

***SHOULD THE WORLD HEALTH ORGANIZATION (W.H.O.) APPLY THE
PRECAUTIONARY PRINCIPLE TO LOW AND HIGH FREQUENCY
ELECTROMAGNETIC FIELDS?***

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Introduction

I have been asked by Dr Kheifets to provide the arguments for an affirmative answer to the question that is posed in the title to this article. I have not been a major player in the precautionary principle movement, but I was responsible for a policy relevant research and risk evaluation program in California which used procedural strategies that adherents to the “precautionary principle” would applaud even though no risk management recommendations, precautionary or otherwise came from that program. I have recently described these as “democratic, transparent foresight strategies.”¹ and I will say more about them below.

After chairing a W.H.O. workshop in Rome² and attending the Precautionary Summit in Lowell Massachusetts in the year 2001^{2a} I have been giving a great deal of thought to the “Precautionary Principle” from the perspective of someone who has some experience in quantitative decision analysis^{3,4}.

So perhaps that might provide some justification for choosing me for this role. It is also true that I am on record⁵ as being “close to the dividing line between believing and not believing that” extremely low frequency (ELF) electric and magnetic fields cause some

degree of added risk of several diseases. Some might believe that anyone with this degree of scientific certainty about a hazard would automatically have to advocate expensive precautionary avoidance measures. I will explain below why this assumption is naïve.

Precaution or Foresight?

I learned that the original formulation of the “principle” was made in German as the *Vorsorgeprinzip*, literally the “fore care principle”². But the word “sorge” has a penumbra of meaning that is wider than “care”. It can be used to mean “uneasiness” “concern” “solicitude”⁶. One can use “sorgen” for the care that one takes with a baby or a kitten. The Germans proposed to use this principle not only for agent by agent regulatory action, but as a more general principle to guide planning for sustainability^{2a}.

Precaution derives from the Latin “cauere” to be on guard to take great care⁷. “Precaution” would be to be on guard and take great care ahead of time. But the care that is taken is not the one that one lavishes on babies.

Precaution has a somewhat more reactive, targeted and defensive flavor than *Vorsorge*. In the libertarian risk-taking United States “precaution” has a slightly timorous risk-averse overtone, while “foresight” might imply sagacity and strategic thinking prior to choosing a risk avoidance option. I have used “Foresight” advisedly to describe the risk evaluation

and policy analysis activities carried out by the California EMF Program because they preceded any policy recommendation or implementation (what American regulators call ‘risk management’). I will use the words “Required Precautionary Protective Action” (RPPA) to refer to the choice and implementation of regulations or governmentally required actions taken in the face of uncertainty to protect people’s health. While I use the term “Voluntary Precautionary Protective Action” (VPPA) to refer to protective action taken by individuals or institutions without regulatory or legal requirement.

Is it a Principle or a Collection of Strategies or Guidelines?

In our Rome conference, it was made clear to us by regulatory lawyers from the European Community that Continental law since the time of Napoleon is thought of as deriving from principles. Thus in Europe there are legal reasons to talk about principles, even though when challenged it is difficult for them to concisely state the principle². In the same workshop Dr Douglas Weed reminded us that from a philosophical point of view “principles” are foundational assertions or commandments, from which other more detailed assertions or commandments flow. In ethics the principles of beneficence and non-maleficence would command guidelines that exercised *foresight* and considered the well being of the various stakeholders. These principles would also suggest precautionary protective actions both voluntary and required. The principle of respecting autonomy would mean that the process would be *democratic* and *transparent* to assure informed community and individual consent in choosing between policy options in the face of

potential risk. A number of us in the Rome conference argued that for the wide world beyond the European Community, clear communication would be better served by speaking of precautionary “strategies” or “guidelines”. We felt that it was bad communication strategy to use the term “principle” which elicits a vain expectation that a brief commandment can be produced upon request. Better to call a spade a spade and talk about precautionary guidelines. Then when challenged to explain, one simply lists them. Nonetheless, here are a few of the formulations that have been called “The Precautionary Principle”:

The Wingspread formulation was:

“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. In this context the proponent of an activity, rather than the public, should bear the burden of proof. The process of applying the Precautionary Principle must be open, informed and democratic and must include potentially affected parties. It must also involve an examination of a full range of alternatives, including no action⁹.”

The Rio formulation stated:

“Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty shall not be used as a reason for postponing cost effective measures to prevent environmental degradation¹⁰”

Contrasting the Two Statements

The Rio formulation requires the threat of serious or irreversible problems in order not to postpone action with the excuse of uncertainty. By implication it seems to suggest that when faced with the threat of mild and reversible problems one should indeed use the lack of full scientific certainty to postpone cost effective measures to prevent harm. Is this really how we behave? The United States Food and Drug Administration requires pharmaceutical companies to list minor transient drug reactions that have been reported in post market surveillance even if there is less than scientific certainty of a causal relationship. This required “right to know” information can be of great use to doctors and patients.

Some might interpret the Rio Declaration as advocating cost effective precautionary measures every time there is a moderate degree of scientific certainty about serious irreversible threats, others might interpret it to mean that the lack of scientific certainty should not preclude the consideration of cost effective actions. The introductions of “serious or irreversible” and “cost effective” as well as the further restrictions added by the European community (see below) were probably done to narrow down the candidates for foresightful consideration and subsequent required precautionary preventive action respectively.

The Rio Declaration would have been more rational and defensible if it was billed as the “Suitable Certainty Principle” and stated like this:

The suitable degree of scientific certainty required by governments to pass from inactivity to requiring precautionary planning or cheap or expensive protective actions should depend on the severity , magnitude, irreversibility and unfairness of the health or environmental threat.

This variant would have made it clear that the commandment is about how *governments* should use the degree of scientific certainty to guide their *requirements*. While it does not prejudge when an expensive protective action is warranted under uncertainty, it makes it clear that there are times when it is appropriate to take precautions without a high degree of scientific certainty about the dangers and the efficacy of the precautionary action. This formulation also acknowledges that fairness often enters into the precautions that governments take. The Rio Declaration does not deal with democracy, transparency or foresightful policy consideration or with the burden of proof.

The Wingspread formulation does address democratic, transparent foresight strategies and does not restrict their application to “serious or irreversible” problems, nor does it prejudge the options to be considered by permitting only cost effective ones. Indeed it allows “no action” as a permissible option. The Wingspread formulation does raise the issue of burden of proof. I will address this more, below.

Later modifications by regulatory agencies in Europe¹⁰ and Canada¹¹ have added the requirement that the Required Preventive Protective Action be triggered by reasonable scientifically based suspicion of a threat, that they be proportional to the risk, attentive to costs and benefits, consistent with actions in other venues, not be motivated to protect home industries, open to intermittent reconsideration and targeted to the risk in question.

Neither formulation makes it clear that the actor who is being admonished is government nor that they are not talking about individual or institutional voluntary action but with governmentally required precautionary protective actions ranging from right to know laws to outright banning of products or processes. Neither formulation deals with the criteria nor the procedure for determining what is a threat that warrants the resources needed for risk evaluation and policy option consideration. Will an article in a sensational tabloid newspaper be sufficient to initiate evaluation and action or will a panel of “never cry wolf” scientific consultants decide if an issue warrants consideration. Who will determine the ground rules for this gate keeping process?

Neither formulation reflects any realization that different stakeholders in society adhere to different ethical frameworks that might dictate different precautionary actions when presented with the very same scenario of choice under uncertainty.

Four Ethical Frameworks

Making policy in the face of uncertainty is characteristic of many public health issues. Examples include global warming, mad-cow disease, and irradiated foods. In the course of designing and critiquing the California Program’s school and power grid policy projects, it became clear that stakeholders have different policy frameworks that they use in approaching such problems involving voluntary and involuntary exposures. It also became clear that many arguments about policy choices are really arguments about frameworks. Economists, engineers, and regulatory agencies often use a predominantly results-oriented “*utilitarian*” framework. Any given stakeholder using this framework considers his/her options along a number of criteria and chooses the option that produces the best trade-offs between the various criteria. In order to find the option with the best

balance of criteria, the utilitarian stakeholder may assign dollar values to tangible criteria such as project costs and even to criteria such as aesthetic consequences or quality-adjusted years of human lives saved. When stakeholders using this approach end up advocating different courses of action because they have different interests, the utilitarian resolves the conflict by choosing the solution that aims at producing the “most good for the most people at the least cost.” Sometimes this ignores the interests of some small segment of society.

On many issues, members of the general public do not adhere to the utilitarian framework. Often they adhere either to a “*social justice*” framework that tries to fulfill duties to or protect rights of the vulnerable regardless of cost, a “*non-interference*” or libertarian framework that tries to protect individual and property rights from governmental interference, or a framework that requires “*virtual certainty*” of a problem before taking action.

Adherents to these frameworks might prefer different policy options. For example, suppose a municipality that owned its own electrical utility decided that it was probable that magnetic fields from power lines and appliances were hazardous and wanted to do something about it. The utilitarians in town might recommend that the municipal utility should pay for the most cost-effective measures to reduce exposure, even if not deriving from the sources for which they were responsible. For example, they could buy up enough old, high-exposure electric blankets and replace them with new, low-exposure models, to prevent as much disease that might be caused by the power grid. The adherents to the social justice framework might point out that the minority of people living next to the power grid were still at unequal risk. They might invoke a strong form

of the “precautionary principle” that expensive avoidance policies are warranted on the basis of a few credible scientists suspecting a small risk that violates the rights of even a small group of people. They might say that following the precepts of environmental justice, there was a special duty to protect this group if it was particularly vulnerable to EMFs, had less access to medical care or had been unfairly singled out for EMF exposure on the basis of previous exposures to other hazards, low-income levels, or race. From this perspective environmental agents like EMFs should be treated as “guilty until proven innocent.” Therefore, this framework would propose that the people living near the power lines should be protected by modifying the lines to lower fields even if it were more expensive to do than buying up old electric blankets. They might also invoke a duty of the utilities “to clean up their own mess” at the utility’s expense. The adherents to “non-interference” might oppose both options because they involved involuntarily taxing the many for the benefit of the few. Regardless of the degree of confidence in the existence of an EMF hazard, they might prefer a “right to know” information program that would require the labeling of transmission towers, rental agreements and documents during home sales to allow the free market and voluntary actions of those who were concerned to solve the problem. Adherents to the “virtual-certainty-required” framework would not want to take any action unless all scientists in the field were totally convinced of a problem. For these adherents, EMFs are “innocent until proven guilty.” Utilitarians who are interested in the most good for the most people tend to focus on the population burden of ill health (the epidemiologist’s Population Attributable Risk) as a parameter of interest, while the social justice adherents as well as American regulators focus on the individual lifetime theoretical added risk of the most highly exposed (which is based on the

epidemiologist's Attributable Risk in the exposed). This is because the social justice framework and the law tend to focus on protecting the individual from risks that are more than de minimis (1 added case per million lives in some American regulations). There is no technical resolution to these kinds of arguments¹². A democracy handles them through the political process.

It is worth noting that scientists are trained to use the “virtual certainty required” or “beyond a reasonable doubt” framework or something close to it. They use this framework in guiding their communications with other scientists, in their choice of research topics and by unreflective extension, in their communications with policy makers. Now there are many reasons why academic scientists would behave that way. As an analogy imagine an early prehistoric hunter who was prone to come back to the cave falsely trumpeting that he had found woolly mammoths just around the corner. Pretty soon nobody would want to hunt with him because he had started too many wild goose chases. Science is kind of like hunting in some ways, and for similar reasons there is a price to falsely incriminating things. For one thing, there is a price to one's own scarce resource. Each researcher has only about 30 to 50 years of research productivity. If one is always off looking for nonexistent woolly mammoths, one is not going to be very productive. So there are lots of reasons from a pure scientific point of view to fear false positives more than false negatives. Deriving from that, there are all kinds of scientific sociological reasons: one's probability of getting tenure, one's probability of getting grants, one's probability of being admired by one's colleagues and by people from other disciplines – all are much more driven by not falsely incriminating things than by missing things. For example, nobody cared too much that Linus Pauling thought there was a

triple helix rather than a double helix. But when he started saying that vitamin C could cure the common cold, he was finished as a scientist. Scientists tend to bring this “beyond a reasonable doubt” standard of evidence, that tolerates false negatives in order to avoid false positives into the domain of public health where there is a much greater cost attached to a false negative finding than is the case in the purely scientific arena. This scientific fear of “crying wolf” encouraged and nurtured by the powerful industrial interests who have their own interests to fear true or false positives has contributed to the long delay between early warnings about agents such as asbestos and DES and the initiation of required precautionary preventive action¹³.

Stakeholder Interests Have Some Influence on their Choice of Ethical Frameworks

Stakeholders often try to satisfy more than one ethical framework in choosing a course of action either because a particular stakeholder sees the merit in several frameworks or because adherents to individual frameworks bargain with each other to find solutions that attend to more than one framework. It should also be acknowledged that a given stakeholder, while tending to adhere to one or the other policy/ethical framework most of the time on the basis of philosophical sympathies may shift frameworks from issue to issue or even on the same issue depending on his/her interests and the ratio of opportunity and risk presented by the options being considered. Margolis¹⁴ has argued that we have developed shortcut paradigms to deal with different combinations of opportunity and risk. When faced with a potential risk that offers us no benefit or opportunity we use the “better safe than sorry” paradigm. This is true no matter how uncertain the hazard or how

small the probability of its affecting us. As soon as the risk is accompanied by opportunity, or its avoidance is accompanied by inconvenience or cost we tend to flip into the “Is this a good deal?” paradigm. This “flipping” has something of the quality of the transition between two perceptions of the famous visual illusion drawing that can either be perceived as an old lady or as a duck. Once “flipped” into the duck perception it is hard to imagine how one could have seen an old lady. Margolis gives the example of the New York parents who were enraged that the school district had endangered their children by not removing asbestos cladding from pipes in their schools (“better safe than sorry”). When the school administrators announced that schools would be closed in the fall to remove the asbestos and reopened for compensatory months in the summer, the parents were outraged that they were being inconvenienced and required to find child care in response to such a trivial risk (“Is this a good deal?”). Margolis believes that stakeholders derive their paradigms from their perceived interests and that they trot out arguments about unfair exercise of power, untrustworthy behavior of government and their concerns about involuntary exposures to dreaded agents as an afterthought and justification. While policy makers must be alert for stakeholders who adjust their policy framework to conform to and justify their narrow parochial interests, it is clear to me that financial interests are only part of the story and that the concept of “policy frameworks” helps to explain many public policy conflicts. For a given uncertainty scenario, the libertarians may prefer “right to know” precautions, the utilitarians will prefer cost effective precautions and the social justice adherents may be willing to spend more money and attend more to issues of distributional and restitutorial justice. It is unlikely

that any democratic society could agree to adhere to any one of these styles of precaution for all possible future decisions.

Precaution in the Regulation of Individual Products or Precaution in Anticipatory Long Term Strategy?

The question posed to me for this workshop is about whether or not to impose right-to-know warnings or land use or product design changes on electrical and communication facilities. As such it is a question about reacting and regulation of individual products. However, as Marco Martuzzi and Joe Tickner pointed out to me when commenting on an earlier draft of this paper, precaution or foresight could be exercised ahead of time when planning for major sectors of society like communications, transportation, energy etc and their intersections. This precaution might take the form of anticipatory impact assessments, establishing mechanisms of post market surveillance etc. The transparent, democratic foresight strategies listed below have relevance to this broader anticipatory style of precaution as well. They could have been applied at the dawn of the cell phone revolution, but that train has left the station, so having made this point I return to the narrower question presented to me for discussion.

Democratic, Transparent Foresight and Precautionary Strategies

Below, I list the strategies that I think are implied by the Wingspread formulation. After each strategy is listed I comment briefly on whether I think it aims at being democratic, transparent, exemplary of foresight or whether it involves Required Precautionary Protective Action. I sometimes comment on the practicalities of implementation.

1 The government should fund an open organization to work with stakeholders to develop criteria to decide if allegedly dangerous practices or technologies pose such a threat that they warrant a simultaneous evaluation of risk and alternative policy options exploration. Once developed the organization should be the one to decide if foresightful evaluation is conducted.

Comment: This strategy aims at being democratic, transparent and exemplary of foresight. It does not involve recommendations for RPPAs. Even if this organization were only convened on an ad hoc basis in response to public outcry, it would require designated funding and would be an inherently controversial activity. It would be more costly as a standing organization. I personally think it is an idea whose time has come. The decision whether to invest the resources to evaluate whether to continue or initiate a new technology or some other policy variant is a value laden issue that requires more than scientific factual input. But what threshold must be exceeded to warrant this consideration, and does any particular problem exceed that threshold? This would be the job of this organization. W.H.O. could convene such a group for health related problems. If the criteria for getting through this gate keeper, allowed only large scale issues like global warming, genetically modified foods etc. then one would limit the number of issues that would require the effort and cost of pursuing the steps mentioned below.

In this and the subsequent strategies I discuss below, I talk about the proponent industries co-funding the various strategies. I see the government funding a core capability and industries adding funds for special additional projects with standard

budget line items including stakeholder participation, determined by the government.

2. *Each government should oversee an organization that explores and evaluates alternative policy options for the practice or technology that has been judged to be a threat warranting such an evaluation. This evaluation should be done in an open manner with meaningful and adequately funded participation of relevant stakeholders and with unbiased peer review. The proponent of the technology or practice that has been judged to be a potential threat should co-fund this evaluation.*

Comment: This strategy strives to be democratic, transparent and to exercise foresight, but does not necessarily result in RPPAs but could well stimulate VPPAs. This will require designated funding both in terms of the technical policy analysis and public participation. (The California Public Utilities Commission (PUC) directed the states utilities to provide \$7million in rate payer moneys to fund the California EMF program which was overseen by a Stakeholders Advisory Committee including members from the utilities and public interest groups. The program invested two million dollars in analyses of EMF options for schools and the powergrid and hundreds of thousands of dollars in direct expenses and staff time in stakeholder involvement, including a direct grant of \$20,000 to public stakeholders to hire their own experts to critique the governments experts). One should then consider a wide range of alternative courses of action and define ahead of time the criteria by which they are to be compared. Sometimes the criteria need to include health tradeoffs. For example we get some environmental and health benefits from eschewing the use of DDT in malarial countries, but are

the alternatives as effective in preventing malaria? A holistic approach to the options should be taken. Stakeholders will usually inject non-health criteria into the comparison of options. For example, discouraging children from using cell phones may have good or bad impacts on behavior or social development. Analyses can be carried out leaving the degree of certainty of hazard and the magnitude of population burden and theoretical individual lifetime added risk as variables. One can then ask the question: “How certain must we be of how much disease before we would require cheap or expensive precautionary protection measures?”¹⁵

The answer to this question depends, as we have shown above, on the policy framework to which you adhere. Ashford¹⁶ has stressed the importance of attending to the costs and benefits of each of the different stakeholders. This means that the policy analysis involves a cost benefit or cost effectiveness analysis from the point of view of each of the relevant stakeholder groups as well as a “most good for most people at least cost” analysis to address the concerns of powerful utilitarian stakeholders. It also involves an ethical analysis of the impact of the several courses of action from the point of view of distributive and restitutive justice and its impact on the autonomy of the various stakeholders. This addresses the concerns of the many adherents to the social justice and libertarian policy frameworks. While some variants of the social justice framework and indeed some regulatory schemes in the United States preclude any consideration of cost, cost effectiveness analysis, is somewhat less controversial than cost benefit analysis, which involves assigning dollar costs to a variety of

important outcomes such as human life, aesthetics, quality of life etc. Assigning these benefit numbers is a matter of controversy and could well vary from country to country and culture to culture. We left these valuations and controversial issues like the discount rate, as variables in the EMF policy models developed in the California program to facilitate the stakeholders understanding of the importance of these assumptions¹⁵.

Even though no RPPAs are involved in this kind of policy exploration, this recommendation of the Wingspread formulation is really quite controversial and would be a major change in direction. It is controversial because parties whose technology is being compared to alternative approaches see it as increasing the probability of tort litigation and increasing the probability of RPPAs. Some members of the scientific community will oppose early policy analyses because it violates their unquestioning adherence to “beyond a reasonable doubt” evidentiary criteria or because it threatens the prestige, power and financial advantage of serving as society’s arbiter of what alleged hazards to take seriously. Nonetheless, I personally advocate a much wider use of policy analysis for suspected threats much earlier in the process instead of delaying for years in research (as is happening now with radio frequency research and risk assessment) to achieve “beyond a reasonable doubt” levels of certainty about hazardousness and about the magnitude of population and individual risk. Policy explorations can result in agreements to do nothing for now, voluntary precautionary action or in RPPAs. Public health has a long and distinguished non-regulatory track record for drawing attention to potential problems and gaining the widespread

acceptance of VPPAs. Neither the adoptions of VPPAs nor RPPAs should be considered as admissions of tort liability, and the law should be adjusted to reflect this so as to remove that reason for resisting sensible foresightful policy exploration and or precautionary action.

With regard to EMFs, the ratepayers of California have already paid for a policy options exploration for ELF avoidance on the powergrid and homes and in schools ^{15,17}. Because computer models accompanied both analyses, which allow one to vary cost, risk and other assumptions, these California models have some potential for use in other settings.

One could engage in similar, if simplified analyses with regard to the use and design of cell phones base stations, radio and television transmitters and wireless communications between computers and their peripherals. I personally think the threshold has been reached to say that there are sufficient grounds for suspicion to warrant these kinds of participatory policy explorations in the radio frequency (RF) arena. One could argue that W.H.O., with oversight from an international stakeholders advisory committee could oversee an industry/government funded policy options exploration of these matters carried out by knowledgeable contractors.

3. The government should oversee a policy relevant research and risk evaluation process governed by risk evaluation guidelines. The evaluation and the guidelines should be

subjected to stakeholder comment in an open and transparent process. The scientists involved in the work and peer reviewing it should be free of financial conflict of interest and extreme ego involvement in the issue at hand. The proponent of the technology deemed to be a potential threat should co-fund this process. Risk Evaluation Conclusions should be formatted to accommodate those who demand virtual certainty for action and those who might use a lower degree of certainty that a hazard exists to require RPPAs or pursue VPPAs.

Comment: Once again this strategy aims at being transparent, democratic and exemplary of foresight, but involves no RPPAs. The Wingspread formulation recommends that the burden of proof of safety lie with the proponent, without speaking in detail of what this means. The California PUC authorized the investor-owned utilities and encouraged the municipal utilities to bill their rate-payers to pay for a series of policy relevant studies (exposure assessment in schools and the general work place, a miscarriage epidemiology study and the two policy projects and risk assessment). There was broad stakeholder oversight of the research topics chosen, the request for proposal process and the details of the policy and risk assessment (but not the epidemiology or exposure) studies. The utilities had the burden of paying for the work and participating in the oversight. In this project, they did not select their preferred scientists to do the work or decide whether or when to publish the results. They did not prepare the risk evaluation or fully control the guidelines used to prepare it, although, they like other stakeholders made public comments on both. During a subsequent regulatory phase they will undoubtedly have their own assessment of risks. If there was a governmental agency or an independent agency receiving money and administering research and risk assessment

contracts for suspected agents, contractors might be freed of financial conflict of interest. However, the current American procedure for spreading the burden of proof to responsible parties involves direct contracts from industry to a network of laboratories and contractors who are largely dependent on industry for their funding and this creates at least the appearance of a conflict of interest. There has been much discussion of this as it relates to RF exposure research. I would personally recommend a transparent research and risk evaluation process for RF exposures with stakeholder involvement similar to what we used in California. In my limited experience the W.H.O. seems to rely on expert driven closed meetings to deal with these issues. This is a style that is actually against the open meeting laws of the governmental jurisdiction in which I am used to function. This may reflect American political values that are not required in other parts of the globe where citizens are more trustful of or more obedient to their governments.

The California Risk Evaluation formatted its conclusions using the International Agency for Research on Cancer (IARC) categories but also using the more graduated categories listed below. This aimed at making it easier for adherents to the different policy frameworks to develop policy:

Degree of Certainty

<i>Are EMFs at home or at work safe, Or do EMFs increase the risk of..... to some degree?</i>	<i>Degree of Certainty on a scale of 0 to 100</i>
Virtually certain that they increase the risk to some degree	>99.5
Strongly believe that they increase the risk to some degree	90 to 99.5
Prone to believe that they increase the risk to some degree	60 to 90
Close to the dividing line between believing or not believing that EMFs increase the risk to some degree	40 to 60
Prone to believe that they do not increase the risk to any	10 to 40

degree

Strongly believe that they do not increase the risk to any degree 0.5 to 10

Virtually certain that they do not increase the risk to any degree < 0.5

This graded way of expressing, what American regulators call “Hazard identification” allows for use in quantitative decision making and by stakeholders W.H.O. are deciding on VPPAs. The California program also used pre-stated risk evaluation guidelines that involved making explicit the reviewers prior probability of hazard, stating the evidentiary tests to be applied and forcing a graded narrative response to the question of how likely the pattern of observed evidence was under the hypothesis that ELF_s caused an effect or a disease as opposed to the hypothesis that ELF_s produced no effect or disease. The likely false positive and false negative rates of these evidentiary tests needed to be considered to help decide how much weight to put on them. The above mentioned degree of certainty was then expressed by the reviewer after systematically considering all this evidence, much in the way that a physician makes a diagnosis after considering a body of evidence. I call this a “Bayes-Influenced” approach to risk evaluation. The guidelines¹⁸ we used to carry out this style of risk evaluation received extensive public comment and was unanimously approved by an outside Science Advisory Panel. It represents the three reviewers reaction to the more traditional risk evaluation that is driven by simple combinatorial rules for mechanistic, animal pathology and human epidemiology streams of evidence and which results in categorical labels such as “inadequate”, “possible” or “probable”. That way of formatting conclusions does not facilitate individual or public decision-making.

The fruits of this third guideline activity that would allow one to compare the relative safety of alternative courses of action. This gets partially around the quite legitimate complaint that no risk evaluation process can produce absolute or even virtual certainty of safety. One can however compare ones “posterior” probability of hazard and risk (after systematically reviewing the evidence) for the various courses of action, while paying attention to the uncertainty bounds around those estimates.

Finally, if by saying that the “burden of proof lies with the proponent” one means that he cannot proceed to market unless he has funded an independent due diligence review of the potential hazards of his product, as is the case with pharmaceuticals, I agree that this should happen more often, although I doubt that it is practical for all products and technologies.

4 The technology proponents should co-fund, and the government should oversee a process with adequately funded meaningful involvement of stakeholders in the choice between the policy options developed in strategy #2. The choice could range between doing nothing to relying on voluntary action to adopting cheap or costly RPPAs, including “right to know” messages. This choice should involve careful consideration of the most good for the most people at the least costs as well as the distribution of costs risks and benefits and to issues of distributional and restitutional fairness and autonomy.

Comment: This strategy strives for transparency, democracy, foresight and may or may not result in cheap or expensive RPPAs. This is another area of controversy.

Some interpret the Precautionary Principle as advocating the most expensive

RPPAs at the slightest hint of danger of the most trivial type of ill health and completely ignoring approximate risk assessments for assessing the range of population burdens of ill health or added personal theoretical lifetime risks. As an American and world citizen, I am certainly not in favor of that. I have noticed that stakeholders who stand to bear no cost, or who would spread the cost to everyone for a protection that adheres primarily to them, tend to be more enthusiastic about expensive RPPAs in response to low degrees of certainty of hazard. Margolis¹⁴ has pointed out that industry stakeholders are not the most appropriate advocates against inappropriate spreading of costs. They are there primarily to defend their own interests. If costs are passed on to the consumer in a way that does not affect sales they will tend to go along. So stakeholder oversight groups ought to include philosophical advocates for the greatest good for the most people at the least cost who have no financial conflict of interest for this position. Many academic economists and decision analysts could play this role.

On the other hand, there are all kinds of examples where a careful analysis would show that there are RPPAs in the face of uncertainty that make sense from both a duty ethics and a results ethics point of view. Nevertheless society sometimes chooses RPPAs that are driven by other criteria. When has only to look at the such governmental precautionary measures as the institution of America's Star Wars initiative to realize that more than cost effectiveness is driving the policy.

Without some analysis I do not know what my position would be with regard to voluntary or required informational and other precautionary actions with regard to cell phones, base stations TV transmitters, radar installations and wireless

computer networks. Nonetheless I personally feel very strongly that it is inappropriate to import our academic scientists “beyond a reasonable doubt” criterion as an excuse for postponing analysis and public health policy decisions. I would therefore advocate the transparent democratic foresight strategies described above with early decisions about some of the cheap measures and more deliberate discussion of some of the more expensive ones. While some have expressed doubts that risk assessment has any role to play in this process ¹⁹ I think there are appropriate uses to provide approximate magnitudes of population burden and individual added risks to exposed people that reflect what is known. It is important to consider how these theoretical risks are distributed among relevant stakeholders as well as for the population taken as a whole.

But having said this, one still asks what if any role W.H.O. would have in implementing this risk management strategy

What Democratic Transparent Foresight Strategies and RPPAs should W.H.O. or other Health Agencies Advocate?

The assignment I was given was to answer the question: “Should the W.H.O. apply the Precautionary Principle to high and low frequency EMFs?”. If by this one means should the W.H.O. advocate high cost RPPAs on the basis of the current degree of certainty that a hazard exists, then I would say that W.H.O. and other health agencies like mine in California do not have the authority or the expertise or the societal standing to make this kind of decision for society. Just because a health agency has made a reasoned

pronouncement about degree of certainty of hazard, magnitude of individual risk or population burden does not mean that it has expertise on all the other criteria that need to be considered in choosing courses of action. But I think W.H.O. and similar health agencies do have the expertise, authority and standing to convene stakeholders and to oversee the first three of the transparent, democratic foresight strategies I have outlined above to move toward a decision. The W.H.O ought to be pursuing these strategies and encouraging member nations to do the same.

With regard to the questions, should the W.H.O. endorse the European Union's regulatory version of the Precautionary Principle, I would emphatically say "no". The last time I looked W.H.O. stood for the *world* health organization, not the European health organization. W.H.O. is not a regulatory organization and even if it was, the European Union's regulatory structure is not relevant to all countries in the world. I personally find the European regulatory formulation very difficult to understand.

Some may respond that W.H.O. and other health agencies make vigorous policy recommendations about smoking, safe sex, clean water, and indeed take a leadership role in advocating for health when stretched budgets for education, industrial development, defense and the like beckon with competing priorities. Doctors routinely advise their patients about courses of action and don't simply provide them with alternatives from which to select.

I would answer that this advocacy usually pertains to situations that are primarily within the health or public health sector. The choice between abstinence, safe sex and

unprotected sex presents ethical framework challenges but no involved cost benefit calculations or societal tradeoffs outside of the health sector. On these kinds of issues both the science and the politics have allowed the agencies to take this aggressive stance. They are courses of action that are occurring after prolonged societal discussions. In the 1950s the Surgeon General gave a cautiously worded statement that smoking was hazardous to health. In the 1990s health agencies are openly pushing tobacco taxes, advocating smoke free restaurant ordinances and paying for advertisements that ridicule tobacco executives.

Some may also respond that health agencies and doctors are often asked if a hazard is “real enough” to require action or if a treatment “really works”. These framings of the question, I would argue, are pleas from stakeholders who want to use the agency or doctor as a “beyond a reasonable doubt” gate keeper in the initiation of policy discussion. With an individual patient this serves as a hint about his/her policy framework and one can answer: “looking at the evidence I have some reasonable doubt that it would work, but it is more likely than not to work, there seem to be no dangers and it is cheap, do you want to try it out?” If he is a true “virtual certainty required” adherent he will decline. When one stakeholder in a community or a politician asks the question, “are you sure it’s a problem?” one needs to remember that other stakeholders may adhere to a different policy framework than your interlocutor and that by consenting to choke off policy discussion through the use of the “beyond a reasonable doubt” criterion you have effectively entered the political discussion on one side of the issue

If health agencies are to play a trustworthy role in early stages of thinking about alleged health threats, I believe that they should be vigorous in the use of transparent democratic foresight strategies and in helping to facilitate democratic discussions about whether or not to adopt cheap or expensive required precautionary protective actions.

The first Buddhist emperor Shotoku Taishi in 604 AD said, “When big things are at stake, the danger of the error is great. Therefore, many should discuss and clarify the matter together so the correct way may be found.²⁰” This advice is still well founded.

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