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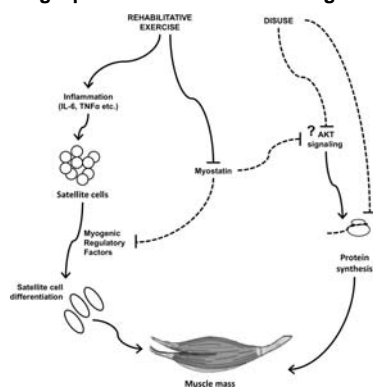
Risk prioritization in environmental health: A difficult must

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Life is optimization

Diagrammatic representation of the main mechanisms responsible for regulating skeletal muscle mass following a period of disuse and during subsequent rehabilitation in humans.



Marimuthu K et al. J Appl Physiol 2011;110:555-560

Journal of Applied Physiology

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Basics: prioritization is the survival issue; no risk, no food



Source: Wikimedia

Theodor Kittelsen: En uheldig bjørnejakt

This was a fact of life already for the first microbial organisms.

We should have learned it

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Golden old times before chemicals?

If risks always existed, did they increase?

Table 1. Telegrams sent by HM The Queen to subjects reaching the stated age in the first and fortieth years of her reign.

	100 years	105 years
Year 1	200	10
Year 40	2227	262

Queen Elisabeth II: Reign 6. Feb 1952 -

Source: Colin Berry, Risks, costs, choice and rationality, Proc. Roy. Inst. Gr. Brit.

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How high is the risk of death?

We have poor inborn ability to assess the level of risk

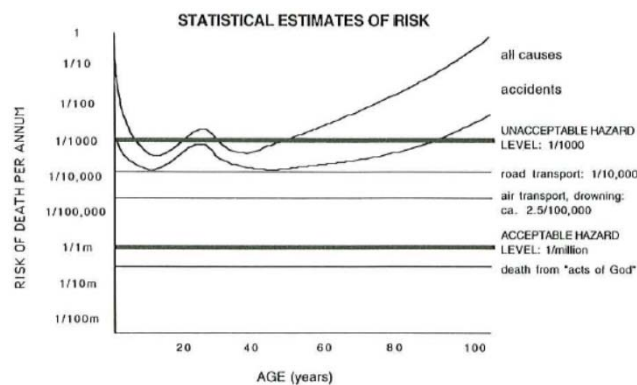


Fig. 1 Estimates of annual rates of risk of death with advancing years and their 'acceptability'.

Source: Colin Berry, Risks, costs, choice and rationality, Proc. Roy. Inst. Gr. Brit.

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Why prioritize?

- To aid in setting health service priorities
- To aid in setting health research priorities
- To aid in identifying disadvantaged groups and targeting of health interventions
- To provide a comparable measure of output for intervention, programme and sector evaluation and planning

Source: Murray, WHO Bulletin 1994:72:428

- Prevention of disease: why not regulate everything?

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Prioritization of risks

- Levels of risk vary greatly
- Prioritization is a must, but very hard to sell to the public
- We easily accept measures causing a burden to somebody else
- Resistance to change our own behaviour to reduce risks is great

Table 4. Cost effectiveness of selected US regulations

Regulation	Cost per premature death averted (SM,1990)
Car seat belt standards	0.1
Car fuel system standards	0.4
Car side impact standards	0.8
Car rear seat belt standards	3.2
Asbestos ban	110.7
Ethylene dibromide drinking water standards	5.7
1,2DCP drinking water standard	653.0
Atrazine/Alachlor drinking water standard	92070.0
Wood preserving chemicals, hazardous waste lighting	5700000.0

Data from Belzer [23]. The benefits measured are of deaths or injuries averted, no attention is paid to concepts such as water quality or environmental benefit. Colin Berry: Risks, costs, choice and rationality

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Population statistics aside, individual risk level is also important

- Man must be able to breathe, drink, eat and live in the environment trusting on its safety: **trust**
- Individual risk level may vary remarkably: **justice**
 - Occupational risks (policemen, fire fighters etc)
 - Recreational (mountain climbing, careless fireworks)
 - Lifestyle (smoking, alcohol, sexual habits, diet)

Two different viewpoints:

- **Population risk**; perhaps low individual risk but widespread exposure (e.g. PM10, radon)
- **Individual risk** (food poisoning, snake bite, solvents e.g. benzene, vinyl chloride)

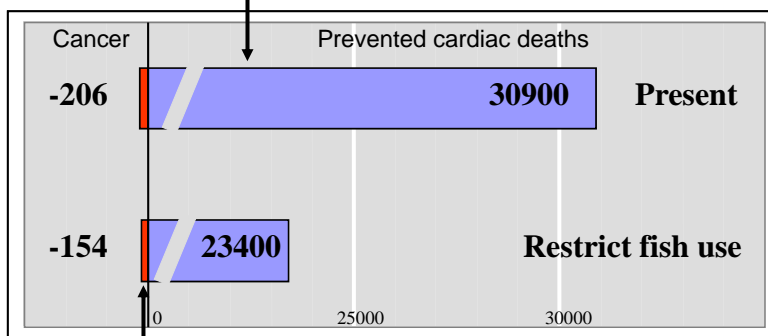
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Benefit vs. risk: POPs in fish

Restricting fish consumption would increase cardiac mortality in Europe, when the preventive effect of omega-3 fatty acids disappears
Number of reduced cancers dwarfs with this even assuming the worst case

If risk managers assume responsibility of total health effect of salmon consumption



If risk managers care only for cancer due to pollutants

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Tuomisto JT et al. 2004



Approaching the risk: risk is no simple matter

- **Description and analysis of the risk**
 - Cognitive and intellectual level
- **Risk perception**
 - Insight and digestion
- **Credibility**
 - Level of trust

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The first difficulty is to differentiate between hazard and risk

Hazard in the two pictures is the same, risk is not

Hazard is the property of a substance or other factor

Risk also includes the likelihood of the hazard to become true and therefore the same hazard may cause totally different risk in different conditions

Figs: Wikipedia



Chances of dying from selected causes (USA statistics)

Chapman and Morrison, Nature 1994:367:39

Cause of death	Chances
Motor vehicle accident (little motivation to restrict)	1 in 100
Murder	1 in 300
Fire	1 in 800
Firearms accident	1 in 2,500
Electrocution	1 in 5,000
Asteroid/comet impact	1 in 20,000
Passenger aircraft crash	1 in 20,000
Flood	1 in 30,000
Tornado	1 in 60,000
Venomous bite or sting	1 in 100,000
Fireworks accident	1 in 1 million
Food poisoning by botulism (high motivation)	1 in 3 million
Drinking water with EPA limit of trichloroethylene	1 in 10 million

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Extrapolation, not statistics as basis

Risk level uncertain and comparison to other risks difficult

- "A US EPA scientist remarked at a professional meeting that implementation of a risk-based regulation had resulted in the saving of 1000 lives annually.
- While certainly an impressive statement, because of the uncertainty and conservatism in the process, the more reasonable interpretation is that no more than 1000 lives per year would be saved, almost certainly many less, and maybe zero." Gargas et al, in Ballantyne et al (ed): General and applied toxicology 1999
- Make it clear to yourself whether the risk is a **measured** or **extrapolated** risk

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Difference between measured and extrapolated risks

- **Measured risk:** we have direct knowledge in **real** conditions on incidence in **human** populations
 - Death statistics (e.g. traffic accidents)
 - Epidemiological studies (e.g. cancer rate in smokers vs. non-smokers)
 - Clinical experience (mushroom poisonings)
- **Extrapolated risk:** we extrapolate from other **species** or from high exposure **levels**
 - Safety margins (e.g. 100x from animal data)
 - Modeling of cancer incidence from accidents or occupational setting (model crucial: linear, threshold)

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Problems from different sources of information

- **Extrapolated** risk is difficult to communicate to people
- The public and even some authorities think that if a limit value is exceeded, there is a high risk
 - There is usually ample safety margin
 - Even if the risk is real, it is often statistically unlikely (e.g. cancer risk usually unmeasurable by epidemiological methods, i.e. less than 1 %, but people think almost everybody will contract cancer)
 - Often risks thought to be caused by "others"
- A very real **measured** risk is not thought of as "my risk", if pleasure is involved (alcohol, speeding in traffic): willingness to accept "self taken risks"

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Prioritization is a must

- Because risk assessment methodologies vary, a common picture can only be obtained by using similar metrics
- Wrong decisions will cause huge waste of resources (both financial and personal resources)
- Unfounded scares will cause unnecessary fears; people have the right to make their own decisions, but correct information must be available
- Important decisions will be delayed due to false assumptions of priority (e.g. fine particulate limit values in EU, difficulty of climate change abatement)

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Approaching the risk

- Description and analysis of the risk
 - Cognitive and intellectual level
- **Risk perception**
 - Insight and digestion
 - This is especially challenging in risk prioritization
- **Credibility**
 - Level of trust

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Risk perception

- Dread is not directly correlated to magnitude of risk
- Familiar risk - unknown risk (alcohol/gene manipulation)
- Magnitude of episode (car accident vs. accident of jumbo jet)
- Voluntary/involuntary (1000x difference?) (mountain climbing/being subject to criminal assault; note that risk-taking is also used to elevate self-respect)
- Association to psychologically sensitive issues (nuclear power/nuclear weapons, chemicals/big money)

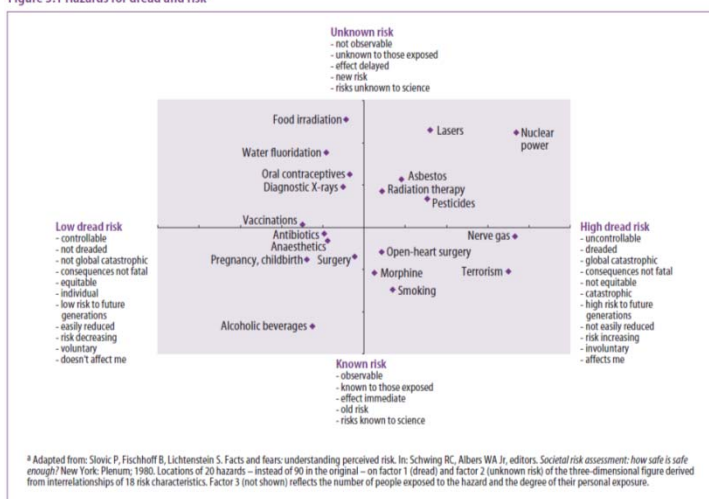
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Risk perception – unknown, high dread

The right upper corner illustrates difficult topics – unknown, high dread

Figure 3.1 Hazards for dread and risk^a



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World Health Report 2002



Risk perception

- Risk psychology is not very well known, but even existing knowledge is poorly utilized
- Do not **underestimate** the intellect and understanding of the audience
- Do not **overestimate** the previous knowledge of the audience
- Do not forget the power of attitudes and prejudices

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Problems with credibility

- You have to earn credibility, it requires patience, you can lose it in minutes (how many years a cashier has to be honest after misappropriation?)
- The worst approach is to suggest someone just being emotional: in the present society one has also to consider different attitudes of males and females
- People are truly afraid, never minimise that
- Special problems with such associations as nuclear power vs. nuclear weapons

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Typical differences between professionals and lay people

- "Differences among researchers", difficult to understand that they are part of scientific discussion, tendency to pick up one's own favourite (climate change skeptics a typical case)
- Different safety margins hard to understand: limit value is not a line between safety and risk
- Familiar risks are belittled, especially if they would threaten own pleasures
- **Understand** the difficulties and sympathize! But **don't be fooled** to accommodate with popular beliefs

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Only the dose determines that a thing is not a poison

- Surprisingly difficult to sell even to professionals
- Familiar examples may help (vitamins, necessary trace minerals)



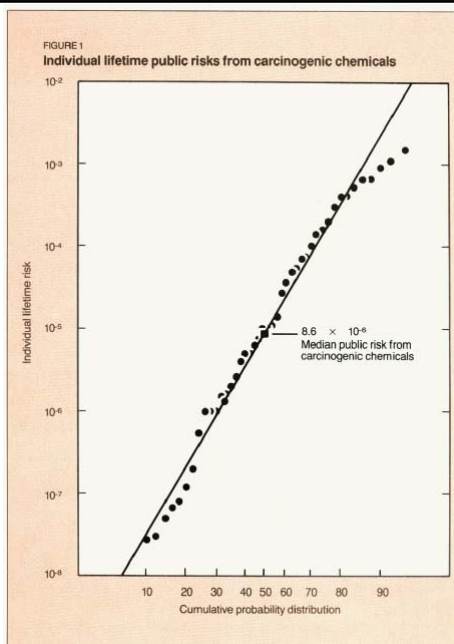
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How to prioritize then?

Early attempt to use previous decisions as a basis for new recommendations: even among carcinogen limit values the scatter of EPA decisions is over 10000 fold

Travis & Hattamer-Frey, Environ. Sci. Technol. 1988:22 (8): 873-876.



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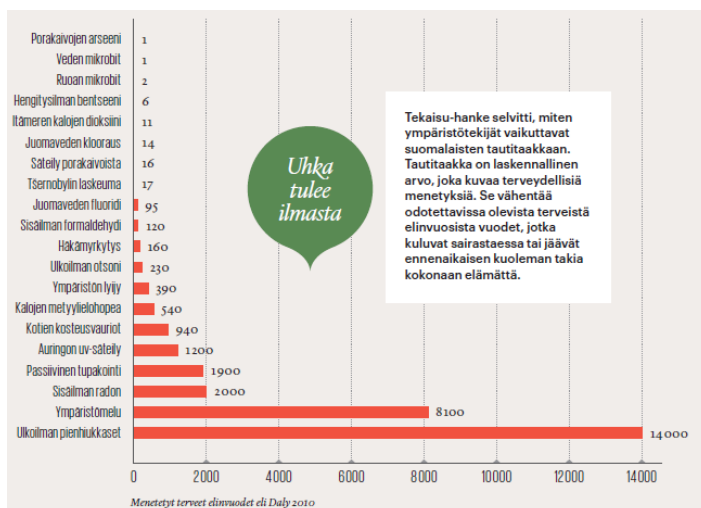
The most used modern tool: DALY

- **Disability Adjusted Life Years**
- Assumes a standard expected lifetime (e.g. 80+ yrs)
- Counts years lost due to premature death
- Counts years lost during illness (i.e. even serious infection is short, so impact minor)
- Counts years lost due to disability, weighed by the degree of disability
- Age weighing (peak value between 20 and 40 years)
- May include 3 % discounting (future loss is valued lower than a loss today)

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The most important environmental risks: air pollution leads, noise, radon, passive smoking, UV



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