RAIA Paper On Indoor Environment and Health

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This Note addresses some of the important areas and issues in this important emerging field of Environmental Health. It does not seek to be definitive, but rather a general introduction to this rapidly developing area.

I. Introduction

Modern medicine has been outstandingly successful in the twentieth century in bringing science to the diagnosis and treatment of disease. This success in the area of infectious disease, and the rapid changes in the use of synthetic chemicals, has given rise to an increase in the proportion of illness attributed to environmental factors. Illnesses such as cancer, asthma, allergy, degenerative diseases and chronic fatigue syndrome are on the rise in most first world countries.

As the medical approaches of diagnosis and treatment become unaffordable, attention is now turning to the area of primary prevention, by appropriate modification of the environment. This is the modification of risk factors to reduce the incidence of particular health problems in the population. Primary prevention has proven cost effectiveness in health management, whereas secondary prevention and many medical interventions do not. Australia spends $22 billion of the public budget on the health system currently, and it has been suggested that this could be reduced by nearly 50% with appropriate initiatives in primary prevention.

In assessing prospects for such preventive measures, governments are increasingly looking to areas outside the traditional health care system as places where appropriate changes may help improve the health of the population. In the last decade, attention has become focused on the indoor, or built, environment, and this represents a major opportunity for architects to profitably improve the health of all Australians.

II. Built Environments - The new health frontier

Most people are aware of outdoor air pollution, and assume that health problems emanate primarily from that problem. This is incorrect. The average worker, parent or school child spends approximately 90% of their time in some form of indoor environment (home, office, factory, car, bus, shopping centre, school, etc), and about 60% of the time is spent in the home.

In addition, pollutant levels inside most indoor environments are considerably worse than in the outdoor environment. The indoor draws its air from the outdoor environment, and adds pollutants derived from furnishings, construction materials, heating and other sources within the building. The more the building is tightly sealed for energy conservation purposes, generally the greater the retention of these indoor pollutants, and the worse the quality of the

indoor environment.

This means that most of a modern human life is spent in environments which are the least conducive to good health, and where health risk is intimately associated with the materials, equipment and maintenance of this environment. An architect looking to create a high quality built environment must be prepared to specify more than construction materials and methods. Specifications for ventilation, equipment, furnishings and maintenance of the building (painting, cleaning, etc) are essential, and are integral to the success or otherwise of the structure as a healthy building. Failure in any of these areas can lead to the loss of all advantages gained by improved materials and construction.

III. What are the health problems?

Beyond the well known, if somewhat controversial, condition known variously as "Sick Building Syndrome" and "Tight Building Syndrome", there are a number of health problems for which there is good evidence that the built environment is a major contributor.

A. Asthma and allergy

The best known, and arguably among the most important, is asthma and allergy. Asthma incidence and prevalence has doubled between 1983 and 1993, and is arguably Australia's fastest growing major health problem. Around four million Australians are asthmatic, and six million suffer sinusitis and hay fever. Over 80% of these people are allergic (that is, they react adversely to one or more environmental factors). The direct and indirect costs of asthma and allergy are now thought to exceed three billion dollars in Australia, and we have arguably the highest asthma and allergy rate in the world.

The best known cause of allergy, and of asthma specifically, is the dust mite. More than three quarters of allergy sufferers are allergic to dustmite (about the same number who are sensitive to cockroach, according to recent research [10,11]). More precisely, they are sensitive to proteins in the faeces of the dust mite. The dust mite survives in temperate Australian homes mainly in the bedding, pillows and carpets, and requires high relative humidity for its survival and reproduction. This is found in the microenvironment of the bedding and carpet, where humidity is usually higher than atmospheric humidity. Vacuuming with normal vacuum cleaners tends to worsen, rather than improve the problem, as the faeces are only a few microns in size, and tend to pass through most simple filters in cleaners, to become re-suspended in the air.

As well as the dustmite, other allergens (allergy causing agents) such as moulds and grass pollens are common allergens, and can cause or worsen asthma in most allergic people. Current research also demonstrates that formaldehyde and volatile organic compounds (VOCs) of various types cause worsening of asthma, either through a true allergic response, or through irritation of the delicate membranes of the respiratory tract [3,7].

B. Chronic fatigue syndrome and multiple chemical sensitivities

Illnesses such as chronic fatigue syndrome (CFS) and multiple chemical sensitivities (MCS) are also increasing in prevalence. Many of these cause non-specific, multi-organ system symptoms, and many researchers have noted the similarity between CFS and sick building syndrome (SBS). Increasing evidence is mounting to implicate environmental chemicals and biological agents in this illness, as the focus turns away from post-infective causes. In 1989, CFS was estimated to cost Australia over $80 million per year in direct health costs and loss of productivity. The escalation in numbers suffering the illness (mainly because of the chronic nature of the illness) would now place that figure closer to $200 million. This does not take into account the lost opportunities for children who are increasingly being affected.

CFS patients are more likely than most to suffer allergies, and most become adversely affected by chemicals, even if chemical exposure is not the source of their problems.

MCS is a condition that primarily affects the nervous system [1,4,5], particularly the brain, and most often has characteristic symptoms including decreased short term memory, poor concentration, weakness and fatigue, and altered mood and emotional states. Most MCS sufferers are markedly intolerant of alcohol.

Specific testing, such as the Auditory Evoked Response Potential (AERP) test and SPECT brain scans usually demonstrate significant changes in MCS sufferers, and these changes are consistent with neurotoxic damage.

This increasing sensitivity to the smell and adverse effects of chemicals in the indoor and outdoor environment is far more common than usually appreciated, affecting up to 15% of US college students [4]. Between one half and two percent of the population are sickened or disabled by this sensitivity, to the extent that they seek to intentionally minimise exposure to volatile chemicals in order to avoid symptoms. Many cannot work at all in the usual school or office environment, and most need to specially build or modify their homes in order to attain any reasonable quality of life.

When exposed to volatile organic chemicals such as aromatic hydrocarbons, formaldehyde or cleaning agents, they suffer a broad range of disabling symptoms which effectively reduce their ability to work or learn, often very significantly. Some children (commonly) and adults (less commonly) develop marked behavioural and neurological disorders after such exposure, further damaging their ability to work, or to learn at school.

C. Damage to immunity, nervous system, fertility and genetics

The field of toxicology is currently undergoing a revolution. Past concepts of threshold limit values (TLV), no observed adverse effect levels (NOAEL), and acceptable daily intake (ADI), derived from animal toxicological studies, are now clearly inadequate to describe the

types of health problems of which humans complain. Studies of exposure at these "safe levels" have shown unexpected negative health consequences, mainly related to damage to immune and nervous system function, reduced fertility, damage to the chromosomes, and damage to mitochondria, which are responsible for generation of energy within cells.

The fact is that most of these toxic responses have never previously been assessed for over 98% of currently available chemicals. Our focus has been on fatalities and cancer, and even here, toxicology has failed to provide useful protection where combinations of chemicals have been used.

Recent studies have demonstrated damage to the nervous system in workers exposed to as little as 3% of the TLV [8,9], a workplace standard largely set by manufacturers of chemicals some decades ago. Exposure to common volatile chemicals at levels below the NOAEL have been shown to alter fertility in males (reduced sperm counts, abnormal sperm and abnormal motility), while the same chemicals can cause trans-generational effects by damaging mitochondria in females, and genetic material (chromosomes) in males and females.

The damage to the nervous system is especially worrying, especially for school children, and for workers whose effectiveness depends on mental capacity, memory and decision making. The damage is slow and insidious, and tends to affect short term memory, concentration, and decision making capacity in the early years. Later, the damage becomes indistinguishable from Alzheimers disease, and many researchers have pointed out the relationship between the increase in Alzheimers and Parkinsons disease, and the increasing use of chemicals which lead to this type of nervous system damage.

Of course, as far a the health of the population at large is concerned, the greatest problems may relate to genetic damage and reduced fertility in males. The 30 to 50% drop in sperm counts in the past three decades has been confirmed by recent research, and is thought to be due to the oestrogenic (oestrogen like) effect of many environmental pollutants, including certain compounds found in plastics, cleaning agents and pesticides. A further increase at the same rate would see the majority of first world males considered infertile within two generations.

Clearly, a precautionary approach to this new information suggests that it is time to make a considerable effort to reduce exposure to agents in the home, school and workplace which are likely to cause or contribute to health problems. The situation appears to be urgent.

IV. Conclusions

While much remains uncertain about the degree to which health can be improved by appropriate design and management of the built environment, the evidence currently before us suggests that, along with the diet, the indoor environment may exert the single biggest modifiable influence on the health of the community.

There is no longer any doubt that minimisation of allergens and chemical irritants, especially in the first three years of life, can reduce the incidence of asthma and allergies by as much as one half. Design and maintenance of homes, schools and workplaces to achieve this goal is a cost-effective primary preventive measure which Australia will need to pursue if it is not to continue the trend of increasing asthma, and diminishing ability to afford medical management, including drug therapy.

The rise in asthma, chronic fatigue syndrome, allergies, multiple chemical sensitivities, and chronic degenerative diseases should remind us that the largest gains from medicine have already been made, and that we will soon be unable to afford this medical approach. On the other hand, it provides the opportunity for the creation of new health professionals, committed to primary prevention of these diseases and health problems.

It is in this role that architects will soon need to take their place. The information and knowledge required for architects to do this is emerging in the field of Environmental Health, and those who are willing to keep on top of this field now will be creating a future for themselves and for millions of Australians well into the next century.

An architect who is prepared to create healthy buildings can do more for the longevity and health of Australians in a decade than a doctor can in their whole professional career. And all this at no cost to the taxpayer!

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V. Further reading and References

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