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Who is "anti-science"?

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ABSTRACT

Objectives: "Anti-science" accusations are common in medicine and public health, sometimes to discredit scientists who hold opposing views. However, there is no such thing as "one science". Epistemology recognizes that any "science" is sociologically embedded, and therefore contextual and intersubjective. In this paper, we reflect on how "science" needs to adopt various perspectives to give a comprehensive and nuanced understanding of a phenomenon.
Study design: Opinion paper.
Methods: Based on a targeted literature survey, we first clarify the known limits of traditional scientific methods and then reflect on how the scientific reporting about Covid-19 mRNA vaccines has evolved.
Results: The first reports of the Covid-19 mRNA vaccines randomised controlled trial results showed impressive efficacy. Nevertheless, an abundant literature has since depicted a far more nuanced picture of the effectiveness and safety of those vaccines over the medium-term. We organise them around five themes: (i) differentiating between relative and absolute reduction; (ii) taking account of time in reporting effectiveness; (iii) taking account of all outcomes, including adverse effects; (iv) stratifying effectiveness and considering other decision criteria (efficiency, equity, and acceptance); (v) changing the outcome of concern and assessing vaccines' effectiveness on mortality.
Conclusions: Science offers a wide range of perspectives on a given study object. Only the process of deliberation amongst scientists and other stakeholders can result in accepted new knowledge useful to support decision-making. Unfortunately, by trying to reduce "science" to simple messages set in stone, scientists can become the worse enemies of science.

1. Objectives

Increasing "anti-science" has been reported [1]. Anti-science accusations have long been pervasive in medicine and public health, for example to counter the rise of "alternative medicine" movements [2]. Even within allopathic medicine, anti-science has been used to dismiss contradictory views [3]. Some argue that being anti-science reflects psychological dispositions and social contexts [4]. Anti-science trends were particularly exacerbated during Covid-19 in the United States, and reported to have originated from far-right extremism [5]. But is there really a "science" and an "anti-science"?

2. Study design and methods

This opinion paper relies on a targeted literature survey to first clarify the known limits of traditional scientific methods, and then reflect on how the scientific reporting about Covid-19 mRNA vaccines has evolved, to illustrate the wide range of perspectives that science can adopt on a given study object.

3. There is no such thing as "one science"

Science aims to understand observed phenomena [6] and achieve clarity [7]. The production of scientific knowledge involves four closely interrelated dimensions: epistemology (relationship with evidence), methods (data collection tools), ontology (nature of the world and

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possible manipulation of objects), and teleology (purpose of research). Hence there is no single way of looking at the world, there are a multitude of paradigms reflecting the complexity and interweaving of these four dimensions [8]. Even within a discipline, the same data can lead to very different results [9].

Epistemology, also known as the philosophical study of knowledge and its limits, recognizes that any "science" is sociologically embedded and therefore contextual and intersubjective [10]. Science is a methodological approach to explore questions in a knowledge domain. Thus, there is no such thing as a single "science", rather various disciplines utilise a set of formalised and systematic approaches based on continued interchange between theorising and empirical (experimental) testing of hypotheses. Although a contested concept, an important feature of any "scientific method" is that it remains dialogic, involving interchange, retesting, re-evaluating, validation, and, over time, the formation of intersubjective understanding [11].

Every discipline is associated with several research tools and approaches. Let us first note that neither medicine nor public health is a science: they both are a field of practice relying on a wide variety of evidence and research methods, particularly epidemiology and biostatistics [12]. In medical studies, the gold standard of the randomised controlled trial (RCT) is the basis of evidence-based medicine (EBM). The double-blind RCT allocates volunteers randomly to one of two (occasionally more) groups: the "treatment group" receiving the intervention, and the "control group", receiving a placebo instead. Randomisation is supposed to result in "fully similar" groups so that the outcomes can be attributed as truly being caused by the intervention. However, the treatment effect of a trial intervention is measured in terms of average changes of each group, with a wide scatter around that average value. Yet, average improvements are a poor guide to clinical decision-making for a particular patient [13]. The current dominant approach of EBM faces important criticisms and contradicts Sackett's initial design, namely that the best available evidence of research findings should be utilised in conjunction with clinical judgement and patient preferences. [14] In this light, the imposition of RCT findings to the treatment of diseases as the gold standard without also being situated in both the patient's unique context and a wider set of available evidence risks being a major over-simplification.

Questioning the results of RCTs could be labelled "anti-science" because they have been given a privileged status, negating other forms of knowledge generation [15]. This is unfortunate since many medical breakthroughs have arisen from single observations: Jenner's cowpox vaccinations, Snow's understanding of cholera propagation, or Semmelweis' handwashing to stop puerperal sepsis. Today's mainstream medical science doctrine relying on a blind application of EBM [16] would have dismissed these findings as anecdotal and thus unscientific. In terms of epistemology, precluding forms of understanding can stifle knowledge creation, even if something is currently understood as incontestable, since it foregoes the need for continued reason-giving and justification as part of any social construction of knowledge.

Since experimental methods are difficult to apply to large populations, public health relies on observational studies and mixed methodologies that often require sophisticated synthesis and theoretical analysis. Of course, the "science of using science" [17] shows that the utilisation of "science" in public health results in widely varying evidence, as any observed effect can simultaneously also be the cause for another effect [18]. Thus, in this field, there are recurring debates about the concept of evidence [19], and the determination of what "works" or is "true" often remains indeterminant and contested.

Concerningly, the moniker "science" is often exploited if it can generate an industrial profit, while a multitude of other important evidence – for instance, on social or commercial determinants of health [20–22] – is conveniently overlooked. Here, understanding the dynamics of how knowledge is socially constructed and used is crucial. This is because health interventions, and what is determined to be science, can often be captured by combinations of favoured scientific practice, pathway-dependency, vested interests, politics, louder voices, or, regarding our immediate concern, by ideational hegemonies that prohibit wider dialogic knowledge production.

4. An illustration: Covid-19 vaccines

The "anti-science" mantra has been used to refer to those people "hesitant" of vaccines [23], and particularly Covid-19 vaccines. But what does science say about Covid-19 vaccines? Below is a reflection on the "scientific reporting" of the two most widely used vaccines utilising the messenger ribonucleic acid (mRNA) platform: BNT162b2 (Pfizer-BioNTech) and mRNA-1273 (Moderna).

As for other medical commodities, the double-blind clinical trial is usually brandished as providing the most reliable scientific results regarding these vaccines, even if conducted by the pharmaceutical firms commercialising them. The results from both mRNA vaccines clinical trials were published in the New England Journal of Medicine. Pfizer published interim results on December 31, 2020, showing 95% efficacy in preventing Covid-19 [24]. A follow-up publication, published on November 4, 2021, showed 91.3% vaccine efficacy through 6 months of follow-up [25]. Moderna published interim results on February 4, 2021, showing 94.1% efficacy in preventing symptomatic Covid-19 [26]. Another publication at the completion of the blinded phase, also published on November 4, 2021, showed 93.2% vaccine efficacy in preventing Covid-19 illness [27]. None of these studies identified safety concerns. Real-life estimates of vaccine effectiveness using observational data soon followed the first waves of vaccination. The American Centers for Disease Control and Prevention announced on April 2, 2021 that primary data indicated 90% effectiveness against SARS-CoV-2 infection for both mRNA vaccines [28]. An analysis of the first four months of vaccination campaign in Israel, published on May 5, 2021, estimated the Pfizer vaccine effectiveness after 7 days of second dose to be between 91.5% for asymptomatic infection and 97.5% against severe or critical Covid-19-related hospitalisation [29]. These encouraging results comforted the idea that these vaccines were "miraculous" [30], even while notifications of breakthrough infections started to be reported by the end of the first half of 2021 [31].

However, science is not about miracles, and scientific evidence of efficacy does not equate to effectiveness and broader impacts. Science is about questioning facts and depicting the whole complexity of the natural and social worlds. Let us adopt a broader look at the mRNA Covid-19 vaccines. First, let us note that the design of the "gold standard" clinical studies referenced above was questioned from the start – notably due to the choice of their outcome(s) of concern, that is the indicator(s) measured to assess effectiveness: in this case, symptomatic infection, which is different to measuring severity of or mortality from the disease [32,33]. Later on, the quality of the data of the Pfizer trial was also questioned, notably due to suspicion of data falsification, unblinding of patients, and lack of controls [34]. These two concerns should have reduced the faith in the "95% efficacy" claims made from the trials and opened a debate amongst scientists and decision-makers. This did not widely occur at the time, nor did it question the choice of mass vaccination strategies as the only exit strategy from Covid-19 [35].

Nevertheless, an abundant literature has since depicted a far more nuanced picture of the effectiveness and safety of those vaccines over the medium-term, as summarised below.

First, science – through the clinical trials of mRNA vaccines – showed efficacy above 90% (see above). Yet, this is calculated in terms of relative risk reduction – that is, the percentage of reduction in adverse outcomes between the vaccinated and the unvaccinated. However, "the most useful way of presenting research results to help your decision-making" [36] is absolute risk reduction – that is, actual difference in risk between two groups. When calculating Covid-19 vaccines' absolute risk reduction based on the same reported outcome data, it is far less convincing – 1.2% for the Moderna and 0.84% for the Pfizer vaccine [37].

Second, science – through observational data – showed that a third dose of the Pfizer vaccine was 93% (relative) effective against admission to hospital, 92% (relative) effective against severe disease, and 81% (relative) effective against COVID-19-related death. Of note, these results were found after a median follow-up time of only 13 days [38] which is a clinically meaningless timeframe, being a short-term outcome irrelevant to policymaking, and even if "true", pragmatically impossible to apply as it would require vaccination twice a month.

Third, science – based on the individual clinical trials – showed a good safety profile of Covid-19 mRNA vaccines [25,27]. However, a re-examination of pooled safety data to get more statistical power, showed that the mRNA vaccines were associated with an excess risk of "serious adverse events of special interest" (as defined by the Brighton Collaboration [39]) of 12.5 per 10,000 vaccinated – that is, one in every 800 vaccinated [40]. Such an adverse event rate must be contextualised in relation to risk-benefit estimates, which we regard as an imperative from a research and policy ethics perspective.

Fourth, even with increasingly reported waning effectiveness, science suggests that the Covid-19 vaccines remain effective in preventing severe Covid-19 among at-risk populations [41–45]. Yet, science – in a risk-benefit analysis – also showed that adolescents do not benefit from the Pfizer vaccine, except for non-immune girls with comorbidities [46]. Unstratified effectiveness measured by only a single performance measure, should not be the only criterium to inform clinical and policy decision-making, equally important are considerations of efficiency, equity, and acceptance.

Fifth, while the clinical trials were not designed to evaluate the vaccine's effect on mortality, a systematic review of observational data showed an effect of the vaccines reducing "Covid-19 related death" [47]. Yet, the Pfizer study's supplementary material shows there was one more death ("overall mortality") in the vaccine than placebo group [25, 48]. Albeit a statistically insignificant result, hiding this finding is not "responsible conduct of research" [49], nor ethically defensible. It indeed may damage the trustworthiness of science, given that the pooled mRNA trial results showed a statistically significant relative "all cause" risk increase for mRNA vaccination (hazard ratio 1.03) [50].

Scientific findings will always be questioned, but one avoidable critique relates to the skewed reporting of study findings, like relative rather than absolute effectiveness, which is misleading, and indeed a form of "anti-science". As suggested above, scientific method is a means to gaining new knowledge, not truth. Of note, scientific approaches only produce data. It is the process of deliberation amongst scientists (and other stakeholders) [51] that results in accepted new knowledge, which ultimately will be modified by future findings. Only the application of the best available knowledge can lead to "wise decision-making" [52], particularly when facilitated within democratic procedures. In sociological terms, this form of decision-making can better mirror our perceived "lifeworld", thus enhancing mutual social understanding by better capturing shared experience and collective problem solving [10].

Rather than uncritically continuing to perpetuate the "follow the science" vs "anti-science" dichotomy, let us all look in the mirror and reflect what really constitutes science. If nothing else, this involves the curiosity of deliberating the multiple perspectives arising from the different lenses of inquiry. Being open-minded and critical does not immediately equate to being "anti-science", as some medical and political thought leaders want us to believe.

5. Conclusion

By trying to reduce "science" – which, by definition, explores doubts, complexity, and is in constant evolution – to simple messages set in stone, scientists can become the worse enemies of science. The independence of science should be paramount, however, the pervasive influence of political expediency, industrial interests and corruption in healthcare and medicine does not serve its inquiries [53,54]. To regain public trust in science, it is high time scientists acknowledge the limitations of their methods and of their results, and to provide decision-makers, populations and healthcare providers with appropriate tools to judge how to best apply particular research results to individuals and communities. Science can never provide insights that allow the imposition of a universal blueprint to all [18]. What it requires is reinvigorated commitments to deliberative science and politics, democratic procedures, open contestation without epithets, genuine reason-giving, and, most importantly, humility.

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Competing interests

The authors have no competing interest to declare.

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