特集：生活環境化学物質と人体暴露

WHO's Human Exposure Assessment Locations (HEAL) Programme

Hidehiko TAMASHIRO[1] and Kersten GUTSCHMIDT[2]

1 . Introduction : Goal and Objectives

Human exposure to a pollutant occurs when a person comes in contact with that pollutant, either through the skin, through the air, or through food or drink. In order to study health effects and devise appropriate pollution control strategies it is important to know the level of this exposure. The World Health Organization (WHO) and the United Nations Environmental Programme (UNEP) have thus co-sponsored an international exposure assessment effort, the Human Exposure Assessment Locations (HEAL) programme in order to develop and apply techniques for the determination of direct human exposure world-wide.

The goal of HEAL is the promotion of improved human exposure monitoring and assessment internationally with the following four specific objectives :

* To provide comparable and valid assessment of human exposures to selected environmental pollutants at each of the HEAL ;
* To improve, field test, harmonise and demonstrate methods for the integrated monitoring and assessment of human exposure to pollutants ;
* To promote the assessment of human exposures to pollutants as a basis for development of environmental control strategies for the protection of public health ;
* To provide an overview of existing exposures of selected populations to pollutants on a regional and global basis and if possible, observe trends in this regard ;
* To improve national capabilities for environmental monitoring and human exposure assessment, particularly in the developing countries (WHO/UNEP, 1985).

The HEAL programme was endorsed in 1982 as a possible framework for internationally co-ordinated assessments to human exposure.

[1]Department of Health in Sustainable Development, WHO
[2]Department of the Protection of Human Environment, the Cluster of Sustainable Development and Healthy Environments, WHO

2 . Co-ordination Mechanisms

WHO/UNEP developed the HEAL programme as a health-related component of UNEP's Global Environment Monitoring System (GEMS). Under this component different projects are carried out for environmental monitoring of ambient air, food, and water in a network of stations around the world to assess pollutant status and trends. The HEAL programme has concentrated on assessing total human exposure in various countries around the world.

WHO in Geneva has co-ordinated the HEAL programme in co-operation with the WHO Regional Offices, the UNEP/GEMS Headquarters in Nairobi and the Monitoring and Assessment Research Centre (MARC) in London. The international component of the HEAL programme has been financed by WHO/UNEP and contributions received from different countries inlcuding Japan as a major donor. The exposure monitoring and assessment studies on country level were financed by the countries themselves.

For each pollutant in the HEAL programme, a participating institution serves as the Technical Co-ordinating Centre (TCC) for that pollutant. The TCCs prepare monitoring protocols, design and implement stringent quality assurance (QA) programmes, and help other participants implement the monitoring procedures. The TCC also provides technical support, stores data, and prepares reports on the results of the study. National Institute of Public Health, Japan, has played an important and active role in the development and implementation of the project since its inception. Each country, however, has a major technical responsibility to conduct the studies within its borders.

3 . Implementation

During the initial stage (primarily 1986-1988), technical and operational aspects were discussed and different documents and protocols were prepared. Quality assurance and quality control (QA/QC) schemes for the participating laboratories were put in place in 1986.After successful participation in that part, seven countries around the world started their pilot studies and par-

ticipated in the human exposure assessment.

In the pilot phase, the following four issues were addressed:

* Exposure assessment methods training
* Quality assurance and analytical performance evaluation
* Data on exposures to specific chemicals
* Global availability of training facilities.

During the pilot phase, three groups of chemicals were focused (Table 1). These three groups of chemicals because 1) they posed significant health risks (Williams, 1991), 2) analytical techniques were widely available for them, and 3) many of the HEAL participants had an interest in assessing exposure to them. They were likely to present different exposure pathways. In addition to obtaining exposure data, the pilot phase addressed exposure assessment methods, quality assurance and analytical performance evaluation, training, and global availability of training facilities. The framework for conducting the studies was relatively rigid and all members performed the same pollutant with identical protocol in a fixed location.

In 1986 three Technical Co-ordinating Centres (TCC) were appointed, each for a special pollutant (WHO/UNEP, 1986a):

The TCCs (Table 2) were established to provide technical expertise, training, quality control samples, and analytical performance evaluation for all participating countries. The TCCs evaluated the data and methods and produced reports that were available to WHO and UNEP. Following the pilot study, the WHO and UNEP reviewed the methods used for human exposure assessment, and subsequently recommended the preparation of guidelines for quality assurance, training, and improved monitoring and assessment techniques for the next stages of the HEAL programme (WHO/UNEP, 1992a, b; Kollander, 1993).

As the products, several documents or guidelines were published: a guideline for integrated air, water, food and biological exposure monitoring (WHO/UNEP, 1986c), protocols from the TCC in Japan for the determination of nitrogen dioxide (WHO/UNEP, 1987a), from Sweden for cadmium and lead (Vahter M. and Slorach S., 1986) and from the USA for organochlorine compounds (UNLV-ERC, 1986). The results of the pilot study within HEAL programme were presented in several reports separately (lead and cadmium: Vahter and Slorach, 1990; nitrogen dioxide: Matsushita and Tanabe, 1991; HCB and DDT: WHO/UNEP 1989a, b; Williams, 1991).

Based on the results of the pilot phase, the programme entered into its second stage (primarily 1989-1990). The established TCCs were continuing their activities, while new TCCs were added to promote the human exposure

Table 1. Pollutants according TCCs in the HEAL pilot phase

Pollutants	TCC
Heavy metals: lead (Pb) and cadmium (Cd)	**Sweden**: Institute of Environmental Medicine, and Department of Environmental Hygiene, Karolinska Institute, Stockholm; National Food Administration, Uppsala
Combustion product: NO_2 (nitrogen dioxide)	**Japan**:National Institute of Public Health, Tokyo; Yokohama City Institute of Health, Yokohama
Pesticides: HCB (hexachlorobenzene) and DDT (dichlorodiphenyltrichloroethane)	**USA**: Environmental Research Centre, University of Nevada, Las Vegas

Table 2. HEAL Technical Co-ordinating Centres

Pollutant	Institution
NO_2, VOC	National Institute of Public Health, Tokyo
Pb, Cd, Hg	Karolinska Institute, Stockholm
Pesticides	USEPA, Las Vegas Laboratory
Fluorides	Institute of Environmental Health Monitoring, Beijing
Arsenic	Institute of Public Health, Santiago
PAH, PM_{10}	USEPA, RTP NC (for Kuwait study only)
Statistical Survey Design	USEPA, Washington DC
CO	USEPA (under consideration)
PCB and Dioxin	WaBoLu (supporting Czechoslovakia)

assessment to other pollutants (Table 3). The protocol, however, was less rigid: each country could choose pollutants which were of interest to them and it wasn't anymore essential to monitor this pollutant at the fixed HEAL. As a result, the number of participating countries increased from the initial seven to 27. The country activities were either to conduct field studies or to participate in the QA/QC programme. NO_2 human exposure, for example, were determined in Germany, Hungary, and Russia. Another study in Kuwait focused on NO_2 as well as on PM_{10} and PAH. Furthermore, different countries were interested in the determination of additional pollutants like mercury, fluoride, arsenic, pesticides, dioxins, volatile organic compounds, etc.

Furthermore, an indoor air pollution study was incorporated into the organisational setting of acute respiratory infections (ARI) studies in Kenya and the Gambia supported by the WHO and the National Academy of Sciences (NAS), USA. The objectives of the study were to:

* Measure CO, CO_2, NO_2, respirable suspended particles (RSP) with their associated polycyclic aromatic hydrocarbons (PAHs), as an indicator of air pollution in a representative number of houses in the Maragua area, Kenya;
* Evaluate the main factors contributing to high indoor air pollution exposure for children aged below five years in the study population;
* Explore the feasibility of assessment of the relationship between the level of indoor air pollution and the ARI incidence.

Thirty six households were randomly selected from

Table 3. HEAL member countries and pollutants of interest

Original Members (7)	**Pollutant studied**	**Proposed Studies**
Brazil	NO_2	Hg
China	NO_2, Pb, Cd, Pesticides	F
India	NO_2, Pesticides	
Japan	NO_2, VOC, Pb, Cd	
Sweden	NO_2, Pb, Cd	
United States	NO_2, Pesticides	
Yugoslavia	NO_2, Cd, Pb, Pesticides	
Members Added in 1990-1992		
Bulgaria		NO_2
Chile		As
Czechoslovakia		Pb, Cd
Egypt		CO, Pb
Germany	NO_2	
Hungary	NO_2	
Israel		Pb
Kuwait	NO_2, PM_{10}, PAH	
Lithuania		NO_2
Mexico		Pb, Cd, As, F
Norway		
Pakistan		
Philippines		CO, Pb
Poland		
Romania		
Saudi Arabia		
Singapore		Pb
Thailand Turkey		Pb
United Kingdom		
USSR (Russia)	NO_2	

250 in the area. The air pollution survey consisted of administration of a questionnaire, 24-hour average measurements, and daily pollution pattern measurements. Furthermore, repeated 24-hour measurements of suspended particulate matter and NO_2 was carried out in 18 randomly selected kitchens in the Gambia. In addition, hourly measurements were performed in a few cases. Depending on the season the study design had one or two components ; 24-hour average measurements and daily pollution pattern measurements. The results were published elsewhere (WHO/UNEP, 1987b ; WHO/UNEP 1988, WHO, 1984, Koning de, 1988).

During 1991-1992, a few workshops were held including the workshop on statistical survey design and human exposure assessment monitoring (Bad Elster, Germany) and the co-ordinators meeting on lead (Bangkok, Thailand). The former workshop provided a comprehensive overview on the environmental and statistical aspects of human exposure assessment research with the objective of communicating and disseminating survey and statistical methods throughout the international scientific community in support of the objectives of the HEAL programme. The latter meeting was attended by 20 HEAL participants from all over the world, focusing on human exposure assessment to lead.

4 . Reappraisal and Potential Future Directions

These developments gave WHO/UNEP an indication of the importance of international activities in human exposure assessment. But the "explosion" of participating countries also brought "side effects". The most experienced was overwhelmed by having to provide assistance and QA/QC materials to all these institutes. In addition, most of the studies conducted was relatively limited in their scale and the data and information resulted from the studies were not necessarily representative of the populations and therefore they were not very useful as an instrument for decision-making.

Realising the advantages and disadvantages in the first two phases, the proposals were made in 1994 for the re-orientation of the HEAL activities. It was pointed out, that the strengths of the HEAL programme are 1) the existence of the TCCs, 2) the training opportunities in scientific sampling methods for the collaborating organizations, 3) the conduct of limited studies, and 4) the generation of reliable data. On the other hand, the weaknesses are that 1) the studies have a limited scope and small sample size, 2) the number of participation institutions and countries is still relatively small, 3) the list of pollutants is limited, and 4) the studies are designed as pilot or demonstration studies. Furthermore, many of the HEAL studies was carried out in where the concentrations of the pollutants and the exposure through the air and water might have been relatively high. In this case, the use of the exposure framework in the fixed location monitoring could have been of great value in determining the primary contributions. However, this framework would not work if the exposure is comparatively low. This aspect of the HEAL programme was not acknowledged in its own publications.

Having taken these into consideration, it was proposed that the HEAL programme and its activities should have been restructured : human exposure assessment should be linked more directly to environmental epidemiology investigations and environmental health decision-making, thus universally becoming a more useful tool for environmental health management. Training and technical support activities were similarly intended to more fully integrate exposure assessment into the important facets of environmental health management : from environmental epidemiology to pollution prevention and control, and decision-making. Linkage to the WHO/UNEP/USEPA project HEADLAMP should be established. The proposed new HEAL programme should have an important linkage to, and integration into, other programmes related to information management and decision-making, as well as human resources development and capacity building activities in and outside WHO. Key features will include at a minimum the following :

* Support to the development of methodologies of human exposure assessment for the comparative health risk analysis and to the development and evaluation of mitigation strategies ;
* Increased collaboration with other organizations in pursuit of the development of standard protocols for QA/QC in environmental measurements and reporting data ;
* Establishment of a global network and strengthening of active and participatory networking for human exposure assessment and related human resources and capacity development, especially in the developing countries.

These proposed activities would help establish infrastructures in the countries and generate more useful information for decision-making by both government agencies and NGOs.

5 . Conclusion in line with global needs and changes in the field

HEAL programme has evolved significantly since its

inception in terms of its concept and activities, availability of human and financial resources and lastly but not least the co-ordination mechanism itself, even though its scientific importance and relevance continue to remain throughout. Some participating countries have established their infrastructures sufficiently enough to cope with the national QA scheme for human exposure assessment and other related activities and to co-ordinate their national programmes with less external support. In the meantime, financial and human resources of WHO and UNEP for the programme implementation have diminished as opposed to the increased inputs to the new priority areas and projects with response to the emerging economic, social and environmental changes in the world, especially in the developing countries.

As a result, the programme has shifted its focus with the major thrust of normative functions of more traditional UN agencies, such as the development of the standards and guidelines, training, etc. In addition, the recent development and availability throughout the world of telecommunication technologies such as the Internet and the World Wide Web enable the global networking for information sharing and dissemination feasible with much less financial expenditures even in the developing countries. This type of technological revolution also forces to change the mode of international operation in many fields of sciences and public health practices including the humane exposure assessment. The above-mentioned potential reorientation of the programme has taken these factors into consideration and future interventions which would allow more cost-effective approaches to the comprehensive analyses of human exposure assessment within the broad context of sustainable human development.

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