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Commentary

An Argument for a Consequentialist Epidemiology

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Epidemiology is the study of the causes and distributions of diseases in human populations so that we may identify ways to prevent and control disease. Although this definition broadly serves us well, I suggest that in recent decades, our discipline's robust interest in identifying causes has come at the expense of a more rigorous engagement with the second part of our vision for ourselves—the intent for us to intervene—and that this approach threatens to diminish our field's relevance. I argue here for a consequentialist epidemiology, a formalization and recalibration of the philosophical foundations of our discipline. I discuss how epidemiology is, at its core, more comfortably a consequentialist, as opposed to a deontological, discipline. A more consequentialist approach to epidemiology has several implications. It clarifies our research priorities, offers a perspective on the place of novel epidemiologic approaches and a metric to evaluate the utility of new methods, elevates the importance of global health and considerations about equity to the discipline, brings into sharp focus our engagement in implementation and translational science, and has implications for how we teach our students. I intend this article to be a provocation that can help clarify our disciplinary intentions.

future; history; methods; philosophy

Editor's note: *An invited commentary on this article appears on page 1192, and the author's response appears on page 1195.*

Epidemiology is the study of the causes and distributions of diseases in human populations so that we may identify ways to prevent and control disease (1). Although the terminology around this definition varies, some variant is, broadly speaking, well established and repeated in nearly all the major introductory textbooks in epidemiology (2–15).

In many respects, this is an elegant articulation of a vision. It neatly communicates 2 central actions for the field: 1) we identify causes so that 2) we may intervene. Our underlying vision then is parsimonious, clear, and useful. This definition also builds on the roots of the discipline and formalizes some of our central founding myths. John Snow's ghost map is a useful exemplar of an effort to understand the causes of disease (through understanding their distribution, no less) directly intertwined with an effort to intervene, which reduced the number of death from cholera (16). Similarly, the early work of William Farr to document deaths in mid-19th century London was explicitly linked to his attempts to understand the causes of these deaths, and the implications of this work for potential intervention occasioned epic battles with other leading figures of the time around the identity of these causes (17). In one of the oldest definitions of epidemiology on record, from the Epidemiological Society of London for the Investigation of Epidemic Diseases in 1876, suggested that its purpose was "the investigation of (a) the various external or physical agencies and the different conditions of life which favor their development or influence their character; and (b) the sanitary and hygienic measures best fitted to check, mitigate, or prevent them" (18, p. 3).

Our vision for ourselves has implications for how we, as a discipline, spend our time. That is as it should be. Conversely, how we spend our time should well reflect our vision.

However, in practice, academic epidemiology now spends most of its time concerned with identifying the causes and distributions of disease in human populations and far less of its time and imagination asking how we might improve population health, what might happen if a particular approach were taken to try to do so, where and when it may be appropriate to attempt inflections to the course of the health of populations, and whether our efforts to elucidate particular causes is usefully guiding our way to population health improvement. I

conducted a review of articles published in 2012 in the 4 leading epidemiology journals and found that over 85% of papers were concerned with etiology, with little particular attention to how that etiology may be relevant to intervention. Epidemiology journals are concerned with illicit drug use and cognitive function in the mid-adult years (19), strategies for establishing the causal role of epigenetic processes (20), and the relationship between premature birth and age at onset of puberty (21), as they should be. However, these articles vastly outnumber those that are concerned with optimizing cholera monitoring (22), identifying potentially modifiable experiences that may, if acted upon, reduce the burden of mental disorders (23), and the drivers of uptake of pneumococcal vaccination (24).

Our interest in the identification of causes at the expense of understanding efforts to "check [or] mitigate" them (18, p. 3) is relatively new and is driven principally by central moments in the field's recent history. Miettinen (25) and then Rothman's (26) articulation of a causal formalism paved the way for a generation of epidemiologic scholars who have since elaborated on, improved, and elevated causal thinking and its operationalization causal modeling as the dominant analytic framework and approach in epidemiologic science. I take no issue with this elevation of causal thinking in epidemiology. However, this interest in identifying causes has, during the past quarter century, increasingly come at the expense of a more rigorous engagement with the second part of our vision for ourselves (27)—the intent for us to intervene—and this approach threatens to result in an imbalance in our vision that takes the field far away from relevance and into obsolescence.

Let us go back to the textbooks—bellwethers of the dominant contours in the field and charged with articulating a foundational vision of the field to lay the groundwork for the training of young epidemiologists. A review of 14 leading textbooks showed that all these books (2–15), without exception, devote the overwhelming majority of their content to educating the reader about how we may identify the causes and the distributions of disease. The chapters that one might construe to be relevant to our understanding of how this may be applied to improving the health of populations are few and far between. We do not provide either a framing for or an orientation around what approaches to the improvement of population health are most relevant in particular contexts and why, how we can assess what approaches matter and when, how and where we may best intervene, and the role of epidemiologists in both framing these questions and in helping lead public health science to their answers.

Does this matter? If epidemiologists advance the understanding of causes in population health and leave intervention to others, is that so bad? I would argue that it is, on two grounds.

First, it has long been convincingly suggested that epidemiology is a pragmatic discipline, informed by an effort to produce useful findings that may improve the health of the public (28). Without conceding an inch on our standing as a science and concerned with understanding the rules of nature (in our case concerning the production of disease in populations), our efforts to do so are nestled within broader, supererogatory obligations to public health, which we serve as its core science.

Second, and perhaps more alarming at a deeply pragmatic level, our focus on causal thinking at the expense of pragmatic thinking is not cost-free, and it runs of the risk of marginalizing us as a discipline. No more chilling evidence can be found than the recent shift away from epidemiology in many of the National Institutes of Health strategic plans (29, 30) and the de facto exclusion of epidemiology from several funding opportunities. It is hard to see how any discipline rooted in the health sciences can thrive if the largest funder of health-related research in the world declares its contribution essentially unwelcome.

Why have we arrived at this state of affairs? It is possible to spend several other essays tracing the historical contours of epidemiology to map how we ended up at this impasse. However, I leave that to others. Instead, I focus here on one possible cause with the intention of offering one possible solution.

We are where we are today because our discipline has not been anchored in a suitable philosophical framework that can formalize our thinking, can serve as a lodestar and a corrective, and can, if nothing else, allow us to argue about our contribution in such a way as to make for a reflexive science, one that in an ongoing way challenges itself and takes different approaches when we drift from our underlying principles. I argue here then not for a redefinition of epidemiology but rather for a recalibration, optimizing the balance between epidemiology that is concerned with etiology and epidemiology that seeks to prevent and control disease to improve the health of populations. This then is an argument on emphasis and an argument that is grounded in an explicit formalization of a philosophical orientation that can serve the field well. I argue therefore for a consequentialist epidemiology.

A CONSEQUENTIALIST EPIDEMIOLOGY

We may best grapple with what we mean by a consequentialist epidemiology by first discussing consequentialism's contrast: deontology. Deontology is concerned with the inherent morality of particular positions, consistent with moral norms that transcend any immediate concern with the consequences of one's actions. Therefore, the right action or the right choice is independent of the consequence of a particular action: Some actions are right because they are consistent with what is normative whereas, conversely, others are wrong because they are inconsistent with what is normative (31, 32).

In many respects, our dominant approach in epidemiology is deontological. We have a clearly articulated epidemiologic canon, one that specifies the norms of epidemiologic science. We endeavor to launch studies that minimize bias, conduct analyses that take into account particular confounders, and follow our underlying counterfactual potential outcomes approach to its natural conclusion. New epidemiologists are trained to maximize their work's consistency with these norms. We are concerned principally with a correct approach and the rigor of our methods.

This is well echoed in our introductory epidemiology textbooks. We offer initiates to the field a set of approaches, a set of methods taught from a normative perspective that perpetuates adherence to these methods as the highest-order principle within the field. Epidemiology trade journals are the keepers of this methodologic flame, of the inherent rightness of our methodologic approaches.

I see much to admire in this current approach. In my estimation, epidemiologic studies are much more thoughtful about causal inference than are studies in many other disciplines. We are conservative and thoughtful about our inferential claims, and that is to our credit.

However, our dominant deontological approach explicitly crowds out its converse. I suggest that we have much to gain by taking on deontology's complement: consequentialism.

A consequentialist approach is centrally concerned with maximizing desired outcomes (33), and a consequentialist epidemiology would be centrally concerned with improving health outcomes. We would be much more concerned with maximizing the good that can be achieved by our studies and by our approaches than we are by our approaches themselves. A consequentialist epidemiology inducts new trainees not around canonical learning but rather around our goals. Our purpose would be defined around health optimization and disease reduction, with our methods as tools, convenient only insofar as they help us get there. Therefore, our papers would emphasize our outcomes with the intention of identifying how we may improve them.

Let us consider 2 examples. In 1 article, it was recently suggested that if they had graduated from high school, 245,000 people who died in 2012 would still be alive (34). Others have suggested similar findings (35). If this is right, it provides us an opportunity to inform and influence a "live" and active political debate that can have real consequences for the health of the US population. Yet, epidemiologists' engagement in the issue remains limited on all fronts. A consequentialist epidemiology would prioritize the assessment of the potential contribution to population health of particular interventions implemented to boost the number of high school graduates or the impact, on population health, of natural and large-scale changes in social context that increased educational achievement.

To take another example, the issue of gun violence has long bedeviled the United States and has finally come to the fore in public debate. Although epidemiology has provided evidence for the role of gun availability in driving gun-related homicides and suicides, we have not tackled some of the more salient questions that a consequentialist epidemiology might consider essential. What would be the implications of changes in our gun laws that emulate those in other countries? What may be the unintended consequences of such approaches? Would interventions at different levels (e.g., local gun registration vs. federal-level bans on types of guns) be more effective than other approaches? Have there been changes in approaches to guns in other places that can suitably inform a United States–based policy change?

This approach would have epidemiology leading the way on both implementation science and on translation of population health science, when in actuality, we are at best involved in these emerging movements on the margins. Centrally, we would recalibrate our engagement and focus, continuing to solidify our role as the methodologists of public health science but equally focusing on becoming scientists who seek solutions to questions in population health.

I am arguing here less for a wholesale reimagining of a discipline and much more for a shift in emphasis. However, it is an appreciable shift, and one that, in many respects, is a return to our origins, accepting that we have made substantial stride in our causal thinking and in our causal methods but re-engaging in efforts that are explicitly concerned with practical solutions that might improve the health of populations.

Epidemiology, the science of public health, is eminently well-suited to a consequentialist focus, if for no other reason than our interest in what is the desired "good" is clear, if nuanced. In contrast to other sciences, we know what we are hoping to achieve: the improvement in population health. That is quite different than the goals of, say, physics, in which the animating end is a better understanding of nature and in which the outcomes of its science may equally be good (more efficient and less polluting fuels) or bad (more lethal explosive devices). We also have different aims than disciplines with which we are closer kin, for example, biostatistics. We are by central definition concerned with a desire to improve heath, a seldom-questioned good, giving us a readily measurable metric, an articulation of an outcome that can serve as our desired consequence, far more readily than do other sciences. Insofar as health is a human right (36), a consequentialist epidemiology benefits from a clear focus on an outcome that is near universally agreed upon to be valuable and unquestionably worthy of inquiry.

Two digressions around the notion of health as the central outcome of interest for a consequentialist epidemiology are worth articulating. First, there is some nuance to this universal good arising from potential disagreement on what measure of health we may wish to maximize. A conventional utilitarian (recognizing here that utilitarians are motivated by consequentialist principles) would argue that our overriding goal is to maximize the overall good; maximizing the aggregate health of populations should be our central overriding outcome of interest. A pluralist may be more concerned with the distribution of health, raising the question of how we may achieve adequate distribution of health (37). Two decades' worth of research about health disparities in the United States, and to a lesser extent globally, has implicitly rested on this question, on what health outcomes we may optimally wish to achieve to reduce differences in health outcomes across population subgroups. Therefore, a consequentialist approach forces us to tackle issues that we often skirt in the field around the forms of health that are more desirable. I shall comment on this further below.

Second, the critiques of consequentialism (38) range from concerns that consequentialism is not demanding enough, that is, that a focus on consequences can justify any act or any approach or conversely, that consequentialism is overly rigid in its insistence on the focus on outcome above all else. The concern that consequentialism is not demanding enough typically focuses on the permissiveness of "by any means necessary" consequentialism, that is, the idea that a focus on consequences can justify any act or approach. For example, would an effort that aims to better understand the potential impact on health of broad school-based interventions be acceptable if it rested on poorly drawn and biased samples? However, in the context of epidemiology, there are 2 protections against this concern.

As in the context of any science, there are overarching norms of behavior, the imposition of principles of honesty, integrity, and replicability among others that override the concern

with the outcomes of any science or of epidemiology (39, 40). In the case of epidemiology, this obviates the need for satisficing approaches that aim to specify a level of good to be achieved that falls short of good maximization. A consequentialist epidemiology therefore is constrained by a deontological scientific approach, a set of supranormative principles that ensures that the permissiveness that may emerge from a strict consequentialism does not tempt epidemiologists with the embrace of either inappropriately permissive methods (e.g., fabrication of data to facilitate an outcome that maximizes health) or with the embrace of shoddy work. Although a consequentialist epidemiology is concerned centrally with the ends, these ends do not always justify the means if the latter fall short of accepted scientific norms.

In addition, as the science of public health, epidemiology is, at least by inference, bound by some of the foundational tenets of medicine. The physician's nostrum to "first do no harm" underlies all that we do in medicine, health, and public health, establishing for epidemiology an opportunity for a clear positive duty distinction within consequentialism. That is, although epidemiology should indeed be motivated by outcome maximization, it is so only insofar as we are not harming some for the benefit of all. Therefore, well-established scientific and medical normative principles are readily available constraints on epidemiologic consequentialism, allowing us then, within those, to focus on the promotion of health as our desired good.

Conversely, when consequentialism is seen as overly demanding, the concern is that a single-minded focus on outcomes permits little opportunity for moral positions (or approaches) that transcend, in importance, the outcomes of interest. Typically this is expressed as a concern about the limitations imposed by consequentialism on moral permission or moral indifference. Analogously, in epidemiology, a concern with outcomes over and above all else constrains our embrace of elegant mathematics and the satisfying aesthetics of novel approaches to situations in which they are directly leading to us maximizing our outcome of interest: health. In the case of epidemiology, this critique is not a substantial concern. In many respects, this is exactly the point of a consequentialist epidemiology. In agitating for a demanding, rigorous approach that focuses us ruthlessly on our outcomes—rather than our approaches and methods—I am articulating a direction for the field that is, in some respects, different than our current focus and that can have, as I discuss below, tangible implications for how we move forward in our science.

THE IMPLICATIONS OF A CONSEQUENTIALIST EPIDEMIOLOGY

I have suggested that the time is right for epidemiologic consequentialism. My argument is informed by the observation that consequentialism is much more consistent with the core goals and approaches of epidemiology than is pure deontology. I also suggest that there are reasons for adopting a consequentialist epidemiology that extend well beyond conceptual consistency with the goals of the field. I maintain that an explicit embrace of a consequentialist epidemiology has implications for how we approach several challenges that we face in the field.

1. Centrally, a consequentialist approach helps with the setting of priorities in epidemiology. "Big wins" in epidemiology (e.g., tobacco smoking, folate supplementation) have been scarce lately, and it is incumbent upon us to reverse this if we are to avoid disciplinary obsolescence. A consequentialist epidemiology dwells on the identification of causes and distributions only insofar as they may indeed help to prevent or control disease. I have noted earlier some of the external pressures that the field is facing from large funders. Implicit in these pressures is a growing dissatisfaction outside the field of epidemiology with epidemiologic description and correlation and a sense that our current approaches are not leading to "wins," to tractable solutions to diseases and challenges to health, or to science that is more saliently useful to decision makers with a responsibility to the health of the public. Sadly, the detractors may have a point. Whether we in the field embrace our identity as pragmatic scientists or not, others have clearly already done so. It is perhaps a dispiriting argument for a consequentialist approach that we are being cornered into it by market demands. But it is a strong argument nonetheless. A refocus on efforts to maximize health as our outcome of interest, even if at the expense of the development of epidemiologic methods and novel approaches, is one solution. It is that clarity of focus that I hope this essay motivates.
2. Epidemiology frequently grapples with questions about its scope. As fields as disparate as social and genetic epidemiology grow, there have been several thoughtful commentaries recently that articulate a future for the field that crosses "levels" and that have epidemiologists questioning how social environments are associated with epigenetic marks that imprint the influence of social factors, all of which can lead to richer causal pictures (41, 42). These discussions are also frequently accompanied by suggestions of potential newer subfields or approaches, which inevitably provoke debate about whether these are truly new or whether they are epidemiology at all. A consequentialist epidemiology sheds some of this concern with disciplinary taxonomy and identity. An approach is useful insofar as it helps us move closer to our goals, that is, maximizes our outcome of interest: health. Whether social epidemiology should exist as its own subfield and whether it should embrace the study of molecular mechanisms is mostly irrelevant when we are measuring our outcomes clearly. If disciplinary and subdisciplinary distinctions are useful to organize us as a profession, they merit discussion, but that discussion is not germane to our concern with the promotion of population health.
3. Discussions about the scope of the field in epidemiology have an analog in discussions, also not infrequent, about the introduction of new methods to the discipline (43, 44). These discussions typically are concerned with the appropriateness of these methods to the field and whether or not they constitute a fruitful expansion of our methodologic armamentarium (45, 46). A consequentialist orientation obviates these discussions. A method is useful if it helps us identify ways we can prevent disease and improve health. For example, the recent emergence of complex systems dynamic modeling in epidemiology (47) may be an interesting

diversion, but it surely is not more than that unless we can show that these methods can help us engage with and contribute to a solution to the pressing public health challenges of our time. Clearly, an untested method needs exposition and elaboration, frequently improved by the rigors of peer review and critiques of published approaches. However, our critical lens, from a consequentialist perspective, is different than it might be from a deontological one. A method is vetted, critiqued, discussed, and adopted widely if it can move our more clearly articulated goals forward appreciably. Absent that, the introduction of a new method will only slow us down from achieving our desired outcomes. This analytic lens is in some respects appreciably different from our current analytic lens, in which incremental improvement is normative.

4. Epidemiology as a discipline is largely missing from academic leadership around issues of global health importance, unlike, for example, economists. Although there are many plausible reasons for this state of affairs, clearly one of them has been the field's challenges in setting priorities for our efforts and energies. If we are centrally concerned with maximizing health or with the promotion of more equitable health states across populations, we inevitably have to be concerned with disease and health in low- and middle-income countries. Thirty-nine percent of preventable child mortality happens in the African region, and 43% happens in the South-East Asian region (48). There is an 11-year life expectancy gap between the world's poorest and richest countries (49). Our refocusing and attention to this issue will not, in any immediate way, result in immediate engagement with global health concerns—the predominance of funding in high-income countries will, if nothing else, ensure that this remains a difficult transformation to bring about. However, our discipline's efforts to bring global health issues into focus have been paltry thus far. A consequentialist epidemiology argues for a redoubling of our effort in the area.
5. A consequentialist approach to epidemiology raises issues that might otherwise not come to our attention or at least that we might be able to put aside as we continue on our disciplinary path. To focus here on one, I have in this essay glanced on the issue of health maximization versus distribution of health across populations. This is a central issue of concern to an epidemiology that is focused on the clear articulation of health promotion as its outcome of interest. However, our engagement with this issue is limited and remains wide open (50). Although economists have long articulated the tradeoffs inherent in approaches that promote efficiency (i.e., overall maximization of outcome) versus those that promote equity, I am aware of very few explicit illustrations that have tackled this issue in epidemiologic science. This leaves epidemiology in an odd place, with an underdeveloped intellectual engagement in an area of central import to our field. It is also a disservice to our colleagues in public health practice who have few empiric examples available to them to help anticipate the consequences of particular approaches. I present this here as one issue that readily emerges from the arguments presented in this essay. There are undoubtedly more.
6. The emergence of implementation science (51) and translational research (52) has been one of the sentinel shifts in biomedical and population health sciences over the past decade. Motivated in part by ever-tightening health resources, both movements aim to formalize an intellectual engagement by bridging the gap between scientific ideas and their pragmatic actualization. Epidemiology stands to, and should, make sentinel contribution to both efforts. With a few exceptions, however, we have not as a discipline had meaningful engagement in either area. A consequentialist epidemiology concerned with understanding how our etiologic insights can contribute to optimizing population health brings into sharp focus the imperative for epidemiology's engagement with this intellectual shift. It also clarifies our potential contribution to both areas and signals our commitment to translating our findings and working across disciplines to implement programs that capitalize on insights from our science.
7. Last, but clearly not least, a refocusing of a discipline has implications for how we train the next generation of epidemiologists. Our current educational approach, as noted above, is rooted in an exposition of our core methods, in an effort to teach trainees our canon so that they may apply in their eventual practice of epidemiology. However, in so doing, we are far from a focus on health outcomes and do little in introductory courses to push our trainees to focus on core principles the application of which may be central to how we can improve the health of populations. A consequentialist epidemiology necessarily would occasion a shift in how we teach and what we prioritize in our teaching, particularly early on in our students' careers.

CONCLUSION

No field should take a call for recalibration lightly. I do not suggest here that the field's foundations need to be challenged, and as a matter of course I broadly accept the widely used vision for epidemiology as a discipline. My argument rests with our relative emphasis in the field. Leading textbooks and journals reflect the field's values and clearly prioritize our interest in etiology far above that in solving the challenges that face human health. A consequentialist epidemiology challenges this relative emphasis, elevates the search for tractable solutions, and checks our impulse for ever-better approaches to etiologic insight. There is here no suggestion that this is an "all or none" approach, but rather an attempt at articulating an orientation that can help guide us in setting priorities and that can perhaps inform the efforts of rising generations. Change is always difficult and slow. Perhaps a provocation is a first step, seeding argument and disputation that, if nothing else, can help clarify our disciplinary intentions as we move forward.

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