The Poverty of Popperian Epidemiology

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Science commits suicide when it adopts a creed
Thomas Huxley

Karl Popper is one of the leading scientific philosophers of this century and his death marks the end of an era in philosophy which started with the publication of the Logic of Scientific Discovery in 1934 and went on until 1992 when he published a last collection of essays. He created an intellectual tidal wave in the philosophy of science by his bold claim that falsifiable hypotheses were the essence of scientific discovery. Yet, philosophy evolves and maybe progresses, and the two generations of philosophers who succeeded him have mostly been critical of many of his positions, while acknowledging and respecting his insights.

The present paper does not intend to discuss Popper’s philosophy, although for the sake of clarity, it will be necessary to make some incidental critical remarks. What is at stake is rather a movement of ideas which spread in the epidemiological literature and which became known as Popperian epidemiology.

There have been several epidemiological critiques of Popperian epidemiology. However, Popperian epidemiology is primarily a set of philosophical claims which call forth a philosophical critique.

Popperian epidemiology is understood as the common core of claims propounded by a group of self-christened Popperian epidemiologists, which sets them apart from the mainstream of epidemiological thinking.

These basic tenets include:
1. An allegiance to Karl Popper.
2. The claim that science is based on the negative version of the hypothetico-deductive method, the method of conjectures and refutations.
3. The denial of the validity of induction.

George Schlesinger, one of today’s leading philosophers, wrote a brief rejoinder to Popperian epidemiologists,1 which he called: ‘There is a Fascination Frantic in Philosophical Fancies’, which could be viewed as a pasquinade. However, Schlesinger did not enter into a detailed discussion of the issues. Why this critical stance? What could a philosopher object to in Popperian epidemiology?

This paper proposes a philosophical critique of Popperian epidemiology: I shall nail Eight Theses to the door of Popperian epidemiology.

Thesis One: Popper’s Philosophy is not Suited to Epidemiology
Ever since Aristotle, the theory of scientific explanation availed itself of what is now called the hypothetico-deductive method. To explain an event is to be able to deduce it from universal laws and a set of initial conditions. The evidence available, if relevant, confirms or refutes the theory. Confirmation which is akin to probability, is semi-quantitative and comes in degrees, while refutation is binary, true or false. Some of the major philosophers of science in the middle of the century, and Popper among them, were proponents of this thesis.

Standard epidemiological methods which stem from J S Mill’s inductive canons, teach us how to obtain knowledge from facts alone, or how to make more or less general statements from mere observable, descriptive data. The methods of analytical epidemiology are paradigms of what, ever since Hume, philosophers call inductive procedures.

However, Popper for whom physics serves as a model for what science ought to be, uses the hypothetico-deductive schema only negatively: he tests the consequences of the hypotheses solely through refutation.

Popper claims that there is an asymmetry between falsification and inductive support and that it is possible to refute a theory conclusively, but not to confirm it.
His opponents claim that the reverse is the case. If the consequences of a theory repeatedly come out false, we shall never be able to prove the theory to be false because we can never prove that there are no interfering influences. Any scientific theory plays host to a whole network of interrelated assumptions and hypotheses. If a prediction made by a theory fails, it is usually impossible to blame a single hypothesis. On the other hand, if the predictions come out true and continue to be true, this indicates that we are on the right track: successful predictions provide evidence that both initial conditions and hypotheses are true.

This asymmetry between refutation and confirmation stems from logic: if \( p \) and \( q \) are sentences, one can then prove that:

- if \( (p \land q) \) is false, either or both \( p \) or \( q \) is false.
- if \( (p \lor q) \) is true, both \( p \) and \( q \) are true.

In brief, Popper's opponents conclude that prediction is much more important than failure and inductive support than refutation, since success provides positive evidence for the hypothesis being tested, while failure provides disputable evidence against it. Lakatos' concludes that 'exactly the most admired theories simply fail to forbid any observable state of affairs.'

Medawar's who proposes a Popperian view of science, acknowledges that there are situations in science where one undoubtedly uses induction in the style of J S Mill. He later added that 'we turn naturally to inductive reasoning when we undertake a retrospective causal analysis of a state of affairs already given.'

In the same vein, Lewontin stresses how Popper's philosophy is inadequate for biological sciences: biologists 'have tried to construct their science as a set of universal "laws", according to the general intellectual disdain for the merely particular.' Contrary to physics, epidemiology and medicine are applied sciences and their claims and theories are not universal but time and space-indexed.

Finally Popperian epidemiologists too often misinterpret Popper. Schlesinger, writes in an anthology devoted to causality in epidemiology, that he is not 'absolutely sure that Popper has said all the ludicrous things associated with his name.' Popper indeed writes: 'We can learn from experience,' an inductive claim. He introduces the concept of corroborating which is a measure of 'acceptability' or of the 'intuitive idea of degree of support by empirical evidence', an inductive concept, and he even acknowledges that he needed a 'whiff of confirmation'.

**Thesis Two: Popperian Epidemiologists Misconstrue Induction**

Science argues from statements about observed cases to statements about those that have not been observed or from sample to populations: this is induction. David Hume showed that induction cannot be deductive. Indeed, deductive arguments will not do for the purpose of increasing our knowledge of the world, since they are essentially truth-conserving like those of mathematics.

If science is to be successful, the conclusions of scientific arguments must contain more information than their premises: we need a truth-increasing type of rational argument which is by definition an inductive argument i.e. an argument in which we expect the conclusion to follow only probably or presumptively from the premises.

However, there is a price to pay for crossing the barrier from truth-preserving to truth-increasing arguments and this is uncertainty. Inductive inferences, contrary to deductive inferences, being defeasible, imply that no scientific argument is conclusively verifiable or refutable. Acceptance is always tentative. While deductive inference which is the essence of mathematics is an all-or-nothing matter, inductive support is a matter of degrees. Induction is essentially the task of rationally proportioning our beliefs and the degree of our convictions to the strength of the evidence, which is what we mean by being reasonable.

A correct deductive argument in logic is called valid (and a wrong deductive argument is called invalid). On the other hand, a strong inference is a semi-quantitative and hence an inductively correct argument which guarantees a highly probable conclusion. Paradoxically, Popperian epidemiologists emphasize strong inferences which contradicts one of their basic tenets: the jettisoning of induction. In addition they use a faulty definition of induction. Induction does not necessarily proceed from the particular to the general. Inductive arguments may have universal propositions for their conclusions as well as for their premises and they may also have a particular proposition for their conclusion.

Inductive methods constitute the substance of standard epidemiological texts such as Rothman's, Kahn's, Miettinen's etc. Their *modus operandi* is constituted by design strategies, data analysis, design of experiments, statistical theory and cognitive techniques.

Moreover, why should Popperian epidemiologists reject a hypothesis on the grounds that it failed a given test in the past, unless we conclude that it will also fail the same test in the future? This conclusion is an inductive inference.

Monsieur Jourdain, one of Molière's leading roles unknowingly spoke prose all his life. Likewise, though Popperian epidemiologists are unwilling to admit it, we all, Popperian and non-Popperian epidemiologists, use
inductive just as much as deductive argument, during our lives, including our professional lives.

More specifically, likelihood ratios which are sometimes called the factor in favour of the hypothesis (the Bayes factor) are clearly inductive.

If we have two hypotheses, \( H_1 \) and \( H_2 \), and evidence \( E \), we have:

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\frac{\Pr(E|H_1)}{\Pr(E|H_2)} = \frac{O(H_1|E)}{O(H_2)}
\]

where \( P \) represents probability and \( O \), odds.

Turing called the right side of this equation (the odds ratio) the factor in favour of the hypothesis \( H_1 \) provided by the evidence \( E \). The logarithm of this factor is called the weight of evidence by Good.\(^{14}\)

**Thesis Three: Popperian Epidemiology Rests on an Act of Faith**

The improperly called 'principle of induction' stipulates that things which have happened in the past will continue to happen in the future.

Popperians wonder how such a principle of regularity may be justified. Actually the demand should be dismissed because it is pointless.

The question about how it would be rational to proceed in science if induction were accepted cannot even get a foothold because inductive methods are part of the framework of our life, of human nature, and as a result they cannot come up for review within this framework i.e. in terms that do not presuppose the validity of inductive arguments.

In other words, to ask for a justification is tantamount to ask for an external standard against which to appeal. Do we ask for a justification for the law and do we wonder whether the law is legal? Or do we question what the grounds are for triangles to be three-sided? We do not ask either for a measurement of a standard unit of measurement because the standard is determinative of the process of measurement itself.

In a similar way, we can no more find a deductive justification (i.e. a justification outside of the context which presupposes the validity of deductive inference) for the principle of deduction than we can prove inductively the principle of induction. The rationality of induction like that of deduction is embedded within the nature of human rationality.

Strawson\(^{15}\) concludes that 'to call a particular belief valid or invalid, would imply that it was deductive' and similarly 'to call a particular belief reasonable or unreasonable is to apply inductive standards'.

To sum up, justifying induction would be pointless because inductive arguments serve to define what rational arguments are all about.

However, we can of course always meaningfully ask for the justification of a particular argument i.e. about the validity of a specific deductive procedure, or of the reasonableness of a single inductive procedure, which is what methodological issues in epidemiology are all about.

But why should we, following the Popperians, reject a theory on the grounds that it has failed some testing procedure in the past, unless we accept this as evidence that it will fail the same testing in the future, which is an inductive inference.

Since they reject induction, Popperian epidemiologists deprive themselves of the most widely accepted rational justification for scientific investigations. They find themselves at a loss to provide grounds to justify their method and remain thus exposed to a barrier of sceptical arguments. In view of his need for some sort of grounds on which to rest his Popperian method, Weed claims that 'scientists maintain a certain faith in the regularity of nature, and so in the existence of natural laws'.\(^{10}\) This is to acknowledge that after all, Weed maintains a certain faith in induction!

The rejection of arguments based on faith and the rift between science and theology, is one of the great achievements of modern rational thought starting with Galileo and Descartes. Yet, Popperian epidemiologists are now bringing back faith into science.

However, in his critique of inductive procedures, Maclure, without documenting his claim, blames induction for involving a leap of faith,\(^{11}\) a statement which, incidentally, flies in the face of a fast developing chapter of contemporary logic i.e. inductive logic.\(^{16}\) Yet, Maclure's appraisal suggests that what is good for Popperian epidemiologists is bad for their opponents.

**Thesis Four: Popperian Epidemiology is Manichean**

Maclure\(^{17}\) contrasts what he calls two philosophies of science, the verificationist approach and the refutationist.

First of all, no philosopher defends the ideas Maclure attributes to the 'verificationist'. Further, no philosopher claims that all statements of natural laws are 'conclusively verifiable' but merely that it is possible, through experience and observation, to make them more or less probable or improbable. 'Confirming evidence' in scientific philosophy usually means evidence in favour of a theory.

Secondly, Maclure's characterization of Popperian versus non-Popperians is bewildering.

Maclure writes that for 'refutationists', science is based on disproof which actually corresponds to the second canon of induction of John Stuart Mill.

On the other hand, he attributes to the 'verificationist', some ideas which are those of Popper such as that
Thesis Five: Popperian Epidemiology is Logically Flawed
Logic is to philosophy what mathematics is to physics or statistics to epidemiology. There are many errors or logical misunderstandings in the literature of Popperian epidemiology which although minute are potentially misleading. There is no point in listing them here and I shall limit myself to point out some conceptual difficulties.

It is incorrect and even abusive to accuse epidemiologists of having neglected deductive logic: effective communication through writing and talking makes implicit use of deductive logic!

Moreover, Popperian epidemiology is in difficulty when confronted with statistical methods of proof which are so evidently inductive. A scientific hypothesis never excludes any outcome of a relevant testing procedure: it will merely be more or less compatible with the available evidence according to some sort of statistical criterion of fit. Probability statements are not falsifiable. Significant results are often said to be statistically inconsistent (at a certain probability threshold) with a certain hypothesis which would therefore be rejected. Yet there is no logical inconsistency here, since statistical rejection is not a deductive logical refutation: it is actually a decision to act as if the hypothesis was false and it is always tentative.

Finally, Weed and Lanes take an undefendable stand about subjective probability, an error which is still widespread in the literature of public health: they claim that subjective probability belongs to the psychology of science. Actually this common misunderstanding stems from the ambiguity of the word 'belief' which may refer to different uses. It may describe either a mental state or a feature of a proposition.

Belief in something may be unshakeable, profound, obstinate, justified, awkward, silly etc. This first use is private and is analogous to the acquiescence to the proposition which is believed. This is what Weed and Lanes mean by 'subjective'.

On the other hand, belief that something is so and so, may be true or false, meaningless or self-contradictory. This second use is public: it refers to the proposition itself. Plato in the Theaetetus showed that belief is not a psychological issue. Subjective probability refers to rational degree of belief. Bayesianism is the philosophical view that probability can be seen as rational degree of belief and that new evidence modifies rational degree of belief by a process of conditionalization: in other words confirmation is a conditional probability function. This is how scientific hypotheses are beliefs or candidates for belief.

Bayesian induction inference is no more psychological than deductive inference. De Finetti showed that even if degrees of belief and the object of inference were subjective in its first meaning, the rules of consistency would still be logical, not 'subjective'.

Thesis Six: Popperian Epidemiology is Philosophically Wanting
Popperian epidemiologists declare the process of scientific discovery to be 'extrascientific'. They reason that this process is similar to artistic creation and involves complex psychological processes. The assumption is that anything creative is non-scientific.

However Hansson has now shown after Popper that the process of scientific discovery is open to logical analysis. For instance, there is a great difference between good reasons and bad reasons for advancing a hypothesis.

Further, Popperian epidemiologists force us to choose between two unpalatable alternatives. Theories ought to be testable: if not, like those of Freud, Marx, Darwin and the evolutionary theory, they fall outside the realm of science. 'The practice of epidemiology', writes Maclure, 'is scientific to the extent that it is consistent with Popper's logic'. Yet, probability is a chapter of logic and reasoning is a much broader and complex activity than a mere application of deductive logic.

'Epidemiologic studies which do not test hypotheses (e.g. purely methodological studies) may be epidemiology but sensu Popper, are not science'. This may suggest that linear algebra, astronomical exploration and the natural history of diseases are not science either. Does not this correspond to a very narrow view according to which the sole content of science is limited to the testing of theories?

Ludwig Wittgenstein warned us against philosophical speculation: 'Do not think: look!' If we want to know what science is all about, we must first of all look at what scientists are actually doing and we then reach a broader picture.

There is little concern in the epidemiological literature with discovering laws of nature and universal statements because, except for trivial statements, there are no such things in medicine and in epidemiology. That tuberculosis was present in pharaonic Egypt is a scientific fact and whether there were cases of AIDS in the 1920s is a scientific issue. Medical science is not concerned with scientific laws expressed in some form of universal statements. Epidemiological generalizations are time- and space-indexed which means that they are
true in certain specific, or in need-to-be-specified situations.

Science, including epidemiology, is about the furniture of the world, about what there is and the where and when. What is the nature of things: what is schizophrenia? Is it a disease or a set of diseases? Does it have anatomical, biochemical and/or demographic criteria? Finally, how do things interact within the causal network? What kind of predictions can we formulate? Medical and epidemiological research is made of minute, patient and diversified activities: describing the distribution of diseases in a population, describing the natural history of diseases, establishing causal associations, identifying and excluding confounding factors, identifying disease syndromes, evaluating disease processes, setting up procedures of decision analysis etc. Scientific and epidemiological research are complex and multifarious activities which cannot be reduced to a single formula such as testing hypotheses, a view which Coffa called deductive chauvinism.

**Thesis Seven: Popperian Epidemiologists Neglect the Pragmatic Dimension of Epidemiology**

Susser maintains that Popper offers a model which is not relevant to epidemiology: 'of necessity, scientists are pragmatists'.

Scientific theories and hypotheses are accepted and not merely falsified: in medicine and public health, pure falsifiability cannot legitimize acting on our theories. New trends in logic and scientific philosophy tend to repudiate the hypothetico-deductive method and stress the importance of the pragmatics of explanation. 'Our ideas of “knowledge”, “probability”, “certainty”', writes Harvard professor of philosophy Hilary Putnam, 'are all linked to and frequently used in contexts in which action is at issue: What Popper consistently fails to see is that *practice is primary*. Only by wrenching science altogether out of the context in which it really arises—the context of men trying to change and control the world—can Popper ever put forward his peculiar ideas on induction'.

**Thesis Eight: Popperian Epidemiology is Non-Falsifiable**

Schlesinger provides an elegant demonstration by sheer deductive logic that if there are false hypotheses, then there must also be true hypotheses. This refutes one of the fundamental views of Popperian epidemiologists according to which certainty is impossible.

Popperians find themselves in a situation where their doctrine is no more defeasible: it is impossible even through a thought experiment, to imagine any type of situation such that it would lead them to reject their own doctrine. Yet for self-consistency Popperians should reject their own theory on the basis of its irrefutability. Popperians seem to cut the ground under their feet: they try to persuade others to apply a doctrine which they do not seem prepared to take on themselves.

**What are the Sources of the Popperian’s Predicament?**

The gap between science and philosophy and between epidemiology and philosophy is part of a process which began in the 17th century with Galileo, Descartes and the birth of modern science. This caused a breach between appearance and reality and led to the crumbling of human knowledge. It is now split into numerous academic disciplines between which communication becomes more and more difficult.

No doubt there is a need to develop a broad dialogue between epidemiologists and philosophers of science. Epidemiology pervades medicine. It became a kind of 'medical conscience' in its criticisms of the conceptual apparatus, of the methods and of the aims of medicine. This puts epidemiology in a privileged position to liaise between medicine and philosophy. The difficulties encountered by Popperian epidemiology emphasize not only the necessity but also the obstacles to this task. Since the beginning of this century, philosophy has become a profession. Philosophical magazines, like epidemiological magazines are now only accessible to highly skilled scholars. GPs do not read the *American Journal of Epidemiology* any more than literati read the *Philosophical Review*.

The interest evoked by Popperian epidemiology, suggests that epidemiologists, as is already the case in other scientific disciplines, may now feel the need to lay down the philosophical foundations of epidemiology. We do not need a Popperian neither do we need a Marxian or an Aristotelian philosophy of epidemiology. What is needed is a broad approach i.e. an analysis in depth of some of the philosophical issues raised by our discipline. It is to be hoped that this challenge will be taken up and that it will lead to an enlightened interdisciplinary dialogue which could be the starting point of new avenues of fruitful multi-disciplinary research.

**REFERENCES**


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