NATIONAL AFFAIRS

Israel

Consequences of Ignoring Uncertainty
– "Probability of Causation" in Radiation Cases –

by Talma Izak-Biran, Richard Laster, Tamar Berman and Boaz Shnoor*

The nuclear research facility in Israel was built in the 1950s amidst great secrecy. Beginning in the 1980s, nuclear research facility workers who contracted cancer began to seek expert medical opinions and take legal action to seek compensation. Because of the secrecy surrounding the work practices and materials used at the research facility, a situation arose in which workers seeking compensation couldn't discuss their work and exposures with the lawyer representing them.

In 1996, a scientific panel was created to review all these cases and determine whether each worker's disease was the result of his/her exposure to chemicals and radiation at the facility. The scientific panel was the result of a compromise between the State – which sought first and foremost to protect the secrecy surrounding these cases – and the workers – who sought compensation. The scientific panel helped protect the secrecy surrounding the cases by keeping the material out of the court system and media, and by ensuring that only members of the panel – who had security clearance – would handle sensitive material. The scientific panel was essential for balancing security matters with worker health protection.[10]

In 2002, the scientific panel submitted its findings to the arbitrator and recommended awarding compensation to six out of 37 workers (16%). The panel relied heavily on probability of causation (POC) estimates as calculated by the nuclear facility.

Probability of Causation

The POC value falls between 0 and 100% and is meant to express numerically the probability that an individual's cancer is related to his occupational exposures. The POC is commonly used in tort law and in compensation systems and provides the basis for the two major radiation worker compensation schemes: the Energy Employees Occupational Illness Compensation Program Act (the US energy worker compensation programme) and the UK nuclear industry's Compensation Scheme for Radiation Linked Diseases.

In the British scheme, the minimum POC level at which compensation is awarded is 20%, whereas in the US scheme a minimum of 50% is required for compensation. However, both schemes use models which incorporate uncertainty estimates, thus enabling the worker to benefit from the major uncertainties related to the variables entering the POC model: the worker's radiation dose, the relative risk per dose, and the strength of the association between the radiation dose and the cancer type.[9]

The US compensation model, for example, does not calculate a single POC value but rather a central estimate with a range of possible values (including an upper estimate), to reflect the inherent uncertainty in the model's components. A worker is awarded compensation if his upper POC estimate exceeds 50%, an approach intended to minimise the possibility of denying compensation to employees with cancers likely to have been caused by occupational radiation exposures.[11]

Probability of Causation and the Panel

The US compensation scheme POC model uses the worker's radiation dose, with an uncertainty distribution, thereby recognising the major limitations in radiation dose estimates provided by nuclear facilities. In fact, lack of adequate records of worker exposures, especially for intermittent and temporary workers, is one of the major sources of uncertainty in the POC model.[13]

The scientific panel in the Israeli nuclear case, however, based its decisions on POC calculations provided by the nuclear facility as absolute numbers, without uncertainty estimates. For 27 of the workers, the POC value was below 1%. For nine of the workers, the POC value was between 1 and 6%. Only one worker had a POC value exceeding 20%. Of the six workers who the panel recommended receive compensation, three were the workers with the highest POC values (5.28%, 5.97%, 22.4%). For most of the workers with POC values under 1% the panel concluded either that the worker was not exposed to radiation at all or that the worker was exposed to very low levels of radiation. Clearly, the panel relied heavily on the nuclear facility's POC estimates.

Methods

We identified a number of factors which could have potentially led to major underestimation of the workers' radiation dose: a) inconsistent monitoring for some of the workers; b) outdated dosimetry methods in use until the early 1990s; and c) problems relating to monitoring internal radiation exposures when specific time of exposure

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and exposure source are unknown. Internal dose measurement (as opposed to external dose) involves assessment of the intake from the measurements and assessment of the dose from the intake. These assessments contain large uncertainties due to the unknown time of exposure, mode of absorption and biokinetic model.[7]

We concluded that when measuring internal exposure to certain isotopes, from the 1960s to the mid-1990s, it was impossible to measure exposures less than a tenth to a hundredth of the Annual Limit Intake (ALI) for respiratory exposures, and exposures less than a tenth of the ALI for ingested exposures.

Based on these limitations, we estimated the workers' exposures at 10 ALI (50 Rem or 0.5 Sv) and used the National Institute for Occupational Safety and Health Interactive Radio-Epidemiological Program (NIOSH-IREP) to calculate POC estimates for 19 workers using estimated radiation exposure values and uncertainty estimates.[5,6] This group of workers excludes those recognised by the scientific panel (N = 6); those with job descriptions suggesting no significant internal exposure (N = 9); and those with cancer types not included in the Biological Effects of Ionizing Radiation VII report (N = 3).

The table below shows the POC values for the 19 workers selected.

POC values in 19 Israeli Radiation Workers

Cancer type	Central estimate	Range
Colon cancer		
Worker 1	50.1	14.6- 68.9
Worker 2	42.7	11.2- 62.5
Worker 3	42.7	11.2- 62.5
Worker 4	43.3	11.5-63.5
Bladder cancer		
Worker 5	39.3	9.4- 57.4
Worker 6	48.3	13.0-65.3
Worker 7	36.7	8.5-55.4
Stomach cancer		
Worker 8	44.4	7.2-67.4
Worker 9	44.4	7.2-67.4
Worker 10	39.4	6.0-62.3
Worker 11	39.4	6.0-62.3
Prostate cancer		
Worker 12	30	3.7- 50.1
Worker 13	24	2.9- 43.9
Worker 14	23	2.7- 43.2
Other cancer types		
Worker 15	75.1	25.1-88.0
Worker 16	42.5	11.4- 60.1
Worker 17	31.4	4.5- 56.1
Worker 18	27.6	3.1– 45.3
Worker 19	32.9	4.0-52.1

These calculations show that for 19 workers the POC exceeded 20% (the minimum value for compensation in England) and for 15 workers the upper estimate exceeded 50% (the criteria for compensation in the US). In contrast, based on the POC estimates provided by the nuclear facility, none of these 19 workers had POC values above 6%.

This exercise demonstrates the importance of incorporating uncertainty and uncertainty distribution estimates in the calculation of POC values and emphasises the inherent limitations of superimposing a legal construct (POC) on a scientific process. It also shows the advantages of the English and American compensation programmes for nuclear workers as opposed to the Israeli system, which left the question of POC up to the courts.

Conclusions

Finding POC values in nuclear workers exemplifies the complicated relationship between law and science, wherever uncertainty is involved. Law and science differ in this regard in two main points. The first concerns the relationship towards truth. Science's sole objective is scientific truth. Therefore, wherever there is uncertainty, wherever scientists are not sure that their hypothesis is truthful, they will not announce definite conclusions, but will rather wait for more data to come in.[5]

Law's main objective, on the other hand, is adjudicating conflicts. Courts and other legal decision makers (henceforth termed "courts") seek to end a dispute in a timely and efficient manner, and in a way that will allow the parties, in particular, and society in general to move on. To do so, in many cases, courts decide cases, uncertain about the correct result, and with a good chance that they are wrong. Hence, courts will decide a case even when no scientific certainty exists, based upon the available knowledge, according to the preponderance of evidence rule.[13]

The second difference between science and law concerns the attitude towards uncertainty. Scientists are keenly interested in uncertainty's degree and its causes. Analysing uncertainty helps scientists to decide whether to keep on checking their theory, adapt it or even abandon it altogether. This causes scientists to dwell on subtle differences between different levels and kinds of uncertainty, and to draw conclusions from uncertainty itself.

On the other hand, courts traditionally announce at the end of a trial either that the plaintiff is right or that the defendant is right, with no other available solutions. This phenomenon of legal decision making leads courts to classify each piece of scientific evidence according to one of three categories: irrelevant evidence, evidence which supports the plaintiff, or evidence which supports the defendant. If the evidence looks very uncertain the courts would deem it irrelevant. This will be the result whether the uncertainty is due the novelty of the field, the lack of experiments to confirm the theory, or the fact that the theory was not proved in hundreds of studies.[3,8,4] However, if it crosses that threshold it would be classified as supporting one of the opposing sides.[1] Given that in many cases there is no better evidence than the scientifically uncertain evidence, the case might be decided according to that evidence, although it is uncertain. This means that the legal system reduces uncertainty to a yes/no question, without getting into the subtle differences between different kinds and levels of uncertainties and without these differences having any meaningful consequence.

A better approach to scientific uncertainty might be found in a new approach emerging in Israeli law. This approach first appeared in the report of the committee examining the relationship between the contamination in the Kishon River where Israel Defence Force divers dived in training exercises and the cancer cases of these divers.

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The committee was composed of two scientific experts and a former chief justice of the Supreme Court. The experts' report claimed that there were more cancer cases in the divers' population than was to be expected, but that the difference was not statistically significant. The committee chairman, Former Chief Justice Shamgar, said in his minority opinion that due to the small population of divers, statistical analysis is difficult, leading to an uncertain result regarding the causal connection between the pollution and the cancer. However, scientific data suggest that there is a strong possibility that such a connection does exist. In these circumstances law should not and cannot wait until science can be certain, but should give meaning to the partial knowledge and to the existing uncertainty.

Following the same line of argument, the Israeli Supreme Court in two leading cases[7,2] said that where scientific uncertainty is due to lack of scientific research or the impossibility of getting the relevant data and no party can be blamed for the uncertainty, the court would be willing to take uncertainty into consideration by either lowering the threshold for proving scientific general causation or by apportioning the damage between the parties where specific causation is in doubt.

This new approach tries to combine the parties' and the judicial system's need to resolve cases now, with the scientific world's need to announce results only after they are proved beyond any doubt. It acknowledges, on the one hand, that scientific progress is so rapid that there will always be doubts regarding new theories and that there will always be uncertain data, and on the other hand that the parties cannot wait years or decades until scientific certainty is achieved. It does so by trying to incorporate the new uncertain science into the law cautiously by giving it only partial legal meaning but without denouncing it completely.

In conclusion, the use of POC for nuclear workers shows that legal reliance on scientific evidence should include uncertainty, as part of science's inherent limitations. Using a POC value without uncertainty estimates forces a legal construct onto a complex and fluid scientific reality.

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US

Breathing Strife or New Life into Arctic Policy?

Amongst a number of controversial last-minute regulations adopted in the final weeks of his tenure, former President Bush signed a presidential directive[1] entitled: *US Arctic Region Policy*[2] on 9 January, 2009. As the first US Arctic policy update in 15 years, the document describes itself as promoting both homeland and national security. Addressing seven broad areas of Arctic policy, the directive intermingles sovereign and international interests with assertions of duty to maintain and enhance cooperation in the region. It reflects the US's altered defence policies and considers climate change, the increasing level of human activity in the region, the establishment and work of the Arctic Council, and a growing awareness that the Arctic is both fragile and rich in natural resources. However, it lacks prioritisation and could be described as just an extensive list of Arctic issues that are of US concern. President Obama must now decide whether to adhere to the directive, abandon it or craft his own approach to the diverse challenges in increasingly accessible Arctic waters.

First and foremost, the directive reaffirms earlier statements of Bush-administration support for accession to the Law of the Sea Convention (UNCLOS) and advises the Senate to act favourably in this aspect. The justifications for these provisions are not only national security interests, but also other national interests, such as the need to secure rights over marine areas and natural resources, and the policy goal of promoting US interests in the environmental health of the oceans.

Regarding the Arctic, the directive reiterates US commitment to the existing legal framework (UNCLOS and other international instruments) and supports the principles of last May's Ilulissat Declaration[3] by the A5 (the five coastal States bordering on the Arctic Ocean – Canada, Denmark, Norway, the Russian Federation and the United States). It generally opposes the idea of a new "Arctic Treaty", but anticipates that increased activity in the region may necessitate new or enhanced international arrangements on certain topics, and states that the US will consider such arrangements on a case-by-case basis.

It commends the Arctic Council for its work and reasserts that it should remain a high-level forum working within its mandate of environmental protection and

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sustainable development, while indicating the need to update the structure of the Council and its subsidiary bodies.

The directive specifically acknowledges the unresolved boundary with Canada in the Beaufort Sea and recognises the interests of both parties in developing the natural resources of the area, but not addressing the "free passage" issues that underlie that dispute.[4] It also resolves to urge the Russian Federation to ratify the 1990 United States-Russia maritime boundary agreement.

Reaching into the toolkit of soft diplomacy, an extensive section on promoting scientific cooperation contends the importance of research to US interests in the Arctic. Playing a lead role in regional research, the US will continue to support collaboration particularly to advance

Polar bears investigate the submarine USS Honolulu, 280 miles (450 km) from the North Pole Courtesy: US NAVY

current understanding and to predict future environmental and climate change in the Arctic. In doing so, it will guide the effort to establish an effective circumpolar observation network and promote regular meetings of Arctic science ministers to improve coordination.

Addressing maritime transportation – a growing concern as the ice cover recedes – the policy promotes strengthening existing measures, and if necessary developing new measures, which will also improve safety and security and protect the marine environment. Relevant authorities are directed (i) to develop a risk-based capability to address hazards that may arise through increased shipping in the Arctic (an especially delicate and unforgiving area); (ii) to advance work on pollution prevention; and (iii) to develop response standards and logistical support, while contributing to the development of Arctic waterway management regimes in accordance with accepted international standards.

Under the heading: "Economic Issues, Including Energy" the directive notes the challenges of sustainable Arctic development, citing climate change in particular as well as the impacts on indigenous communities. It advocates increased efforts to study changing conditions, involve stakeholders and thus preserve and enhance economic opportunity.

The Arctic is expected to play a significant role in meeting growing global energy demand.[5] The directive indicates that future US policy should seek cooperation with other Arctic nations to ensure a balance between national environmental protection in their designated outer continental shelf (OCS) areas, and the broader development of energy and other natural resources in the region. It stresses the importance of collaboration among the A5 regarding exploration of portions of the area beyond national jurisdiction, to addressing energy, access, production and environmental and socio-economic impacts.

The Directive acknowledges the potential serious consequences to Arctic communities and ecosystems, under the heading "Environmental Protection and Conservation of Natural Resources". Given the Bush Administration's view that current uncertainties impede final decisions and action on climate issues, the directive prioritises environmental research, monitoring, and vulnerability assessments as prerequisites to future climate-oriented decision making.

The policy reiterates the US's support of the general principles of international fisheries management outlined in the 1995 UN Fish Stocks Agreement[6] and similar instruments, as well as its ongoing support for the protection of marine ecosystems from destructive fishing practices. It calls on relevant authorities to pursue marine ecosystem-based management throughout the Arctic and to address changes and expansion of commercial fisheries, possibly through international agreements or organisations.

After the last eight years of sporadic US diplomacy on behalf of the environment, any official US policy recognising the changes in the Arctic and the US's enduring interest in confronting the principal drivers of that change represents a refreshing change. Critics have suggested that the multiple references to climate throughout the directive do not set climate as a priority. They suggest that in order for US policy to protect the Arctic environment and conserve its biological resources, it must commit to rapidly reducing greenhouse gas emissions. In addition, they note that the policy addressing this vulnerable region cannot be implemented or successful until all relevant national policies are in harmony with each other and with international agreements.

In a sign of the new administration's commitment to the Arctic, Secretary of State Hillary Clinton during confirmation hearings before Congress, endorsed UNCLOS, recognised the work of the Arctic Council, commented on the impacts of climate change, and expressed support for the need to protect the Arctic considering the profound environmental changes. Subsequently, the State Department will likely assume a great deal of responsibility in implementing an Arctic policy. Such positive signals have been welcomed by the international community, industry groups and conservation organisations. The World Wildlife Fund used the opportunity to call[7] on officials in the Obama Administration to use the Arctic policy directive as a starting point for revamping, reorienting and strengthening US policy in the Arctic.

The Arctic is a regional microcosm for setting international precedents for engagement and cooperation in the increasingly daunting environmental challenges facing the world. President Obama, in his endeavour to revive the US on multiple fronts, now has an opportunity by way of an Arctic policy to develop an integrated approach to

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ensure energy security, tackle climate change, and shore up international relations. (ATL)

Notes

1 In a memorandum for the counsel to President George W. Bush prepared on 29 January, 2000 it was advised that a presidential directive has the same substantive legal effect as an executive order and it is the substance of the presidential action that is determinative, not the form of the document conveying the action. A presidential directive remains effective upon a change in administration, unless specified in the document, and remains effective until subsequent presidential action is taken. A text of this memorandum is available online at: http://www.fas.org/irp/offdocs/predirective.html.

2 National Security Presidential Directive 66 (NSPD 66) and Homeland Security Directive 25 (HSPD 25), the full text of the directive can be found online at: http://www.fas.org/irp/offdocs/nspd/nspd-66.htm.

3 The full text of the declaration is available online at: http://www.oceanlaw.org/downloads/arctic/Ilulissat_Declaration.pdf.

4 The Beaufort Sea dispute is part of a larger debate over the status of the Northwest Passage. Canada claims the route as "Canadian Internal Waters" while the US classifies the Passage as an International Water. Although favouring free passage, the free passage designation would arguably be detrimental to Canadian and global interests, as it would then offer entry to international vessels that cannot be as strictly controlled as at present.

5 The Circum-Arctic Resource Appraisal released by the US Geological Survey in July 2008 reported that the area north of the Arctic Circle has an estimated 90 billion barrels of undiscovered, technically recoverable oil, 1,670 trillion cubic feet of technically recoverable natural gas, and 44 billion barrels of technically recoverable natural gas liquids in 25 geologically defined areas thought to have potential for petroleum. These resources account for about 22% of the undiscovered, technically recoverable resources in the world. Approximately 84% of the estimated resources are expected to occur offshore. Visit http://energy.usgs.gov/arctic/ for in-depth information on the Appraisal.

6 Formally entitled the "Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks".

7 To read the WWF press release go to: http://www.worldwildlife.org/who/media/press/2009/WWFPresitem11267.html.

Germany

Environmental Code Fails

Cited from a declaration by Federal Environment Minister, Sigmar Gabriel (unofficial translation):

"The Environmental Code (*Umweltgesetzbuch*) has failed due to opposition from Bavaria's State Government and the lack of willingness on behalf of the Christian Socialist Party (CSU) to reach a compromise. During a discussion in Munich on 26 January with Bavarian State Prime Minister Seehofer, I once again reaffirmed my willingness to negotiate and offered further substantial amendments to the Draft Environmental Code. However, even this endeavour to reach a settlement was rebuffed. The consequence now being that a substantial bill endorsed by the Federal Government will not enter into the legislative process…"

"…In Germany, there will still be no easy, transparent and (un)bureaucratic environmental law cast from the same mould; the continuing fragmentation of laws will persist…"

To provide our readers with further information, Minister Gabriel, atour request, has promised to elaborate his opinions in the next issue.

Courtesy: SZ

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