# Medical Progress: Science versus Practice

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**Abstract:** In recent years, notable figures within the medical community have expressed concerns about the rate of medical progress, suggesting that the rapid advances of medicine's 'golden age' are now giving way to an 'age of disappointment'. While these pessimistic pronouncements about medical progress must–implicitly if not explicitly–appeal to some criteria for what medical progress would be, the task of explicitly defining medical progress has been notably neglected. We take up this task, drawing on insights from the philosophy of science concerning both scientific progress and the aims of medicine. Among other things, we differentiate between *medical scientific progress* and *progress in medical practice*, and suggest that this distinction helps to evaluate the aforementioned concerns about the current rate of medical progress. While it is not our goal to draw conclusions relating to the state of medicine at the present time, we propose a unifying account of medical scientific progress according to which such progress leads, necessarily, to progress in medical practice, and show how this account both plausibly distinguishes between medical scientific progress and other (non-medical) instances of scientific progress, and does justice to the 'dual character' of medicine.

## 1. Introduction

Heralded as the "golden age of medicine", mid-twentieth century medicine is frequently characterised in terms of remarkable progress (Le Fanu 2012: 5-188; Porter 1997). While the significant contributions of non-medical factors, such as improved living standards, to overall health improvements, have often been underestimated (e.g., McKeown 1976; Kaplan and Milstein 2019), some progress in the mid-twentieth century is evident: backed by advances in both diagnostic and treatment techniques, once-lethal conditions like septicemia, pneumonia, and meningitis became treatable or preventable, insulin emerged as a pivotal treatment for type 1

diabetes, and so on (Porter 2002). As O'Mahoney (2020: 245) puts it, "the white coat was a vestige of the golden age, associated with professional competence, scientific progress."

Today, the once widespread confidence in the inexorable progress of medicine is waning. Notable figures within the medical community have expressed pessimism regarding our ability to sustain the previously robust momentum of progress. Indeed, it has been suggested that the golden age is giving way to what has been dubbed the "age of disappointment" (O'Mahony 2019, 2020).

To motivate this pessimism about our capacity to maintain the rate of progress achieved in the 'golden age', sceptics have pointed to a variety of different concerns. Some argue that the replication crisis (Baker 2016) presents a significant challenge to our understanding of medical phenomena and that substantial changes to our research practices are necessary (Munafò et al. 2017; Williams 2015; Begley & Ellis 2012). Other worries concern the institutional and financial structures within which medical research occurs. For instance, the pharmaceutical companies which fund and conduct much of present day medical research have a conflict of interest between maximising return for their shareholders and producing affordable medicines (see e.g., Stegenga 2018). Similarly, the economic motivation to engage in revenue-raising medical research into treatments for overmedicalised conditions has resulted in new research doing little to improve medical care or people's quality of life (Brown 2015). As O'Mahoney (2020: 323) describes it, "at present, medical 'progress' gives us the dubious and ruinously expensive gift of helping us to survive long enough to experience loss of independence and chronic disease." Related to both these concerns is the thought that all medical progress so far is the result of harvesting all the low-hanging fruit, in the form of 'magic bullet' medications (Stegenga 2018). With all such fruit harvested, progress has slowed, if not stalled. Finally, pessimists have expressed concern that many chronic conditions are proving resistant to the development of effective treatments (Callahan 2013; Le Fanu 2012).[1]

Importantly, in arguing from observations regarding recent medical developments to a pessimistic view about progress in medicine, one must, tacitly or explicitly, appeal to some account of *what it would take* for there to be progress–and more or less thereof–in medicine. However, those voicing these worries are not entirely clear about what they take progress in medicine to consist in, despite calls for us to reorient medicine and "devise a fresh concept of medical progress"

[1] Going even further, an anonymous referee worried that the history of medicine features not only fluctuations in the rate of progress, but also sustained periods of *regress*. We briefly return to the issue of regress in section 4.

(Callahan 2013: 41). Given that we cannot judge whether progress in medicine has slowed or stopped without first determining what progress in medicine would be, it is surprising that this latter question has received such little attention.

This paper seeks to remedy this lacuna. We propose a unifying account that distinguishes between *medical scientific progress* and *progress in medical practice*, but nevertheless posits a tight connection between the two. The account draws upon resources from the philosophy of science, in which there has been a sustained debate about the nature of scientific progress (for overviews see Dellsén 2018; Niiniluoto 2019). By developing such an account, we hope to advance the conversation about how much progress there is in medicine. Moreover, we believe that theorising about the nature of progress in medicine will assist in informing critical research decisions, such as those regarding the methods we ought to use in medical science, and which medical research is most deserving of our limited intellectual, financial and material resources.

In §2, we review the long-standing debate about the nature of scientific progress, identifying resources upon which our account will draw. In §3, we suggest that the most promising account with which to capture the nature of *medical* scientific progress is one on which understanding takes centre stage, as per the 'noetic' account of scientific progress (Dellsén 2016; 2021). We go on to develop this account with an eye towards doing justice to the so-called 'dual character', or 'twofold aims' of medicine. To this end, we spell out the aforementioned distinction between medical scientific progress, on the one hand, and progress in medical practice, on the other. However, we also propose that the two are intimately related, roughly in that a given instance of scientific progress only counts as *medical* scientific progress if it leads to progress in medical practice. In §4, we spell out the latter notion of progress in medical practice, drawing attention to various cases in which medical scientific progress comes apart from progress in medical practice in order to further clarify how these kinds of progress are related. Finally, in §5, we conclude by returning to the issue of how much progress we have seen in medicine, both historically and recently, and suggest that our discussion sheds important light on this important debate.

## 2. Scientific Progress

While it is widely agreed that science makes progress, perhaps more so than any other human endeavour (see, e.g., Sarton 1936: 5; Kuhn 1970: 160), there has been an enduring and trenchant debate in the philosophy of science regarding precisely what constitutes scientific progress. Here

we will outline some useful distinctions and conceptual apparatus that have emerged in the course of this debate, as well as four of the leading accounts on offer.

Before launching into the theoretical background, let's briefly consider an illustrative example by looking at a potted history of the development of scientific thought about the nature of light (Buchwald 1989). A prominent early example is Newton's corpuscular theory, developed in the 17th century, which proposed that light was made from tiny corpuscles which moved only in straight lines. Around the same time, Huygens proposed a wave theory, according to which light consists of waves spreading through an all-pervading 'ether'. Both corpuscular and wave theories could explain that light reflects and refracts, but only wave theories could also explain diffraction and interference. Two centuries later, Maxwell developed an electromagnetic theory, according to which light is an electromagnetic wave, while contemporary quantum theories of light propose the existence of photons which exhibit both particle-like and wave-like properties.

As a useful foil for more plausible accounts of scientific progress to be discussed below, consider first a deliberately naïve view according to which science makes progress via the proposal and ensuing acceptance of entirely true theories (Dellsén 2018; Niinilouto 2019). Since we have good reason to think that Newton's, Huygens' and Maxwell's theories are all strictly speaking false, such a view would judge that science made no progress investigating the nature of light before the 20th century. Clearly, though, this judgement is mistaken; something has gone awry. The account has failed to recognise that there can be a succession of theories, each of which is strictly speaking false, and yet each of which is in a significant sense an *improvement* over its predecessor. The accounts of scientific progress outlined below are all attempts to cash out precisely the significant sense of improvement at play in our judgement that we can make scientific progress about the nature of some phenomenon without yet having developed an entirely true theory of that phenomenon.

Requiring that our investigations have yielded the truth about some phenomenon in order for there to be progress therefore seems too demanding.[2] On the other hand, mere *change* in our theorising about said phenomenon does not seem sufficient for there to be progress. In other words, progress is a partly evaluative, or 'thick' concept (Väyrynen 2021). To ask if there has been

[2] Relatedly, one might be skeptical that the very notion of 'truth' should be applied to scientific theories, particularly in the special sciences, e.g., because this implies that the theory holds true under all possible testing conditions whereas in fact any given theory can only be verified in specific circumstances.

scientific progress regarding some phenomenon, or in some scientific subdiscipline, or during some period in the history of science, is not simply to ask whether there has been change, but to ask whether there has been *improvement*. This brings out the simple but important fact that it is always a normative verdict to say, of a given episode, that it constitutes scientific progress; it is not something that is dictated by historical or empirical facts alone.

While there are arguably many ways for science to improve, philosophical discussions of scientific progress have focussed on *cognitive* improvements in science, whereby we come to better represent some phenomenon (Niiniluoto 2019: §2.1). This might be a matter of coming to have more accurate beliefs or a greater store of knowledge regarding the phenomenon, or improvements in our representational devices, i.e., the models or theories we have proposed. A result of this focus on cognitive improvements is that various other ways in which science might become better have been largely set aside in this debate. So, for example, science could improve its methods (methodological progress), be better taught (educational progress), become more equitable (social progress), be better funded than before (financial progress), and so forth. While setting aside the ways in which science might make various 'non-cognitive' forms of progress in this way has served to simplify and focus the debate about (cognitive) scientific progress, in the domain of medicine such a narrow focus risks losing sight of the importance of clinical practice and public health outcomes in determining what counts as genuine improvements within medicine. We will return to this issue shortly.

To propose that improvements in the methods of science do not constitute (cognitive) scientific progress may well raise an eyebrow. However, such concerns can easily be assuaged by adopting an influential distinction, due originally to Bird (2008), between those developments which *constitute* (cognitive) progress and those which *promote* it. Roughly, we may say that a cognitive change *constitutes* progress just in case that change is an improvement in and of itself–and thus regardless of its causal consequences down the line. By contrast, a development *promotes* progress just in case it brings about, or raises the probability of, change(s) that constitute(s) progress at some later time(s). Note that these definitions are not exclusive: a given cognitive change can easily *both* constitute *and* promote progress simultaneously. Indeed, most changes that constitute scientific progress will also promote it, because scientific advancements tend to be built on previous scientific results. In other cases, however, developments will promote progress without also constituting it–and methodological progress in science has generally been taken to

fall into this category, since the scientific purpose of developing better methods is surely that they *lead to* scientific advancements down the line.

With these distinctions and clarifications in place, we can now provide an overview of the four leading accounts of scientific progress. The first such account proposes that progress is not simply a matter of developing and accepting entirely true theories, but rather a matter of developing and accepting theories that are *closer to the truth* than our previous theories. The intuitive notion of 'closeness to the truth' can be made precise by appealing to the technical notion of *truthlikeness* (also known as *verisimilitude*): scientific progress is said to occur when accepted theories are more truthlike than their predecessors (Popper 1970; Niiniluoto 1980, 2014). Moreover, one theory is more truthlike than another if it is true in a set of possible worlds that are, on average, more similar to the actual world than the worlds in which the other theory is true (Oddie 1986; Niiniluoto 1987). A high degree of truthlikeness is thus not the same as 'approximate truth'; rather, it is, roughly speaking, a matter of balancing approximate truth and informativeness so as to closely represent the (whole) truth.[3] In sum, the idea behind the *truthlikeness account* is that science progresses by making incremental steps towards the truth.

Historically, the main alternative to the truthlikeness account of scientific progress was an account inspired by Kuhn's (1970) influential ideas about scientific revolutions as changes in scientific paradigms (see also Laudan 1977; Shan 2019). In short, Kuhn suggested that the only notion of scientific progress that makes sense in light of the supposed incommensurability of different paradigms was one on which progress consists in having solved, or having the ability to solve, a greater number of problems. Importantly, what counts as a 'problem' and a 'solution' is entirely determined by the paradigm that scientists adopt at a given time. In particular, Kuhn explicitly does not require of a genuinely progressive 'solution' that it appeal to theories that are true or truthlike to any degree, so progress on this account may come from accepting entirely false theories. Indeed, Kuhn and many other proponents of the *problem-solving account* were suspicious of the very notion of truth (and similarly for related notions like truthlikeness), so it was important for them to disentangle the notion of scientific progress from notions like truth and truthlikeness.

[3] This can easily be demonstrated by way of example. Take the theory that there are 8 billion people on earth, and the theory that there are less than 100 billion people on earth. The former is false (at time of writing there are 7.88 billion people on earth), while the latter is true (indeed, it is true simpliciter, not merely approximately true). Nevertheless, the false theory is more truthlike than the true theory, since it informatively describes a state of affairs similar to the actual world, while the true theory describes a great many possible worlds, many of which feature far more earth-dwellers than the actual world.

A more recent alternative to the truthlikeness account is based not upon the thought that truth or truthlikeness are problematic notions, but upon the concern that merely coming to accept a more truthlike theory is not enough for there to be progress. On this *epistemic account* (Bird 2007, 2022) science makes progress by accumulating *knowledge*, which goes beyond true belief. In particular, in order to know something, one's belief must in some sense be justified, warranted, or reliable (though precisely how to characterise this sense is hotly contested). Thus the epistemic account implies that in cases where a true theory about some phenomenon is accepted on inadequate grounds–e.g., because the method used to test the theory was unreliable–there was no progress with respect to that phenomenon–regardless of how much correct information is conveyed by the theory, and also regardless of how many of the current paradigm's 'problems' the theory 'solves'. Proponents of the epistemic account view this implication as a consideration in its favour, since it may seem counterintuitive that science could make progress using unreliable methods, such as mere guesswork, even in those lucky cases in which unreliable methods lead to the truth.

Finally, the most recent prominent account of scientific progress appeals to the recently revitalised notion of scientific *understanding*. Understanding is commonly thought to be intimately related to explanation, perhaps in that if one can explain something then one has at least some degree of understanding of it (Kim 1994; Grimm 2006). However, being able to reliably predict some future event given the current state of things, or to manipulate it by intervening on those things, may also imply a certain level of understanding (Dellsén 2020). In short, one's level of understanding seems to be determined by the accuracy of one's representation of how some things depend on other things–e.g., causally–such that one can explain, predict or manipulate the former by appealing to, inferring from, or intervening on, the latter. This understanding-based account of scientific progress, which is also known as the *noetic account*, holds that understanding, thus conceived, is at the heart of scientific progress (Dellsén 2016, 2021, 2022). After all, theories that impart no understanding, e.g., because they concern spurious correlations of various sorts, do not seem to deliver scientific progress–even when they are known or highly truthlike.

The leading philosophical accounts of scientific progress thus differ with respect to the type of cognitive achievement they take to be constitutive of scientific progress: is it truthlikeness, problem-solving, knowledge, or understanding? Another dimension across which such accounts may differ concerns, roughly speaking, the *subjects* whose cognitive situations must improve in

order for there to be progress. Since this dimension is crucial to our account of progress in medicine, we will take some time to spell it out carefully.

On one natural view, which seems to have been tacitly assumed in much of the debate until quite recently (see, e.g., Niiniluoto 2017: 3299), it is individual scientists themselves who must undergo some sort of cognitive improvement, e.g., by gaining knowledge or increasing their understanding, in order for scientific progress to occur. A related view is that it is the scientific community–considered as a single collective agent rather than as a mere collection of individual agents–which must undergo such a cognitive improvement (Bird 2019, 2022; Ross 2021; Harris forthcoming). While these views differ on the issue of whether progress is made by individual scientists considered as multiple distinct agents, or the scientific community considered as a single collective agent, these views share the common assumption that progress should be understood in terms of the cognitive improvements of those *by whom* scientific progress is made.

In a recent paper, Dellsén (2023; see also 2021, 2022) argues against this common assumption and proposes to replace it with an alternative conception of how scientific progress is grounded in cognitive achievements. Dellsén's main argument is that defining scientific progress in terms of the cognitive states of those by whom progress is made renders mysterious why the general population should accept that substantial portions of public spending should go towards attempts to achieve scientific progress. After all, those who make scientific progress in a given community constitute a tiny fraction of the overall population. Why should anyone else place much, if indeed any, value on scientific progress, if it is merely a matter of improving the cognitive states of those who make it?

To put the matter into sharp relief, suppose for instance that a small community of scientists obtain some result that would normally deliver scientific progress, but that the group–for whatever nefarious reason–decides not to publish the result and indeed to keep it entirely secret within the community. Has there been scientific progress in such a case? Dellsén (2023: 25-26) suggests that we should answer this question in the negative. Not primarily because it would be 'counterintuitive' to talk of scientific progress in such cases, but because our notion of scientific progress should capture what's genuinely valuable about progress in a way that allows us to, e.g., make decisions about whether to spend public funds on a research project by appealing (at least in part) to whether, or the extent to which, the project would deliver scientific progress.

How, then, should we conceive of scientific progress if not in terms of the cognitive improvements of those by whom progress is made? Dellsén (2023: 26-27) suggests that a promising approach is to switch the focus to those *for whom* progress is made, i.e., to the *users* rather than *producers* of scientific research. To substantiate this idea, note that an integral part of the scientific process is to publish one's results, e.g., in an academic journal or research repository, at which point we may say that the results become *public information*. Dellsén suggests that scientific progress occurs when the state of the overall corpus of public information changes so as to enable the actual or potential users of that information to undergo the cognitive changes required for scientific progress, e.g., by gaining knowledge or increasing their understanding (depending on which of the four accounts previously mentioned is adopted). Of course, scientists themselves are in many cases the most eager users of the scientific results obtained by other scientists, so there is no implication here that scientific publications shouldn't often be aimed primarily at other researchers.

One might still feel the intuitive pull of the idea that scientific progress must depend, in part, on the actual cognitive improvements that are actually undergone by individual scientists (or the collective agent they supposedly comprise). After all, wouldn't it be better–more progressive, even–if the various theories and results that have been made public–e.g., by being published in an academic journal–are also actually known (or actually used for problem-solving, etc.) rather than merely *enabling* people to gain knowledge (etc.)? Relatedly, wouldn't the hypothetical nefarious scientists who refuse to publish their results have made *some* progress–albeit perhaps not as much as they could have done–when they came to improve their cognitive states?

Lingering concerns of this sort can be assuaged by considering a distinction between the cognitive progress of *science*, on the one hand, and the cognitive progress of *scientists*, on the other. To explain, note that there is a perfectly legitimate sense in which a budding scientist who learns some long-established and well-known fact has made progress for themselves–a sort of 'personal' cognitive progress. Surely, however, this does not constitute any cognitive progress of *science* as such, or indeed of any particular scientific discipline. Thus, one can admit that there is a sense in which there is 'more progress' whenever individual scientists (or groups thereof) actually come to have more knowledge, increase their understanding, and so on, but quickly add that this is so only in the sense that these *scientists* have undergone 'personal' progress. Since accounts of scientific progress are clearly concerned not with the 'personal' cognitive progress of

scientists, but with the cognitive progress of science as such (or of some particular scientific discipline), such cases can thus be set aside as ultimately irrelevant.

Let us take stock. Philosophical discussions of scientific progress have primarily focused on the issue of what type of cognitive achievement–*truthlikeness*, *problem-solving*, *knowledge*, or *understanding*–is constitutive of the cognitive progress of science. This issue should be distinguished from various distinct, albeit related, questions regarding what promotes scientific progress, how science might progress in non-cognitive ways (e.g., methodologically, socially, and financially), and what it takes for scientists to make 'personal' cognitive progress for themselves. Importantly, however, no account of scientific progress is complete without also specifying, roughly speaking, *whose* actual or potential cognitive achievements are constitutive of progress. Here we find in the literature a contrast between *by-whom approaches*, which roughly identify progress with scientists' own cognitive achievements, and *for-whom approaches*, which roughly identify progress with improvements to the information to which the actual and potential users of science have access.

## 3. Medical Scientific Progress

Having reviewed extant philosophical work on the progress of science in general, we turn now to the task of formulating and motivating an account of *medical* scientific progress specifically. The importance of such an account should be apparent at this point, for recall (from §1) that to substantiate (or indeed to alleviate) common concerns about medicine not making as much progress as it used to, or as much we would like, one must evaluate developments in contemporary medicine through the lens of some account of what such progress would be. In particular, those who are concerned that *medical* science in particular is progressing too slowly, must in some way (i) distinguish medical from non-medical scientific progress, and (ii) offer an account of the former with which the rate of medical progress at present may be meaningfully compared to the rate of medical progress in the past. These will be our aims in the current section.

Let us start by considering the issue of whether an account of medical scientific progress should adopt a by-whom or a for-whom approach. A by-whom approach would imply that medical science makes progress when medical researchers themselves, or perhaps some relevant subgroup thereof, undergo the relevant type of cognitive improvement, e.g., by gaining knowledge. Such a development would be progressive regardless of the extent to which, and indeed whether, those

researchers convey their findings to any of the medical professionals whose work would benefit from said findings, or indeed the population at large who would be empowered to improve their health were they to be supplied with the relevant information. To put the matter into sharp relief once again, suppose that a group or community of medical researchers who all specialize on a specific disease (Alzheimer's, for example) discover an affordable, non-patentable, but permanent cure. We can suppose that these researchers develop a highly truthlike theory of the cure's mechanism of action, that they have the corresponding knowledge, that they have vastly improved understanding of the disease, etc., such that no matter which cognitive achievement one takes to matter for progress, these scientists have secured that achievement for themselves. However, because publishing their findings would put them all out of a job, they all decide to take their discovery to their respective graves. In our view, it would be absurd to say–as proponents of the by-whom approach must say–that this would be an instance of medical scientific progress. Instead, these researchers have chosen, for reasons of self-interest, to not allow their discovery to result in medical scientific progress.

This suggests that the reasons to eschew a by-whom approach to scientific progress in general are amplified when we look to medical science in particular. Indeed, in the context of medical science it appears that a by-whom approach is a non-starter. After all, medical science is ultimately supposed to contribute – if only indirectly, e.g., through medical practitioners – to the maintenance of people's health, e.g., by curing or managing their diseases. This is, arguably, what distinguishes *medical* science specifically from other sciences, e.g., those parts of non-medical biological science which nevertheless concern the human body (Varga 2024).[4] On the by-whom approach, however, there is nothing inherent in medical scientific progress that guarantees that it promotes this goal. If medical scientific progress ends up helping people, it would be a fortunate but precarious by-product of the fact that researchers undergo a specific kind of cognitive improvement for themselves. Whether or not such cognitive improvements contribute to curing or managing people's diseases or promoting their health would be entirely irrelevant to whether there was medical scientific progress as such.

[4] To be sure, medical scientific progress may not necessarily make any *immediate* difference to people's health; indeed, this may take decades or even centuries. However, as we'll argue more carefully shortly, such progress must at some point make a difference to medical practice in order to count as scientific progress of the specifically *medical* type that we are concerned with here.

A for-whom approach to medical scientific progress, by contrast, can easily explain what has gone wrong in the imagined case. In short, the Alzheimer's researchers would have come *exceedingly close* to contributing to medical scientific progress, because all that was left for them to do was to publish their results, thus contributing to the public information to which various relevant actors, including medical professionals and pharmaceutical companies, would have access. In general, a for-whom approach to medical scientific progress urges that what matters for progress is not ultimately the mental states of individual medical researchers, but what they put out in the public domain. This is not to deny that researchers' own mental states are an important part of the process by which scientific progress is normally made; rather, it's to say that changes in such mental states often promote, but never constitute, medical scientific progress.

Assuming, then, that a plausible account of medical scientific progress should adopt a for-whom approach, there remains the issue of what sort of cognitive achievement the publication of scientific results should enable amongst those who would thereby gain access to them. Should these publications enable their audiences, e.g., medical professionals, to have more *truthlike beliefs* about the medical phenomena in question? Should they be better placed to provide 'solutions' to what they themselves consider 'problems' (in Kuhn's sense of these terms)? Should they simply be enabled to *know more* than they did previously? Or should these publications enable the audience to increase their *understanding*, thus enabling them to explain, predict and manipulate the relevant phenomena?

In our view, all the aforementioned answers have some *prima facie* plausibility. Indeed, this is not the place to make a detailed case for one of them over the others, for – as we'll highlight below – the most important upshots of our subsequent discussion appeal not to any one of these answers but rather to the by-whom conception that could be adopted by proponents of any of them. With that said, we do think there are reasons to favour the understanding-based account over its rivals, roughly because we suspect that the understanding-based account is best placed to account for the role of medical science in helping us to explain, predict, and manipulate diseases and other health-related aspects of human bodies. Consider, for example, what sort of cognitive status one hopes that one's doctor has achieved regarding a disease for which one seeks their consultation. If the doctor possesses a high level of understanding of the disease, then they will be able to *explain*

why one has that disease, *predict* its future development, and–most importantly–*manipulate* it.[5] Such manipulation would normally involve seeking to either cure the disease, by intervening in various ways on its causes (via medication, surgery, etc.), or to alleviate or neutralise its symptoms, by intervening on the causal pathways from the disease to those symptoms. This suggests that medical scientific progress is intimately bound up with the specific kind of information that enables us to *understand* medical phenomena, as per the understanding-based account.

Importantly, the understanding-based account also implies that a great deal of information about the human body and the diseases that threaten it can be made publicly available *without* contributing to progress, since not all such information would facilitate understanding when made available. This is an important respect in which the understanding-based account differs from, and is arguably superior to, the alternative accounts on offer; in short, these alternative accounts arguably count too many episodes as progressive. Let us now illustrate this point by considering various cases in which the understanding-based account diverges from the alternative accounts on offer.

Consider first the truthlikeness and epistemic accounts of medical scientific progress, in their for-whom versions.[6] On these accounts, scientific developments which enable medical professionals to come to truly believe, or know, more about a medical phenomenon will be classified as progressive. This will be so even if the propositions in question do not facilitate better medical care or public health outcomes at all. A notable class of such cases concerns spurious correlations about medical phenomena. For example, not flossing your teeth is significantly, albeit spuriously, associated with being obese (Hujoel, Cunha-Cruz, and Kressin 2006). Clearly, though, incentivising or promoting flossing is not a way to reduce obesity, and reducing people's bodyweight is not a way to improve their dental hygiene habits. If putting medical professionals or patients in a position to know about these correlations does nothing to empower them to improve individual or public health outcomes, it seems a mistake to categorize the public release of this information as medical scientific progress. What is needed, rather, is to provide people with a more

[5] One might think that a doctor can have the capacity to manipulate a disease without having any understanding of it. However, according to the notion of understanding that is appealed to in understanding-based accounts of progress (see section 2), the capacity to manipulate a phenomenon implies at least a rudimentary level of understanding in so far as it requires a somewhat accurate representation of how intervening on some variable is a reliable way of intervening on another.

[6] In what follows, we only consider for-whom (as opposed to by-whom) versions of the relevant accounts, since we have already argued that for-whom accounts of medical scientific progress are considerably more plausible than by-whom accounts.

accurate representation of the causal factors that lead to obesity, i.e., to enable them to increase their understanding of the phenomenon.

What about a problem-solving account in the spirit of Kuhn and his followers? As noted above, the core idea of the problem-solving account is that progress can only be defined relative to a given scientific paradigm. In particular, what counts as 'solution' to a 'problem' is entirely determined by the paradigm that scientists adopt at a given time, so if that paradigm implies that a 'problem' has been 'solved', then there is progress–regardless of whether the 'problem' and its 'solution' have any connection to reality. Thus, a for-whom version of the problem-solving account of medical scientific progress would have to say that various past remedies that fit the medical paradigms of their times were in fact progressive, in so far as they enabled people to 'solve' various alleged 'problems' identified by the paradigm. Indeed, this implication of the problem-solving account is embraced by Laudan (1977, 16), who explicitly indicates that one can make scientific progress by 'solving' the 'problem' of why bloodletting cures certain diseases. In our view, these implications constitute a *reductio* of the problem-solving account, especially when conceived of as an account of medical scientific progress. By contrast, the understanding-based account happily does not count such cases as progressive, since there is no causal relation whatsoever between the relevant diseases and bloodletting, and thus no way to explain, predict or manipulate the effectiveness of bloodletting for curing them.

Of course, more could be said to refine the truthlikeness, epistemic, and problem-solving accounts in the light of these concerns. In particular, these accounts could be narrowed so as to be more discerning regarding *which* truthlike theories, *which* pieces of knowledge, or *which* solutions to problems, need to be communicated to medical professionals and patients in order for there to be medical scientific progress. The relevant theories, knowledge, or solutions would be those which facilitate better medical outcomes, by affording power and control over diseases and other health-related phenomena. While we have no issue with developing these accounts in these ways, we simply note that the understanding-based account comes ready-made with a focus on the relevant aspects of medical phenomena, viz., those that provide understanding. Thus, developing these alternative accounts in this way would largely serve to bring them so close to the understanding-based account that the differences between these accounts would be negligible for current purposes.

We thus tentatively conclude that the understanding-based account, combined with a for-whom approach, comprises the most promising general theory of scientific progress from which to fashion an account of medical scientific progress. This, however, leaves us with the task of saying what, precisely, distinguishes medical scientific progress in particular from the progress of science in general.[7] Fortunately, the for-whom approach to which our understanding-based account is wedded provides a natural way of drawing this distinction. Let us explain.

According to the general for-whom understanding-based account of scientific progress, progress on some phenomenon is made to the extent that the relevant people are put in a position to understand that phenomenon. Which people are *relevant* will depend on the phenomenon itself, and who can make use of information about it. In some cases, the relevant people might comprise the entire population, while in others it might be a narrower class of people, e.g., policy-makers, academic researchers, or civil engineers. In particular, then, sometimes the relevant people will be those who are involved in medical practice or public health in one way or another, e.g., medical professionals and public health officials. Thus, we propose that an episode of scientific progress also counts as medical scientific progress just in case the developments of that episode positively feed into medical practice in some way. As we shall put the point below, medical scientific progress can be distinguished from non-medical scientific progress by the fact that the former promotes *progress in medical practice* (see §4).

It follows from this characterisation of medical scientific progress that sometimes such progress occurs even when it is unintended. Penicillin, for example, was famously discovered by accident in 1928 when Fleming noticed that some of his petri dishes of *Staphylococcus aureus* had been contaminated by *Penicillium notatum* mould, which had inhibited the growth of the bacteria. By sharing his results, Fleming made substantial medical scientific progress without initially aiming to do so. Relatedly, medical scientific progress can occur when scientists are investigating entirely non-medical phenomena. X-rays, for example, were discovered by physicist Wilhelm Röntgen while experimenting with cathode ray tubes. This is an example of a 'physical phenomenon' in an intuitive sense, the discovery of which has positively fed into medical practice

[7] To be clear, we are not trying to analyse the terms "scientific progress" and "medical scientific progress" as they are actually used, either in general or by medical practitioners. Rather, we are using these terms to refer to importantly different kinds of progress which, once distinguished, can help to clarify the nature of various achievements related to medicine and medical research.

(thus constituting medical scientific progress) by facilitating the diagnosis of internal damage which is otherwise invisible.

On the other hand, our account allows that some conditions, despite being treated by medical professionals in medical contexts, are not such that scientific developments which improve their treatment constitutes medical scientific progress. Here we have in mind *overmedicalised* conditions such as baldness.[8] Although there are surely scientific discoveries that facilitate better hair regrowth technology, for example, and such discoveries may well constitute scientific progress, they arguably do not feed into medical practice in the right way to qualify as *medical* scientific progress. After all, baldness is not a disease and hair loss does not make one less healthy. With that said, we will not take a stand here on which conditions are genuinely medical and which are overmedicalised (for a discussion, see Kazcmarek 2019). Rather, we simply want to point out that it does not follow from our account that any condition that is *treated as* medical, or that is *treated by* medical professionals, is such that scientific developments which lead to improvements in its treatment will therefore count as medical scientific progress.

To be clear, our view is not that scientific developments which fail to feed into medical practice are never rightly called scientific progress. Rather, we are seeking to discern which, of those developments that constitute scientific progress, are also rightly categorised as *medical* scientific progress. We are not, therefore, saying that investigation of biomedically relevant phenomena must feed into medical practice in order to be scientifically progressive *tout court*. For instance, it is arguable that Vesalius's corrections to Galen's anatomy, and Harvey's demonstration that the heart acts like a pump, provided publicly available understanding that did not feed into medical practice.[9] If that's so, then these were cases of scientific progress (and anatomical scientific progress, etc.), but not, on our view, medical scientific progress.

Let us take stock once more. We have suggested that the most promising account of medical scientific progress is one that combines (i) a for-whom approach, according to which scientific progress is a matter of making scientific information available in the right sort of way, (ii) an understanding-based account, according to which the cognitive achievement involved in progress is increasing understanding, and (iii) the thesis that what distinguishes medical scientific

[8] Other arguably overmedicalised conditions include erectile dysfunction, menopause, and shyness (which is distinct from social anxiety disorder). Similar concerns apply to dubious 'conditions' such as drapetomania (bad breath), hypoadrenia (adrenal fatigue), and leaky gut syndrome.

[9] With thanks to [blinded] for drawing our attention to these cases.

progress from non-medical scientific progress is that the cognitive achievements of the former must positively feed into medical practice. We are now in a position to see that these three elements form a coherent whole that is greater than the sum of its parts. For example, one might ask to whom precisely medical information needs to be made available, as per (i). The answer is provided by (iii): it needs to be made available to those whose having that information would positively influence medical practice. Indeed, one might ask the following-up question of what sort of information needs to be made available to these agents. The answer is provided by (ii): it is information that would increase those agents' understanding, and thus enable them to explain, predict, and manipulate the relevant phenomena.

## 4. Progress in Medical Practice

In the previous section, we proposed that medical scientific progress is scientific progress that feeds positively into medical practice–or, as we also put it, scientific progress that promotes *progress in medical practice*. In this section, we flesh this out by discussing what it is to make progress in medical practice, and how this relates to, and differs from, medical scientific progress.

To a first approximation, we can think of medical practice as the application of certain knowledge, attitudes, competencies, and skills in service of fulfilling the aims of medicine. Thus, on our view, medical scientific progress feeds into medical practice by enabling understanding which can be used in the service of fulfilling those aims. Of course, precisely what the aims of medicine are is a subject of considerable debate. Some propose that there is a single, overarching aim (e.g., Pellegrino 2001; Broadbent 2019; Varga 2023a) whereas others argue for a more pluralistic view, suggesting that medicine has multiple legitimate aims (e.g., Boorse 2016; Brody and Miller 1998; Schramme 2017). Amongst those who believe in a singular aim, there is disagreement about what that aim is. One view is that the aim of medicine is narrow in scope: to cure diseases (e.g., Broadbent 2019). Another view is that the aim of medicine is much wider in scope: to enhance both individual and collective health, well-being, and autonomy (e.g., Varga 2023a). Indeed, these are best seen as families of views that are further differentiated by the way in which they characterise key notions such as 'disease', 'health', and 'autonomy'.

We will not take a stand on these matters here. Instead, we want to emphasise that given our account of medical scientific progress, one's view regarding the aim(s) of medicine (and so what it would take for there to be progress in medical practice) has *significant* consequences for

which scientific developments get to count as medical scientific progress. To illustrate, suppose that one thinks that the aims of medicine are narrow in scope; perhaps medicine only aims to cure disease. In that case, the scientific research that led to preventative measures taken against diseases–e.g., improving hygiene and nutrition–may surprisingly not count as medical scientific progress. On the other hand, suppose that one thinks that the aims of medicine are wide in scope, perhaps encompassing the promotion of health, well-being, and autonomy. In that case, a broad range of scientific developments may count as medical scientific progress, including, perhaps surprisingly, much work in psychology. Thus, narrower accounts of progress in medical practice, when plugged into our account, will classify fewer episodes of scientific progress as medical scientific progress. *Mutatis mutandis* for wider accounts of progress in medical practice. Moreover, even when a scientific development counts as medical scientific progress by the lights of all these different accounts of the aim(s) of medicine, they might nevertheless disagree on how much progress in medical practice this development led to.

One striking observation, which transcends disagreements about the aims of medicine, is that there is no straightforward inference to be made from the extent to which there was medical scientific progress in some episode, to the extent to which it led to progress in medical practice. One episode might constitute substantial medical scientific progress, while only slightly furthering the aims of medicine, and thus causing only minimal progress in medical practice. Conversely, another episode might constitute minimal medical scientific progress and yet cause substantial progress in medical practice. To illustrate this point, consider for now two imaginary cases (we will consider a concrete example later in this section):

**(1) Longevity Protein.** Scientists identify a novel protein that enables exceptional longevity in the already long-lived. When it is administered to people over 100 years of age, it extends their lifespan by an additional 20 years. Scientists isolate and synthesise the protein and begin marketing it as a treatment.

**(2) Affordable Malaria Drug.** Appealing to previously established scientific results, scientists successfully substitute a costly ingredient with a cheaper and more widely available ingredient in the manufacture of antimalarial drugs. This change enables wider treatment access for at-risk communities.

Consider first the case of the Longevity Protein. Identifying a protein capable of enabling extreme longevity would constitute a notable scientific discovery. It also seems that, when shared appropriately, this discovery would constitute substantial medical scientific progress, because it facilitates far greater understanding of an aspect of the phenomenon of ageing, and appropriately promotes some progress in medical practice. As noted earlier, the precise reason why the availability of the longevity protein will count as medical scientific progress depends on one's account of the aims of medicine. Perhaps the longevity protein makes centenarians more resilient to diseases. Alternatively, the longevity protein might have a positive effect on the ongoing health, well-being, and autonomy of centenarians, and could also bring potential benefits to their families and wider communities.

With that said, we think that Longevity Protein is a case in which substantial medical scientific progress promotes only minimal progress in medical practice. Why so? Because facilitating improvements in our understanding of the ageing processes at play in centenarians can, at present, only benefit the few centenarians that are currently alive. The vast majority of people alive would see no noticeable benefits from the improvements in medical practice that came about as a result of this discovery.

Of course, as people live longer, the improvements in medical practice caused by the longevity protein may become relevant to an increasingly broad segment of the population. In this way, as circumstances change, this scientific development may lead to commensurably more progress in medical practice. This observation highlights something interesting about the relationship between medical scientific progress and progress in medical practice. The current state of the art of medical practice, as well as the health issues currently relevant to the population, will determine whether and the extent to which an episode of scientific progress promotes progress in medical practice. In some possible world in which humans routinely live past the age of 100, distributing the longevity protein would constitute more substantial progress in medical practice.

Next consider our second case, Affordable Malaria Drug. Whether and the extent to which this is a case of medical scientific progress depends on the details of the case. Facilitating in the relevant people the understanding that allows them to see how an expensive malaria drug ingredient can be substituted with an inexpensive alternative might only constitute a small amount of medical scientific progress. Regardless, this development would constitute massive progress in medical practice, more or less irrespective of how one characterises the aim(s) of medicine. After

all, enabling a more widespread treatment of malaria would not only cure more people of the disease, but also positively impact the health, well-being, and autonomy of malaria patients, as well as their families and communities.

What is interesting about Affordable Malaria Drug is that, in this case, great progress in medical practice does not seem to be the result of any particularly notable medical scientific progress. We already had a high degree of understanding of malaria and the drug–ingredients, mechanisms, and so on. Further, we already understood the structural similarities between the more expensive ingredient of the malaria drug and the more affordable ingredient with which it was substituted. Compared to Longevity Protein, Affordable Malaria Drug involves only a very modest scientific discovery, viz. that one ingredient may be substituted for another. Nevertheless, this minimal scientific progress results in massive progress in medical practice.

Indeed, it is worth emphasising that progress in medical practice can arise entirely independently of new scientific advancements. In other words, while our definition of medical scientific progress guarantees that whenever such progress occurs there is also some progress in medical practice, and thus medical scientific progress is *sufficient* for progress in medical practice, medical scientific progress is *not necessary* for progress in medical practice. In brief, this is because medical practice can improve in ways that do not stem from scientific advances at all. Here we will briefly explore two purported instances of progress in medical practice: (a) greater patient participation and autonomy, and (b) increased empathy exhibited by healthcare professionals.

First consider greater patient participation and autonomy. Clinical medicine in the past has been dominated by a broadly paternalistic approach: doctors, given their medical knowledge, were considered better equipped than patients to determine the best course of action. On this approach, doctors were the primary decision-makers and patients were the passive recipients of care, prevented from offering input and side-lined from active participation. In many cases medical information was actively withheld from patients, especially if the doctor believed that it could cause distress or if they thought the patient was incapable of understanding. During the second half of the twentieth century, the ethos of medicine changed to champion patient involvement, recognizing patients as active participants in their own health care (e.g., Kaba & Sooriakumaran 2007; Topol 2016). This new approach sees doctors and patients as collaboratively making health decisions. Doctors, based on their medical expertise, can offer up several different options to a

patient, and then work with them to decide which option would be best for them, given the patient's values and preferences. It is also notable that this shift away from medical paternalism occurred alongside the emergence of the principle of informed consent as a cornerstone in clinical medicine: respecting patient autonomy, and ensuring that patients are fully apprised of all potential risks, benefits, and alternatives before undergoing any medical procedure or intervention.[10]

Relatedly, consider the increased focus on empathy in healthcare professionals. Empathy here reflects the capacity of healthcare professionals to adopt the patient's perspective, and then assist based on both a cognitive and empathetic appreciation of their needs and circumstances (see, for example, de Waal 2008). Clinical empathy is expressed through, amongst other things, active engagement, mirroring the patient's feelings (such as by verbally reflecting their sentiments) and then encouraging patients to expand on their reports of their symptoms (Coulehan et al. 2001). Clinical empathy is seen as especially important when dealing with stigmatised diseases, as these pose a barrier to information-gathering, diagnosis, and treatment (Courtwright & Turner 2010; Major et al. 2018; Varga 2023b). Clinical empathy's central role in medical care is gaining recognition, with medical institutions now embedding empathy training into their teaching programs. One might question whether clinical empathy, so operationalized and taught, is actually empathy or something perhaps closer to sympathetic concern. This is an open empirical question to be sure, but there is at least some evidence to suggest that it might be closer to the former. For example, research shows that patients' decisions to share (or withhold) more comprehensive life histories and distressing symptoms depends on their perception of a doctor's emotional resonance with them (Halpern 2014). Doctors who are responsive to the emotional cues of patients can reliably elicit more detailed life histories (Suchman et al. 1997), and perceived empathy in doctors is linked to better clinical outcomes. This is because patients share their concerns more openly which results in both more accurate diagnosis and better treatment adherence (Neumann et al. 2009).[11]

[10] It is also noteworthy that contemporary discussions about the requirements for *informed consent* often emphasize that patients must have *understanding* of a procedure in order for their consent to it to count as properly informed (Shavisi 2016). A for-whom understanding-based account thus has the virtue that medical scientific progress will also facilitate informed consent.

[11] One referee points out, relatedly, that a major and growing problem in medicine is the transactional nature of the relationship between patient and physician. Physicians sell treatments products that often happen to align with their patients' interests, but the physician is primarily motivated to sell their treatment. Exhibiting genuine empathy is inconsistent with performing unnecessary tests and treatments, which means that some physicians (at least sometimes) do not exhibit genuine empathy for their patient(s).

Now, greater patient participation and autonomy in healthcare and the increased empathy exhibited by healthcare professionals are arguably cases of progress in medical practice. This is especially evident if one thinks that medicine's aim is not simply to treat diseases, but instead promote health in a manner that promotes autonomy and well-being (e.g., Boorse 2016; Varga 2023a). The paternalistic approach that previously dominated medicine actively prevented this goal from being realised. Indeed, even if the aim of medicine is understood more narrowly, i.e., as merely curing diseases, these developments towards increased participation and empathy arguably still count as progress in medical practice insofar as diseases are more effectively treated when patients are empathetically engaged with by healthcare professionals, and actively involved in diagnosis and decision-making (e.g., Surchat et al. 2022; Rakel et al. 2011; Attar & Chandramani 2012; Wu et al. 2020; Del Canale et al. 2012).

In this case, it is thus plausible that medical practice has progressed, but this progress was not plausibly caused by prior developments in medical science. While medical scientific progress has enabled patients to better understand their conditions and treatments, this is distinct from practitioners being empathetically engaged with their patients and actively involving them in the decision-making process. The latter represents a shift where the role of the patient changes to that of an active participant instead of being a mere recipient of care. Strikingly, this process largely involves doctors taking the time to cultivate in patients an understanding of the medical phenomena that is made available in episodes of medical scientific progress, but is nonetheless difficult for laypeople to grasp without assistance.

The fact that progress in medical practice can occur without medical scientific progress is a positive feature of our view that can diagnose and explain why certain purported cases of ‘medical progress’ (and here we intentionally use an ambiguous term not specified to be medical scientific progress or progress in medical practice) appear contentious. For example, it is an unfortunate fact that the history of medicine is filled with cases where ethical considerations were disregarded. In these cases, it is often not clear whether to count them as instances of medical progress, and on what grounds to do so (or not to do so). To illustrate, consider the following case:

> **(3) HeLa Cell Line.** While Henrietta Lacks was a patient, the doctors treating her took samples of her cancerous cells and shared them with researchers without her knowledge or consent. These cells were widely shared with other researchers, and are the cornerstone of

> numerous discoveries in medical science. Henrietta Lacks and her family received no compensation from her cells being used, nor was their consent sought when her name, medical records, and genome were publicly published.

Cases like HeLa Cell Line present a puzzle when contemplating the nature of medical progress. Undoubtedly, the HeLa cell line has advanced our scientific understanding of various medically relevant phenomena. Despite the unethical means by which the cell line was obtained and the ongoing unethical behaviour of many researchers, HeLa Cell Line constituted substantial medical scientific progress. But even if there is medical scientific progress, there is clearly something about the ethical transgressions central to the case that makes us hesitant to grant it the honorific 'medical progress'.

Our account can explain this hesitation, for we can point out that the evident medical scientific progress was accompanied by *regress* in medical practice. The attitudes and practices exhibited by doctors and researchers not only run counter to the aims of medicine, at least on some accounts of the latter (e.g., Varga 2023a), but have actively contributed to medicine being treated with justified suspicion by African Americans. Arguably, then, the HeLa Cell Line is a case of medical scientific progress but regression in medical practice, which explains our difficulty in assessing whether it is a case of 'medical progress'.

But was the episode progressive overall? Given our account, that question is ill-formed. There is simply no further fact of the matter once we have investigated both the extent to which there was medical scientific progress, and the extent to which there was progress (or rather regress, in this case) in medical practice. When we loosely talk about progress in medicine what we are referring to is either medical scientific progress or progress in medical practice. Which of these we are referring to will depend on where our interests lie in the particular case. Does HeLa Cell Line constitute progress in medicine *qua* medical scientific progress? Yes, since people were put in a position to understand various phenomena, and that understanding has been applied in service of the aims of medicine. Does HeLa Cell Line constitute progress in medicine *qua* progress in medical practice? No. In fact, it seems clear there has been regress. The unethical behaviour of doctors at the time the cells were taken and the ongoing unethical behaviour by many researchers run counter to the aims of medicine. The fact that these two senses of progress can come apart and push in

different directions explains why we are sometimes conflicted when evaluating specific developments in medicine.[12]

In sum, while a precise account of progress in medical practice will require taking a stand on the aim(s) of medicine, even without such an account we can draw several broad upshots from our account of the interaction between medical scientific progress and progress in medical practice. Firstly, since scientific progress only counts as medical scientific progress when it promotes progress in medical practice, one's account of the nature and aims of medicine will determine which scientific developments count as medical scientific progress. Secondly, there can be substantial medical scientific progress that causes only minimal progress in medical practice, and *vice versa*. Insofar as our goal is to promote progress in medical practice, then, we cannot simply aim to make as much medical scientific progress as possible. Rather, we must think carefully about the way in which scientific investigation of particular phenomena can help improve health outcomes, preferably in sizable populations and amongst those most in need.[13] Thirdly, there can be progress in medical practice without any medical scientific progress at all, e.g., in various patient-centric reforms of the practice of medicine, which illustrates that medical scientific progress is sufficient but not necessary for progress in medical practice. Finally, the fact that progress in medical practice comes apart from medical scientific progress on our framework can be used to helpfully diagnose and explain the uncertainty we face when evaluating contentious events in the history of medicine.

## 5. Conclusion

Despite recent concerns about the rate of progress in medicine, the task of explicitly defining progress in this field has been notably neglected. This paper has taken up this task, drawing on

[12] One referee suggests that medicine is not a science at all but a practice (cf. Wieland 1975). The account of progress that we have described in this paper can accommodate such a view. On such an account whether there has been progress in medicine overall would just track whether there had been progress in medical practice, ignoring what we have called the progress of medical science.

[13] Philip Kitcher (2001, 2011) has argued science is well-ordered when its inquiries are directed toward *significant* questions; those endorsed by well-informed participants to an ideal democratic deliberation. Kitcher and colleagues (Flory and Kitcher 2004; Reiss and Kitcher 2009) have further argued that medicine is not currently well-ordered (based on a 1990 report from WHO's commission on Health and Research for Development, 90% of global resources are directed towards investigating diseases that affect 10% of the world's population). However, Kitcher and colleagues also suggest that medicine could become a well-ordered science by adhering to a "fair-share" principle whereby the resources dedicated to diseases are proportionate to the global amount of suffering and harm that it causes. The distinction offered in this paper provides another way to express this vision: medical research should be oriented towards maximising progress in medical practice, rather than maximising medical scientific progress.

insights from the philosophy of science concerning scientific progress and the aim(s) of medicine. We have differentiated between medical scientific progress and the progress in medical practice, and developed a for-whom, understanding-based account of the former. On this view, the 'dual character' of medicine is represented by the presence of two distinct types of progress, which are nevertheless interconnected: an instance of scientific progress is also medical scientific progress just in case it contributes to progress in medical practice.

In concluding our paper, we circle back to the notion of an 'age of disappointment' and thus the view that advancements in medicine may be decelerating or coming to a halt. To accurately assess such claims, our analysis emphasises the need for a clearer understanding of what constitutes progress, but we also propose a more nuanced view: the perceived stagnation in medical science which gives rise to many of the concerns we canvassed in §1 does not necessarily imply a lack of progress in medical practice, which ultimately serves as the benchmark for evaluating medical scientific progress. After all, as we explored in §4, there can be substantial progress in medical practice on the back of minimal scientific progress, or even in the absence of any scientific developments at all.

This observation invites further reflection and warrants a more detailed exploration elsewhere. However, it is conceivable that medical science has reached a plateau in its progress, in which further advancements have become increasingly challenging. This could stem from various factors, such as the inherent complexity of unresolved medical issues, or the disproportionate increase in costs and resources required for only marginal improvements. Perhaps an important factor is also the tremendous progress that medical science already achieved in the twentieth century, particularly in controlling dangerous infectious diseases. This success has contributed to longer lifespans, but it also brings to the fore more complex age-related diseases. Indeed, we may have reached a 'natural' threshold in our ability to prolong life, beyond which making significant medical scientific progress becomes increasingly difficult.

In light of the nuances that our view introduces, even in such a scenario, it is possible to maintain a consistent rate of progress in medical practice, if there is a strategic shift towards progress in medical practice that does not stem from scientific developments. Such a shift may involve systematically refining the application of existing medical results and technologies, improving access, fostering better rapport with patients, providing more compassionate care, or implementing approaches that significantly improve overall healthcare experience. Of course, this

raises questions about how progress in medical practice should be assessed across these various aspects. Such an evaluation largely depends on one's view of the fundamental aim(s) of medicine–i.e., whether those aims are to eliminate disease, to enhance patient autonomy and well-being, and/or something else–as the benchmarks for progress will differ accordingly.

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