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SYMPOSIUM ON 'SAFETY IN MAN'S FOOD'

Risk and benefit in food and additives

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Every human activity can be looked at from the point of view of risks and benefit, though we often have difficulty in deciding on an agreed definition for these terms.

For risks of death and disease a few principles can be formulated, keeping in mind as our standard examples the risks of ski-ing, smoking, pregnancy, accidents to workers on a building site or in deep sea fishing, or risks in war (Starr, 1969).

In modern society we all take risks every time we cross a street or drive a car. From consideration of the risks which we accept we can see what distinguishes acceptable from unacceptable risks (Lowrance, 1976; Sinclair, Marstrand & Newick, 1972).

We consider it a reproach if some easily avoided risk is left concealed so that individuals are not able to take avoiding action, and for unavoidable risks, such as those attendant on childbirth, we try to provide services to all members of the community, so that gross discrepancies of risk do not face some women in comparison with others. A high social gradient where poor persons are heavily at risk, is rightly regarded as a reproach to the organization of society.

This concept of spreading the risk is linked to the question of 'who benefits'. If the available resources of society, such as maternity hospitals or neonatal care, are unevenly distributed, then some individuals benefit, leaving others at risk. Many occupations carry a high risk: deep sea fishing, ship building, coal mining, and construction work all have an excess of injury and death from accidents. In 1973 there were 231 fatal accidents in the construction industry, a rate of one death per 5 000 workers per annum and twenty times as high as in chocolate manufacture (HM Chief Inspector of Factories, 1974; Hunter, 1976). These risks are voluntarily accepted in one sense, and yet economic pressures drive men to undertake risky

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jobs. But the benefits are distributed to other individuals, often to all the members of the society.

Another class of risks is found where the risk is openly acknowledged, and even a part of a voluntary or free-time activity, as in ski-ing, rock climbing or motor racing. A totally risk-free version of these sports would probably be uninteresting, in that the social value lies just in the pitting of personal skills, strength and judgement against a tough obstacle.

A point that is rarely made is that our attitude to risk alters with the information derived from the risk.

The use of new drugs must carry risks. Where side effects are quickly picked up it becomes possible to assess benefit against the open risk, and the risk is now taken voluntarily or avoided.

A different example is the effect on wild geese of the introduction of the insecticide carbophenothion as a seed treatment (Denning, Bunyan, Brown, Stanley & Jones, 1976). Grey lag and pink footed geese are far more sensitive than any of the other species tested, whose sensitivity in turn ranged from 1200 to 6 mg/kg for LD50. Many wild geese died after eating treated seed, but because the ecology of the geese was known it was clear that an unusual event had occurred, it was traced to the insecticide, and the manufacturer agreed not to use the insecticide in the areas where the geese were known to overwinter. This success story was dependent on monitoring of the population, knowledge of the natural history of the species, awareness that species vary widely in their response to the chemical environment, and co-operation between farmers, research staff of the ministry concerned and the industry.

The implication is that the introduction of any potentially toxic molecule into the human environment is only justifiable if monitoring procedures are undertaken in order to measure the effects of this new molecule.

Food

For food we have the knowledge that some selection of food is essential, and the question is whether some patterns of intake are safer than others, and whether there is a wide difference between individuals in what they should eat in order to minimize risks to health.

Food is dangerous stuff. Obesity is a major disease, and the high fat diet eaten in most developed countries has been convincingly linked both to coronary artery disease and also to cancers of breast and colon (Wynder, 1976; McLean, 1977).

We accept the risks of an unwise food pattern on the grounds that it is voluntary, open, or pleasurable. This does not absolve education or opinion-leaders from trying to inform the public of the consequences of various patterns of food choice.

For certain contaminants there is an apparent anomaly in our attitude. Nitrate in drinking water is present at a level of about 50 mg/l. This leaves a safety margin of less than two before methaemoglobinaemia is likely to become a problem for infants. For most substances added deliberately to food we demand a safety

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margin of 100 between the dose that causes any adverse effect, or perhaps any physiological effect in animals, and the dose used by man. Such margins are of course impossible for common salt, or dietary protein, fats, or modified starches.

Moreover the nitrate is reduced to nitrite in the saliva and can lead to formation of carcinogenic nitrosamines in the stomach, through reaction with dietary amines. (Issenberg, 1976). But there is little anxiety about nitrate in water. It seems likely that this is because no-one deliberately adds nitrate to drinking water. It is not seen as a hazard to many, with benefit to few, but rather seen as an evenly distributed risk, and the benefit, as cheap water, accrues to all. The alternative is seen as expensive water treatment and piping schemes. It looks as if people often prefer to take risks rather than spend money (Ashby, 1976; Lederberg, 1974; Sinclair *et al.* 1972). The objection to other, far lesser risks, is not to the risk as such, but to the element of deception or exploitation, or imposition. No-one likes to be 'made a monkey of', or told what is good for him, or to have lead dust fly into the home in order that someone else should drive his car on a road nearby.

Food additives

The wide range of food additives covers the antioxidants, preservatives, flavourings, many substances such as modified starches, and colours. Often the additive is very close to natural and known food components, such as ascorbic acid, or hydrolysed starch. However, acetylated and phosphated starches are really new molecules that can form a high proportion of the carbohydrate intake of infants, for a benefit that is essentially one of marketing. The tinned baby foods containing these starches do not settle into a lump requiring re-mixing after storage.

The benefits of food additives are largely that they make processed convenience foods possible. Storage of biscuits, crisps and most fat-containing manufactured foods would not be possible without antioxidants. Food colours in the UK, if permitted, are free of control in respect of how much is added or to what food. As a result an increasing concentration and total intake of colours comes about as competitive marketing leads to deeper coloured soft drinks, sweets and confectionery.

If we consider the food additives, we have first to think whether any risk exists at all. It is usually said that there is a threshold for biological effects, that if a sufficiently small number of molecules are introduced into the system then no effect will take place at all. This is true for experiments where a small number of healthy animals are treated with a compound, and rather crude changes are looked for. But in the situation which we are considering we have to consider a population of millions, including the old, young, sick and those on the threshold of adaptation, for whom a normally negligible stimulus might lead to breakdown of some physiological system, for example, an increase in salt intake to an individual close to heart failure.

In this laboratory we have found no threshold in the response of the rat liver to phenobarbitone, in its action in increasing the rate of drug metabolism. As the dose

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decreases so it becomes more difficult to detect the effect, and other factors such as dietary fat, become relatively more important, but we must assume that for large populations every stimulus will have an effect, and that separate stimuli will add up (McLean, 1974, 1977).

The same argument has been powerfully argued for carcinogenic effects (Crump, Hoel, Langley & Peto, 1976).

Table 1. *To be acceptable, risks of life and health should be*

1. Minimized, or if unavoidable, evenly distributed in the society.

Unless:

2. Voluntary, not imposed.
3. Open, not concealed.
4. Benefit and risk apply to the same persons.

And where unavoidable:

5. Information on consequences of risk should be measured in order to reduce future risk.

Food additives:

6. Are not requested by the consumer.
7. Are concealed.
8. Cannot be avoided by the individual consumer.
9. An exploitation of uninformed patterns of taste.
10. Lead to loss of information.

In the light of Table 1, food additives are seen to be widely distributed in society, but not voluntary. It would take extraordinary measures on the part of any person in a developed society to lead a normal life without taking in food additives, even if we were to confine our avoidance to say, antioxidants and colours, it would be a hard task.

The consumer does not ask for the additive when he buys goods, but he gets them so they are in a sense concealed.

The benefit comes in two important forms. First, cheap food depends on the technical strength of the whole food production industry, from pesticides, herbicides, motorized farming and transport. The convenience food industry is dependent on antioxidants to enable economic transport and storage to allow cheap distribution of foods, from biscuits to margarine. It seems most unlikely that the populations now benefitting from these techniques would be willing to do without. But the second group of benefits is much more dubious, in that 'mouth feel' and colour are said to be benefits to the consumer. The food industry has elevated the weakness of the untrained individuals' liking for the sweet and brightly coloured, into a 'positive benefit'. It seems more likely that marketing has exploited this weakness to create and strengthen an infantile group of taste preferences (Galbraith, 1975).

Demand is not an invariable guide to acceptability of a product, as can be seen from the demand for heroin or cigarettes.

But it is in the last point that food additives seem most at fault. Toxicity testing using animals is fraught with difficulties. Often a routine set of tests is carried out

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and no information about mechanisms of toxicity is found. As a result it is impossible to extrapolate from animals to man with any confidence.

Tests of carcinogenicity are hard to interpret; does mutagenicity to bacteria, or the production of lumps in the mouse liver indicate a hazard to man (*Lancet*, 1974)? If so, then several additives present a risk. I personally do not feel that increased liver tumours in mice with high spontaneous liver tumour incidence indicate a hazard.

Once animal testing is complete there is very little done to investigate the response of the human population to a new chemical input. We know that some chemical substances cause cancer and other diseases in man. We have discovered these effects because of some unusual circumstance. Often because only a few people were exposed, and the disease incidence was either massive, as with lung cancer and smoking, or else a relatively rare disease was caused, as with mesothelioma and asbestos, or aplastic anaemia and chloramphenicol, or nasal cancer and wood workers. It is extremely hard to detect that some substance doubles the incidence of a common disease, as for instance, carbon disulphide and death from coronary heart disease.

Since we are all exposed to food and food additives there are no control groups to study. These problems apply just as much to new foods or new patterns of food intake, as they do to additives.

It is highly probable that some of the differences in patterns of disease found in comparison between different countries and due to differences in food intake. It will be the task for the next years to discover these links, and epidemiological techniques cannot be expected to uncover the links without clues from laboratory work.

Table 2 suggests some actions to be taken to increase the acceptability of the risks in eating food and additives.

Table 2. *Action to reduce hazards in food to an acceptable level*

1. Inform consumers of the risks of high fat diets and obesity, and other risks as they become certain (but not before).
2. Reduce by 10% p.a. the permitted levels of use of compounds such as colours added for marketing purposes. That is, compounds not requested by the consumer and which do not carry a measurable benefit in cost terms. (Permit sale of separate additives such as glutamate or food colours.)
3. Information on laboratory tests of safety to be admissible only if public, and require the results of all tests, on compounds rejected because of toxicity, to be published in order to increase our information on structure and toxicity of chemicals.
4. All testing of toxicity to be conducted by separately responsible organizations, charged with evaluating the interactions of the required molecules with biological systems, not asked to show 'that compound X is safe'.
5. Human studies on foods and additives must be increased in number and time to give reasonable assurance of safety in use and that the main groups in the population are not put to risk.
6. Proper attention to safety must become a paying proposition.

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The objective should be to permit the maximum informed choice by consumers, the maximum freedom of action by producers that is compatible with the agreed goals of society. Private industry has developed admirably effective means of production, these have to be directed into socially acceptable goals because there is no self-regulatory force.

Obesity in developed countries and infant malnutrition in the less developed countries (Millard, 1976) is abundant evidence that we could produce safe and health-promoting diets, but our social instruments for doing so are primitive in comparison with the technical means of production. The next task of nutritionists will be in this direction.

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