Pseudoscience in medicine: cautionary recommendations

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Abstract

Introduction: Certain real life applications of scientific and social science ideas that knowingly reject accumulated empirical biomedical evidence have been termed 'pseudoscience,' or empirical rejectionism. An uncritical acceptance of empiricism, or even of evidence-based medicine, however, can also be problematic.

Objectives: With reference to a specific type of medical denialism associated with moral failure, justified by dissident AIDS and anti-vaccine scientific publications, this paper seeks to make the argument that this type of denialism meets certain longstanding definitions for classification as pseudoscience.

Methods: This paper uses a conceptual framework to make certain arguments and to juxtapose arguments for evidence-based approaches to medicine against literature that highlights certain limitations of an unquestioning approach to empiricism.

Results: Discussions of certain real life examples are used to derive the important insight that, under certain conditions, moral failure can result in the violation both Type I and Type II scientific error types, with catastrophic consequences.

Conclusion: It is argued that the validity of all theory should not be assumed before sufficient empirical evidence has accumulated to support its validity across contexts. However, caution is required, to avoid the consequences of an unquestioning approach to empiricism.

Keywords: Pseudoscience; denialism; medical practice; medical theory; empiricism.

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Introduction

Certain emergent problems with potentially catastrophic consequences require medical responses in a matter of hours, or days. Examples of these include outbreaks of Zika[1], Ebola[2], Lassa[3], Middle East Respiratory Syndrome (MERS-CoV)[4], swine flu/H1N1[5], or rapidly increasing global antibiotic resistance[6]. To meet these challenges, healthcare professionals require up to date scientific knowledge. It is not enough that this knowledge is up to date. It also needs to be scientifically rigorous. A reliance on empirical evidence and rigor, however, should not be confounded with a dogmatic faith in empiricism itself, which can also be problematic[7-9]. In light of this tension, between a need for a pragmatic approach to evidence-based medicine (EBM), and the dangers of an uncritical acceptance of EBM, amidst uncertainties associated with its shortcomings, this paper seeks to provide a discussion of these issues, and to derive cautionary recommendations for those exposed to these same issues.

In doing so,dissident examples of AIDS[10,11] and vaccine denialism[12-18] are employed as an interpretive schema, or lens, through which to view events that link dissident perspectives in scientific publication to harmful outcomes. Such an approach offers a useful heuristic in order to highlight a certain type of harmful use of science, which, according to established literature[19], has previously been categorised as 'pseudoscience.' These examples are taken to represent pseudoscience in medicine, which is defined here as scientific denialism associated with moral failure, justifying itself in terms of dissident scientific publication in order to advance agendas with the potential to do medical harm to human populations. According to Kuhn[20], [with the exception of extraordinary problems] the "three classes of problems-determination of significant fact, matching of facts with theory, and articulation of theory-exhaust, I think, the literature of normal science, both empirical and theoretical (p.34)." Medical pseudoscience, as discussed here, falls outside of Kuhn's classes of problem.

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This definition of medical pseudoscience is derived here,specifically, from two examples. The first relates to the moral failure on the part of a government, associated with AIDS denialism, which justified its medically harmfulactions at the time on the basis of certain dissident scientific publications[11]. The policy stance in this case persisted, for years, after the emergence of evidence of the large scale loss of human life caused by these actions. The second example relates to the emergence of the anti-vaccination movement, based on the publication of two scientific papers in particular[12,13], which mooted a causal relationship between measles-mumps-rubella (MMR) vaccination and autism. This movement has also been linked to an increase in fatalities due to non-vaccination[18].

Through the use of a heuristic, in the form of the interpretive schema offered by these two examples, a textured discussion of the dangers of medical pseudoscience is provided here. The problems of dogmatic empiricism are also, however, highlighted, to demonstrate the pervasiveness of medical pseudoscience as a problem that cannot be simplistically argued away with reference to notions of scientific evidence.

In light of the problem of medical pseudoscience, the objective of this paper is to inform those potentially affected by the phenomena discussed here, and to provide cautionary insights on the basis of a considered engagement with the literature. Given recent literature that highlights the vulnerability of the scientific publication process to political and ideological agendas[21], it is important to note, up front, that science itself is also subject to agendas of power[20,22,23], and that an empirical approach to solving these problems of medical denialism cannot also be considered to be value free or more just than other, non-empirical approaches.

Indeed, although some have argued that political conservatives in the US have been prone to deny scientific evidence related to climate change, recent evidence finds that scientific denialism may characterise those both on the left and the right of the political spectrum[21]. If no political denomination at this time has a monopoly on dissident, or anti-science, discourse, the arguments made in this paper are perhaps timely, and serve to provide cautionary insights, particularly for those at the nexus of ideological and political forces, where scientific work, and particularly empirical findings, might be vulnerable to immoral misrepresentation. It is argued here that the use of the term pseudoscience, albeit uncomfortable, might therefore be useful (or even necessary), in that such uncomfortable debates may be to the benefit of those most vulnerable and powerless in the face of medical need.

The paper proceeds as follows. The need for a cautionary perspective on empiricism is first introduced. To further contextualise the discussions, the topic of medical nihilism is then also introduced. Certain challenges associated with the notion of consensus are then considered, and discrepancies between published recommendations and clinical practice are then discussed. Finally, consideration of the topics of medical denialism and academic pseudoscience round off the paper, and the conclusion section summarises its objective and its key arguments.

The need for a cautionary perspective on empiricism

Unwarranted faith in empiricism can amount to little more than dogma. It must be acknowledged that here is little in the way of evidence to date that demonstrates that an empirical approach can eliminate the dangers inherent in human interpretation and subjectivity. The pervasiveness of medical denialism[14-18], and well-known historical cases, such as the rejection of Semmelweiss's empirical evidence of how to reduce infections in surgicalprocedures24, seem to highlight this problem. The discussions of medical pseudoscience undertaken here therefore need to be grounded in an acknowledgement of the limitations of empiricism itself. The problem of medical nihilism, according to Poland[17], highlights seemingly insoluble problems associated withhuman choices to believe or disbelieve medical evidence.

Medical nihilism

An important debatein the literature relates to discussions of medical nihilism. The McKeown Thesis derives from McKeown's argument that in certain contexts the fall in the crude mortality rate over time was largely "due not to life-saving advancements in the field of medicine or public health, but instead to improvements in overall standards of living (p.725)," and especially those related to advances in nutrition that resulted from improved economic conditions[25]. Debates about McKeown's thesis have persisted in light of the question, are "public health ends better served by targeted interventions or by broad-based efforts to redistribute the social, political, and economic resources that determine the health of populations? (p.725)"[25].

The McKeown thesis has, however, led to what some have termed medical health nihilism[26], whereby some (perhaps "an entire generation of social scientists, historians, and policymakers") have considered the contributions of economics and nutrition to overshadow the role of public health interventions (p.1014)[27]. While some, for example, have questioned the provision of treatment for multi-drug resistant tuberculosis,in certain contexts, in that it may not be cost effective, Farmer and Nardell[27] stress that it is important to avoid the trap of medical health nihilism, in that even though poverty and inequality persist, it is necessary to, nevertheless, "move forward with focused interventions and insist on universal access to high-quality TB care (p1015)."

Problematic consensus

Consensus about medical phenomena, can, however, be problematic under certain conditions. According to social empiricism, consensus is typically epistemologically undesirable (Solomon, 2001). Dissent is valuable, even when there is no discussion (because deliberation can sometimes "make things worse rather than better"), as it does not require discussion to make it valuable, as originally argued by the likes of Mill, Popper and Longino (p.38)[7].

An over-reliance on the dogma of empiricism might therefore open scientific endeavour up to the shortcomings of problematic forms of consensus. EBM, based on the work of clinical epidemiologists in the 1970s and 1980s, emerged as a "new paradigm" at the start of the 1990s, associated with methods such as randomised controlled trials, systematic reviews, and meta-analyses, which produced "an extensive and powerful body of research (p.451)"[9]. Relying heavily on statistics, probability theory and utility theory provide EBM with its conceptual underpinnings. With its hierarchy of evidence, EBM takes its epistemic techniques as superior to traditional methods such as expert opinion, clinical experience, and physiological reasoning. This stance has not gone unchallenged, however.

Indeed, Solomon[9] stresses that EBM has been described as a Kuhnian paradigm, and that it has been criticised in terms of its procedural aspects[28,29], in terms of its fallibility, or its lack of replicability[30], and its incompleteness as a philosophy of science. In terms of the latter, there has been a persistent criticism of EBM that it ignores the basic sciences that inform research and clinical practice, whereby it is "scientifically superficial: it measures correlations," failing to "theorize about the complete organism, still less the complete organism in its social and environmental context (p.462)"[9].

Further, according to Solomon[9], literature suggests that "publication bias, time to publication bias and pharmaceutical funding bias (which subtly affects trial design and evaluation) are responsible for the worse-than-expected track record" of random controlled trials, systematic reviews, and meta-analyses (p.460). Considering these criticisms, Solomon suggests an instrumental, or pragmatic approach, whereby evidence should be ranked with reference to actual (and not theoretically expected) reliability of results.

According to Solomon[9], with the "recent emphasis on translational medicine, we are seeing a restoration of the recognition that clinical research requires an engagement with basic theory (e.g. physiological, genetic, biochemical) and a range of empirical techniques," in that EBM "works best when used in this context (p.460)." Translational medicine seeks to develop interdisciplinary synergies between researchers, and to create interactive linkages between basic science research and research in clinical medicine. Translational medicine might ultimately hold the key to reducing problems associated with discrepancies between published recommendations and clinical practices.

Discrepancies between published recommendations and clinical practices

Much work in other fields draws on precedent in medical research, in order to follow a systematic process, so as to develop evidence-informed knowledge[31]. Thus medical science is acknowledged to lead the way in evidence-based research, notwithstanding the problems associated with dogmatic approaches to empiricism.

Research on medical practice patterns has revealed a discrepancy between "published recommendations and clinical practices"[32]. According to Bryg and Johns[32]:

The emotional appeal of interventional therapy is often so strong that rational thought is denied…Physicians and patients often feel better trying "something" rather than waiting; interventional procedures are powerful and seductive for those seeking action….Many different factors can be given to explain differences between clinical practices and recommendations based on controlled trials. The current efforts to address the medicolegal system and remuneration may not be enough. To change the "art' of medicine through the "science' of randomized

trials, attention to all of these issues is needed to change practice patterns and help us "practice what we preach (p.1309)."

Seminal theory also points to how discrepancies between published recommendations and clinical practices. The seminal work of Kuhn[20] predicts that paradigmatic change can occur in scientific research, but that researchers typically reject novel facts that do not conform to the assumptions and values associated with a particular paradigm. In light of the potential consequences of pseudoscience, this paper seeks to explore the central tenet of Kuhn's work, that advances in science are subject to changes in human values systems and not only to the objective advances of science itself, in relation to examples of how evidence can be ignored, at great human cost. By making these relationships explicit, we might be less likely to repeat the mistakes of the past.

Kuhn's theory suggests that advances in science are essentially a function of how the values and beliefs of scientists in fields change, whereby in 'normal science' fields will typically resist paradigmatic change in the face of contrary evidence, until eventually a tipping point is reached, and sets of values and beliefs then change to accommodate the new paradigm. Kuhn's theory can be used to draw useful inferences, particularly when applied to the phenomenon of 'pseudoscience' and its potentially harmful influence.

As discussed, a powerful example of Kuhn's theory in the medical context is the work of Semmelweiss. The case of Semmelweiss[24] illustrates how professionals can reject innovative ideas even in the face of evidence of the catastrophic human costs associated with this rejection. Semmelweiss, a doctor in the 1800s, demonstrated dramatically lower surgical mortality rates due to handwashing using a chloride of lime solution. Even after providing evidence of this life saving process, his ideas were rejected. It was only two decades later that his work was revisited by the medical profession[24], and the 'new paradigm' of sterile hand washing was embraced.

Other seminal work, for example by Lakatos[33] also stresses the subjectivity of the research process, as fields like Newtonian Physics were shown to have rejected novel facts that challenged the 'hard core,' or fundamental tenets of the field. This work can also be taken to support Kuhn's arguments that it cannot always be assumed that objective evidence will be the basis for how scientific decisions are made.

There are other examples of Kuhn's theory at work in the social sciences. Events such as the Sokal affair, orSokal hoax[34] have highlighted the vulnerability of the academy to empirical rejectionism, or rejection of evidence-based approaches in academic or scientific research, or pseudoscience. Still and Dryden[35] suggest two types of pseudoscience, one related to academic fields entailing deep engagement with some kind of academic process, termed 'big' pseudoscience, and one related to 'erroneous' public beliefs, with less of a deep engagement in academia, but often with a tenacious grip on the beliefs of many within populations. A core argument presented in this paper is that, as predicted by Kuhn's theory, professional medical work, including policymaking, requires constant vigilance on the part of medical professionals so as to avoid the influence of pseudoscience.

Pseudoscience in the form of medical denialism

The examples of AIDS and vaccine denialism might be a useful interpretive schema, or lens, through which to view events that link dissident perspectives in scientific publication to harmful outcomes. As stressed previously, science is also an agenda of power[20,22,23], and an empirical approach to solving these problems of medical denialism therefore cannot also be considered to be value free or more just than other, non-empirical approaches.

Nattrass[11] summarises certain catastrophic events at the nexus of pseudoscience, political power, and moral failure on a national scale:

AIDS policy in post-apartheid South Africa has been shaped by persistent antipathy towards antiretroviral drugs (ARVs). This hostility was framed initially by [the president's] questioning of AIDS science and subsequently by direct resistance to implementing prevention and treatment programmes using ARVs. Once that battle was lost in the courts and in the political arena, the health minister [at the time] continued to portray ARVs as 'poison' and to support alternative untested therapies. Demographic modelling suggests that if the national government had used ARVs for prevention and treatment at the same rate as the Western Cape (which defined national policy on ARVs), then about 171,000 HIV infections and 343,000 deaths could have been prevented between 1999 and 2007. Two key scientific bodies, the Medicines Control Council (MCC) and the Medical Research Council (MRC) fall under the ambit of the national Department of Health. Although notionally independent, both have experienced political interference as a consequence of their scientific approach towards AIDS (p.157).

This example is illustrative, offering useful insights into a paradoxical situation of power misuse that led to the deaths of many who were the most vulnerable and powerless. This paradox seems to mirror the anti-science discourse driven by politicians in current political discourse, whether relating to the denial of climate change, or the selective use of science in support of political agendas (for a useful summary of these current issues, see Washburn and Skitka[21]). Given the hundreds of thousands that may have died due to the amoral implementation of political ideology in the case of South Africa, describing this using the term 'medical pseudoscience' is perhaps necessary (uncomfortable as the term may be to the academic ear), so as to not do disservice to those that have perished due to the application of this particular type of scientific denialism. Indeed, it would seem that such events pass out of consideration relatively quickly, both by the public and by academic discussions. Those involved in this perpetration live on, with little in the way of accountability. This example seems to illustrate a unique form of pseudoscience, which bears classification as such, and the development of its own stream of literature.Exploring this paradox is useful, as it can offer insights into tensions between science and agendas of power. Further exploration of this example offers more detailed insights into the harm that pseudoscience can cause.

The use of this particular example might also serve to highlight the differences between pseudoscience and discourse that highlights legitimate criticisms of evidence-based approaches to medicine. This particular form of pseudoscience is taken here to relate to the power relationships of political actors and the prioritisation of ideology, in such a way as to actively engage in empirical rejectionism, at the expense of the most vulnerable and powerless in a society.

An important lesson can be learned from these events. This large scale loss of human life was found to be due to scientific denialism on the part of certain respected academics. According to Nattrass[11] the cause can be traced back to the publication of scientific research, as accomplished (highly respected at the time) academics argued that AZT itself caused AIDS rather than treating or preventing it. An example of the link between these events and scientific publication is Duesberg's[10]. Denialist members of the Presidential AIDS Advisory panel (half orthodox scientists, half AIDS denialists) asserted that "AIDS would disappear instantaneously if all HIV testing was outlawed and the use of antiretroviral drugs was terminated (p.162)[11]. Another example of this type of pseudoscience, in the form of medical denialism, or empirical rejectionism, is the spread of the anti-vaccine movement. The link between dissident academic publication and the rise of the pseudoscientific anti-vaccine movement is also seen in the emergence of the populist anti-vaccine movement, which advocated halting MMR immunisation[18]. This example of vaccine nihilism, according to Poland[17], highlights the problem that "there are no magical solutions to the deep divide between those who accept the scientific method and evidence and those who do not and simply choose to disbelieve the evidence (p.1)." This movement emerged on account of scientific publications that put forth the thesis that MMR vaccine was linked with the development of autism[12,13]. This example also serves to highlight the dangers of denialism, and its potential human costs[14-16].

Policy applications of pseudoscientific ideas and ideologies, including economic ideas, and the human costs of these are beyond the scope of this work, but further study of examples like this by further research might be instructive. This example clearly highlights Kuhn's[20] predictions, challenging assumptions that empirical rejectionist behaviour is necessarily benign.

Resistance to scientific thought itself has a long history. Contestations between empirical rejectionist belief systems and science, and the catastrophic costs in human life caused by belief-system resistance to science throughout history is well documented[38]. Following Kuhn[20], a condition for scientific advancement seems to be its coincidental alignment or convenient instrumental value for powerful agendas. In contrast to South African AIDS denialism in the context of a developing nation, the anti-vaccine movement serves as a cautionary tale about the pervasiveness of pseudoscientific beliefs in developed nations. Academic literature on pseudoscience may offer further insights into these discussions.

Academic pseudoscience

Seeking to define prevalence of pseudoscience in the psychology discipline, Lilienfeld[19] suggests that academics follow Bunge's seven 'indicators of pseudoscience' for guidance. These include: (i) overuse of ad hoc hypotheses to avoid refutation, (ii) emphasising confirmation, above refutation, (iii) lack of self-correction, (iv) reversed burden of proof, (v) excessive reliance on testimonial and anecdotal evidence, (vi) use of obscurantist language, and (7) lack of connectivity with other disciplines. The use of science to justify the objectives of the AIDS denialist

state, and the objectives of the anti-vaccine movement are considered to warrant the term 'pseudoscience' as they seem to meet these criteria. More than this, these examples offer examples of moral failure that seem to require differentiation from other instances of conflict with empiricism.

Thus, it is arguably useful to differentiate these examples by using the term pseudoscience, so as not to confound their discussion with broader debates on empiricism itself. It is therefore important to provide an informed discussion that embraces these broader debates, and which locates these two examples of a specific form of pseudoscience in relation to debates on empiricism, and the weaknesses of dogmatic empiricism as a potential remedy for the problem of denialist pseudoscience. To understand the real threats of pseudoscience it is perhaps necessary to return to first principles.

An example of this kind of 'first principle' can perhaps be found in the doctrine 'do no harm.' With reference to the field of psychology, which has no equivalent of the Food and Drug Administration's (FDA's) oversight function, Lilienfeld[19] stresses the importance of the medical and mental health professions' credo primum non nocere, or 'first, do no harm.' The harm associated with pseudoscience is well illustrated in light of the examples considered above.

The tensions between unlimited thought in academic contexts (which are good) and opportunistic use of ideas for political or ideological reasons that are largely inseparable from issues of power use and abuse, which can lead to loss of human life (which are bad) are not independent of real life contexts informed by medical science. A conceptual framework is needed in order to better understand these tensions.

According to Solomon[7], from "the work of historians of science, sociologists of science, anthropologists of science, feminist critics, social psychologists and decision analysts, we now know much more about the variety and pervasiveness of bias," whereby no one "has designed a group (or individual) scientific practice in which bias is eliminated, or even reduced to insignificant levels (p.169)." Solomon's[7] work has sought to offer scientists a heuristic based on decision vectors, or the decisions that are made to accept one theory over another, particularly when both offer overlapping predictions about phenomena, or where both seem to fit the available data. These decision vectors can be based on empirical data or conceptual rationales.

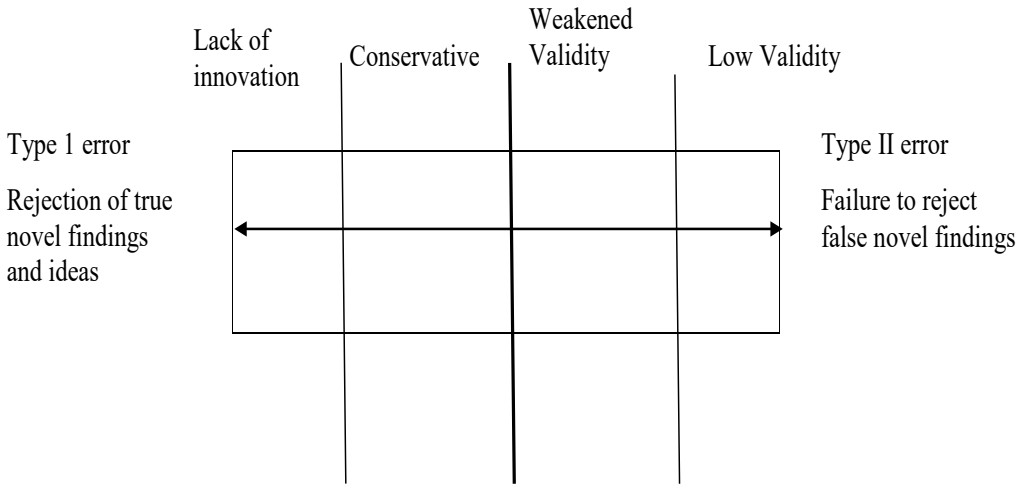

Figure 1. Modes of biomedical error thresholds

Arguably, the wellspring for most pseudoscientific ideas has been academia. As well it is expected to be, given academic freedom and the role of the academy in generating all types of ideas, without limit. How do we then differentiate theory from recommendations for healthcare practice? Figure 1 offers a model, with the hope that it might be a useful heuristic for understanding the tensions between the two scientific error states, namely between making a Type 1 error of rejecting a true novel finding, versus making a Type II error of failing to reject false novel findings. These representations acknowledge the criticisms of empiricism highlighted in previous sections, and relate only to discussions of the tensions between theorising and empirically testing theory.

In health sciences research, the centre line (in bold) shown in Figure 1 represents the optimal state, where the types of errors are balanced. This, in many studies, is put at the 95% confidence threshold, where statistical testing is at the five percent level of significance. As we know, however, this value is arbitrary, as increasing the size of a sample can increase the chances of obtaining a significant effect. A health science practitioner or researcher, however, needs to navigate between modes in different roles. As a theorist, one might need to be open to all ideas, and to consider all potentialities. To theorise innovatively, one would need to sacrifice validity temporarily, to develop models that can then be tested for validity.

Dissident theory that predicted that HIV was caused by ARVs, for example, is an example falling into the low validity portion of the continuum shown in Figure 1. However, so should all health theory that has not been empirically tested, in some way. This example is useful as a special case, however, in that it represents the extreme of Type 1 error, whereby these scientists rejected accumulated evidence that clearly supported the use of ARVs. A Type II error, however, is also evident, in that there was a failure to reject theory that was patently at odds with the accumulated evidence to date. The model shown in Figure 1 is only useful in that it identifies problems related to validity versus problems related to conservatism and lack of innovation, but it does not show that at the extremes, both the violation of Type 1 and Type II errors can converge. The example of AIDS denialism illustrates that it is important for a healthcare practitioner to understand that there is not simply one continuum of error that can be made, but that both kinds of errors can mirror each other at the extreme.

Whereas many have discussed the example of Semmelweiss[24], this instance of a Type I error has seemingly not to date been considered in relation to an example of the coincidence of Type 1 and II. This is however evident in a government's refusal to allow treatment of HIV victims with ARVs on the basis of theory developed by respected academics. Similarly, while seminal theory byLakatos (1970) also stresses how core tenets of fields can reject new knowledge, this theory also relates primarily to Type 1 errors, as does Kuhn's[20] seminal work. The Sokal hoax[34] highlights the potential for theory to be published by respected journals, but which was specifically formulated on the basis of confounding logics. Further research should differentiate between extreme forms of Type I and Type II error violation. The two forms of pseudoscience discussed here might be taken to exhibit characteristics of these extremes, and that such a characterisation might be useful in differentiating them from other forms of medical denialism.

A contribution of this paperis arguably in the way it identifies and highlights dangers associated with the way that both Type I and Type II errors can actually be committed under certain circumstances. At these extremes, a phenomenon is identified, termed medical pseudoscience, a relatively unique form of pseudoscience that takes the form of extreme denialism, but which is vulnerable to those with political agendas or other motives associated with moral failure. Knowledge of this categorisation is arguably important, particularly when healthcare providers and policy makers can be lulled into a false sense of security in deriving policy or practice from dogmatic perspectives of empiricism that do not acknowledge the shortcomings of empiricism, or EBM itself. Certain conclusions and recommendations that derive from this analysis are now presented.

Conclusion

The objective of this paper was to provide a discussion of the dangers of medical pseudoscience, which might be particularly relevant in a global context wherein anti-science, or dissident and denialist discourse, seems to alsobe driven by political forces, making such discourse vulnerable to agendas associated with moral failure.

It is concluded that taking recourse to unquestioning approaches of empiricism may however also be wrongheaded. Instead, the approach of Solomon[7-9] is recommended, one of cautious pragmatism. More specifically, evidence should be ranked with reference to actual (and not theo-

retically expected) reliability of results[9]. Thus, threats associated with medical nihilism might be mitigated, pragmatically, to reduce harm.

In extending debates about dissident and denialist medical discourse, this work sought to build on other, related, work. Such work includes research that highlighting the dangers of inflexible and slow responses to epidemics[37], a lack of an adequate bioethical response to novel discoveries[38], constraints posed by human values to scientific progress itself[39], and changes to the scientific discovery process on account of emergent technologies[40,41]. This work also sought to extend discussions of empiricism to embrace issues associated with medical pseudoscience.

It is also concluded that these examples of medical pseudoscience might benefit from further research that conceptualises them as extreme forms of the violation of Type 1 and Type II errors, whereby at the extremes, such phenomena share epistemic similarities.

In conclusion, much hope rests on the promise of translational medicine[9], and its potential to address certain of the shortcomings of empiricism through a more interdisciplinary and pluralistic approach to both the methodological and theory-development processes of medical science. Going forward, however, epistemic caution may be an important watchword in a world in which political forces may increasingly have the power to harnessscientific and medical denialism in pursuit of ideological agendas.

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