivalent times, the media had a challenging role as the scientific uncertainties loomed largely.

This section will briefly present three exemplars of media unwittingly spreading mis/disinformation while facing 'uncertainties' in science. These messages were 'balanced' and cannot be classified as 'fake news', and hence the journalistic practice of balance and fact check clearly was inadequate.

Indian exceptionalism

At the height of the global surge, around August 2020, the death rate in India (and some of the South Asian countries) due to COVID 19 appeared to be inexplicably low. "The mystery of India's low coronavirus death rate"("The mystery of India's low coronavirus death rate," 2020) screamed a headline in a newspaper. It further stated that India has the "lowest number of deaths per 100 confirmed cases...at 1.5 percent...In comparison, the United States, the most infected country, has a death rate of 2.8 percent...India's number of deaths per 100,000 population is 7.73, compared with 64.74 in the United States."**1** The Indian exceptionalism was maintained because in India as people are "habituated to dwell in lesser hygienic condition and with lesser medical attention throughout their lifetime", and consequently, they have "naturally acquired better immunity and more resilience against many infective diseases" (Roy, 2020).

Airborne controversy

While the early pandemic protocols emphasised handwashing, fearing the transmission through the 'fomites route', the potential for airborne transmission came as a rude shock. "After insisting for months that the novel coronavirus is transmitted via respiratory droplets produced when an infected person coughs or sneezes, the World Health Organization (WHO) on Tuesday said that the airborne spread of COVID-19 cannot be ruled out" (Phelamei, 2020) says a news item reporting the modified advisory from World Health Organisation (WHO) on the transmission modes of SARS-CoV-2 virus. The shift in the policy recommendation in the light of lingering uncertainties and uncovering of new knowledge was framed as a 'failure' of science institutions, thereby weakening confidence in public institutions.

Stoking fear of vaccine

Early on during the pandemic, amid unprecedented lockdowns imposed, vaccines appeared as the last hope; but with numbers dwindling (and before the second wave ravaged), suspicion, mistrust and fear of side effects resulted in vaccine hesitancy. '23K adverse events post vaccination in India: Govt' says The Tribune ("23K adverse events post vaccination in India: Govt," 2021) reporting on the press release issued by the National Adverse Event Following Immunization (AEFI) Committee (Ministry of Health and Family Welfare & Division, 2021).

The Government of India rushed to approve the Covaxin "for restricted use in clinical trial mode...through an accelerated process on the basis... incomplete data on the vaccine's efficacy for peer review... [raising] more questions than answers" (Mohapatra & Mishra, 2021) . The clinical trials were marred with allegations that illiterate volunteers were recruited, who cannot read the consent forms, nor are they able to report adverse events (Bhuyan, 2021a). (In hindsight, though slow to come, the clinical trial results of the Covaxin are more than satisfactory.)

Vaccine hesitancy, defined by the World Health Organization (WHO) as a "delay in acceptance or refusal of vaccines despite availability of vaccination services"(MacDonald, 2015), is a crucial hindrance for massive vaccination drive worldwide. "Questions about vaccine efficacy, potential side effects, or speeding through regulatory approval processes" (Hotez et al., 2021) are found to be the critical drivers of hesitancy in the context of the COVID19 vaccines. The vaccine trials and approvals, particularly around Covaxin,

1 See (Cohen, 2021) for a discussion on this theme. See also ("India has one of the lowest Covid mortality rates in world but each death painful: Vardhan," 2021) and ("At 1.11%, India's Covid fatality rate lowest in the world, says Harsh Vardhan as toll crosses 2 lakh," 2021) for similar media stories.

India's first home-produced vaccine, have been criticised (Thiagarajan, 2021). While scholars warned that "medical therapy approved for public use in the absence of extensive safeguards has the potential to cause harm, not only for COVID-19 prevention efforts and vaccine recipients, but also for public trust in vaccination efforts worldwide" (Trogen, Oshinsky, & Caplan, 2020). When the vaccines were rolled out with ambiguous safety and efficacy scrutiny, it was accompanied by misinformation and mal-information linking the vaccine to deaths (Srivastava, 2021a).

Meanwhile, in the absence of public data on adverse events following immunisation (Bhuyan, 2021b), concerns were expressed by the experts (Thacke, 2021). Although not easy (Remmel, 2021), transparency in AEFI would help the hesitant section gain confidence and shun reluctance. Following public pressure, the Government responded with data (Ministry of Health and Family Welfare, 2021). Harnessing this well-placed public criticism of policies, the anti-vaxx groups had the field day by linking deaths after vaccination as deaths due to immunisation(Srivastava, 2021b).

All these uncertainties had policy implications; if indeed the Indians are less susceptible to the COVID19, then the crippling lockdowns are excessive; if the airborne transmission is the main route, then masking within home and dwelling would be necessary; if indeed the vaccines are unsafe, it would not be a panacea for the pandemic.

Discussion

All the three cases presented above are illustrative. The media citation is also indicative; almost all mainstream media carried similar messages. In the first part of this discussion, we will show that these messages are not mal-information or dis-information but are definitely misinformation. They do not do justice to the norms of journalism of 'telling truth'. We will further show that these framing emerged out of the regular everyday journalistic practices and are not attributable to the bias of the particular journalist or media channel. We would also argue that the actual practice of fact checks, both ex-ante and post-ante are inadequate to deal with such disinformation arising out of or uncertainties in the science. Lastly, we suggest that journalists have a lot to learn from the strategies evolved to deal with scientific uncertainties in climate change science.

Misinformation arising out of uncertainty in science

The indices, case fatality ratio (CFR) and the 'deaths per lakh population' used to establish the Indian exceptionalism suffer from 'denominator fallacy'. The 'figures' used to make the Indian exceptionalism are eminently 'fact checkable'; the numbers are actual. However, the claim is misplaced.

The fact check process first identifies 'fact-checkable claims', then look for the best available evidence regarding the claim at hand, and finally, the relative truthfulness of the claims is arrived at. The sources are evaluated on the parameters of proximity, expertise, rigour, transparency, reliability, and conflict of interest to evaluate the reliable evidence. The central quest of the ex-post fact check is "scrupulous analysis driven by one basic question: 'How do we know that?'." (Mantzarlis, 2018). However, as Shapiro et al. (2013, p. 668) note, "zeal for accuracy is a professional norm, but also that it is a norm of compromise – the compromise being simply understood rather than articulated. A small, easily checkable, fact needs to be checked, a larger but greyer assertion, not so much, unless it is defamation" (Shapiro, Ivor, Brin, Colette, Bédard-Brûlé, Isabelle, and Mychajlowycz, 2013, p. 668).

CFR is the ratio of actual infected cases as the numerator and the total susceptible population as the denominator. Serosurveys conducted in India clearly show that the infection spread gradually, and the prevalence of infection in rural, urban, urban slums and non-slum urban areas differed considerably. In short, the spread of the infection was uneven spatially and temporarily, between regions and even within different city locations. Thus, in computing the CFR or deaths per million, taking India's whole population as susceptible is a grave error. Epidemiologists use a more reliable infection fatality rate (IFR), the proportion of the actually infected to the actual death. Amid the raging pandemic, this measure is not easy to come by. However, a study (Cai, Novosad, Tandel, Asher, & Malani, 2021) found that among men aged 50–89, IFR is 0.12%

in Karnataka, 0.53% in Mumbai, but it was as high as 5.64percent among migrants in Bihar.[2], bursting the myth of 'Indian exceptionalism[3].

Evolving science and constructing conflict

Since the outbreak in December 2019, scientists are continually unveiling new and novel knowledge about the novel coronavirus. Nevertheless, at all stages, the epistemic uncertainty remains exceptionally high. In the early days of the pandemic, most of the case studies across the globe on the transmission undertaken by tracking and tracing the infection suggested direct droplet inhalation or fomite route of transmission (Q. Li et al., 2020; W.H.O, 2020). Suspecting airborne transmission, air samples were collected in COVID hospitals and other places. The results were dodgy, with some showing and some not, and in most, the attempt to culture failed. The public health officials, including WHO, suggested specific pandemic protocols such as face masks, hand washing, and physical distancing based on the evidence available. Two significant developments led to a fresh perspective.

Meanwhile, scientists working with aerosols mimicked the emission of droplets and droplet nuclei from the human mouth and nose using nebulisers in laboratories. These suggested that tiny droplets could linger in the air for a prolonged duration and traverse a greater distance. Nevertheless, there was hardly any case study that suggested airborne transmission.

In the iconic case study of a super-spreading event in a Chinese restaurant, the infection spread to those in the direction of airflow, and the rest of the diners at the adjacent tables were unaffected (Y. Li et al., 2021). This particular case, while pointing out that the droplets could be carried by air currents to longer distances, at the same time strongly suggested against airborne particles that can distribute throughout a room. In contrast, a 'super spreading event' associated with the music event held at Mount Vernon, Washington, in March 2020, all but eight of the sixty-one became sick, despite the members practising physical distancing and hand sanitisation. Two people died. "We believe it likely that shared air in the fellowship hall, combined with high emissions of respiratory aerosol from singing, were important contributing factors," the study concluded (Miller et al., 2021). Slowly studies on super spread events, where one person infected many, began to accumulate, suggesting aerosol transmission. As more and more cluster cases were intensely analysed, it was evident that in some of the clusters, particularly in poorly ventilated and crowded indoor spaces, the spread of the infection could be explained only with an airborne hypothesis. In the light of the new knowledge uncovered, WHO recommended that crowded and closed unventilated space should be avoided along with the mask, hand wash and physical distancing, modifying its earlier public health measures.

The terminology also played a part in the confusion. In the epidemiologist lexicon, the terms "droplets" falling off to ground and "droplet nuclei" lingering in the air are classified based on a size threshold of 5µm. However, for an atmospheric aerosol researcher, whatever floats in the air for more than a few seconds are 'aerosols'.

This episode was simultaneously a case of epistemic uncertainty evolving into judgemental uncertainty as more and more evidence accumulated and an ontological uncertainty, as many things about the virus were still evolving knowledge. Nevertheless, the media coverage framed these developments as 'conflict' between 'independent scientists' and the 'WHO institutional experts'; or as 'experts in disagreement', treating this as a case of mere 'judgemental uncertainty'. Sure, experts did differ from each other; but the disputation was about data, what airborne droplet means, and what implications can be drawn from the available data for public precautions and probable protective measures.

Presenting the debate as a controversy between a 'good guy' and a 'bad guy', the conflict frame at the same time appear to meet the journalistic norm of 'objectivity and 'balance' and helps create an engaging story[4].

2 "The severe economic and physical distress during the arduous return journey, piled on top of their poorer baseline health may have made migrants highly vulnerable to death after infection. The same phenomenon could explain why mortality was higher in Mumbai than in the southern states — because Mumbai's outbreak was concentrated among a poor slum population with poor health and worse access to care," speculate the authors.

3 The same study points out another puzzling phenomenon. The death rate in India of those over the age of 60 is less than in the developed world. "Most of India's mortality advantage occurred among those over the age of 60. Our study cannot explain why this was the case, but one explanation likely has to do with the types of people who make it to old age in India relative to in other countries. Many of the most vulnerable may already have died, leaving a relatively robust group of elderly survivors, who further may have immune systems strengthened by a lifetime of viral exposure," speculate the authors.

4 Stocking and Holstein (2009) detail four kinds of journalistic attitudinal clusters to how journalists treat conflicting views in scientific controversies; Lehmkuhl & Peters (2016, p. 11) note that in the face of encountering scientific uncertainty, journalists "addressed this perception in their decision-making process by choosing at least one of four strategies: Omission, he says – she says,

However, to scientists, polarisation is "a source of irritation . . . because scientific standards of objectivity require not balance or equal time but empirical verification of opposing hypotheses" (Nelkin, 1996, p. 1602). Sandman (1988, p. 37) puts it, 'For science, objectivity is tentativeness and adherence to evidence in the search for truth. For journalism, objectivity is balance'. When faced with two confounding accounts, the journalist fulfilled their obligation to objectivity by balancing 'two sides'. Presented as incommensurable conflicting claims, the journalistic presentation polarised what essentially was an ambiguity in the face of 'unknown unknowns as well as limited and evolving shreds of evidence available at hand.

'Man-eating-dog' criteria going awry

The theory of news values, the concept of news factors, describes why a topic is newsworthy and therefore selected by the media for circulation. "[T]here is evidence that science is being progressively fitted into the news story format, which demands recency as a news value, as opposed to features-style reports"(Taylor, 2010, p. 221); consequently, news factors influence the selection and presentation of science news too. One of the classical news factors is 'range', that probe whether 'nobody', 'a few people', 'specific group', or 'all citizens of at least one nation/region' are directly affected by an event(Badenschier & Wormer, 2012, pp. 70–71). In science, communication, particularly regarding risk, tends to explore potential harm, probability of damage, and personal relevance of risks. This is often measured by the number of people affected. Also, the dictum 'what bleeds leads' indicate that disasters, destructions, and deaths are tantalising for media coverage.

When reporting the loss of life and injury in a disaster, reporting the number of deaths, or affected in the headline is standard journalistic practice. In such calamity, the number of deaths or affected suggest the magnitude of the suffering. However, reports such as '23K adverse events post vaccination in India', without indicating the proportion, are least to say misleading. Out of the 75,435,381 vaccine doses that had been administered until then, 23,000 adverse events were reported, of which only 700 cases (@ 9.3 cases / million doses administered) were reported to be severe nature; the rest 'mild' such as headache, low-grade fever, chills and so on. The potential thromboembolic (clot in a blood vessel) major worry from covishield was around 0.61 cases/ million doses.

Vaccine hesitancy differs from resistance; while hesitancy is being unsure about taking a vaccine, resistance is absolutely against vaccination. While the gaps in transparency for vaccine approval in India is reported to be one of the critical factors influencing hesitancy, the misinformation and lack of information on vaccine safety and efficacy add to the confusion. Unwittingly presenting the adverse events without indicating the proportion exacerbate the anxiety and reinforce the reluctance.[5].

Reporting uncertainty – some suggestions

The three stories discussed above clearly does not meet the journalistic norm of telling 'truth' and 'objectivity', although none of them can be faulted for not adhering to the usual journalistic practices of the fact check, balance and news value. In the case of Indian exceptionalism, it was a clear case of 'denominator fallacy' while the 'airborne or not' controversy is a journalist narrative to get an engaging story by creating a conflict frame. The story reporting deaths from AEFI was misled by not giving the proportion of the risk. Neither the ex-ante nor the ex-post fact-check process can capture these media misrepresentations and force a re-look by the editor/journalist. In the light of these discussions, some suggestions are made for the journalist while reporting uncertainty in science.

Presenting 'uncertainty' as part of the science communication message is not just an add-on of supplementary information but fundamentally "shapes the meanings, interpretations, implications, and schema activated regarding the ambiguity, imprecision, and confidence of the message and the messenger." In the face of more than one opinion, media often uses the 'balance' concept to report both sides. Climate change communication scholars warn that 'she said/ he said' type 'false balance' media coverage under-represents overwhelming scientific consensus and results in "intentionally biased coverage of global warming" (Boykoff & Boykoff, 2004, p. 134). A journalist needs to be wary of 'false balance'.

Negotiation (with scientific sources), Structure and/or Language"

5 Of course, "current data on vaccines also shows that other big obstacles to vaccination are vaccine shortages and mismanagement" (Tarfe, 2021) and all the ills cannot be laid at the door of vaccine hesitancy.

Scholars have observed that the 'Merchants of Doubt' have "intentionally manufactured distrust around the science of climate change, exaggerating areas of uncertainty while downplaying areas of strong consensus and agreement" (Corner & Clarke, 2017, p. 54). The journalist needs to be aware of this danger and not be carried away. Opinion divergence may mean 'disagreement' (say the view of two scientists in the absence of overwhelming evidence of the airborne potential of novel coronavirus), or a 'controversy' (a long-standing rift in the scientific community, say the durability of immunological memory from COVID 19 infection or vaccination) or a 'scepticism' (as in lay meaning, that is questioning the scientific consensus, but not open to evidence, such as anti-vaxx arguments). Rice et al. (2018, p. 6) point out "former type of opinion divergence is likely to be both frequent and accurate, while the latter two would likely be misrepresentations of scientific opinion."

A grounding in the 'nature of science' would help. Latour and Woolgar (1986) suggest that the nature of scientific conclusions range from speculative conclusions (type 1) to well-accepted facts (type 5). As the knowledge evolves, as in the case of the pandemic, scientific conclusions move from type 1 to type 5 and the degree of uncertainty shifts from high to low uncertainty. In the midst of the evolving knowledge, such as the pandemic or climate change, "Type 2 or Type 3 statements in the Latour and Woolgar typology, precisely the zone where hedging, qualifiers and other linguistic strategies for the communication of uncertainty play an important role" (Kandlikar et al., 2005).

Further, journalists need to discriminate between 'technical uncertainty' and 'deficient uncertainty'. Rice et al. (2018, p. 304) warn conflating them in the media framing. For example, a journalist reporting that technical uncertainty on the side effect of vaccines (for example, estimates of the likely rate and amount of AEFI) would not be misrepresenting science. However, if it were portrayed as deficient uncertainty (for example, 'we are in the dark about the adverse effect of vaccines'), it would be a misrepresentation because studies have quantified the potential adverse effects. Studies (Smithson, 1999).

From simply communicating news about research by simplifying and reducing the complicity, the role of contemporary science journalist has expanded "performing a wider plurality of roles, including those of curator, convener, public intellectual and civic educator, in addition to more traditional journalistic roles of reporter, conduit, watchdog and agenda-setter" (Fahy & Nisbet, 2011, p. 778)[6]. In this emergent "knowledge-based journalism"(Patterson, 2013, p. 7), environmental journalists have cast aside the traditional notions of balance and replaced them with newer notions of objectivity. By implementing a transparent method, indulging in pluralistic search for consensus, and what Daston and Galison (2010, p. 314) defined as "*trained judgment*", these environmental journalist pursued a new path that avoided 'false balance' and outright advocacy (Fahy, 2018). To mitigate the ills of false balance, (Revkin, 2014, p. 157) suggests that instead of looking for the extreme ends of a spectrum of opinion, seek areas where scientists are in 'deep consensus'. Dunwoody (2005, p. 90) suggest "weight-of-evidence" reporting to not fall into the trap of manufactured doubt. Alternative or minority views are presented, along with information on where the proportion of scientific knowledge and expert opinion lies on a given issue.

The dangers of mis/dis/mal-information – infodemic co-emerging with the pandemic can be addressed to a great extent by ex-post fact-checking. Nevertheless, uncertainties inherent to science and the 'doubts' seeded by motivated groups to portray scientific opinion as 'unsettled' using 'junk science' present a challenge. The journalist needs to negotiate these uncertainties and seed doubts with a better understanding of the sources of scientific uncertainties and the varied media frames used to communicate them. The journalist must encourage the citizen's exercise of autonomy while at the same providing epistemic guidance. Scores of studies from patient autonomy in medical settings to climate change show that readers are not always averse to uncertainties; laypersons encounter various uncertainties all through their lives yet make decisions. By presenting qualified judgements and critical commentary on these judgements by experts, journalists could empower laypersons to identify choices that serve their self-defined best interests.

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6 While noting the change in the media behaviour, it is also essential to keep in mind, in today's world, media is itself a big business, and 'in essence, the media's main order of business is manufacturing attention and delivering it to advertisers'

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