COMMENTARY

From Popperian science to normal science. Commentary on Sestini (2009) ‘Epistemology and ethics of evidence-based medicine’

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In ‘Epistemology and ethics of evidence-based medicine: Putting goal-setting in the right place’, Piersante Sestini argues that evidence-based medicine (EBM) is highly consistent with Karl Popper’s philosophy of science, which famously demarcated science by the falsifiability criterion and highlighted for generations of scientists the inherent fallibility of scientific claims. In this commentary, I will demonstrate, contra Sestini, that Popper and EBM share only superficial similarity. Furthermore, Sestini’s focus on the centrality that formulating the clinical question plays in evidence-based practice instead highlights EBM’s compatibility with the Kuhnian picture of ‘normal science’.

Despite Sestini’s claim to find high compatibility between EBM and Popper’s objective theory of conjectural knowledge [1], he illustrates only a thin allegiance between the two. Sestini finds Popperian influence in the EBM criterion that clinicians begin by ‘formulating an answerable question’. While an unanswerable question would certainly fall outside of the purview of Popperian science, it was the untestable hypothesis that interested Popper in his demarcation of science from pseudoscience. A hypothesis is considered scientific if it is testable, that is, falsifiable by way of a possible observational event that is incompatible with theoretical prediction [2]. All other theories, even those making empirical claims, are pseudo-science. For example, broad ideological theories, like Marx’s theory of history and Freud’s theory of psychoanalysis, make empirical claims about the world and have remarkable explanatory power (according to Marxists and Freudians), yet cannot be disconfirmed by singular observational events. The grandness of their claims, and constant supply of confirming evidence – ‘a Marxist could not open a newspaper without finding on every page confirming evidence for his interpretation of history; not only in the news, but also in its presentation – which revealed the class bias of the paper – and especially of course in what the paper did not say’ ([2], p. 46) – seemed to permit such discretion ([2], pp. 43–77). Unlike the logical positivists’ claim that non-science is non-sense, Popper allowed such metaphysical speculation to be meaningful and informative. They were not, however, scientific claims [3].

Sestini also links the ‘evidence-based’ criterion – the evidence determines the answer to clinical problems – to Popper’s demarcation of science:

External clinical evidence both invalidates previously accepted diagnostic tests and treatments and replaces them with new ones that are more powerful, more accurate, more efficacious, and safer, which is as close as it could be to Popper’s criterion of demarcation based on falsifiability [4]. Yet an accurate reading of Popper reveals that theories can only be falsified and not confirmed by any inductive evidence. The ‘replacement’ of old invalidated theories with new ones is merely conjectural. In a dramatic break from the common picture of science as an inductive process, Popper proposed that science progresses through a series of conjectures and refutations [2]. Scientists hold onto their conjectures until damning evidence falsifies them in a methodology of ‘trial and the examination of error’ ([1], p. 18). Once falsified, the conjecture is abandoned, a new one is proposed, and the effort at falsification is repeated. The growth of scientific knowledge, for Popper, results from an enlarging body of falsified knowledge claims. While Popper’s account of science avoids the vexing ‘problem of induction’ for empiricism [5,6], critics have frequently argued that a theory of scientific reasoning devoid of theory confirmation is unworkable for actual scientific practice [7]. What is a Popperian biomedical researcher or doctor supposed to do when faced with competing solutions to a clinical problem – that is, two unfalsified claims? Popper is quite clear that we have no logical grounds for selecting one over the other. It is surprising that Popper is such a hero to scientists given how irrational he made theory choice.

Yet Sestini’s comment is also linked to the democratic tenor of the evidence-based programme. EBM was lauded in the early literature as an iconoclastic practice [8]. Much like Popper’s critical science, evidence-based practitioners do not resist disconfirming evidence nor hold onto their theories dogmatically. Popper took this critical attitude even further by encouraging scientists to pursue actively disconfirming observational evidence in order to increase the robustness of their theories. This picture of the proper scientific attitude is hugely attractive. The Popperian scientist’s character traits include creativity, critical thinking and open-mindedness [2]. EBM, however, does not demand the critical scientist that Popper envisioned. EBM offers a detailed systematic approach to clinical problem solving that demands rule-following and compliance (albeit those rules may be reasonable!) rather than open-ended inquiry. A re-examination of Sestini’s area of interest, the formulation of the clinical question in evidence-based practice, demonstrates this to be the case.

Forming a clinical question

Sestini correctly observes that evidence-based practice hinges on the properly formulated clinical question. Boston University Medical School’s on-line training module for ‘Forming a Clinical Question’ [9] describes five basic steps for practising EBM.

1 convert information needs into answerable questions;
2 track down with maximum efficiency the best evidence with which to answer them;
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<table>
<thead>
<tr>
<th>Box 1 Sample PICO application from Forming a Clinical Question Worksheet [11].</th>
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<tr>
<td><strong>Sample Case:</strong> A 75-year-old non-compliant male patient with chronic venous insufficiency refuses to wear his compression stockings because of discomfort. He’s heard that horse chestnut seed extract was just as effective and would like to try that therapy.</td>
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<tr>
<td><strong>A Possible Question:</strong> In the case of a 75-year-old man (Patient) is horse chestnut seed extract (Intervention) as effective as compression stockings (Comparison) in treating chronic venous insufficiency (Outcome)?</td>
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3 critically appraise the evidence for its validity and usefulness; 4 apply the results of this appraisal in clinical practice; and 5 evaluate your performance.

The PICO procedure [10] is then enlisted to flesh out Step One, the task of framing an answerable question. The components of a well-specified clinical question will include detail of the ‘P’, the patient population; ‘I’ the Intervention that is being considered; ‘C’, the comparison against different or no intervention and ‘O’, the outcome or effect of the intervention (see Box 1).

Framing a researchable clinical question is explained to be pivotal to the evidence-based process, as the question will impact the entire EBM research procedure – which search terms are selected, which literature is subsequently found and what evidence-based answer results. EBM trainees are told that beginning with a well-developed question is pivotal, as a ‘good clinical question will: (i) save time when researching; (ii) keep the focus directly on the patient’s need; (iii) suggest the appropriate form that a useful answer may take’ [12,13].

Here we see that EBM’s priorities underwrite the framing of the (good) clinical question. We may, of course, have no qualms about the values driving question formation, and many of us will find the PICO criteria entirely reasonable. Many practitioners accept the evidence-based principles, and feel justified in adopting the prescribed methodologies. Those methods support EBM’s clinical values of expediency, comprehensive knowledge of the medical literature and patient-specific care. We expect members of the EBM community to hold those values to be worthwhile.

The expectation that evidence-based practitioners ‘stick with the program’ becomes more evident once the clinical question is formed and the research phase – gathering information and assessing the evidence – beings. Against Popperian scientific democracy, which values multiple opinions and sources for investigation, EBM is unapologetic in its insistence that evidence-based resources are preferable over the open market of medical information and knowledge. For example, practitioners are instructed that the Cochrane Database of Systematic Reviews is preferable over Medline because the former provides time-saving ‘digested’ and ‘synthesized’ analyses of only the studies that have been determined to meet EBM standards of methodological soundness and clinical relevance [14,15]. Even the background information that might be required prior to formulating the clinical question is authorized by EBM. Students are directed to the BMJ’s Clinical Evidence, for instance, which provides evidence-based topic overviews [16]. When digested research summaries are not available, clinicians are instructed to conduct the critical appraisal of published journal articles on their own using the evidence-based criteria for methodological soundness and clinical relevance [17].

The effectiveness of this approach to clinical problem solving is not at issue here; this review of the rule-following that is expected from EBM practitioners was initiated in order to prove that EBM is not patterned after a Popperian philosophy of science. Popperian science requires a ‘critical attitude’ and methodological risk-taking. Yet Thomas Kuhn notably disputed the idea that science could operate productively if constant and concerted efforts were made to undermine all scientific claims [18]. I will now argue for strong symmetry between EBM and Kuhn’s characterization of ‘normal science’.1

**Normal science**

In The Structure of Scientific Revolutions, Kuhn argued that paradigms set the basic foundations for a discipline; they entail basic and incontrovertible assumptions (i.e. theoretical and methodological commitments) about the nature of the discipline and are the necessary precursor to normal science. A community adopts a paradigm because it offers some promise of success – the evidence-based programme, for instance, was adopted throughout health care because it offered an innovative approach for improving health research and patient care. ‘Normal science’ is the productive practice of EBM, the work that is done to actualize that promise of success ([18], pp. 23–35).

While this description seems mundane, Kuhn inflamed many scientists by characterizing normal science (or ‘paradigm-based research’) as ‘an attempt to force nature into the preformed and relatively inflexible box that the paradigm supplies’ ([18], p. 25). By this, he meant that those basic assumptions that ground the paradigm are not called into question. Instead, science works to fit its findings into the pre-set confines that define the paradigm. Kuhn described normal science as a ‘puzzle solving’ activity ([18], p. 35), whose operations never challenge the structure of the paradigm. Yet if no effort is made to challenge the basics, to see or think about things differently, then isn’t normal science a boring and narrow-minded activity? Quite the contrary, Kuhn insisted. The ‘mop-up job’ of normal science can be quite fascinating work. Furthermore, the confidence in the paradigm and restrictions placed on considering alternative frameworks turn out to be essential to the development of science. Kuhn pointed out that ‘by focusing attention on a small range of relatively esoteric problems, the paradigm encourages scientists to investigate some part of nature in a detail and depth that would have been otherwise unimaginable’ ([18], p. 24).

While Popper thought that every scientific claim should be constantly put on trial and thereby held up for refute, Kuhn insisted that science would not be able to progress if the basic paradigmatic assumptions were thrown out at the first sign of trouble. Instead the ‘system’ that the paradigm defines needs to be worked through, 1 I acknowledge Sehon and Stanley’s [19] convincing argument that EBM is not a Kuhnian paradigm. They correctly argue that EBM fails to meet the criterion of incommensurability with past paradigms. My argument is that EBM does successfully meet other features of Kuhnian science, namely, EBM operations are akin to ‘normal’ or ‘paradigm-based’ science.

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Practitioners must deal with an explosion of available medical literature. Practitioner information needs are not currently being met.

Practitioners must keep up to date with the current research. Research findings are often delayed in being implemented into clinical practice.

EBM, evidence-based medicine.

anomalies need to often be set aside, and research needs to nurtured and shielded from radical dissent. When problems and criticism arise regarding EBM’s paradigmatic assumptions – what about patients’ values? Isn’t clinical expertise important for clinical practice? Is qualitative research under-appreciated? – the EBM leaders respond with minor adjustments to the movement’s theoretical commitments if needed, but the substance of the programme remains intact. The Evidence-Based Medicine Working Group has, for instance, expanded the original definition of EBM not only to involve the application of the best evidence to clinical practice [20], but also to integrate clinical expertise [21] and patient values ([22], p. 6). They have also added claims like ‘the evidence is never enough’ to the programmatic literature ([23], p. 6). Important to the success of normal science, EBM is not abandoned or denied at the first signs of trouble, nor, Kuhn would argue, should it. Normal science operates productively when the fundamentals are held securely, as our energies can then go into doing the work of evidence-based practice – producing evidence-based resources, teaching evidence-based practice skills, treating patients – and thereby working to realize the promise of better clinical research and care that first initiated the adoption of this health care regime.

Evidence-based medicine shows that same insular nature as the ‘normal science’ described by Kuhn – defining the problems of medicine, offering EBM as a solution and instructing its practitioners on the appropriate values of clinical research that evidence-based methods properly capture. To illustrate, we can return to the on-line tutorial, where the question ‘why study EBM?’ is rhetorically posed to the participants and answered by outlining the problems faced by clinicians and the solutions that EBM offers in response (Table 1).

In keeping with normal science, EBM defines its own problems and then offers its own solutions. Thus EBM is more characteristic of Kuhnian ‘normal science’ than Popper’s bold theory of conjectures and refutations. When one further considers that Popper’s framework makes theory choice akin to guesswork in key instances, however, it seems that no theory of clinical medicine should aspire to be Popperian.

References