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REVIEW

A compass for health: rethinking precaution and its role in science and public health

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The precautionary principle continues to be a highly controversial topic in health and environmental policy. Despite its prominent role in key environmental treaties and European Union policy,[1] consensus on its scientific foundations and practical implications remains elusive. In our view, three common criticisms of the precautionary principle arise from misunderstandings of how precautionary policy relates to science; and in this viewpoint we address these criticisms. The precautionary principle has been criticized for: stifling innovation,[2] causing unintended consequences potentially more serious than the problem that triggered the precautionary action in the first place,[3] and creating 'false positives'—apparent risks that waste resources and distract from real problems.[4,5]

Background

The precautionary principle encourages policies that protect human health and the environment in the face of uncertain risks. In this broad sense, it is not a new concept. Precaution is at the heart of medical and public health practice, as embodied in the 'first do no harm' tenet of medicine. The term 'precautionary principle' can be traced to the German word *Vorsorgeprinzip*.[6] An alternative translation of this word might be the foresight or 'forecaring' principle—emphasizing anticipatory, forward-looking action rather than reactive impeding of progress.

A widely cited definition of the precautionary principle is the *Wingspread Statement*, which states: 'when an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically.'[7] The 2001 *Lowell Statement on Science and the Precautionary Principle*,[8,9] signed by an international group of scientists, legal scholars, medical professionals and others, elaborated on elements of the principle, including:

- Upholding the basic right of each individual (and future generations) to a healthy, life-sustaining environment;
- Action on early warnings, when there is credible evidence that harm is occurring or likely to occur, even if the exact nature and magnitude of the harm are not fully understood;
- Identification, evaluation, and implementation of the safest feasible approaches to meeting social needs;
- Placing responsibility on originators of potentially dangerous activities to thoroughly study and minimize risks, and to evaluate and choose the safest alternatives to meet a particular need, with independent review; and
- Application of transparent and inclusive decision-making processes that increase the participation of all stakeholders and communities, particularly those potentially affected by a policy choice.

In this context, precaution becomes a compass to guide decisions under uncertainty rather than a hammer to force a specific action when a pre-specified level of evidence has been met. It encourages changes to the research agenda to support examination of broader hypotheses, expanded characterization of uncertainties, the study of cumulative and interactive effects as well as risks to vulnerable sub-populations, and preventive interventions.

Precaution and innovation

The precautionary principle encourages making decisions using the broadest possible range of information and participants. It does not create rigid prohibitions to new technologies when there is risk of harm. Absolute proof of safety is impossible; the challenge for policy makers is to find the balance between potential risk and social benefit in the absence of proof of safety. The precautionary principle provides guidance in these contested policy dilemmas, encouraging utilization of the evidence as a whole, including: the strength of the evidence of risk, uncertainty and ignorance about the risk, its potential magnitude, and the availability of feasible alternatives to the proposed technology. Precaution can be a tool to redirect innovation towards safer and cleaner practices to meet human needs.[10]

Proponents of genetically modified food, for example, claim that the precautionary principle would block development and use of the technology on the basis of a hypothetical risk, with negative consequences for feeding the hungry in less-developed countries.[11] A precautionary approach to regulation of this

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potentially powerful technology would begin by clarifying its intended purposes. Is the purpose of genetic modification of food to increase food production, to support a more ecologically sustainable form of agriculture, or to create business opportunities? Once the purpose is identified, alternative methods of achieving this purpose should be identified, and weighed against the genetic technology, both in terms of efficacy and potential risks. This alternatives analysis should be very broad—examining a wide range of food production strategies, and including the full range of interested parties.

Toxics use reduction (TUR) in Massachusetts provides an example of how precaution can stimulate innovation under uncertainty. The Act encourages companies to identify ways to reduce their reliance on listed toxic substances rather than calculate acceptable emission levels. These substances are on the TUR list because there is some evidence, though not always proof, of their acute or chronic toxicity. The law does not ban or even directly limit the use of toxic chemicals. Rather, manufacturing firms using listed substances are required to understand how they use chemicals and for what purposes, and to account for the materials they use. They must then develop plans on preventive measures they can take to reduce their waste and use of toxic substances (though they are not required to implement these plans), and measure their progress. In examining safer options, they must analyse potential risks associated with alternative chemicals and processes. In 10 years of experience with the Act, toxic chemical emissions have been reduced more than 80%; toxic waste, almost 60%; and toxics use, almost 40%, indexed for changes in manufacturing activity, all without command and control requirements. The most important driver for change has been the requirement to understand materials use and examine preventive options. Massachusetts firms have saved more than US$15 million in the process, excluding the unquantifiable benefits to health and the environment.[12]

Does precaution stifle innovation? Some technologies and substances probably should be slowed or blocked, after a careful review of their benefits, risks, alternatives, and overall uncertainties. Precaution encourages this review, but does not indiscriminately stifle innovation. To the contrary, a thorough search for alternative ways to achieve the same social goals will often identify technologies that should be encouraged. There is a tremendous need for innovation in integrated pest management and organic forms of agriculture, for example.

In the case of genetically modified foods, precaution is needed because science does not yet understand the range of effects of the introduction of foreign genes into food crops, while there is a significant risk that harmful effects, should they occur, would be difficult to control because of the widespread dispersal of the modified organisms.[13,14] In the case of TUR, the law presumes that formation of hazardous waste is not desirable and that exposures to toxic substance should be avoided if possible. While not prescribing actions to be taken, the TUR planning process encourages implementation of safer and cleaner production systems and products that may provide economic benefits to the firm.

Precaution and trade-offs

Avoiding unintended negative consequences of technologies or policies is an important aspect of the precautionary principle. Well-intended precautionary public health interventions can and often do result in serious adverse consequences.[15] Often, however, these adverse consequences are the result of incomplete analysis, lack of foresight, and inadequate consideration of uncertainties, rather than a failure of precaution.

Critics have suggested, for example, that the precautionary principle might dictate a ban on DDT because of its long-term environmental effects, with serious negative consequences for the control of mosquitoes that spread malaria.[3] DDT is cheap, evidently effective, and readily available, but also persistent in the environment, with significant ecological impacts. How can we use the compass of the precautionary principle in this dilemma? Schettler *et al.*[16] argue that application of the precautionary principle would not simply require the banning of DDT, and the abandonment of those at risk for malaria. Precaution would demand evaluation of a variety of potential mechanisms of harm, assessment of alternatives, and participation of those potentially affected in the choice of malaria prevention strategies.

The non-precautionary error is to begin from too small a set of options—either spray a pesticide with uncertain human impacts or let people die from malaria. This dichotomy ignores several important points: for example, there may be many other effective options for controlling malaria and protecting people, and DDT may not be as effective as it once was, due to mosquito resistance. Including members of communities where malaria is endemic in the assessment and choice of alternatives will also help insure that decisions reflect a full range of information, uncertainties, values, and needs of those affected. The DDT debate also highlights a common bias towards addressing short-term, knowable risks (such as malaria), at the expense of more subtle, long-term risks with less-direct causal links (such as cancer) and disruption of natural ecosystems where DDT is sprayed.

Unintended consequences are a serious concern in all precautionary public health interventions (or with any change in technology for that matter) and should be thoroughly considered. However, concern about these trade-offs should not keep public health practitioners from taking preventive actions in the face of uncertainty. Unintended consequences are a risk of policy decisions. But they can be minimized, while acting in a more precautionary way, by: exploring and implementing a wide range of preventive options; including a broad range of perspectives in decision-making processes; using a multidisciplinary scientific lens and systems perspective to examine risks before and after interventions take place, and developing methods to monitor public health interventions for early signals of problems.[17]

Precaution and 'false positives'

One concern often raised against precaution is that it may lead to acting against false-positive risks—over-regulation that diverts important resources from 'real' risks. It has been argued that precaution amounts to increasing the sensitivity of the screening tests for environmental hazards.[18] By analogy to medical screening tests, it therefore follows that the number of false-positive tests must increase. It is hard to disagree with this reasoning, if one accepts the premise that precaution simply means increased test sensitivity. We argue that this is only one

aspect of the precautionary principle, however. Precaution also encourages a broader view of how technologies impact society and economy. A decision to act on limited knowledge about a hazard may ultimately turn out to have been due to a 'false positive', but if it spurs innovations, stimulates new economic forces, and raises awareness of ecologic cycles and other lessons of sustainability, then it may still be judged to have been a worthwhile decision. Precaution does not mean only more-sensitive tests; it also means linking risk evaluation to alternatives assessments and more democratic discussions of social needs and goals.

For example, arguments that organic food is safer than conventional food because of its lack of pesticide residues may in the end be a considered a false positive because research has not demonstrated clear health benefits associated with this food. A recent study found that children who consumed a primarily organic diet had one-sixth the levels of organophosphate pesticide metabolites in their urine as children fed conventional foods.[19] This study is important because it indicates that an organic diet may reduce exposure to certain pesticides. One might decide, on a precautionary basis, that this reduction in exposure is sufficient justification to buy organic foods, but this is very different from the risk-based approach in which one would wait for strong evidence that these levels of pesticides were harmful before trying to avoid them. Because of the limits of observational epidemiology, this strong evidence of risk may never be found. Thus, from the narrow perspective of traditional risk assessment, 'buying organic' for health reasons may represent a 'false positive'.

However, there are myriad other benefits from promoting organic agriculture, including increased biodiversity, reduced use of synthetic fertilizer and pesticides (which can contaminate soil, air, surface and groundwater, and lead to human exposure), reduced energy use, and improved worker safety.[19,20] These benefits are not directly associated with the health of people who eat organic food, but they are significant and indirect benefits nonetheless. It is not possible to evaluate all the consequences of organic agriculture, and there may be some negative consequences (such as soil loss) as well, but the net impact appears to be positive.[21] Without innovations in organic agriculture, these benefits would not have been realized.

The concern for false positives should also be weighed against the very substantial evidence of numerous false negatives that have resulted from past practices. The recent report *Late Lessons from Early Warnings; The Precautionary Principle 1896–2000*, published by the European Environment Agency,[22] repeatedly demonstrates the human, ecological, and economic costs of not taking precaution and the need to learn from past failures to heed early scientific evidence of risks. The report describes how lack of scientific proof of harm was misinterpreted as evidence of safety in science and policy in 14 different cases including asbestos, lead, and polychlorinated biphenyls (PCB).

Conclusions—precaution and foresight

Many recent environmental crises have arisen from the failure to act quickly to avoid unintended consequences of seemingly beneficial technologies, and precaution is seen as a way to avoid these mistakes in future decisions. There is, of course, no such thing as absolute safety, nor absolute certainty, and so mistaken regulations, and failures to regulate, will occur. But we believe that society has not yet realized the full potential of science-based policy to prevent damage to ecosystems and health while ensuring progress towards a healthier and economically sustainable future.[9] Far from being anti-science,[23] precautionary policies can stimulate innovations in science, medicine, and technology to promote the health and safety of the planet.[24]

The concept of 'foresight', inherent in the precautionary principle, involves the establishment of long-term goals for protection of health from environmental degradation, a practice that is fairly common in public health. Examples are smallpox eradication campaigns and the setting of smoking cessation goals. Such goal-setting, coupled with development of public policies and metrics, focuses attention not on what futures are likely to happen but rather with how desirable futures can be obtained.[25] Recently established Swedish environmental quality objectives[26] provide an excellent example of how precaution can serve as a compass directing society towards practices that are more ecologically sound, health promoting, and sustainable.

Much work remains to be done to define how precaution should be applied in practice. The precautionary principle cannot be easily 'dropped into' many existing environmental regulations because of the broader perspectives and interest groups involved. We urge the scientific and public health communities to help define what precaution means in practice, including tools for its implementation.[27] Interest in precaution provides an opportunity to move towards a more constructive view of environmental and health policy, reinvigorating the core values and preventive traditions of public health.[21]

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