An Introduction to

Medical Geography

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Contents

1

Geography of Health

HEALTH GEOGRAPHY

Health geography is the application of geographical information, perspectives, and methods to the study of health, disease, and health care. Adopting a socio-ecological rather than the bio-medical model, health geography adopts a more holistic approach, emphasizing treatment of the whole person and not just components of the system. Under this model, new illnesses (e.g., mental ill health) are recognised, and other types of medicine (e.g., complementary or alternative medicine) are combined with traditional medicine. This alternative methodological approach means that medical geography is broadened to incorporate philosophies such as structuration, structuralism, social interactionism, feminism, et cetera. Thus the field of health geography was born.

History of Health Geography

A classic piece of research in health geography was done in 1854 as cholera gripped London. Death tolls rang around the clock and the people feared that they were being infected by vapors coming from the ground. Dr. John Snow thought that if he could locate the source of the disease, it could be contained. He drew maps showing the homes of people who had died of cholera and the locations of water pumps. He found that one pump, the public pump on Broad Street, was central to most of the victims. He figured that infected water from the pump was the culprit. He instructed the authorities to remove

the handle to the pump, making it unusable. After that the number of new cholera cases decreased.

Areas of Study

Health geography can provide a spatial understanding of a population's health, the distribution of disease in an area, and the environment's effect on health and disease deals also with accessibility to health care and spatial distribution of health care providers. The study is considered a subdiscipline of human geography, however, it requires an understanding of other fields such as epidemiology, climatology.

Geography of Health Care Provision

Although health care is a public good, it is not 'pure'. In other words, it is not equally available to all individuals. The geography of health care provision has much to do with this. Demand for public services is continuously distributed across space, broadly in accordance with the distribution of population, but these services are only provided at discrete locations. Inevitably therefore, there will be inequalities of access in terms of the practicality of using services, transport costs, travel times and so on.

Geographical or 'locational' factors (e.g. physical proximity, travel time) are not the only aspects which influence access to health care. Other types (or dimensions) of accessibility to health care except for geographical (or spatial) are social, financial and functional. *Social* accessibility to health care depends on race (like separate hospitals for white and black people), age, sex and other social characteristics of individuals, important here is also relationship between patient and the doctor. *Financial* depends upon the price of a particular health care and *functional* reflects the amount and structure of provided services. This can vary among different countries or regions of the world. Access to health care is influenced also by factors such as opening times and waiting lists that play an important part in determining whether individuals or population sub-groups can access health care – this type of accessibility is termed 'effective accessibility'.

The location of health care facilities depends largely on the nature of the health care system in operation, and will be heavily influenced by historical factors due to the heavy investment costs in facilities such as hospitals and surgeries. Simple distance will be mediated by organisational factors such as the existence of a referral system by which patients are directed towards particular parts of the hospital sector by their GP.

Access to primary care is therefore a very significant component of access to the whole system. In a 'planned' health care system, we would expect the distribution of facilities to fairly closely match the distribution of demand. By contrast, a market-oriented system might mirror the locational patterns that we find in other business sectors, such as retail location. We may attempt to measure either *potential accessibility* or *revealed accessibility*, but we should note that there is a well-established pattern of utilisation increasing with access, i.e. people who have easier access to health care use it more often.

Health Geographers

Notable Health Geographers Include:

- Jonathan Mayer
- Melinda Meade
- Ellen Cromley
- Anthony C. Gatrell
- Jim Dunn
- Robin Kearns
- Sara McLafferty
- Graham Moon
- Gerard Rushton
- W.F. (Ric) Skinner

Historical Geography

Historical geography is the study of the human, physical, fictional, theoretical, and "real" geographies of the past. Historical geography studies a wide variety of issues and topics.

A common theme is the study of the geographies of the past and how a place or region changes through time. Many historical geographers study geographical patterns through time, including how people have interacted with their environment, and created the cultural landscape. Historical geography seeks to determine how cultural features of various societies across the planet emerged and evolved, by understanding their interaction with their local environment and surroundings. For some in the United States, the term *historical geography* has a more specialized meaning: the name given by Carl Ortwin Sauer of the University of California, Berkeley to his program of reorganizing cultural geography (some say all geography) along regional lines, beginning in the first decades of the 20th century. To Sauer, a landscape and the cultures in it could only be understood if all of its influences through history were taken into account: physical, cultural, economic, political, environmental.

Sauer stressed regional specialization as the only means of gaining sufficient expertise on regions of the world. Sauer's philosophy was the principal shaper of American geographic thought in the mid-20th century. Regional specialists remain in academic geography departments to this day. But some geographers feel that it harmed the discipline; that too much effort was spent on data collection and classification, and too little on analysis and explanation. Studies became more and more area-specific as later geographers struggled to find places to make names for themselves. These factors may have led in turn to the 1950s crisis in geography, which raised serious questions about geography as an academic discipline in the United States.

MINERAL DUSTS AND HUMAN HEALTH

The Mineral Dusts and Human Health Project (MDHHP), which ran from fiscal year 2001 through fiscal year 2004, utilized an interdisciplinary approach (involving mineralogy, economic geology, aqueous and stable isotope geochemistry, analytical chemistry, remote sensing, regional geology, and toxicology expertise) to help understand how the geologic

characteristics of mineral dusts (and the source materials from which the dusts are derived) may influence their roles in human health. A key aspect of the project was its integration of earth science and health science expertise and activities. A summary of MDHHP outcomes and publications is included below.

The project's primary focus was upon asbestos and fibrous dusts related to mining, mineral processing, or mineral products, and so the project addressed environmental and human health priorities of the Mineral Resources Program outlined in USGS science planning documents. To a limited extent, the project also successfully applied the same interdisciplinary approach (in collaboration as appropriate with other USGS projects) to study potential health implications of other earth materials such as: metal-bearing mine wastes, mill tailings, and smelter emissions; dusts from dry lake beds; soils; volcanic ash; coal and coal fly ash; and dusts from building collapse. The studies identified many topics for a spectrum of earth materials where substantial further research is needed to address increasing societal concerns.

The majority of the project's funding came from the USGS Mineral Resources Program. The Mendenhall Program supported a post-doctoral toxicology position linked to the project for two years, and the Earth Surface Dynamics Program and Energy Resources program contributed support for the toxicology position.

The Mineral Dusts and Human Health project's focus was primarily on asbestos-containing dusts, although other dusts and dust sources were also investigated to a lesser extent. The project was initiated to provide impartial scientific input to help address renewed societal and regulatory concerns about potential health effects associated with exposure to asbestos. In the past, societal and regulatory concerns were focused on commercial and industrial asbestos. However, in recent years, largely as a result of significant health problems at Libby, Montana, concerns have increased substantially regarding so-called "naturally-occurring asbestos" (NOA) and other fibrous minerals that occur a) as accessory minerals in other industrial

mineral deposits (such as vermiculite deposits like those mined at Libby, and such as some talc deposits) and b) in rock units (such as serpentinite-bearing ultramafic rocks).

The project provided insights about a number of asbestos issues that benefit a wide variety of stakeholders. The project's activities also provided information that can be used to help address some of the many unanswered questions remaining about asbestos. For example, many questions still remain about how asbestos actually causes toxicity, and whether or not fibrous but non-asbestiform varieties of the same minerals can also trigger toxicity.

Further, relatively little is known about the full range of geologic environments in which asbestos or other fibrous minerals can occur, the extent to which natural erosion or anthropogenic disturbance of these sources contributes to background levels of asbestos in the air, and the extent to which such background contributions can themselves trigger disease. Although the project's primary focus remained on asbestos and related minerals, limited studies were also carried out on other mineral particulates and/or their potential source material, including: mine wastes; mill tailings; soils affected by smelter emissions; mercury mine calcines; dry lake beds such as Owens Lake, CA; volcanic ash; various soils; coal dust and coal fly ash; and dusts generated by collapse of buildings such as the World Trade Center. These studies demonstrated that a similar interdisciplinary approach to that developed by the project to study asbestos can provide important insights into potential health concerns tied to many other types of earth materials that may be liberated as particulates into the environment. The studies also identified many topics in this realm where substantial further research is needed to address increasing societal concerns. The USGS Mineral Resources Program is currently (FY 2005-2009) funding a follow-up project titled "Earth Materials and Human Health" to address unresolved questions about asbestos and the potential health impacts of other earth materials such as mine wastes, soils, volcanic ash, dry lake bed dusts, coal dust and coal fly ash, and others.

MINERAL DUSTS AND HUMAN HEALTH (MDHH) PROJECT OUTCOMES

- USGS characterization work on fibrous amphiboles and vermiculite at Libby, Montana (funded in part by the US EPA and in part by the USGS Mineral Resources Program) has provided key scientific information that is being used or will be used to help:
  a. Assess the nature and extent of amphibole contamination present at Libby, at hundreds of plants nationwide where Libby vermiculite was processed, and in approximately a million homes with vermiculite insulation from Libby.
  b. Guide remedial efforts at sites where fibrous amphiboles from Libby are present.
  c. Understand how the fibrous amphiboles at Libby and geologically similar deposit types influence toxicity.

Results of the USGS activities will directly support or influence vermiculite-related cleanup activities nationwide.

- The project's geologic studies of vermiculite deposits nationwide:
  a. Indicate that not all vermiculite deposits contain fibrous amphiboles, and therefore not all types of vermiculite deposits need to be regulated as though they contain asbestos.
  b. Provide methods that are being used to help assess whether a particular vermiculite sample is from deposit types likely to contain fibrous amphiboles.
- The project's studies of the geologic occurrences of asbestiform or other potentially toxic fibrous minerals:
  a. Provide a geologic model of formation that helps explain why some types of talc deposits do not contain asbestiform amphiboles and why others do.
  b. Demonstrate that there are many possible geologic sources for asbestiform or other potentially toxic fibrous minerals nationwide. These sources, through

either natural erosion or anthropogenic disturbance, may contribute to background levels of fibrous particulates in the air, and so must be taken into account in the interpretation of epidemiological data on asbestos-related diseases, and in the development of appropriate air quality standards for asbestos.

- The project systematically compared the mineralogical, geochemical, and toxicological properties of a wide variety of asbestos-related toxicological standards. Results show that there are considerable variations in all of these properties between different standards of a given asbestos mineral. Toxicological studies do not routinely take such variations into account, which may help explain seemingly conflicting results of different studies using different standards of the same minerals.
- The project developed, tested, and demonstrated the utility of AVIRIS (Airborne Visible and Infra-Red Imaging Spectrometer) remote sensing techniques to map the occurrence of potentially asbestos-forming minerals over large areas. The technique is particularly valuable for helping evaluate areas where potentially asbestos bearing rock units may occur, but where geologic mapping is limited. This activity was carried out in collaboration with colleagues at the California Geological Survey.
- As a result of these project activities, USGS has responded to many requests for expert geologic and mineralogic information on asbestos, including:
  a. A request from the American Thoracic Society to write a summary of asbestos mineralogy for its revised criteria for assessing asbestos-related disease.
  b. A request to participate in the Federal Interagency Working Group on Asbestos. This Working Group is charged with evaluating current asbestos-related issues, and how these issues can be addressed by the regulatory agencies based on sound science input

from science agencies such as the USGS. Regular participation by project members in this working group highlights the need for the USGS' impartial earth science input into asbestos issues.

c. Multiple inquiries by other Federal agencies, State agencies, industry, and the public for scientific information on asbestos-related issues.

d. A formal request for a project scientist to serve as an expert witness in Federal litigation related to Libby.

e. A formal request for a project scientist to serve as an expert member of a committee overseeing activities of the Congressionally mandated U.S. Navy Lung Disease Assessment Program.

World Trade Center Dust Characterization

- Based on the characterization work done by USGS-MDHHP members on Libby, the USEPA and US Public Health Service, in the days immediately following 9-11, requested USGS assistance to assess the amounts and spatial distribution of asbestos in the dusts deposited by the collapse of the World Trade Center (WTC) towers. This emergency response effort was carried out by MDHHP scientists, was funded under the auspices of the MDHHP, and utilized the full mix of analytical capabilities developed by the project to study asbestos and other dust-related health issues.
- A field crew was mobilized to lower Manhattan area by September 16, collected more than 35 samples of the dusts from around lower Manhattan, and returned the samples to the Denver labs for analysis by September 20.
- AVIRIS thermal images of Ground Zero showing locations of burning "hot spots" in the debris were provided to emergency responders by September 18, for use in fighting fires on site.
- Preliminary USGS findings on the dusts were released on September 27, 2001, to emergency response

authorities. The USGS studies provided an early and detailed (in terms of types of analyses and numbers of samples analyzed) summary of the dust mineralogy, chemical composition, and geochemical reactivity.

- A key USGS result was the conclusion that amphibole asbestos was likely not present in anything but very low levels in the dusts. However, the USGS results did indicate the presence of chrysotile asbestos in levels around 1-2%.
- The USGS study provided an early measure of the chemically reactive, alkaline nature of the dusts. The study also provided insights into the processes by which the dusts may have interacted chemically with water.
- USGS results have been cited by many different government agencies, Congressional representatives, the media, and the public. Project scientists continue to receive requests for information and results nearly 4 years later, and continue to field invitations to give presentations on the results.
- The study demonstrated that there is an appropriate role for a natural science agency such as the USGS in emergency response situations involving earth materials.
- The study and other related project work has resulted in a formal request for a project scientist to serve as a member of the World Trade Center Expert Technical Review Panel established by the EPA in consultation with the White House Council on Environmental Quality.

The USGS World Trade Center Response would not have been possible without the types of expertise developed through many years of project activities funded by the Mineral Resources program.

Characterization of Non-asbestiform Dusts and their Sources

- USGS-MDHHP members, in cooperation with USGS scientists on other projects, have carried out reconnaissance studies of other atmospheric particulates

and their sources. These studies show that the same interdisciplinary approach used for asbestos can successfully be applied to help understand how mineralogical and chemical characteristics of dusts and their source materials may influence human health.

- The project integrates mineralogical, geochemical reactivity, and toxicity characterization tests of earth materials to evaluate the role of particle mineralogy and reactivity in toxicity. For example, dusts from Owens Lake are well known for their high arsenic contents. Work in collaboration with the USGS Southwest Dusts project shows that the arsenic is likely to be quite bioaccessible, and that the dusts also contain other bioaccessible, potentially toxic, elements such as chromium.
- Early results of MDHHP studies characterizing volcanic ash have led to an invitation for a project scientist to serve as an expert member of the newly formed International Volcanic Health Hazard Network.

HUMAN HEALTH AND MEDICINE

NIH is supporting the development of effective, high output, informative, and less costly systems and has identified several areas for research in nanomedicine, which it defines as integration of nanotechnology and medicine. NIH is planning to support the research on biological molecules such as proteins, DNA, and RNA as well as research into how these molecules interact with each other and with environmental agents. One of its primary objectives is acquisition of a comprehensive database and development of quantitative nanomaterial measurements, said Olden.

NIH researchers and independent scientists have identified the need for mathematical and analytical tools to quantify manipulations and interpret measurements of nanomolecules. Thus, mathematicians and chemists need to get involved in the effort to understand what these variations, changes, and readouts mean to biological processes.

Once an early biomarker of a disease or dysfunction is identified, then scientists can use targeted pharmaceutical or gene therapy to correct the faulty components. — Kenneth Olden

Additionally, NIH is planning to develop very sensitive detection systems that would be able to detect a single cell or a few cells that are diseased or perturbation of a pathway. Once an early biomarker of a disease or dysfunction is identified, then scientists can use targeted pharmaceutical or gene therapy to correct the faulty components, noted Olden.

Pebble Chemistry as an Example of a Medical Application of Nanotechnology

Nanotechnology, especially as it is applied to biological systems, is an intricate, interdisciplinary field, said Martin Philbert of the University of Michigan. Researchers have begun to build nanoparticles that are intrinsically biocompatible, that do not alert the immune system to their presence, and that can contain a variety of highly functional and highly specific elements that might be toxic but which are shielded from the biology by a shell. One example, the Probes Encapsulated by Biologically Localized Embedding (PEBBLE) was created as a nanoparticle platform with multi-functional capabilities. Generally, PEBBLEs are fluorescent dyes that are encased in a molecular shell, protecting cells from the dye and protecting the dye from cellular degradation or manipulation, stated Philbert. The presence and intensity of the fluorescence is directly proportional to the pathway or molecule that the sensor is measuring. Currently, they are being used in research facilities and offer researchers the ability to measure real-time binding, translocation, and molecule production, instead of the widely used tools available for steady-state or endpoint measurements. However, they may have use for a wide range of research and medical needs.

PEBBLE Chemistry

The simplest iteration of a PEBBLE is a polymer shell that contains a fluorescent molecule, ranging in size from 20

nanometers to 600 nanometers in diameter. One 20 nanometer particle occupies 1 thousandth of a human motor neuron in the anterior horn of the spinal cord; thus, cells have a potentially tremendous capacity for the retention of a wide range of PEBBLEs sensing and reporting on a variety of cellular pathways and processes.

Philbert stated that the analytical chemistry that can be performed within the conserved space of the cell is much more sophisticated. A dye can be incorporated that changes with time as a function of the analyte of interest. The system can also be constructed in a more complex fashion using ionophores. When irradiated with the appropriate wavelength of a laser, light is emitted and can be measured, allowing for an amazingly useful property where the measurement system is completely calibratable and the fluorescence is reversible, said Philbert.

PEBBLES as Stepping Stones to Understanding Cellular Processes

One aspect of nanoparticle research has focused on the use of nanoparticles as sensors of cellular activity. This can include extra cellular measurements, such as the presence of oxygen or nitrogen radicals in the extra cellular space and the presence of the molecules in the blood and tissue, or measurements at the subcellular level. Protein movement, oxidation or reduction reactions, and the production of super oxide ions within the cell may be tracked by the use of fluorescent nanoparticles. There are also design prototypes for measuring lead and mercury, and soon, according to Philbert, the ability to measure phosphorylation and other chemical reactions inside the cell will be possible.

The light emitted from individual nanoprobes introduced into the volume of the cell can be viewed using confocal microscopy. The concentration of oxygen at each individual point is reported by a dot in the co-focal viewing field when observing the cell. The intensity of the light emitted by the dot indicates the concentration of oxygen at that point in the cell. With this new look at the cell, Philbert suggested that our assumptions about how oxygen enters the cell, diffuses through

the cell, and is used in the cell may not be entirely correct. Nanoparticles can also be used to track the movement of particular cellular compartments. Endosomes can take up the nanoparticle, and depending on surface charge, size, and other characteristics, transport them to the apical surface or the basal lateral surface of the cell.

The reason why scientists have attempted to go smaller and smaller is that they were trying to find out if there is a point at which the sensors that are being designed and placed into systems to measure biological activity begin affecting or changing the very processes they are intended to measure. Once a molecule is below 100 nanometers, it begins interacting with proteins, potentially signaling proteins, and can result in entirely unintended consequences, which is why PEBBLEs have been kept close to 100, and less than 200, nanometers. Thus while there are many advantages to keeping PEBBLES very small, scientists really do not know yet what the interactions with proteins and other elements of the cell are going to be, said Philbert. With this new look at the cell our assumptions about how oxygen enters the cell, diffuses through the cell, and is used in the cell may not be entirely correct. — *Martin Philbert*

PEBBLEs on the Path to Understanding Tumor Biology

One area of research, according to Philbert, focuses on targeting molecules to tumors for treatment and eradication. Coating a PEBBLE nanoparticle with a magnetically responsive metal allows researchers to target nanoparticles to specific locations within the body and to obtain a better image of tumors from magnetic resonance imaging (MRI). These MRI images reveal a significant contrast enhancement due to the presence of the nanoparticles within the tumor tissue, that is, nanoparticles allow for very good contrast from normal tissue, where the tumor becomes clearly visible to the observer.

Fine resolution of small tumors is not the only possibility within the same nanoparticle. Ruthenium (Sol Gel Ru-DNPs) can also be included within the nanoparticle. When a laser is turned on, Sol Gel Ru-DNPs can produce a large amount of

singlet oxygen only when it reaches the target, in this case a brain tumor called 9L gliosarcoma produced in the rat brain. Therefore, researchers can kill this clone of the gliosarcoma, which does not respond to chemotherapy or radiation therapy. Coupled with a fiber optic that is only a millimeter in diameter, the tumor can be stopped or at least reduced in size with time. Because the 9L gliosarcoma is extremely aggressive, if one or two cells are left, after some time the tumor will re-grow. However, with a single injection and only 10 minutes of laser irradia:

> *The ultimate goal of this research is to create particles that are not going to interfere with the normal biology of the organism and are going to have very high therapeutic index. -Martin Philbert*

Nanoparticles used in tumor killing experiments are larger than 100 nanometers; thus, they do not cross the blood-brain barrier (BBB), and therefore are excluded from healthy brain tissue, said Philbert. These nanoparticles penetrate into the tumor only when a tumor changes the porosity of the blood vessel. This process of BBB penetration takes approximately 5-10 minutes and once clearance through renal and other mechanisms is considered to be complete, the laser is turned on. The nanoparticles are delivered systemically and then pass through the BBB before a laser is turned on to activate the killing activity, but further research will be need to understand what happens to these particles as they circulate through other parts of the body?

Approximately twenty different kinds of these nanoparticles have been created and researched in vivo in the Philbert lab alone, all of which have shown effects on the reticular endothelial system and the kidneys. These nanoparticles are discarded as the ultimate goal of this research is to create particles that are not going to interfere with the normal biology of the organism, yet have a very high therapeutic index. Philbert suggested that many of the products that can be created will ultimately not be deployable because early safety testing will show them to be completely unfeasible from a toxicological standpoint.

EXPANDING SCIENTIFIC UNDERSTANDING

Today, science is at the optimal time to begin to study the impact of nanomaterials on human health, said Vicki Colvin of Rice University. Science is looking at the birth of a new industry, and beginning to address risk in a way that has not been done with any other developing technologies before (i.e. well before large-scale amounts of these materials are introduced into the environment or onto consumers). This provides public health with a unique opportunity to shape a new, emerging area with research on environmental health issues that we might encounter, while avoiding the problems that have plagued chemistry in the past.

Kenneth Olden of the National Institute of Environmental Health Sciences echoed this, and noted that very few studies have been done thus far on nanoparticles and their effect on human health and the environment. Science needs to start investing in research of these issues.

Toxicity and bioavailability of engineered nanomaterials is largely unknown. He noted that it will be a daunting, costly, and time-consuming challenge to assess every single nanomaterial that is made individually, which means there will be a need to set priorities.

NIH is trying to develop some effective, high output, more informative, and less costly systems. Two of its primary objectives are to maintain a comprehensive database and develop quantitative ways of measuring nanomaterials. Efforts such as this will help science develop standard materials for assessing environmental health impacts.

Unlike incidental particles, very little is known about engineered nanoparticles and how they interact with cells or human organisms. There are only about 30 papers written on the environmental and health impacts of these particles; however, there is a wealth of knowledge on incidental nanoparticles and how these particles interact with biological organisms, noted Colvin. Questions remain whether the engineered nanoparticles will act as a bulk solid or a molecular system.

Size isn't Everything

In most cases, nanoscale systems will alter in physical size upon interaction with an aqueous system. For example, it is very common for many nanostructures to adopt a different chemical form simply through relatively minor interactions; consequently, size is not a constant factor in biological interactions, noted Colvin. Furthermore, the surface area can make up a sizeable fraction of these materials, and they can be derived to make many different biomedical systems. By changing surface coatings the nanomaterial toxicity can almost be completely altered. For example, changing the surface features of the materials can change a hydro-phobic particle into a hydrophilic one.

Hypothetically, surface coats could, for instance, make it possible to eat nanoscale mercury if it has the right surface coating, while it may be dangerous to eat nanoscale table salt if the surface coating was not correct. For this reason, the scientists' typical view of toxicology, which is driven by the composition of an inorganic particle, may have to be modified for nanoscale materials, because the surface is going to affect different dimensions of environmental and health effects, according to Colvin.

ROUTES OF ADMINISTRATION AND POTENTIAL HEALTH EFFECTS

Fullerenes and other nanomaterials can accumulate in the body, depending on the dosing route. For oral administration, 98 percent of fullerenes are eliminated within 48 hours via feces and urine (Yamago et al., 1995). The 2 percent that is not excreted is found throughout the rest of the body, noted Oberdörster. Intravenous dosing is rapidly transported to the liver (73-92 percent), the spleen (up to 2 percent), lung (up to 5 percent), kidney (up to 3 percent), heart (approximately 1 percent), and the brain (approximately 0.84 percent) within 3 hours. After 1 week, 90 percent of intravenously administered fullerenes are still in the body, noted Oberdörster.

Inhalation of nanoparticles may also be problematic because the particles are often small enough that alveolar macrophages cannot detect or scavenge the particles for elimination. By

evading alveolar macrophages, nanoparticles can enter the lymphatic and circulatory systems to be distributed throughout the body within 24 hours, noted Oberdörster. This has been studied with a number of particles, including titanium dioxide. It should be noted that not all nanomaterials evade phagocytosis, and in studies using nano- vs. bulk TiO2, ~20% of nano-sized TiO_2 can be recovered by repeated lung lavages to obtain alveolar macrophages, as compared to ~80% of bulk-sized TiO_2. Depending on the quantity of inhaled materials, it is also possible to overload macrophages. Inhaled particles can also be transported to the brain via the olfactory or trigeminal nerves. This process was first noted in studies from the 1940s, and the current hypothesis is that these nano-sized particles move in a similar mechanism as viruses. This is one mechanism to bypass the blood-brain barrier, Oberdörster suggested, and could be exploited for drug delivery.

Oxidative Stress

Nanoparticles, including C60, metal Qdots, and TiO_2 can be redox active, which may lead to DNA cleavage, oxidative stress, and/or an inflammatory response. For example, C60 fullerenes, if exposed to light, can either make singlet oxygen or be electron donors to make super oxide radicals. The potential dilemma is that not only does the immune system use super oxide radicals to kill foreign toxicants; the super oxide radicals can cause hydroxyl radicals, which can lead to DNA cleavage. The good news is that the body has some ability to prevent the undesired DNA cleavage through super oxide dismutase, part of the antioxidant defense system, noted Oberdörster.

Oxidative stress is potentially a larger issue. A number of ambient or laboratory-produced ultra-fine particles cause oxidative stress, a mechanism that leads to cell damage or cell death. The severity of damage is dependent on the chemistry, as some particles result in more oxidative stress than others. In a recent study in her laboratory, Oberdörster looked at oxidative damage, brain translocation, and gene expression changes in large mouth bass exposed to fullerene C60.

Glutathione (GSH), a molecule involved with antioxidant activity, can be used as a marker of redox activity. The gill region, where fullerenes would probably be present, showed decreased levels of GSH, which was unchanged in the liver and brain. Protein oxidation, another marker of oxidative stress, was unchanged in the liver, brain, and gills. What was interesting, noted Oberdörster, was the increase in lipid peroxidation in the brain, an increase not seen in the gills or the liver. She hypothesized that lower lipid peroxidation in the gills and liver of fullerenes-exposed animals suggests that some tissues are more capable of responding to and repairing fullerene-induced cellular damage.

Complementing this data, she found that in the liver the expression of some inflammation-related genes was modulated. Genes associated with hormone regulation, immune cell response, and clotting and anti-clotting pathways were found to alter their expression after exposure to fullerenes. Expression of repair enzymes was increased, suggesting that the fish were starting to repair damage incurred by the response to fullerene molecules. As this was a preliminary study, the fish were euthanized for experimental study before further response to the fullerene molecules could be studied.

Genes associated with hormone regulation, immune cell response, and clotting and anti-clotting pathways were found to alter their expression after exposure to fullerenes.
— Eva Oberdörster

Inhalation and Cytotoxicity

Particle size determines whether particles are respirable or inhalable. This difference can be critical, as inhaled particles can be trapped and cleared, whereas respirable particles are often more likely to be retained. In rats, particle sizes less than 3 µm are considered to be respirable. For humans less than 5-10 µm is respirable, while 10-50 µm is inhalable, noted David Warheit of the DuPont Company. These particles tend to be deposited at the junctions of the terminal bronchioles and alveolar ducts in rats and the level of respiratory bronchioles in humans. The alveolar regions of the lung, which are primarily

used for exchange of oxygen and carbon dioxide comprise 95 percent of the lung surface area and are the pulmonary compartment where diseases such as asbestosis and silicosis are manifested.

Particle size and aggregation is an important consideration for deposition in the alveolar region. Particles such as fine-sized iron (i.e., 1 µm) are primarily deposited as discrete particles though they have some limited potential to aggregate. Conversely, although there is a potential for some types of particles to disaggregate, ultra-fine or nanoparticles generally tend to deposit as aggregates due to high Van Der Waals forces, rather than discrete particles. This means that if an inhaled particle with a diameter of 50-100 nm forms an aggregate of 5-10 particle types, in terms of deposition it may have the properties of a 200-500 nm particle, suggested Warheit.

> *Whether particles aggregate and then disaggregate once they reach the lung fluids and the process for generation of nanoparticles will become increasingly important.*
> *— David Warheit*

In addition to concern about deposition, particle clearance from the lungs may also be important for assessing nanoparticles. Normal clearance in the lung is performed by phagocytosis of particles by alveolar macrophages. These cells exit the lungs via the mucociliary escalator to be coughed up or swallowed. This process is effective for the fine-sized (100 nm to 3 µm), low toxicity particles if the clearance system is not overloaded; however, it is unknown if this happens with ultra-fine particles or nanoparticles.

Some current hypotheses suggest that nanoparticles are more toxic (inflammatory, tumorigenic) than fine-sized particles of identical composition, noted Warheit. This concept is based on a systematic evaluation of only three particle types: titanium dioxide, carbon black, and diesel particles. Thus, he noted that the current hypotheses are based on a paucity of data.

Determining toxicity can be complicated because not all nanoparticles are more toxic than fine-sized particles of the same chemical composition. The surface coatings of particles,

exposure to UV radiation, and dispersion properties can change the behavior of the particles. Whether particles aggregate and then disaggregate once they reach the lung fluids as well as the process for generation of nanoparticles-for example, gas phase versus liquid phase synthesis-will become increasingly important. He suggested that developing a working hypothesis for determination of particle toxicity will depend on the capacity of the particles to cause cell and lung injury, promote inflammation, inhibit macrophage function, and persist in the lung. Finally, Warheit observed that species' differences complicate research because some species, such as rats are particularly sensitive to particles, sometimes making it difficult to extrapolate the results to humans.

Toxicity of Carbon Nanotubes

In a recent study, Warheit investigated the toxicity of intratracheally instilled carbon nanotubes, which are approximately 1 nm by 1-5 µm as a singular particle. However, due to strong electrostatic potential, they rarely exist as individual discrete particles and agglomerate into nanoropes.

Following instillation of the carbon nanotubes into the lung, the tissue was analyzed by looking at cell proliferation, histopathology, lung weights, etc. at 24 hours, 1 week, 1 month, and 3 months post instillation. Through this paradigm, the researchers would be able to determine the initial, transient reaction, but also ask whether the toxicity was sustained or progressive.

Fifteen percent of the animals died within the first 12 hours due to high agglomeration from electrostatic attraction, which essentially coated the airways of these animals. This was not because of the toxicity of the material, but rather because the material coated their airways. Thus, these animals died from suffocation because of the unique properties of carbon nanotubes, said Warheit.

The animals that survived the first 24 hours post instillation survived through the 3 months. Exposure to carbon nanotubes produced only a transient inflammatory response at 24 hours, but this was acute, with no inflammatory effects seen at 3

months. Interestingly, Warheit reported that they did see multifocal granulomatous lesions in the lung tissue studies. These lesions are not commonly seen in dust-exposed rats. In the center of the lesions were the agglomerated carbon nanoropes walled off by foamy multi-nucleated macrophages cells. The distributions of the lesions were not consistent, nor were they dose dependent or progressive from 1 to 3 months.

Warheit put these results into the context of possible exposure in the workplace. Since carbon nanotubes are used in the electronics field for diode, transistors, cellular-phone signal amplifier, and ion storage for batteries, his DuPont colleagues, as well as NIOSH.

Particles need to be thought of as having inherent toxicity, and being carriers for organic molecules and metals. — John Froines

Researchers, performed exposure assessments in the workplace. The results suggested that the dust was less than 53 $\mu g/m^3$, which was extremely low. Most of the nanotubes were aggregated into nanoropes, which may not be respirable. Warheit concluded by stating that scientists cannot assume that all nanomaterials are the same as their bulk counterparts, which suggests that materials will need to be tested on a case-by-case basis, a process that may be infeasible because of resource constraint. He suggested that priorities for studying particles based on surface coating, surface charge, and particle aggregation will need to be made.

John Froines of UCLA raised the question, does the research that scientists are doing on airborne particulate matter related health effects have relevance to understanding potential issues with respect to nanotechnology? He suggested that there are areas where there are significant differences, but there are also places with commonalities.

For example, most of the ultra-fine particles from diesel emissions are in the 10 nm range, classifying them as nanoparticles. He suggested that a number of biochemical processes may be similar between the air pollution particles and the engineered particles.

Redox Cycling

Nanoparticles from diesel exhaust may contain pro-oxidative chemicals. Quinones, one such chemical, can undergo redox cycling to semiquinones, subsequently generating reactive oxygen species (ROS) such as superoxide radical anions. This cycling can lead to a build-up of ROS that result in oxidative stress. Oxidative stress then produces pro-inflammatory effects, such as allergic airway disease, adjuvant effects in asthma, and propagation of cardiovascular disease.

Airborne particulate matter has a coarse, a fine, and an ultra-fine or nanoparticle mode. These particle modes differ in the carbon, organic carbon, metals, inorganics and polycyclic aromatic hydrocarbon (PAH) content.

Ultra-fine particles have a greater organic carbon and PAH content then the coarse or fine particles. More interestingly, noted Froines, is that the redox activity is greater in the ultra-fine particles, which leads to an increase in glutathione depletion and mitocondrial damage in cells exposed to these particles.

The redox activity in nanoparticles was confirmed in a recent study by Li et al. (2003). Redox activity was examined in the coarse, fine, and ultra-fine particles at 50 or 150 meters from a freeway. At both distances, the redox activity per microgram was greatest in the nanoparticle region. At a distance of fifty miles from downtown Los Angeles, Froines collected particles with the same size distribution, and once again, the ultra-fine particles had the greatest redox activity.

Persistent Redox Activity

Diesel particles need to be thought of as having inherent toxicity, because of their being carriers for organic molecules and metals, noted Froines.

Organic extraction of the particulate matter only removes 10-30 percent of the redox activity from the particles. The remaining redox activity cannot be extracted from the particles, noted Froines. Mucociliary fluid is even less effective in extracting capability. Thus, the active chemical species remain

on the particles themselves, which means that the particles retain their toxicity.

> *Particles need to be thought of as having inherent toxicity, because of their being carriers for organic molecules and metals.* — John Froines

Health Endpoints

There have been a number of health endpoints associated with ultra-fine particles. Animals exposed to ultra-fine particles from freeways show enhanced allergic airway responses and CNS inflammation. In human clinical studies with particles from freeways, particles have also been associated with a statistically significant decrease in heart rate variability and other cardiovascular parameters in normal subjects. Further, exposure to mobile sources has been associated with increased risk to preterm birth and low birth weight. Froines concluded by suggesting that as nanotechnology continues to evolve there is accumulating evidence in the area of air pollution from ultra-fine particle work that there are health endpoints that need further research.

STRATEGIES TO ENSURE OCCUPATIONAL HEALTH

The people currently most affected by nanomaterials, nanoparticles, and their potential impact on the environment and health are the groups that generate and handle the materials, that is the people in the workforce and the laboratories, noted Andrew Maynard, National Institute for Occupational Safety and Health (NIOSH). NIOSH has established a very active research agenda to reduce the potential health impact in these groups. Yet as they begin to look at the research agenda, he noted that there are a number of pressing issues.

Since the 1950s, industrial hygienists have mostly concentrated on inhalation exposure related to mass of the material, because this has been the most useful information for relating exposure to health effects. The use of mass as a paradigm marginalizes nanoparticles and nanostructured materials, because even if there are many of these particles

there is very little mass associated with them. A 1 nanometer particle has only 1 billionth of the mass of a 1 micron-sized Under the mass paradigm nanometersized particles are not looked upon as dangerous; however, we cannot ignore the chemistry of nanoscale materials that have other unique and unusual structures and properties which may cause health problems. — *Andrew Maynard*

Therefore, under the mass paradigm nanometer-sized particles are not looked upon as dangerous, noted Maynard. However, scientists cannot ignore the chemistry of nanoscale materials that have other unique and unusual structures and properties, which may cause health problems.

As noted above, most nanomaterials are insoluble and the surfaces of these materials are very different from the core properties. Nanomaterials have very specific heterogeneous structures, and they are exclusively engineered to specification.

Mass, particle size, and surface structure are all important properties for determining where these particles deposit in the respiratory system upon inhalation and how the body will react, as discussed previously. This is where occupational health faces its first challenge. Health scientists need to understand how these materials may impact health in the workplace or the laboratory, and they may need to undergo a philosophical change in the way these materials are viewed, said Maynard.

NIOSH is concerned with identifying the risks from nanoparticle exposure and considering how to control the risks, whether through reducing risk or reducing the impact. However, to be in a position to assess risk, additional information is needed regarding toxicity of the materials including: how they interact biologically in the body and what the health effects are resulting from toxicity, environmental exposure, and potential exposure routes (i.e., whether the material is inhaled, ingested or absorbed cutaneously), noted Maynard.

He noted that the toxicity of nanomaterials needs to be understood in a framework of the materials' characterization. If scientists do not understand the materials from a physical and chemical perspective, they cannot interpret exposure or

toxicity measurements. Scientists already know how some of the small structure materials behave, but they have a long way to go before understanding the risks posed by these materials, said Maynard.

There are a number of steps that need to be taken in order to understand the occupational health impacts of the nanomaterials, according to Maynard. These include the need to:

- Understand the problem from different perspectives (e.g., industry, public, workers, and regulatory).
- Perform gap analyses to determine a course of action.
- Create a strategic plan for achieving short-, medium- and long-term goals.

In order to achieve these goals, there is a need to coordinate activities between stakeholders (i.e., the people who are directly impacted by the processes), the materials, and the service providers (i.e., the people who have the knowledge that allows us to take action to impact health effects at the workplace). He concluded by suggesting that nanotechnology is a multidisciplinary area that covers a large range of disciplines and that a multidisciplinary approach to the problem is necessary in order to be effective.

Unless we have a multidisciplinary approach to the problem we are not going to make any significant impact. — *Andrew Maynard*

An Open Process

There is a need for increased levels of cooperation between the industries involved, public interest groups, and government parties to find solutions that are economically viable, but still protect the environment and health, asserted John Balbus, Environmental Defense. This is not a small goal, because it is important that nanotechnology development is done right the first time. Modern history has produced a number of technological advances that held such great promise for revolutionizing society; that they were accompanied by safety short-cuts. Not all technological advances proved to be health

concerns, but DDT, polychlorinated biphenyls, tetra-ethyl lead, and chlorofluorocarbons are just a few examples where wide-scale release had a number of unintended side-effects.

Potential Problems

These past problems have implications for nanotechnology. The federal government, through various agencies in the National Nanotechnology Initiative, has increased nanotechnology research funding in the last 5 years from $200 million to $850 million. During the same time period, the investment in environmental health and safety implications research funding had only a slight increase from 0.2 percent to less than 1 percent of total investment in nanotechnology.

Balbus noted that the public expects the federal government to anticipate and to be proactive about the risks of any future commercial products and he questioned whether the funding levels were adequate for environment and health research. Balbus noted there are a number of reasons why the public and public interests groups have reason for concern about nanotechnology. Currently, there is a lack of knowledge about these products that will need to be addressed before scientists can adequately address environmental health concerns. Nanomaterials are:

- Deliberately manufactured so that they have novel physical-chemical properties, and many times unpredicted physical-chemical properties.
- Heterogeneous, and this is not only in terms of the different kinds of nanomaterials that are deliberately engineered, but it is very likely that different nanomaterials will be heterogeneous in terms of fate, transport, and degradation. Should these materials be distributed in the environment, they will be in different stages of transformation.
- Poorly soluble in water, at least for the carbon-based nanomaterials. These nanoparticles have to have surface coatings or surface modifications in order to make them biocompatible.

These properties have a number of implications for environmental health. Nanomaterials are the size of viruses, and as such are able to be transported through the body along nerves and through the lymphatic system, providing an opportunity for these materials to cross the blood-brain barrier, which may result in a number of unintended consequences. Poor water solubility may lead to similar problems-seen with other poorly water soluble chemicals such as PCBs-with increased potential for bioaccumulation through repeated cycle absorption, evaporation, and transpiration. These are only two examples, but Balbus questioned whether science is in a position to answer to these questions, since there is a paucity of data presently. The current observations are not "doom and gloom," but they haven't been reassuring from a health and safety standpoint, he concluded.

2

Prevalence of Diseases in Tribal Areas

COMMON OR FREQUENT DISEASES

Fever : The Koya call it edek and Saora term it as ashu DEPUNO. It causes abnormal body temperature. Sometimes temperatue is accompanied by body region or spasm. It alternates wih fall of temperature and perspiration follows. Body ache and headache are secondary symptoms. The tendency of nausea persists and the patient loses appetite. Long suffering causes swelling of face, abdomen and limbs.

Digonosis and Therapy : The Wadde or Shaman (among the Koya) Kudanboi or Shamanin (among the Saora) is approached to decipher the cause of suffering. He/She locates the cause through divination rite. The Wadde prescribes the juice of neem (Azadirachta indica) leaves to Be taken in small quantity twice a day; whereas the Saora shamanin administers a mixture of horida (caparis horida) and bahada (terminalis balerium) and prescribes spritspecific magico-religious charms to be worn by the patient.

Common Hierarchy : The Koya call it bechata. The patient experiences irresistible pain in the head They describe it as poita or talanopi or head polittting. The Saora term the acute pain as head breaking asunder. Both the Koya and SAora approach their respective magico-religious functionaries for diagnosis and treatment. In both the cases the pain causing

spirit is exorcised symbolically by their respective specialists. The Koya medicin man prescribes and admixture of lime and juggery to be applied on the forehead of the patient, whereas the Saora medicine man prescribes a solution, prepared out of lemon and oila (gesalpinia bonducelia) to the applied over the spot of pain.

Swelling of the Body : This disease is common among the Koya, and it is probably caused due to acute anaemia. The patient loses body weight, develops weakness, loses appetite and feels nauseatic. His/her complexion becomes whitish. The disease is Known as toita among the Koya is approached. He deciphers and exprcises the diseasecausing spirit and prescribes the juice of dimiri tree (ficus glomerata) root to be taken twice after food.

Swelling of Inguinal Lymph glands : The Koyas call this disease GADTUL GADA and Saoras term it as PADAPLANG. Symptoms of this disease include swelling of lymphglands, rise of body temperature and headache. Both Koya and Saora resort to magico religious a practices for diagnosis. They get the intruded sprit exorcised by their Shaman/Shamnin. Koya Shaman prescribes hearth cider to be applied over the glands, whereas the Saora medicine man prescribes honey mixed with the juice of Tulsi (Ocimum sanctum) leaves to be applied over the swelling for remission.

Nephrotic Syndrome : Among the Koya this disease is Known as BIS. The patient develops swelling of body, Which is accompanied b mild fever, loss of appetite and general debility.They believe that disease is caused by spirit – intrusion. Hence they approach the wadde or Shaman to exorcise the spirit from the body. The waddle or shaman prescribes two tea –spoonful of NANDABAGULI leaf – juice to be taken by the patient twice daily before for 20 to 25 days after blowing out the spirit.

Colic Pain : This diseases is known as DOKAMANDITA among the Koya. It is a common diseases and many people suffer from this ailment. The patient often experiences excruciating abdominal pain. The patient becomes gradually

weak and loses appetite. The belief is that the diseases is casused by spirit intrusion. The Shaman is approached to exorcise the spirit. The Shaman prescribes a medicine to be prepared out Sundried rice, few strands of a locally available grass, called pooddaver, ten bits of rasuna (Alinumsabira) and a piece of the bark of mango tree (Mangiferaindica) and taken by the patient trice daily.

Malnutrition : The diseases is known as KANCHAKA among the Koya. The common belief is that it is caused by inadequate food intake as wall by taking or consuming some harmful or noxious food. The Shaman prescribes cashew seed oil to be qently massged at the naval point of the patient for relief.

Hook Worm Infestation : It I a common diseases among the Koya. According to popular belief the diseases is caused by intrusion of a spirit into the body. But allopathic doctors maintain that they Koya suffer from this diseases as they sometimes eat raw pork or beef. The patient loses body weight and his/her legs swell. The medicine men rescribes an admixture of turmeric paste and neem (Azadirachta indica) leaves to be taken orally by the patient once daily before food.

Round Worm Infestation : The common belief among the Koya is that round –worm infestation is caused by spirit sent through witch-craft. The patient runs mild Temperature feels weeks and experiences pain in the abdomen. The patient also frequently feels the urge of influence of witch-craft, who does so through a magico-religious rite. He also prescribes about 10 grams of turmeric paste to be taken orally twice daily along with few neem (Azadirachta indica) leaves. The diseases is known as ASAPUDUKU.

Amoebic Dysentery : It is a common diseases among the Koya as well as among the Saora. The communities it is as DANBORIDUNGTE. In both the communities it is believed that the diseases is caused by inappropriate food, overeating of chillies, excessive summer heat, and by starvation also. Its symoptoms include discharges, which may be followed by rigor. The shaman prescribes the juice of the roots of PATALGARUDA

(Roulfea serpentine) along with honey for the patient to be taken thrice daily.

Blood Dysentry : Among the Koya this diseases is known as NATURDAK; among the Saora it is known as RANGBORIDUNOTE. In both he communities the belief is that it is mainly caused by spirit-intrusion. The spirit eating of unhealthy food and lots of chilli-hot food aggravates the ailment. The prominent symptom is the greater frequency of motions of blood and mucus along with muscular strains; the patient runs body temperature and experiences headance. In both the communities the malevolent spirit is exorcised from the body of the patient by a sorcerer. The shaman among the koya prescribes an elixir, which is to be prepared by boiling together barks of TENTULI (Tamarindus indica) trees,MAHULA Tree (Bassia latifolia), JAMMU (Syzycium intgrifolia lumini) and PIASALA (sptercerpus falerica) and taken thrice a day. wherease the saora reggammer prescribles an emulision to be prepared out of KHADIRA (Accasdia indica) and KENDU (Drospyres melanoxylon) and taken twice a day.

Jaundice : It is not a very common disease. But then several people irrespective of age and sex, suffer from it because of use of unsafe drinking water in the tribal interiors. The koyas call it KIL and the Saora term it as ROGARMEENA. However, both the Koys and Saora firmly believe that the disease is caused by spiritintrusion.

Its symptoms include that the cooler of retinal and urine of the patient turns yellow. The patient externally looks bloodless, and he/she suffers from low temperature, loss of appetite and feels giddy. He/She also experience pain in the abdomen. Sorcere, among both the tribes, is approached to exorcise the malevolent spirit. The Koya Shaman prescribes spaked water of AMLA (Embelica myroblan), BAHADA (Terminalia balerica) and HORRIDA (Terminalia chebula) to be taken twice daily for 30 days, and the Saora Shaman prescribes ground PHATIKABLAM (Annona reticulate) seeds, dissolved in water to be taken once daily in emptystomach. The quantity should not be more than four to five tea spoonsful at a time.

Piles : Koyas call this disease as PEGA and the Saora term it as KINSUM. As per their belief pattern it is a spirit caused disease. Its symptoms include acute pain during defecation, discharge of anal blood after defecation, discharge of anal blood after defecation, loss of body weight and growing weakness. The Sorcerer/shaman is approached to exprcise the malevolent spirit. The Shaman prescribes a finger ring to be worn by the patient which is made out of the scale of BAJRAJKAPTA (a scaly ant-enter reptile).

Diabetes : The Koya term this diseases WADABATITA. Both Koya and Saora a believe this disease is caused by the displeasure of gods and goddesses. Incursion of the wrath of supernatural beings causes diabetic syndrome. Koya wadde and Saora Kudanbio maintain that the disease inducing syndrome is incurable. Its symptoms inclyde frequent urination, fast appetite, quick thirst, perspiration and fatigue. The Koya Wadde prescribes JAMMU CHHELI RASA (juice of Syzycium intergrifolialumini) bark to be twice a day, wherease the Saora REEMMAR advises diabetic patients to take juice of THALKKUNI leaces, an orchid (contella asiatica) and ground METHI (fenugreek) two to three times a day.

Discharge of Blood with Urine : Koyas term the displease as SAKABATITA. They believe that the displeasure of supernatural beings casuses this diseas. Saoras say that the disease is caused by the tube well water, which people in the Saora area now-a-days drink. Its symptoms include abdominal pain, mild body temperature, blood discharges along with urine and head-realing. The Koya shaman prescribes SAPARKACHU (colacasia) and suger cane juice for the patient. Whereas the Saor RAGAMMAR advises the patients to take THALKUNTI (Citrus aurantum) three times a dey.

Goiter : The Saora call it KINGKIGBONGADA and the Koya term it medakaya. Members of both the disease is caused by supernatural wrath. Its symptoma include swelling of thrax and pain in the swollen parts of the body. Some portions bulge out and hang down. Sometimes the protrusions burst and casuse sudden death. Koya medicine man prescribes a paste

to be prepared out of BAJRAMULI, NARDIA and MUSTUMIR and applied over the swollen parts regularly. Whereas the Saora regamar advise the patients to apply the juice of the roots of BAKULA tree (Mimusopa elongi) and PATALGARUDA plant two to three times a day.

Lumbago : Members of both Koya and Saora communities belive that this disesas is caused due to deficiency in food intake. They state that physical labour out weighs their natural strength. They also say that inadequacy of food causes this disease and old men and women normally suffer from this ailment. Its symptoms include pain in the waist region as well as in the major joints of the body. Koya medicine man as Saora medicineman, both prescribe KARANJ oil (Carisea carandus) to be massaged over paining or aching joints and take an extraction of the barks of KENDU tree (Disopros ambriyotres)in small quantity continuously for about a month. Among the Koyas this disease is known as MARSULNOPI.

Rheumatoid Arthritis : The kyoas call this disease PEETTAND and the Saroa trem it has LABLA. It is not a spirit oriented disease. Both Kyoa and Saroa fell that the disease is caused by excess manual labour. Its syomptoms include swelling of body joints and related pain, which prevents a person of function normally. Its therapy is common among the Kyoa and Saora. Their Wadde and Reggammar prescribes a paste to be prepared out of the barks of NEEM (Azadirachta indica) tree. KARANJA (Carisea Carandus) treeand seeds of DHUTURA and applied over the affected joints. In addition, they also advise half-baked ARAKHA leaves to be pasted over the joints for immediate relief.

Hysteria : The Koya call this disease KUNDEL and the Saora trem it as DISUNG. The young and the adolescent are mostly affected by this disease. The belief is that the disease is caused by spirit-intrusion. Its symptoms include acute sensitivity to light, difficulty in hearing, loss of skin sensitivity, partial paralysis of different limbs and inability to walk properly. The only therapy which is resorted to for cure is exorcision of the spirit and propitiation of the supreme god and goddess.

Syphilis and Gonorrhoea : The Kyoa call this disease as BAKADA and Saora trem it as LABLANSUNG. Its symptoms include development of sores over vulva and penis, painful urination, swellinr of genitals, discharge of pus in urination and foul smell of urine. The disease is believed to be the cause of the anathema of the anathema of the Almighty. For care Shaman/Shamanin propitiate the supreme god on behalf of the patient. However, both Koya and Saora are aware of the fact that it is a sexually transmitted disease. The Koya ROTOWADDEprescribes juice of BARUNA (Cretera religiosa) tree brak and DIMIRI (Ficus clomerata) tree bark mixed with pulverized SUNTHI (Ginger dehydrate) and powdered PIPALI (Piper logum) to be taken by the patient twice a day in small quantity. The Soara Reggammar prescribes extraction of soaked HORIDA ('Terminalis chebula),BAHADA (terminalia balerica) and ANALA (Embelica myrobalan) to be taken in small quantity twice daliy by the patient, and apply NEEM (Azdirachta indica) oil over the sores.

Tuberculosis : Saora call this disease LABLAB nad the Koya term it is USBADOGG. As per the belief pattern this disease is caused by spirit intrusion. Among the Saora, the Kudunboi Spropitiates KETUMSUM, onbehalf of the patient. The Saora RAGGAMMAR or medicieman prescribes powdered mixture of HALADI (Caruma domestica), BAHADA (terminalia balerica) and patient twice daliy. The Koya ROTOWADDE presicribes a mixture of Asoka (Araca indica) bark, Aprajeet (Clitria ternatia) nad JAITIRI (Myristica fragrama) for such a patient to be taken thrice daliy.

Leprosy : It is a dreaded disease. The saora call it LABLAN, and the Koya term it is MASA.member of both the communities attribute the occurance of this disease to extrme type of supernatural wrath, they also belive that the disease is incurable, and hence it is an anathema. The patient, if a grown up person, is segregated from the socity. Such a person in course of time become a wander mederer medicant. He is never redmitted to the socity.

Leucosis : This disease is known as SOBEM among the Koya and as LAB AMONG THE Saora. White patches appear

on the skin, which itch often. The cause of the disease is believed to be supernatural wrath, both among the Koya as well as the Saora. A type of whitish fungus found in JAMu(Syzycium integrifolia lumini) tree is collectd and burnt and this black residue is mixed with POLANG oil (Callophylum inophyllum) and applied over the white patches.

Itching : Rough patches appear on the different parts of the body which cause irritation. Afungs that grows in the crevices of old mango trees is collected and burnt. Black residue is mixed with POLANG oil and thenapplied over the rough patches.

Yaws : Koyascall the disease, CHEBA.Both Koya and Saora think that it is caused by intrusion of malevolent spirit. Its symptoms include riseof body temperature, joint pains with blisters and painful itching of body sores. The wounds are not cured and pus oozes out of them. For cure,the spirit is exorcised and the superme god is propitiated with offering of animal blood. The shaman prescribes a paste to be prepared with NEEM (Azadirachita indica)leaves and HALADI (Carcuma domestica) for application over the wounds.

Bronchitis : This is a common disease that mainly occurs towards the end of summer season. It is know as UBSA among the Koya and as MURDUKANASHU among the Saora. This disease is caused due to change of weather. Its symptoms include rise of bodytemperature accompanied by coughing and throat irritation. Its therapy includes rubbing of soya oil over chest and chewing of leave of KENDU(Dyosphyros obenum).

Maums : Among the Koya this disease is known as MADAGADA and among the Saora it is known as PADAPLANG. Its symptoms include swollen cheecks, inflammation of tonsil gland, headache, rise pf body tempreture, aching of eardrums, and frequent coughing. Its therepy includes application of fine cinder over the cheek and pasting of half baked ARAKH leaves around the swollen gland.

Enargement of Tonsils : This disease, known sa GAUGA among the Koya nad as ASHUDAHU among the Saora is caused due to cold; its symptoms include rise of body

temperature,accompanied by headache,coughing and painin the thorax. Its therapy includes taking of the juice of bitter groud and application or liquefied KHAIRA(ACCASIA catecium) on the external surface.

Small Pox : Among the Koya this disease is knoen as AMMA TALUR, and among the Saora it is known as SINGYOL. Its symptoms include rise of body temperature. Eruption of blisters all over the body temperature, eruption of blishter all over the body and itching sensation. After four to five days the blisters start bursting and the body gets disfigured. Blisters may crupt inside the body also, which is more painful.The Saora believe that it caused by the fiery anger of goddess MATAMUNDEM. There is no treatment for this disease. The whole village propitiates through the shaman and the Priest, the presiding deity of this dangerous epidiemic. Only neem leaves are spread around the patient, and during evinging times resin smoke is created in waves to please the deity. the patient is made to seep upon neem leaves, and dried neem leaves are burnt in a pot near the patien ti provide smoothing smoke to the patient. The presiding goddess f the disease is propitiated both among the saora and koya by their respitiated priests and shamans.

Malaria : This disease is know as YANANGBASUM among the Saora, and the WASA-EAEK among the kyoa Its symptoms include high body temperature with rigor. The temperature rises at regular intervals. When the temperature lowers down the patients perspires a lot, and in course if time the patient develops wollen abdomen, face and limbs. The Koya believe that the disease is caused by the intrusion of a spirit callrd, YANANGBASUM.The Koya wadde nullifies the influence of witchcraft on the patient, and among the Saora the Kudanboi or shamanin blows out.The Saora REGGAMMAR prepares a therapeutic powder out of BAHADA (terminalia balerica), pippala bark (ficus religiosa) and KENDU speeds (Azadir achta indica), which the patient is supposed to takes thrice daily. The Koya Shaman prepares mediince out of NEEM leaves, speed and PIPPALI (piper longum) and administers the same to the patients twice daily.

Typhoid : This disease, among the saora, is knpwn as KAHARANAGHU and among the Koya as BECHATA EDEK, The belief among both the communities is that it is caused either by witchcraft or sorcery. Body temperature remaibs abnormally high'and it hardly becomes normal. Fever is accompanied by servere headache and a continuous tendency of nausea. In Saora case god DURISUM is propitiated, and among the Koya, god deudu is worshipped by the PERMA or priest. The Koya wadde prepares a medicine out of GARAGA(Coix lachry majoba), which is given to the patient two to three times a day. The Saora REGGAMMAR prepares a medicine out of NEEM seeds, TULSI seeds and LEMON seeds, which is administered to the patient twice a day.

Scabies : This disease is known as DULABANGA among the Koya, and as GAJI among the saora. It mostly occurs among children. Blistes painfully itch and become sores which emit foul smell. Pus is formed in the blisters painfully itch and become sores which emit foul smell. Pus is formed in the blisters the saora and koya believe that it is a contagious diseases. The saora. It mostly occurs among children. Blistes painfully itch and become sores which emit foul smell. Pus is formed in the blisters. The Saora and Koya believe that it is a contagious disease. The Saora REGGAMMAR prepares a paste out of NEEM leaves, turmeric root and Karanja (Carisea carandus) oil for application over the scabies. The Koya shaman prepares a thick solution out NEEM tree bark, KARANJA TREE BARK AND TURMERIC FOR APPLICATION ON THE SORES FOR CURE.

Ringworm : This disease is known as GATIDULA AMONG the Koya, and as BANAL among the Sarora. The disease develops on the external skin, particularly around the waist, leg joints, surfaces of palms, feet and on the back and around the neck of a person. The skin becomes rough in the affected parts, which cause irritation, and a fluid exudes from the sore. The disease is attributed to environmental factors. The herbal medicine meant for scabies is also used for ringworm. Some time KOCHILA oil is used asan external balm.

Conjunctivitis : The Saora call it ASHUMALI and the Koya call it kantakapoita. Colour of retina of the affected eye becomes red, with actue pain and constant flow of water. According to their belief pattern it occurs due to extreme heat and dusty wind. The affected eye is a frequently dabbed with a piece of cloth soaked in turmeric water. One or two drops of onion juice may be put into the affected eye.

Measles : This is a child-disease. Among the Saora it is known as JEREING and among the Koya it is called PUNDKU.(This disease develops on the external skin..After a few days of fever tiny red eruptions appear all over the body. The eruptions cause actue pain and skin irritation. Both the Koya and the Saora believe that it is caused by a malevolent spirit, who is blood-thirty. The disease subsides if the spirit is appeared with the offering of blood, preferably that a black cock.

Ear-Drum Aching : This ailment is known as ASHUDADU among the Saora and as KELKUNOTI among the Koya. Its symptoms include servere pain in the ear drum. Loss of audible capcity, discharge of pus and headache. For cure they put two to three drops of the juice of the leaves of BANATULSI or wild Ocimum sanctum. It is also known as GHODATULSI.

Sty : This disease is known as JAMAT among the Saora and as POITA among the Koya. Small ball like boils develop on the edge of eye-lid, which cause pain and problems of vision.For cure they apply juice of KANSIRI leaves. This is a kind of edible green for the poor.

Toothache : The Saora call it bubuji and the Koya term it is PALKNOTI. They believe that it is a spirit caused disease. Therefore, the Saora consult with their Kudanboi or Shamnin and the Koya with their wadde or shaman for spirit-exorcision. After the magico religious rite the patient consults his/herher medicineman for prescription of herbal medicine. The Saora medicine man advises the patient to apply paste of buffalo horn at the roof of the affected tooth, whereas Koya medicineman prescribes the extract of KOCHILA tree bark tobe applied around the aching tooth.

Nail – Disease : This disease is known as REYABUBA among the Koya. One corner of a finger or toe mail may cause pain if it has been affected by a foreign material. The shaman prescribes burnt ashes of ARAKH stem to be applied over the aching nail or lemon juice.

Nasal-Bleeding : This is a common disease among the Koya a during the winter seasit is called MUGBDI.. It is believed that the disease is caused by spirit –intrusion.Blood exudes through nasal apertures. The spirit is cast out by shaman through a magico-religious rite. The patient is given juice of PATALGARUDA roots for subsidence.

Evil-Eye : Among the Koyas it is knownas NISTATGADA, and among the Saora it is called KANTAPOITA. It is believed that some women are bestowed with the inherent power of evil eye. Some men also possess this inauspicious quality. If they cast a willful look at a child, then the inauspicious element in their vision making the child sick, and the Child runs temperature, becomesanaemic and loses appetite.

Physical Immaturity : Among the Koya physical immaturity among the boys is known as PASANA and among the Saora it is known as KUSAG. Among the Koya such a boy accompanies his WADDE or shaman to the forest to collect a piece of wood from a male terr of PENJARMARA, which they collect after propitiation. The shaman worships that piece of wood at the village GUDDI or shrine, and then ties it around the neck of the boy with a piece of black string. In case of Saora the Kudanboi or shamanin invokes the JALIYASUM on behalf of a boy who approaches her to attain maturity.

Udderinflammation : This is a disease of parturient women Among the Saora it is known as CHANDGADA. And among the Koya it is known as KIRANJAJA. If the child does not suck its mother's milk. The same gets reserved within the nammary glands, which causes pain.The Koya shaman prescribes the extract of NEEM tree bark to be taken by the patient thrice daily till she is cured. The Saora shmanin prescribes and admixture of honey and ARAKHA leaf –juice to be gently applied over the breast for remission of pain.

CHILDREN'S CLUBS CREATE HEALTH AWARENESS IN TRIBAL AREAS

Koraput, Orissa : All the girls in Puki village under the Badakarenga Panchayat in Koraput district now attend school. Three primary schools and four education centres under the Education Guarantee Scheme have been opened in last couple of years. Villagers of the panchayat are now well aware of various diseases as well as benefits of safe sanitation and the importance of educating their children, thanks to the efforts of Bal Sanghas (children groups) formed in various villages of the panchayat.

Bal Sanghas comprise all the children of the villages between the age group of 6 to 18 years. 59 such groups have been formed in various villages of the district with 2,955 children, including 1,211 girls, as its members. The formation of these groups started in the year 2003 in different villages under the guidance of a local voluntary organisation called SOVA (South Orissa Voluntary Action). These Bal Sanghas have now become torchbearers for others in the tribal district of Koraput. The children go from door-to-door in their villages and motivate parents to send their children to school. They try to motivate parents, teachers and members of the village education committees, panchayat members, and ICDS staffs to strengthen the existing education centres. They spread awareness about malaria and ways to prevent the disease from spreading. They also inculcate a sense of citizenship among the children and create awareness on child rights and campaign for it.

"Due to poverty and illiteracy, children of rural areas are deprived of many facilities they are entitled to. These village-level clubs are formed to provide children an opportunity express themselves and to increase their participation in village development programmes, especially in the area of education and health," said Sanjit Patnaik, secretary of SOVA.

He added that, "Children clubs are an effective strategy for implementing the activities pertaining to the development of children. Issues presented by children in such a platform are

acknowledged more sincerely by elders and duty bearers. Children feel proud when their issues are taken up and they are motivated to participate with more sincerity." "The drop-out rate in the panchayat, which was 374 in 2003, is now 84 and this is due to the efforts of these children's groups," Patnaik said.

"People in villages generally prefer the traditional methods of treatment than to a hospital. We motivate them to go to the nearby hospitals and take medicines. We are trying to make the villagers understand the benefits of sanitation and education," said Parvati Khosla, secretary of the Bal Sangha in Puki village.

"We are trying to convince the parents to send their children to school if they don't listen to us we starts beating drums in front of their homes till they concede. Earlier the children of this village attended the school in nearby Kendubeda village but due to our efforts a primary school was established here in 2005," she added.

A management committee is formed to carry out the day-to-day affairs of the club. The president, secretary and treasurer are elected through a democratic process for a period of three years. Either the post of the secretary or president is reserved for a girl child. Bal Sangha meetings are held once in a month where various problems of the village are discussed and a strategy is prepared to deal with them.

A weekly donation of one rupee is collected from each member as contribution, to pay for the club's day-to-day activities. Above the village-level clubs are the panchayat-level clubs and the office bearers of the village-level clubs automatically become the members of the panchayat level children's club and here also the post of secretary or president is reserved for a girl.

"Through puppet shows and street theatres we try to create awareness about HIV/AIDS among illiterate villagers. Children from different villages encounter different problems, we identify the issues and prepare an action plan to address them," said Minati Badnaik, secretary of the panchayat-level Bal Sangha

of Badkeranga Panchayat. The villagers who initially did not paid much attention to the children's efforts are now showering praise on them and encouraging them. "The children's effort in spreading awareness about malaria is commendable. Earlier in our village, most of the people died because of the fever due to ignorance about the precautionary measures to be taken. "Due to the efforts of these clubs the school dropout rate in our panchayat has come down. These children's are now participating in all our village-level meetings and putting forward their problems," said the villagers of Badakeranga Panchayat.

HYGIENE AND HEALTH PROBLEM

The tribes are suffering from many chronic diseases and the most prevalent which take heavy tolls of them are water-borne. This is mainly because of poor drinking water supply. Even though plenty of water is available in and around the tribal settlements, generally it is dirty and contaminated. Diarrhea, dysentery, cholera, etc, are often the results of this situation.

Apart from this deficiency of certain minerals and other elements are also in the water the causes for such diseases. In B,R Hills tribal region, sickle cell Anemia and Tuberculosis are common among many tribes. Added to this maternity problem is very serious in tribal colonies. Even today maternity work is done by the tribal women. One tribal woman known as Jallesiddamma (staying in Yarakanagadde podu) doing wonderful service in this field and she has been awarded by the government for her health service. Her service is incorporated with all the tribal settlement in B.R.Hills. Hence she has been recognised as "Soliga Thayandira Herige Doctor" (Doctor of maternity) by the tribes and local people.

Remedial Steps

There has been considerable expansion of medical and public health facilities for tribes during the last two Five Year Plans. Health centers are being opened with qualified doctors and with good medical facilities inspite of this it is very difficult

to trace the improvement in their health condition. Due to the lack of transportation and communication in tribal areas, they feel reluctant to go to the hospitals that are located far away from the tribal settlements. Hence primary health center should be established in the remote tribal areas with expert doctors. Moreover, mobile medical service has to be introduced for serving the tribal community. This will play a long inning in solving the health problems of tribes.

Apart from this non governmental organisations should be effectively involved in solving health problems of the tribes in this regard, Jayavijayam tribal hospital located in B.R. Hills in association with VGKK, a non-governmental organization, It serves the tribes with modern medical aids at free of cost. It also bridges the tribes with communicate the modern medical field.

Problem of Communication

Tribes are living in isolation for centuries. The main reason for this isolation is lack of communication. The problem of communication in tribal area may be examined from two angels: (1) needs of the tribes and (2) developments of the tribal areas as a whole. It has been ascertained that the communication facilities may not always prove to be a blessing to the tribal society. It also facilitates the entry of perspective exploiters and other anti-social elements from non-tribal areas, who takes the advantage of innocence of the tribes and exploit them in a variety of ways. But at the same time the march of events cannot be halted and the needs of defence, industrialisation, mining and development can also not be ignored.

Many tribes are good cultivators of some growing variety of crops. With a good network of roads and communication, their production will be able to reach far off markets and they can fetch handsome returns. In the absence of adequate means of communications and transportation. They have to sell their produce at comparatively low prices and are easily brow beaten by the local non-tribal traders to sell their produce at throwaway prices. Mukti colony is far away from the marketing place (24 Kins) in Gundlepet taluk without proper transportation and

communication. Hence, they are forced to sell their agricultural produce at low prices after harvesting and it is inhavitable for them due to lack of storage facilities.

Post and Telegraph services are slowly percolating into the remotest tribal areas, but unfortunately the mail carriers and staff are not regular employees of the post and telegraph department. Beduguli is one of the best examples for this inadequate service.

Remedial Steps

Development of communication no doubt will provide good opportunities for the tribal folk to develop national consciousness and a healthier intellectual horizon. Also the importance of communication in the realm of tribal economy hardly needs an emphasis but what has to be guarded against the danger of greedy and cunning, elements from the plains invading tribal areas to exploit the poor tribes. The best solution in such a situation seems to be taking all sorts of precautions for safeguarding the tribal interest before throwing any of their areas open.

Rehabilitation problem

As an example of general failure in tackling the problem of rehabilitation of displaced tribals more than 2000 tribal families in Karemala, Melukamanahalli, Moguvinahalli, Mukti colony, Maddur colony and Mukalli colony in Gundlupet taluk, Muneswara colony and Srinivasapura colony in Chamarajanagar taluk, Anehola, Kavalichalla dam in Kollegal Taluks are distributed. These are all rehabilitated tribal colonies. Government has taken care to fulfill their basic needs, but, it is far away from expectation and situation is not happier for the reason mentioned below.

Very few of them have taken advantage of agricultural facilities offered in their habilitation camps. The attraction of easy money and industrial employment are too strong, especially for young tribes.

The alternative land offered by the authorities for cultivation is not irrigable and cannot offer adequate return

to maintain the families on it. The cash compensation given to tribes seldom-utilised far productive purposes. It is almost invariably used for daily living expenses until alternative employment is found.

Remedial steps

In the sense of rehabilitation Government should provide only fertile land for cultivation in and around accessible regions. If once the tribes are rehabilitated, the government should provide them clean drinking water, electricity, communication and as much as possible the irrigation facilities for agriculture under the Ganga Kalyana Scheme, Nooru Bavi (Hundred Well) Scheme etc.

TRIBAL HEALTH STATUS AND STATE POLICY ON HEALTH

No single aspect of human life can be attributed to good or bad health as health is a holistic issue and various micro and macro conditions have direct and indirect impact of people's health. An analysis of a community's health status has to encompass its culture, its social and economic status and the larger external political influences and policies. Hence, the health situation of the tribal people in Andhra Pradesh are a result of these complex matrices of political decisions especially since liberalisation of the markets have reached up to the nooks and corners of the tribal habitations as well. The state health policy is exactly on the lines of education where the state seeks to:

1. Promote primary health care through decentralisation of health services by involving local communities
2. Encouraging private investment in tertiary and secondary levels
3. Promoting family welfare and population control
4. Strengthening the performance of the public health system
5. Enhancing health awareness

The future vision and planning of the state health system is being drawn up under APERP which would act as a Bible

for implementing health programmes. Focusing on the above areas of health intervention, the strategies for achieving health for all are:

Community Health Workers (CHW's)

The Government will develop a programme that uses voluntary Community Health Workers to deliver simple health services, backed by a system of referrals to sub centres. The CHW's will need to provide 24-hour service on call and be compensated reasonably by the local community. In parallel, the State will 'consider' supplementing the current system of providing basic care through PHC's. This is how the policy defines making health accessible to all! In the tribal areas, there is an army of 'trained' CHW's (all tribal women) appointed by the health department. They are medical practitioners without an idea of health and can manage to recognise four types/colours of medicines occasionally provided to them by the department. For the greater part they are unpaid assistants of the field level health staff. Their salaries are to be met from contributions of the community.

Increased Private Sector Participation

In the existing situation where government provides free health care in the primary health centres, the number of tribal women who have access to these facilities are minimal. Where infant mortality rate is as high as 212, where 90% of childbirths are performed at home by traditional methods without any access to professional medical services, where women have multiple pregnancies and miscarriages, where there is no tertiary care during or after pregnancy, where government fails to deliver even simple iron tablets, where women and children are increasingly becoming vulnerable to new diseases hitherto non existent among tribals-the government, instead of strengthening its health support systems, has serious plans to withdraw.

Especially areas like diagnosis of diseases like malaria, charging of fees for beds in government hospitals, etc which affect the poor will be privatised.

Health Budgets and Priorities

At the policy level the state government expenditure on public health tripled from Rs.450 million to almost Rs.1,200 million with emphasis on primary health care, health services, family welfare and community development. A number of national health programmes like UIP, NMEP, CSSM, NTCP, NLEP, and others are implemented in the tribal areas of A.P and there has been a significant increase in state allocations in all these areas.

In the tribal areas, however, it appears as if family planning and population control are the primary areas of concern for the government instead of immunisation, safe deliveries and motherhood, endemic diseases like malaria and gastro entiritis, communicable diseases, goitre, etc. The health staff are given monthly targets for family planning, particularly sterlisation while there are no such targets for immunisation or bringing down mortality.

The ANM's and other health staff in the tribal areas visit the villages only to round up 'eligible couples' who are their potential targets. Tribal women are forced into sterilisation and lured with small incentives to adopt unsafe family planning methods. In areas where infant mortality is very high, it is ethically questionable how the government is pursuing population control with such venomous zeal when it has made no attempt to reduce the incidence of infant and child mortality among tribals. The Tribal Welfare Department or the health departments do not provide for treatment of cases with serious endemic diseases in these areas like goitre, sickle cell anaemia, malaria, etc although specific programmes exist in the policy. Whereas statistics show an absolute increase in health education and training, allocation for training of nurses and para-medical health workers has reduced and the concentration is on providing for higher education in health. This is one important reason for neglect of health services in tribal areas as these areas are largely dependent on health workers, quacks or traditional healers. Professional medical doctors show no motivation to work in these remote areas and either fulfil the

minimum mandatory period of service and then make all efforts to get postings in urban centres or manage to be absent from their areas of posting through fraudulent means. After liberalisation, there is a greater out-flow of medical professionals for higher education or more lucrative job opportunities outside the country while some are, on record, posted in some primary health centres in the tribal area! Especially there is no training provided to dais and CHW's on safe deliveries, motherhood and gynaecological problems and hence none of the government programmes ever reach out to tribal women. There is a total absence of training or services in traditional systems or ayurveda which are most relevant to the tribal context and where the tribal women are themselves knowledgeable and have access to using these sources of medicine. However, research on traditional knowledge systems and herbal/natural forms of medicine which in no way benefits the tribal people, is on the rise by external research and donor agencies.

Health Related Services

A good health policy does not stop at distribution of medicines but has a comprehensive approach to health. A good health policy would concentrate on a good economy, creation of safe and hygienic basic amenities and preventive health. The new health strategy of A.P for the tribal areas has no mention of providing safe drinking water which is one of the most serious problems in the tribal areas. Every year there are wide spread deaths during the monsoons as a result of diarrheoea and water borne diseases. Malaria is another serious epidemic here. The whole state health machinery is geared towards distribution of chloroquine, spraying of DDT and taking of blood smears while there is not a single village which is provided with sewerage and sanitation facilities. The government does not look at proper housing, food sufficiency and other important needs as linked to tribal health.

Reduction in food subsidies to the poor has had drastic consequences on the food intake of women who are the first to sacrifice their share to the rest of the family. The state government has reduced the amount of rice and other domestic

items given under ration and has placed a ceiling on the size of the family it provides ration to. It has increased the cost of rice from Rs. 2.00/kg to Rs. 6.00/kg while the quality of rice supplied is the most inferior quality. GCC ltd, which runs the public distribution depots in the tribal areas of A.P is under the threat of being closed down or privatised under the new economic policy and has been deliberately made to reflect all the evils attached to a public sector enterprise.

Non Timber Forest Produce (NTFP)

The tribals of A.P earn a greater part of their livelihood through collection of forest produce (NTFP) which is sold at the weekly markets. GCC ltd has monopoly rights over purchase and trade of NTFP in A.P. Increasingly, GCC ltd does not have the capital flow to purchase forest produce from the tribals who are forced to sell to private traders under highly exploitative conditions. While the monopoly law restricts the tribal from selling his produce for a better price in the open market, it does not bind GCC ltd to purchase all the produce coming out of these areas. Tribal women who are actively involved in collection and sale of forest produce face severe exploitation from traders and do not get a fair price for their labour.

This market exploitation has repercussions on the consumption of food by tribal women for whom NTFP is the only source of cash flow either to purchase food or other domestic items for the household. A good example is the case of tribal women from a small tribal village called Gonduru in Visakhapatnam district. The women were trained for processing and packaging of tamarind, an important NTFP from this area. However, they are prohibited from selling this value-added product in the open market where they receive a better price, because of the monopoly restriction. Even after the visit of the chief minister of the state who spoke eloquently of the women's skills and promised to support all the women's groups through better marketing linkages and to relax the restrictions, the women are forced to sell their products 'illegally'.

Launching fanciful schemes in the name of women's development is the prerogative of the government, and not

decentralisation of powers and rights over resources to poor tribal women especially where it concerns their basic sustenance. There is a lack-lustre enthusiasm on the part of the state government to remove these monopoly restrictions and replace them with support price options so that tribals may earn a better income. This is a clear indicator of how privatisation is not for the benefit of the poor but only where the industry/the capital owners are to flourish from such policy changes.

The New Agriculture and Forest Policies and their Impact on Tribal Women's Health

The Joint Forest Management programme in A.P launched in 1993 has been implemented in most of the tribal villages, particularly in Visakhapatnam, Srikakulam, Vizianagaram and Adilabad districts. With the aid of development incentives like construction of roads, checkdams, etc, the tribals are being drawn into forming Vana Samrakshana Samithis, the pre requisite being that they give up their podu cultivation and take up plantations suggested by the forest department.

The impact of this is being seen among the tribals in Visakhapatnam district where the tribals have less to consume, particularly the diverse traditional varieties of crops, as most of the lands have been converted into plantations. Tribal women now get to consume less food unless they purchase from the market. Women's knowledge in forestry is being downsized by the new tribe of external technical consultants forcing their expertise of forestry on to them. The external funding projects to the tribal areas with World Bank in the lead are pressurizing for new forms of economy in these areas and are pushing for constitutional amendments to bring in corporatised agriculture, large farm holdings, hybridisation and extension of agricultural loans so that farmers can grow cash crops and high capital intensive crops. In Visakhapatnam district, the tribals have rich traditional systems of agriculture, horticulture and vegetable cultivation which reflect the diversity of crops, the consumption nature of economy and the optimal usage of land and resources with minimum capital and external support.

In this district, the government has over a period, been trying to shift the economy of the tribals into new forms of monocultures without forethought to the hazards that they would be exposing the tribals, especially the women who have an important role in the traditional form of agriculture. One of the most fearsome aspects of this new shift is the lack of any information or awareness to tribals on the skills required, the seeds, fertilisers, pesticides, the patterns and yields and the influence of macro market forces on these crops.

Alcoholism and Tribal Women's Struggles

Under the new economic policies of the state, revenues are to be earned from lucrative sectors like sale of liquor. The ban that was imposed on sale and consumption of liquor after strong protests from women across the state, was lifted by the present government as it felt that it could not overcome the state deficits without income from this important source.

The heavy burden of debt accumulated by political decision-makers is inflicted on poor women who have to work harder, not for a better nutrition and quality of life, but in order to keep their men swaying in the liquor dens and the state out of troubled waters! The state is directly responsible for such indirectly negative policies affecting women's health. When tribal women in PNDPalem village of Visakhapatnam district refused to allow the liquor mafia to set up its outlets in the tribal villages, they were brutally 'punished' for daring to defy the local powers and excise authorities.

The mafia swooped down on them with the excise police in tow, their houses were demolished, they were dragged into illegal custody, tortured physically and mentally, forced to drink the urine of the men as a result of which one of the women succumbed to the injuries. The police refused to even register the case filed by the women. Legal suits filed against the excise authorities has led to constant harassment on the women. This nature of brutality is encouraged by the state so that women would rather face the hazards of alcoholism than the wrath of the authorities.

Tribal Women's Health and Forest Rights

All natural resources in the forest (where unfortunately tribals also live) are under serious threat of privatisation in the state under the rationale that industry has the capacity to invest whereas people and government do not have the resources to do so. Hence, handing over of forests to mineral, paper, wood based industries would lead to economic progress of the country as well as improve the incomes of forest dwellers. In the year 2000 the state government passed a G.O (No.112) to transfer forest lands to industries like Reliance and ITC Bhadrachalam through the village institutions of Vana Samrakshana Samithis. Strong protests from NGO's and opposition parties who highlighted the government's back door approaches to privatisation of forest resources, led to hasty withdrawal of the proposals. Similarly, in A.P the mineral wealth found in the tribal areas was attempted to be sold away to private mining industries either by illegally transferring tribal lands or even worse, by removing the constitutional safeguards (Fifth Schedule of the Constitution) to the tribal people. Mining is one of the important growth engines in the new reforms package of the government and most of the minerals in A.P are found in the tribal areas. With all the pretensions of bringing in prosperity to the tribals, the state government passed a resolution last year to amend the state laws under the Fifth Schedule of the Constitution where industries would not be hindered by legal obstacles.

3

Distribution of Health Care Resources

MEDICAL WASTE MANAGEMENT FOR HEALTH CARE INDUSTRY

Bio-medical waste, also known as infectious waste or medical waste is defined as waste generated during the diagnosis, testing, treatment, research or production of biological products for humans or animals. Bio-medical waste includes syringes, live vaccines, laboratory samples, body parts, bodily fluids and waste, sharp needles, cultures and lancets. The main sources of bio-medical waste are hospitals, medical clinics and laboratories. Because bio-medicalwaste can be detrimental tohumanhealth, the law requires such facilities to follow procedures that protect the public from coming into contact with it. Agencies that regulate different aspects of bio-medical waste include Occupational Safety and Health Administration (OSHA), Food and Drug Administration (FDA) and Nuclear Regulatory Commission.

Hospital is one of the complex institutions, which is frequented by people from every walk of life in the society without any distinction between age, sex, race and religion. This is over and above the normal inhabitants of hospital i.e patients and staff. All of them produce waste, which is increasing in its amount and type due to advances in scientific knowledge and is creating its impact. The hospital waste, in addition to the risk for patients and personnel who handle these wastes poses a threat to public health and environment. Keeping in

view inappropriate bio-medical waste management, The Ministry of Environment and Forests notified the" Bio-medical Waste (management and handling) Rules, 1998" in July 1998. In accordance with these Rules (Rule4), it is the duty of every "occupier" i.e a person who has the control over the institution and or its premises, to take all steps to ensure that waste generated is handled without any adverse effect to human health and environment.

The hospitals, nursing homes, clinic, dispensary, animal house, pathological lab etc., are therefore required to set in place the biological waste treatment facilities. It is however not incumbent that very institution has to have its own waste treatment facility. The rules also envisage that common facility or any other facilities can be used for waste treatment. However it is incumbent on the occupier to ensure that the waste is treated within a period of 48 hours.

Medical care is vital for our life, health and well-being. But the waste generated from medical activities can be hazardous, toxic and even lethal because of their high potential for diseases transmission.

The hazardous and toxic parts of waste from health care establishments comprising infectious, bio-medical and radioactive material as well as sharps (hypodermic needles, knives, scalpels etc.) constitute a grave risk, if these are not properly treated/disposed or is allowed to be mixed with other municipal waste. Its propensity to encourage growth of various pathogen and vectors and its ability to contaminate other nonhazardous/non-toxic municipal waste jeopardises the efforts undertaken for overall municipal waste management. The rag pickers and waste workers are often worst affected, because unknowingly or unwittingly, they rummage through all kinds of poisonous material while trying to salvage items, which they can sell for reuse. At the same time, this kind of illegal and unethical reuse can be extremely dangerous and even fatal. Diseases like cholera, plague, tuberculosis, hepatitis (especially HBV), AIDS (HIV), diphtheria etc. in either epidemic or even endemic form, pose grave public health risks. Unfortunately,

in the absence of reliable and extensive data, it is difficult to quantify the dimension of the problem or even the extent and variety of the risk involved. With a judicious planning and management, however, the risk can be considerably reduced. Studies have shown that about three fourth of the total waste generated in health care establishments is non-hazardous and non-toxic. Some estimates put the infectious waste at 15% and other hazardous waste at 5%. Therefore with a rigorous regime of segregation at source, the problem can be reduced proportionately. Similarly, with better planning and management, not the waste generation is reduced, but overall expenditure on waste management can be controlled. Institutional/Organisational set up, training and motivation are given great importance these days. Proper training of health care establishment personnel at all levels coupled with sustained motivation can improve the situation considerably.

Since majority of the health care establishments are located within the municipal area, their waste management naturally has a close linkage with the municipal system. At the same time, the civic authority is responsible for public health in the whole of the municipal area. Therefore, the health care establishments must have a clear understanding with the municipality regarding sharing of responsibilities associated with this issue.

Studies have shown that about three fourth of the total hospital waste is not hazardous/infected (provided strict segregation is practised) and can even be taken care of by the municipal waste management system, e.g., waste generated at the hospital kitchen or garden, the office or packaging material from the store etc. Such practices of strict and careful segregation would reduce the load and the cost of management of the actually hazardous and infected bio-medical waste (collection, transportation, treatment and disposal). Each establishment has to chalkout a programme for qualitative as well as quantitative survey of the waste generated depending on the medical activities and procedures followed by it associated bio-medical research. Bio-medical waste (BMW) is generated in hospitals, research institutions, health care teaching

institutes, clinics, laboratories, blood banks, animal houses and veterinary institutes. Although very little disease transmission from medical waste has been documented, both the American Dental Association (ADA) and Centre for Disease Control recommend that medical waste disposal must be carried out in accordance with regulation.

Most medical waste is incinerated, a practice that is short-lived because of environmental considerations. The burning of solid and regulated medical waste generated by health care creates many problems. Medicalwaste incinerators emit toxic air pollutants and toxic ash residues that are the major source of dioxins in the environment.

The toxic ash residues sent to landfills for disposal have the potential to leach into groundwater. Medical waste has been identified by US Environmental Agency as the third largest known source of dioxin air emission and contributor of about 10% of mercury emissions to the environment from human activities. The air emissions affect the local environment and may affect communities hundreds or thousands of miles away. Dioxin is one of the most toxic chemicals known to humankind. Dioxins have been linked to cancer, immune system disorders, diabetes, birth defects and disrupted sexual development. International Agency for Research on Cancer (IARC), an arm of WHO, acknowledged dioxins cancer causing potential and classified it as human carcinogen. To avoid dioxin production, nochlorinated plastic bags (and preferably no other chlorinated compounds) should be introduced into the incinerator. Red bags must not be incinerated as red colour contains cadmium, which causes toxic emissions. If mercury-containing items are put into a red bag for infectious waste and sent to an incinerator or other waste treatment technology, mercury will contaminate the environment. Airborne mercury then enters a global distribution cycle in the environment, contaminating fish and wildlife. Mercury is a potent neurotoxin that can cross the blood-brain barrier as well as the placenta.

Approximately 75-90% of the bio-medical waste is nonhazardous and as harmless as any other municipal waste.

The remaining 10-25% is hazardous and can be injurious to humans or animals and deleterious to environment. It is important to realise that if both these types are mixed together then the whole waste becomes harmful.

FEATURES OF HEALTH CARE SYSTEMS

As governments and societies attempt to maximise the level of health care benefits generated from the resources available, the nature of health care systems and their funding mechanisms are never far from the discussions and deliberations that take place in academic, political and professional communities. Reforms and change have been the order of the day in many health care systems and, while any attempt to assess their relative success has been virtually impossible given the frequency and extent of such developments, one common thread has appeared to be transference of decision-making to a more local level. In the UK, the reforms introduced in the early 1990s paved the way for the present situation where local decision-makers are required to establish priorities and allocate resources. The separation of the agencies that commission, organise or purchase services from those that provide health care services has become a common feature of health care reforms across many European countries. As a result, patients may have to bypass their local hospitals and travel across both national and international boundaries in order to receive treatment, and NHS patients may be found in hospital beds alongside private patients, as well as the opposite scenario, which has a longer history.

The extent of private sector involvement in health care systems has been another feature in the ongoing debate about the funding and organisation of health care services. For example, just as there is greater involvement with the private sector hospitals in the UK, the Private Finance Initiative (PFI) has become the main source of capital funds for major investment projects in the NHS, funding 85% of major capital projects since 1997.2 However, there are major concerns as to the effectiveness and efficiency of PFI as a vehicle for building new capacity within the NHS, with counter claims suggesting

that it actually constrains service provision and limits future developments, and may not actually represent value for money as originally envisaged, and 'there appears to be no macroeconomic justification for preferring PFI to Exchequer financing, or for regarding one approach as any more affordable than the other'.

The organisational structure of health care systems is also subject to variation and what appears to be more or less constant change and reform. In 1989 the UK Department of Health White Paper 'Working for Patients' proposed a set of reforms in an attempt to improve the performance of the NHS, based on what came to be known as 'internal market'. Under the new arrangements, hospitals and community health units were designated as NHS Trusts and became the main 'providers' of front-line health services. They were required to compete with each other for contracts from Health Authorities (HAs) and general practitioner (GP) Fundholders who were established as the purchasers or 'commissioners' of services. The new organisational structure, which sought to emphasise decentralisation and entrepreneurship, ran counter to other health policy initiatives of the time, most notably The Patient's Charter and the Health of the Nation strategies, which sought to impose central standards and targets. It was also argued that the experiment with a competitive quasi-market in health care for the NHS did not really succeed because in the main it was not tried, as the government was reluctant to reduce the extent of centralised control. It was therefore no surprise that in 1997, the new Labour government declared that the internal market and the reliance on 'competition' as the basis for improving performance in the NHS would come to an end.8 In their place would come a return to collaboration, partnership, integration and the development of new structures to replace the existing HAs. New organisations (with different nomenclatures evident in different parts of the devolved UK) in primary care were constituted to emphasise the increasingly important role of primary care in the planning of health care and to cooperate with secondary care providers. These independent trusts control a highly significant percentage of

the NHS budget and have the capability of retaining budget surpluses and utilising these for the benefit of patients in their locality.

However, there remain serious capacity constraints within the NHS in the UK, particularly in terms of doctors and nurses - a problem that may intensify if some commentators are to be believed. A report in the media has suggested, for instance, that thousands of the country's most experienced doctors may quit the NHS within 3 years after the introduction of the new contract in 2005, which means they can retire early on full pensions. The new contract boosts the salaries of top consultants by £20 000 to £92 000. Their pension contributions will rise in line with their pay, meaning that they will hit the Organisation and funding of health care services maximum achievable pension - just under half their salary - by their early sixties. Some could even retire as early as their mid-fifties with only a slight deduction in their retirement benefits. For most there will be little incentive to keep working punishing NHS schedules until mandatory retirement.

The stark warning presented is that by 2007 nearly 4000 senior consultants will have little or no financial incentive to continue working for the NHS and any mass exodus would exacerbate staffing problems in the service, which at present has a shortfall of 10 000 hospital doctors. The Wanless Report estimated that an extra 30 000 doctors, 24 000 nurses and 94 000 qualified scientific, technical and ancillary workers were needed over the next 20 years or so,10 but even this achievement would not change the position of the UK as below the EU average in the number of doctors and nurses per 1000 population. In addition, the development of league tables, the continued use of performance indicators, the establishment of 'Foundation hospitals', the ongoing political debate surrounding so-called 'patient choice', and the role and extent of involvement of the private sector in the UK make it difficult to ignore the imperative of competitiveness within the health care system. For example, in a comparison of the NHS with a health maintenance organisation in the USA, Kaiser Permanente, the latter achieved better performance at roughly the same cost

as the NHS because of integration throughout the system, efficient management of hospital use, the benefits of competition and greater investment in information technology. At the same time, the nature of the NHS and its financing continue to focus the attention of policymakers, politicians, academics and health care professionals. The rationale for government involvement in the organisation and funding of health care is fundamental to such discussions and is considered in the next section.

The Necessity for Government Involvement in the Financing of Health Care

In order for the market mechanism to deliver Pareto-efficiency, a number of conditions need to exist:

(1) Perfect competition:

- a large number of consumers and suppliers, so that no one consumer or supplier can collude to exert excessive influence within the market;
- product or service homogeneity, so that no one product or service can be distinguished from (and possibly have an advantage over) another;
- complete freedom of entry into the market and exit from it, so that there are no constraints on new suppliers joining the market or existing suppliers leaving.

(2) Perfect knowledge on the part of consumers, so that consumers are fully aware of the characteristics of the product and/or service being provided, know whether they want it, know how much they want, know when they want it and where they can get it.

(3) A certain world, where consumers can choose and plan when and where they will engage in transactions.

(4) Absence of externalities, which arise when the activities of one consumer and/or supplier affect the outcome of the activities of another agent and are not covered by the market mechanism.

In the real world, perfect competition does not exist. Markets are characterised by monopolistic tendencies and other

structures that allow individual suppliers to exercise considerable control over the price to be charged or the amount to be produced. Even if perfect competition did exist, there are certain types of goods that either would not be provided at all or would be provided inadequately or in insufficient quantity by private firms. The demand side of the market mechanism is characterised by a desire for a commodity plus an ability to pay for it. For many products this may be perfectly realistic but for a range of others, it may not be. The characteristics of 'public goods' mean that such commodities are provided by central or local government (e.g. defence, street lighting) or not at all. In addition, governments intervene to finance and provide 'merit' goods, that is, goods and services that are higher on society's preference listing than on an aggregation of individuals' preference listings, alongside private suppliers. Examples of these are to be found in the provision of education, transport and health care.

It is inconceivable that many people would be prepared to directly pay for the provision of speed cameras or traffic-calming schemes, designed to reduce the number of accidents, and it is left to government to provide such schemes. Another problem associated with the operation of the market mechanism is the existence of what are called externalities. There are many examples of externalities in health care that require government intervention. In recent years, the dangers of passive smoking have been recognised and led to the introduction of smoking bans in public places, with New York, Italy and Ireland being prime examples. Such measures to counter the 'adverse effects' resulting from the activities of some members of society on others would not be possible if there were no government intervention in the operation of the market mechanism. Similarly, if there were no regulation and intervention on the 'supply side' to ensure that practitioners were qualified, the market would not prevent anyone from setting up as a practitioner, with potentially serious and even fatal consequences. While regulations and licensure do not necessarily guarantee that 'quacks' and 'one-offs' will not practice, the standards, skills and knowledge required for

qualification go a long way in protecting the safety and interests of consumers, who are unlikely to be sufficiently informed to do so themselves.

Similarly, it is unrealistic to assume that consumers have, or can access, sufficient information relating to health care services (despite the wealth of information available from the Internet), to furnish themselves with the perfect knowledge required to make the decisions necessary when confronted by sickness and illness. Consumers of health care services, as in other areas, are therefore reliant on agents who act on their behalf - health care professionals. Agency arises in situations in which potential consumers recognise that they are not sufficiently well equipped to make rational, informed consumption decisions. They decide to rely on experts acting on their behalf so that they have a better chance of maximising utility. While politicians and policymakers have recognised the importance of involving patients in the decision-making processes and the role of the 'expert patient' has been developed, it is still the case that patients are generally ill-informed and that health care professionals are able to act as the more informed agent on behalf of patients, in relation to problem diagnoses, treatment availability and the effectiveness of interventions.

Other reasons that necessitate government involvement in the funding of health care services, as opposed to reliance on a private insurance-based system, arise due to the existence of adverse selection and moral hazard. Adverse selection occurs when people do not reveal the full extent of their health profile, and thereby their risk level, to the insurer. This may result in people at high risk paying lower premiums than their actual risk would indicate. As a consequence, insurers would inflate the premiums and some people may be left uninsured - those at low risk who do not bother to take up insurance as the premiums are too high and those at high risk who cannot afford the premiums. Moral hazard arises when the attitudes and behaviours of people change once they are covered for the potential costs of treatment. They may choose to take less care of themselves and consume all health care services that they

are entitled to, irrespective of whether they are needed or not. It is therefore apparent that there are powerful arguments in favour of government intervention in health care provision. What is also evident is that the market mechanism would not adequately deal with the supply of professionals.

In theory, a market for health care professionals could exist, but there would be no system of qualification and regulation, and patients would have to choose between practitioners based on their own assessments of quality and price, while there would be no curbs on overprovision of health care services, and, given the lack of knowledge and expertise among consumers of health care services, they would be utterly dependent on doctors and other health care professionals as their agents.

The Role of Health Care Professionals

The motivation of individuals who work within public services in general and within health care in particular has been widely discussed in the literature. Much of this concentrates on the extent to which such individuals are self-interested or altruistic. However, most of the literature on organisational behaviour has made fairly simple assumptions concerning individual motivations and has concentrated on the extent to which individuals or groups of individuals with different motivational structures interact within organisations to affect organisational behaviour.

The economic theory of the firm provides three models to assess the behaviour of organisations. The first group of models is based on what is known as the traditional theory, which represent the firm as a single agent in pursuit of profit maximisation.

The single firm is unable to exert any influence over the prices or levels of production, due to the fact that there are many other firms operating within the same market. Such models have very limited application in explaining the behaviour of organisations in general, yet alone those in health care services assume the existence of perfect competition in markets and bear no resemblance to the nature and complexity of the

modern organisation. The second group of models is based on the distinction between management and ownership and is known as 'managerial theories of the firm'.

These models also consider firms as single agents, but ones that pursue other goals not linked to profit maximisation, such as the maximisation of revenue. Managers will have different goals and objectives in relation to the performance of organisations than the owners of the organisation. For example, it was suggested that the short-term nature of managerial contracts within the NHS could, in some cases, result in decisions being made to protect their employment rather than other desirable, longer-term goals, such as staff or service development.

The third group of models - multiple agent models, derived from behavioural theories of organisational behaviour - regards organisational behaviour as the product of multiple groups interacting within the organisation. Behavioural models take cognisance of the complexities underlying organisations and describe the firm as a coalition of groups with conflicting interests. The firm is a 'satisficing' organisation rather than a maximising entity, which aims to achieve a number of objectives, such as the 'maximisation' of production levels, sales, market share and profit, but with equal emphasis on stability and survival. These behavioural models have been further developed to acknowledge the significance of relationships and interactions within the organisation and how behaviour is influenced through contracts and other forms of incentive structures. Another type of model has been advocated as a logical variation on the behavioural model, which suggests that organisational motivation is the product of multiple actors, but with a dominant single actor mimicking the behaviour of the atomistic firm structure with a single overriding goal.

Models of hospital behaviour have been drawn from the theoretical perspectives of organisational behaviour and the economic theories of the firm. Some have treated the hospital as a profit-maximising entity, in general assuming that

clinicians are the primary decision-makers, while other models predict that other forms of maximisation exist which identify administrators as the decision-making unit.21 Within the UK, managers and health care professionals have been identified as the principal actors within the NHS, who coexist in a power coalition while harbouring different and potentially conflicting sets of interests. There was no consensus on whether either the managerial or the professional body was dominant but, within professionals, consultants were considered to be the dominant actors, over and above, say, nurses.24 Much of the organisational change within the NHS during the 1980s and 1990s was an attempt to redefine the balance of power between doctors and managers, that is, to strengthen the role of management and to encourage participation by doctors in management, with the aim of shifting doctors' orientation and behaviour to be more like that of managers, thus strengthening the management's objective function of the NHS organisation.

However, such attempts were not without their casualties. A dramatic example of conflict between managers and medical staff took place in South Wales in 1995. An NHS Trust ran into serious financial difficulties, partly because medical staff were able to resist the implementation of a plan to make them redundant and to transfer others to another Trust when the service they were providing was to be transferred. In the battle that ensued - including a vote of no confidence in the Chairman of the Trust Board and the Chief Executive of the hospital passed by the medical staff - the Chairman and the Chief Executive of the Trust were replaced and the affair became the subject of an investigation by the Welsh Affairs Select Committee and Public Accounts Committee of the House of Commons.

More recent work has been undertaken to assess the extent to which the desire to strengthen the role of management and the participation of professionals in management had become apparent in reality and to determine whether in fact there is a dominant power base underlying decision-making in NHS Trusts. A survey of 1500 consultants and mangers (as the major power sources) across 100 Trusts was undertaken over

a 3-year period to assess what motivating factors lay behind their agendas and eventually the performance of their Trusts. The findings were that consultants considered production goals to be more important than financial break-even targets, but within those goals, considered quality to be more important than service volume. While the break-even target was generally found to be the primary goal of managers, they proved to be a heterogeneous group with quality ranking as the main priority among those managers who were closest to service delivery. This was at odds with the apparent objective of Trusts, which both groups perceived as being the pursuit of financial targets, consistent with the formal, government-set requirements. The study concluded that the reforms of previous years had done nothing to reduce the power base of the hospital consultant and that the Trusts' primary objective was to maintain service quality.

But what of the primary care sector where the context is complicated by the existence of other factors and situations? While the literature has concentrated on hospitals and NHS Trusts, the same imperatives apply in terms of service quality and financial targets in primary care, but issues relating to equity, wider efficiency objectives and indeed ethical considerations also impinge significantly on the objectives and behaviour of primary care organisations. In addition, there are also the potential conflicts that arise from the different agendas, and objective functions that arise from the role of health care professionals as agents, especially in the context of primary care, with its dual functions of service commissioning and service provision.

Health Care Professionals as the Agents of Patients

The role of the health care professional as the agent of the patient is of particular relevance to the organisation of health care services. The health care professional is in the unenviable position of wearing one hat as health care service provider and, at the same time, having to wear the hat of patient advisor. As providers they seek to diagnose, treat and care for the health care needs and problems faced by patients. As patients'

agents, they aim to put themselves in the place of the patients and provide advice, based on their greater knowledge and expertise, to inform the patients, who can then address their health care needs. In other words, the objectives and goals of health care professionals should mirror those of their patients. This, of course, assumes close correspondence between the health care needs of patients as perceived by patients themselves and those as perceived by health care professionals. Much energy and effort has gone into the assessment of needs of patients. Needs are categorised into those that are perceived and those that are not, by the patient or agent. The former relate to those that exist when an 'abnormality' is identified by the patient which can be dealt with in one, or a combination, of three ways:

(1) no action;

(2) use made of one of the informal agencies involved in health and social care, e.g. self-medication, informal carers;

(3) contact made with health care and social care services at the initial point of contact (i.e. 'expressed need').

Health care professionals may have a different perspective than that of patients, and it may be that the self-perceived needs of the patient are not acknowledged as being 'need' by health care professionals but rather as being 'neurosis'. Thus, because of this assessment by professionals, selfperceived needs would not necessarily be met with service provision.

The other category of needs, namely needs unperceived by the (potential) patient, would encompass conditions that are unrecognised by an individual, the family, carers or friends but that are potentially discoverable by practitioners and professionals on careful investigation of the total physical, mental and emotional well-being of the individual. The problem is that they only become discoverable when patients make contact with the service providers, who then take on the responsibility of agents acting on their behalf. Such needs may warrant intervention (when it is thought that prevention, management or specific therapy would be of benefit) but would

also include those situations where intervention to meet such needs may prove to be unwanted by the patient, e.g. a severe warning to change lifestyle behaviour and habits if serious coronary events are to be avoided.

For some people, the ability to identify or articulate their needs is extremely difficult, while for most lay people their limited knowledge does present a major constraint in equating needs with appropriate interventions and services.

The problem is also compounded by the fact that in the case of health care, patients' reliance on professional advice may lead to potentially difficult and contentious situations. Suppliers of services are, potentially, in a very advantageous situation when needs have to be assessed, especially when the two functions (assessor and supplier) are contained within the same agency.

First described in 1953 in the US, whiplash rapidly achieved notoriety . . . within ten years it had become a subject heading in the Cumulated Index Medicus . . . and quickly became a worldwide epidemic and a multibillion-dollar industry . . . with a current estimate of £3.1 billion in UK.

This sort of example raises the obvious question of whether service provision is patient-led, with health care professionals acting as agents of patients, or whether the supply of such services is driven by professional, organisational, political and economic interests. Supply-induced demand has been defined as 'the extent to which a doctor provides or recommends the provision of medical services that differ from what the patient would choose if he or she had available the same information and knowledge as the physician'. The question as to whether need exists may not be relevant, but it is important to realise that there may not be a coincidence between the views of patients and those of the professionals regarding needs. The perceptions of GPs, nurses and patients may all differ. For example, the relationship between patient and doctor has been portrayed in an amusing, but probably reasonably accurate, way: At the heart of clinical practice is the doctor-patient relationship. In principle this is a principal-agent relationship

in which the patient is principal and the doctor the agent. If a doctor is acting as the perfect agent of his patient, their respective roles would be that the DOCTOR is there to give the PATIENT all the information the PATIENT needs in order that the PATIENT can make a decision, and the DOCTOR should implement that decision once the PATIENT has made it. If that does not sound quite the way it usually is, try reversing the roles of DOCTOR and PATIENT, so that the relationship now gets described as the PATIENT being there to give the DOCTOR all the information the DOCTOR needs in order that the DOCTOR can make a decision, and the PATIENT should then implement that decision once the DOCTOR has made it. The question as to who should assess the needs of patients and how they should be responded to cannot be answered on empirical grounds alone. The question is ultimately both subjective and political and goes to the very heart of the theories of moral justice. What can help in practice is for managers and professionals to be clear about their own particular values and ideas surrounding the notions of justice and equality but also to recognise that other views, in particular those of the patient, need to be borne in mind.

SOURCES OF BIOMEDICAL WASTE

Hospital waste refers to all waste, biologic or non biologic that is discarded and not intended for further use. Medical waste is a subset of hospital waste; it refers to the material generated as a result of diagnosis, treatment or immunization of patients. This constitutes about 85% of the waste generated in most healthcare set-ups. This includes waste comprising of food remnants, fruit peels, wash water, paper cartons, packaging material etc.

Biohazard: Biological hazards, also known as bio-hazards, refer to biological substances that pose a threat to the health of living organisms, primarily that of humans. This can include medical waste or samples of a microorganism, virus or toxin (from a biological source) that can impact human health. It can also include substances harmful to animals. The term and its associated symbol is generally used as a warning, so that those

potentially exposed to the substances will know to take precautions.

Levels of biohazard

Immediate disposal of used needles into a sharps container is standard procedure. The United States' Centres for Disease Control and Prevention (CDC) categorizes various diseases in levels of biohazard, Level 1 being minimum risk and Level 4 being extreme risk. Laboratories and other facilities are categorized as BSL (Biosafety Level) 1-4 or as P1 through P4 for short (Pathogen or Protection Level).

Biohazard Level 1: Bacteria and viruses including Bacillus subtilis, canine hepatitis, Escherichia coli, varicella (chicken pox), as well as some cell cultures and non-infectious bacteria. At this level precautions against the bio hazardous materials in question are minimal, most likely involving gloves and some sort of facial protection. Usually, contaminated materials are left in open (but separately indicated) waste receptacles. Decontamination procedures for this level are similar in most respects to modern precautions against everyday viruses (i.e.: washing one's hands with anti-bacterial soap, washing all exposed surfaces of the lab with disinfectants, etc). In a lab environment, all materials used for cell and/or bacteria cultures are decontaminated via autoclave.

Biohazard Level 2: Bacteria and viruses that cause only mild disease to humans, or are difficult to contract via aerosol in a lab setting, such as hepatitis A, B, and C, influenza A,Lyme disease, salmonella, mumps, measles, scrapie, dengue fever, and HIV. "Routine diagnostic work with clinical specimens can be done safely at Biosafety Level 2, using Biosafety Level 2 practices and procedures. Research work (including co-cultivation, virus replication studies, or manipulations involving concentrated virus) can be done in a BSL-2 (P2) facility, using BSL-3 practices and procedures. Virus production activities, including virus concentrations, require a BSL-3 (P3) facility and use of BSL-3 practices and procedures".

Biohazard Level 3: Bacteria and viruses that can cause severe to fatal disease in humans, but for which vaccines or

other treatments exist, such as anthrax, West Nile virus, Venezuelan equine encephalitis, SARS virus, variola virus (smallpox), tuberculosis, typhus, RiftValley fever,Rocky Mountain spotted fever, yellow fever, and malaria. Among parasites Plasmodium falciparum, which causes Malaria, and Trypanosoma cruzi,which causes trypanosomiasis, alsocomeunder this level.

Biohazard Level 4: Viruses and bacteria that cause severe to fatal disease in humans, and for which vaccines or other treatments are not available, such as Bolivian and Argentine hemorrhagic fevers, H5N1(bird flu), Dengue hemorrhagic fever, Marburg virus, Ebola virus, hant a viruses, Lassa fever, Crimean-Congo hemorrhagic fever, and other hemorrhagic diseases. When dealing with biological hazards at this level the use of a Hazmat suit and a self-contained oxygen supply is mandatory. The entrance and exit of a Level Four biolab will contain multiple showers, a vacuum room, an ultraviolet light room, autonomous detection system, and other safety precautions designed to destroy all traces of the biohazard. Multiple airlocks are employed and are electronically secured to prevent both doors opening at the same time. All air and water service going to and coming from a Biosafety Level 4 (P4) lab will undergo similar decontamination procedures to eliminate the possibility of an accidental release.

Potentially Infectious Waste

Over the years different terms for infectious waste have been used in the scientific literature, in regulation and in the guidance manuals and standards. These include infectious, infective, medical, bio-medical, hazardous, red bag, and contaminated, medical infectious, regulated and regulated medical waste. All these terms indicate basically the same type of waste, although the terms used in regulations are usually defined more specifically. It constitutes 10% of the total waste which includes:

Dressing sands wabs contaminated with blood, pus and body fluids. Laboratory waste including laboratory culture stocks of infectious agents Potentially infected material: Excised

tumours and organs, placenta removed during surgery, extracted teeth etc. Potentially infected animals used in diagnostic and research studies.

Sharps, which include needle, syringes, blades etc. Blood and blood products.

- Radioactive waste: It includes waste contaminated with radio nuclide; it may be solid, liquid or gaseous waste. These are generated from in vitro analysis of body fluids and tissue, in vitro imaging and the rapeutic procedures.
- Chemical waste: It includes disinfectants (hypochlorite, gluteral dehyde, iodophors, phenolic derivatives and alcohol based preparations), X-ray processing solutions, monomers and associated reagents, base metal debris (dental amalgam in extracted teeth).
- Pharmaceutical waste: It includes anesthetics, sedatives, antibiotics, analgesics etc.

BIO-MEDICAL WASTE MANAGEMENT RULE

Therules framedby the Ministry of Environment and Forests (MoEF), Govt. of India, known as 'Bio-medical Waste (Management and Handling) Rules, 1998,' notified on 20th July 1998, provides uniform guidelines and code of practice for the whole nation. It is clearly mentioned in this rule that the 'occupier' (a person who has control over the concerned institution/premises) of an institution generating bio-medical waste (e.g., hospital, nursing home, clinic, dispensary, veterinary institution, animal house, pathological laboratory, blood bank etc.) shall be responsible for taking necessary steps to ensure that such waste is handled without any adverse effect to human health and the environment. Bio-Medical Waste Management Rules are published on 20/07/1998 under Environment Protection Act, 1986. As per this rule every occupier of an institution generating bio-medicalwaste which includes hospitals, nursing home, clinic, dispensary, veterinary institutions, animal house, pathological laboratories, blood banks to take all steps to ensure that such a waste is handled without any adverse effect to human health and environment.

Every occupier of an institution generating, collecting, receiving, storing, transporting, treating, disposing and/or handling bio-medical waste in any other manner, except such occupier of clinics, dispensaries, pathological laboratories, blood banks providing treatment/service to less than 1000 (one thousand) patient per month, shall make an application in Form 1 to the prescribed authority for grant of authorization.

Every operator of a bio-medical waste facility shall make an application in Form 1 to the prescribed authority for grant of authorization. Afee asmay be prescribed by the Government of the State or Union Territory shall accompany every application in Form 1 for grant of authorisation. Bio-medical waste shall be treated and disposed of in accordance with Schedule I, and in compliance with the standards prescribed in Schedule V. Every occupier, where required, shall set up in accordance with the time schedule in Schedule VI, requisite bio-medical waste treatment facilities like incinerator, autoclave, microwave system for the treatment of waste, or, ensure requisite treat. Each State and Union Territory (UT) Government shall be required to establish a prescribed authority for this purpose. The respective governments would also constitute advisory committees to advise the Govts with respect to implementation of these rules. The occupier or operator can also appeal against any order of the authority if they feel aggrieved to such other authority as the Govt. of the State/UT may think fit to constitute. Prescribed Authorities, so far established by various State Governments and the time limit as per schedule VI of the 'Bio-Medical (Management & Handling) Rules, 1998 of waste at a common waste treatment facility or any other waste treatment facility.

HEALTH-CARE WASTE: DEFINITION AND CLASSIFICATION

Health-care waste includes all the waste generated by health-care establishments, research facilities, and laboratories. In addition, it includes the waste originating from "minor" or "scattered" sources-such as that produced in the course of health care undertaken in the home (dialysis, insulin injections, etc.). Between 75% and 90% of the waste produced by health-

care providers is non-risk or "general" health-care waste, comparable to domestic waste. It comes mostly from the administrative and housekeeping functions of health-care establishments and may also include waste generated during maintenance of health-care premises. The remaining 10-25% of health-care waste is regarded as hazardous and may create a variety of health risks. This handbook is concerned almost exclusively with hazardous health-care waste (also known as "health-care risk waste"); general wastes should be dealt with by the municipal waste disposal mechanisms.

Infectious Waste

Infectious waste is suspected to contain pathogens (bacteria, viruses, parasites, or fungi) in sufficient concentration or quantity to cause disease in susceptible hosts. This category includes:

- cultures and stocks of infectious agents from laboratory work;
- waste from surgery and autopsies on patients with infectious diseases (e.g. tissues, and materials or equipment that have been in contact with blood or other body fluids);
- waste from infected patients in isolation wards (e.g. excreta, dressings from infected or surgical wounds, clothes heavily soiled with human blood or other body fluids);
- waste that has been in contact with infected patients undergoing haemodialysis (e.g. dialysis equipment such as tubing and filters, disposable towels, gowns, aprons, gloves, and laboratory coats);
- infected animals from laboratories;
- any other instruments or materials that have been in contact with infected persons or animals.

Cultures and stocks of highly infectious agents, waste from autopsies, animal bodies, and other waste items that have been inoculated, infected, or in contact with such agents are called highly infectious waste.

Pathological Waste

Pathological waste consists of tissues, organs, body parts, human fetuses and animal carcasses, blood, and body fluids. Within this category, recognizable human or animal body parts are also called anatomical waste. This category should be considered as a subcategory of infectious waste, even though it may also include healthy body parts.

Sharps

Sharps are items that could cause cuts or puncture wounds, including needles, hypodermic needles, scalpel and other blades, knives, infusion sets, saws, broken glass, and nails. Whether or not they are infected, such items are usually considered as highly hazardous health-care waste.

Pharmaceutical Waste

Pharmaceutical waste includes expired, unused, spilt, and contaminated pharmaceutical products, drugs, vaccines, and sera that are no longer required and need to be disposed of appropriately. The category also includes discarded items used in the handling of pharmaceuticals, such as bottles or boxes with residues, gloves, masks, connecting tubing, and drug vials.

Genotoxic Waste

Genotoxic waste is highly hazardous and may have mutagenic, terato-genic, or carcinogenic properties. It raises serious safety problems, both inside hospitals and after disposal, and should be given special attention. Genotoxic waste may include certain cytostatic drugs, vomit, urine, or faeces from patients treated with cytostatic drugs, chemicals, and radioactive material.

Cytotoxic (or antineoplastic) drugs, the principal substances in this category, have the ability to kill or stop the growth of certain living cells and are used in chemotherapy of cancer. They play an important role in the therapy of various neoplastic conditions but are also finding wider application as immunosuppressive agents in organ transplantation and in treating various diseases with an immunological basis. Cytotoxic

drugs are most often used in specialized departments such as oncology and radiotherapy units, whose main role is cancer treatment; however, their use in other hospital departments is increasing and they may also be used outside the hospital setting. Harmful cytostatic drugs can be categorized as follows:

- alkylating agents: cause alkylation of DNA nucleotides, which leads to cross-linking and miscoding of the genetic stock;
- antimetabolites: inhibit the biosynthesis of nucleic acids in the cell;
- mitotic inhibitors: prevent cell replication.

Cytotoxic wastes are generated from several sources and can include the following:

- contaminated materials from drug preparation and administration, such as syringes, needles, gauges, vials, packaging;
- outdated drugs, excess (leftover) solutions, drugs returned from the wards;
- urine, faeces, and vomit from patients, which may contain potentially hazardous amounts of the administered cytostatic drugs or of their metabolites and which should be considered genotoxic for at least 48 hours and sometimes up to 1 week after drug administration.

In specialized oncological hospitals, genotoxic waste (containing cytostatic or radioactive substances) may constitute as much as 1% of the total health-care wastes.

Chemical Waste

Chemical waste consists of discarded solid, liquid, and gaseous chemicals, for example from diagnostic and experimental work and from cleaning, housekeeping, and disinfecting procedures. Chemical waste from health care may be hazardous or nonhazardous; in the context of protecting health, it is considered to be hazardous if it has at least one of the following properties:

- toxic;

- corrosive (e.g. acids of pH < 2 and bases of pH > 12);
- flammable;
- reactive (explosive, water-reactive, shock-sensitive);
- genotoxic (e.g. cytostatic drugs).

Nonhazardous chemical waste consists of chemicals with none of the above properties, such as sugars, amino acids, and certain organic and inorganic salts. The types of hazardous chemicals used most commonly in maintenance of health-care centres and hospitals and the most likely to be found in waste are discussed in the following paragraphs.

Formaldehyde

Formaldehyde is a significant source of chemical waste in hospitals. It is used to clean and disinfect equipment (e.g. haemodialysis or surgical equipment), to preserve specimens, to disinfect liquid infectious waste, and in pathology, autopsy, dialysis, embalming, and nursing units.

Photographic Chemicals

Photographic fixing and developing solutions are used in X-ray departments. The fixer usually contains 5-10% hydroquinone, 1-5% potassium hydroxide, and less than 1% silver. The developer contains approximately 45% glutaraldehyde. Acetic acid is used in both stop baths and fixer solutions.

Solvents

Wastes containing solvents are generated in various departments of a hospital, including pathology and histology laboratories and engineering departments. Solvents used in hospitals include halogenated compounds, such as methylene chloride, chloroform, trichloroethylene, and refrigerants, and non-halogenated compounds such as xylene, methanol, acetone, isopropanol, toluene, ethyl acetate, and acetonitrile.

Organic Chemicals

Waste organic chemicals generated in health-care facilities include:

- disinfecting and cleaning solutions such as phenol-based chemicals used for scrubbing floors, perchlorethylene used in workshops and laundries;
- oils such as vacuum-pump oils, used engine oil from vehicles (particularly if there is a vehicle service station on the hospital premises);
- insecticides, rodenticides.

Inorganic Chemicals

Waste inorganic chemicals consist mainly of acids and alkalis (e.g. sulfuric, hydrochloric, nitric, and chromic acids, sodium hydroxide and ammonia solutions). They also include oxidants, such as potassium permanganate ($KMnO_4$) and potassium dichromate ($K_2Cr_2O_7$), and reducing agents, such as sodium bisulfite (NaHSO3) and sodium sulfite (Na_2SO_3).

SOURCES OF HEALTH-CARE WASTE

The sources of health-care waste can be classed as major or minor according to the quantities produced. While minor and scattered sources may produce some health-care waste in categories similar to hospital waste, their composition will be different.

For example:

- They rarely produce radioactive or cytostatic waste;
- Human body parts are generally not included;
- Sharps consist mainly of hypodermic needles.

The composition of wastes is often characteristic of the type of source. For example, the different units within a hospital would generate waste with the following characteristics:

Medical wards: mainly infectious waste such as dressings, bandages, sticking plaster, gloves, disposable medical items, used hypodermic needles and intravenous sets, body fluids and excreta, contaminated packaging, and meal scraps.

Operating theatres and surgical wards: mainly anatomical waste such as tissues, organs, fetuses, and body parts, other infectious waste, and sharps.

Other health-care units: mostly general waste with a small percentage of infectious waste.

Laboratories: mainly pathological (including some anatomical), highly infectious waste (small pieces of tissue, microbiological cultures, stocks of infectious agents, infected animal carcasses, blood and other body fluids), and sharps, plus some radioactive and chemical waste.

Pharmaceutical and chemical stores: small quantities of pharmaceutical and chemical wastes, mainly packaging (containing only residues if stores are well managed), and general waste.

Health-care waste from scattered sources generally has the following characteristic composition:

Health care provided by nurses: mainly infectious waste and many sharps.

Physicians' offices: mainly infectious waste and some sharps.

Dental clinics and dentists' offices: mainly infectious waste and sharps, and wastes with high heavy-metal content.

Home health care (e.g. dialysis, insulin injections): mainly infectious waste and sharps.

HEALTH-CARE WASTE GENERATION

Several surveys have provided an indication of typical health-care waste generation. Data from some of these surveys are summarize and show that generation of health-care wastes differs not only from country to country but also within a country. Waste generation depends on numerous factors such as established waste management methods, type of health-care establishment, hospital specializations, proportion of reusable items employed in health care, and proportion of patients treated on a day-care basis. It is therefore suggested that these data are viewed only as examples, and not used as a basis for waste management within an individual health-care establishment. Even a limited survey will probably provide more reliable data on local waste generation than any estimate based on data from other countries or types of establishment.

In middle-and low-income countries, health-care waste generation is usually lower than in high-income countries. However, the range of values for countries of similar income level is probably as wide in high-income countries as in less wealthy countries.

The amount of radioactive health-care waste is generally extremely small compared with the radioactive waste produced by the nuclear industry.

Developing countries that have not performed their own surveys of health-care waste may find the following estimates for average distribution of health-care wastes useful for *preliminary* planning of waste management:

- 80% general health-care waste, which may be dealt with by the normal domestic and urban waste management system;
- 15% pathological and infectious waste;
- 1% sharps waste;
- 3% chemical or pharmaceutical waste;
- Less than 1% special waste, such as radioactive or cytostatic waste, pressurized containers, or broken thermometers and used batteries.

Before further planning is undertaken, health-care establishments should make estimates of their own waste production, particularly for hazardous health-care wastes. Typical figures for small producers of health-care wastes in Europe.

A survey carried out in selected countries in Latin America and the Caribbean provides estimates of hazardous waste produced by health-care facilities, contain data on health-care wastes generated in the United Republic of Tanzania and in Botswana.

PHYSICOCHEMICAL CHARACTERISTICS OF HAZARDOUS HEALTH-CARE WASTE

When the use of treatment techniques such as incineration is planned, a number of physicochemical parameters of the

waste should be assessed or estimated. The heating value, and moisture content of waste. It is also important to assess the composition of waste, which varies greatly not only from country to country but also among facilities within any given country. This variation may be due to different hospital specializations, waste management practices, use of reusable items, etc. The data from surveys in Italy, China (Province of Taiwan), and India, respectively. A survey of general hospitals in Italy yielded characterization data for hazardous health-care waste. A typical low heating value of wet hazardous health-care waste in middle-income developing countries would be 3500kcal/kg (14.65MJ/kg).

MANAGEMENT PLANNING

Formulation of objectives and planning for their achievement are important for improving health-care waste management at the national, regional, and local level. Planning requires the definition of a strategy that will facilitate careful implementation of the necessary measures and the appropriate allocation of resources according to the identified priorities. This is important for the motivation of authorities, health-care workers, and the public, and for defining further actions that may be needed.

Surveys on the generation of waste will be the basis for identifying opportunities-and setting targets-for waste minimization, reuse and recycling, and cost reduction. A national programme of sound health-care waste management is achievable through an action plan.

The United Nations Conference on the Environment and Development (UNCED) in 1992 led to the adoption of Agenda 21, which recommends a set of measures for waste management. The recommendations may be summarized as follows:

- Prevent and minimize waste production.
- Reuse or recycle the waste to the extent possible.
- Treat waste by safe and environmentally sound methods.
- Dispose of the final residues by landfill in confined and carefully designed sites.

Agenda 21 also stresses that any waste producer is responsible for the treatment and final disposal of its own waste; where possible, each community should dispose of its waste within its own boundaries.

The European Union has elaborated a common "European Community Strategy on Waste Management"; other regional groupings of countries may set up similar policies in the future.

NATIONAL PLANS FOR HEALTH-CARE WASTE MANAGEMENT

A national management plan will permit health-care waste management options to be optimized on a national scale. A national survey of health-care waste will provide the relevant agency with a basis for identifying actions on a district, regional, and national basis, taking into account conditions, needs, and possibilities at each level. An appropriate, safe, and cost-effective strategy will be concerned principally with treatment, recycling, transport, and disposal options.

A national programme of sound health-care waste management can be developed through a seven-step action plan.

Before an action plan is implemented there must be commitment to the development of a national policy, and responsibility must be delegated to the appropriate government authority. The ministry of health or the ministry of environment will usually serve as the principal authority, and should work closely with other relevant ministries. The designated authority will cooperate with other ministries, the private sector, nongovernmental organizations (NGOs), and professional organizations, as necessary, to ensure implementation of the action plan. Policy commitment should be reflected in appropriate budgetary allocations at different government levels. Guidance from central government should lead to maximum efficiency in the use of available resources from health-care establishments.

Health-care Waste Practices

The national agency responsible for the disposal of health-care waste should be fully aware of current levels of waste

production and of national waste management practices. A comprehensive survey is essential for planning an effective waste management programme. It is suggested that a wide-ranging questionnaire be completed for all health-care establishments in order to establish the following:

- number of hospital beds and bed occupancy rate for each health-care establishment;
- types and quantities of waste generated;
- personnel involved in the management of health-care waste;
- current health-care waste disposal practices, including segregation, collection, transportation, storage, and disposal methods.

The survey should also include site observations and interviews with health or support workers (waste workers, cleaners, etc.) at different levels. The information collected will provide a basis for formulating strategy for district, regional, and national levels.

A typical survey questionnaire is reproduced on pages 37 to 42; it has been used in a survey of hospitals in WHO's South-East Asia Region to identify issues that require interventions.

Develop National Guidelines

The foundation for a national programme for health-care waste management is the technical guidelines-plus the legal framework that supports them. Step 3 thus consists of the formulation of a national policy document and technical guidelines based on the results of the national survey; the two may be brought together in one comprehensive document. Their content, should provide the technical foundation on which health-care establishments can build their individual management programmes.

On-site health-care waste treatment facility: The advantages of providing each health-care establishment with on-site treatment facilities include the following:

- convenience;

- minimization of risks to public health and the environment by confinement of hazardous wastes to the health-care premises.

On-site treatment facilities are particularly appropriate in areas where hospitals are situated far from each other and the road system is poor. They must be managed by the hospitals where they are located and may accept health-care waste collected from scattered small sources in the surrounding areas.

The drawbacks of on-site disposal include the following:

- Costs may be high if there are many hospitals.
- Overall, more technical staff may be required to operate and maintain the facilities.
- It may be difficult for the relevant authorities to monitor the performance of many small facilities; this may result in poor compliance with operating standards, depending on the type of facilities, and increased environmental pollution.

Regional and cooperative treatment facilities: On-site waste disposal methods, which may be desirable for large health-care establishments, may not be practicable or cost-effective for smaller institutions, for which regional or cooperative disposal may be the better option. Such systems are in use in several countries, operating on either a voluntary or a statutory basis. For example, a group of hospitals may cooperate to set up a regional health-care waste treatment facility (e.g. a high-capacity incinerator) at one hospital which will then receive wastes from others within the group. In other cases, the local authority or a private waste disposal contractor may establish a centralized plant to receive waste from health-care facilities within its region.

Centralized regional facilities could provide the following advantages:

- greater cost-effectiveness for larger units, through economies of scale;
- spare capacity can be provided more economically;

- future modifications or expansions (relating to flue-gas cleaning systems of incinerators, for example) are likely to be less expensive;
- where privatization of facilities is seen as a desirable option, this can be achieved more easily on a regional basis than for numerous small units; in addition, it will be easier for the relevant government agencies to supervise and monitor the facilities;
- efficient operation can be more easily ensured in one centralized facility than in several plants where skilled workers may not be readily available;
- air pollution may be more easily kept to a minimum at a centralized plant (costs of monitoring and surveillance and of flue-gas cleaning, for example, will be reduced);
- hospitals will not have to devote time and personnel to managing their own installations.

The location of regional facilities for the treatment of health-care waste should be carefully chosen.

Catchment areas should be defined on the basis of estimated waste production by the health-care establishments involved, and the location of the treatment plant within each catchment area should then be based on the following considerations:

- accessibility for the hospitals and health-care facilities to be served (road conditions, distances, and transportation times);
- quantities of health-care waste expected from the various establishments within the identified catchment area;
- whether or not transfer stations are needed (daily transfer of waste direct from hospitals to the regional facility, with no need for transfer stations, would be optimal, avoiding double handling of waste);
- likely changes in the capacity or function of each hospital and hence in the quantity or nature of its waste;
- preliminary environmental considerations, based on a detailed environmental and health impact assessment

(the assessed impact may be lower if the facility is located inside an industrial "park" designed specifically for hazardous industries);

- adequacy of the land area for the facility at a proposed site;
- public attitude towards the treatment method.

Minimizing total times for transportation of health-care wastes to the regional facility should be an important factor in the choice of site and in determining appropriate transportation routes. Allotting adequate numbers of collection vehicles to the various routes in the region will ensure regular collection of waste and contribute to overall cost-effectiveness.

Legislation

Once developed, the policy and guidelines should be supported by legislation that regulates their application. This law is usually based on international agreements and underlying principles of sound waste management.

In order to achieve acceptable practices in health-care waste management and compliance with regulations, it is essential for all managers and other personnel involved to receive appropriate training. To this end, the central government should assist in preparation of "train the trainer" activities, and competent institutions or centres for the trainers' programme should be identified. Details on training programmes.

Waste Management Programme

The national programme for management of health-care waste should be viewed as a continuous process with periodic monitoring and assessment by the responsible national government agency. In addition, the recommendations on treatment methods should be regularly updated to keep pace with new developments. The national agency will base its assessment primarily on reports from the health-care establishments on their success in implementing waste management plans. It should review annual reports submitted by the heads of the establishments and make random visits

to carry out audits of the waste management systems. Any deficiencies in the waste management system should be pointed out to the head of the establishment in writing, together with recommendations for remedial measures. The time limit for implementation of remedial measures should be specified and the head of the establishment should be informed of the follow-up date.

In the case of off-site waste treatment facilities, incinerator operators, road haulage contractors, and landfill operators should also be audited. Periodic review of waste management practices by both the national government agency and the health-care establishments should result both in improved protection of occupational and public health and in enhanced cost-effectiveness of waste disposal.

Waste Management Plan

The proper management of health-care waste depends largely on good administration and organization but also requires adequate legislation and financing, as well as active participation by trained and informed staff.

The head of the hospital should form a waste management team to develop a waste management plan. The team should have the following members:

- Head of Hospital (as chairperson)
- Heads of Hospital Departments
- Infection Control Officer
- Chief Pharmacist
- Radiation Officer
- Matron (or Senior Nursing Officer)
- Hospital Manager
- Hospital Engineer
- Financial Controller
- Waste Management Officer (if already designated)

In certain establishments, the structure may include a Hospital Hygienist, in addition to or instead of the Infection

Control Officer, to address specific problems relating to hospital hygiene. In such cases, some or all of the duties of the Infection Control Officer specified below will be carried out by the Hospital Hygienist.

The Head of Hospital should formally appoint the members of the waste management team in writing, informing each of them of their duties and responsibilities as outlined in the following sections. (In an institution that is not directly involved in patient care, such as a medical research institution, the head of the establishment should use his discretion to appoint members of the waste management team from among the relevant staff.) He or she should appoint a Waste Management Officer with overall responsibilities for the development of the hospital waste management plan and for the subsequent day-to-day operation and monitoring of the waste disposal system. Depending on availability of relevant staff, this post may be assigned to the Hospital Engineer, to the Hospital Manager, or to any other appropriate staff member at the discretion of the Head of Hospital.

Management Structure

A typical hospital waste management structure, with line management responsibilities and liaison paths between key personnel involved in the handling of health-care waste. This structure may be adjusted to the particular needs of each hospital. The sharing of duties of key personnel in large hospitals is described in the following paragraphs; in smaller hospitals, one individual may fulfil two or more sets of responsibilities, but the same principles will apply.

Head of Hospital

The Head of Hospital is responsible for the following tasks:

- Forming a waste management team to develop a written waste management plan for the hospital. The plan should clearly define the duties and responsibilities of all members of staff, both clinical and non-clinical, in respect of the handling of health-care waste, and establish lines of accountability.

- Designating a Waste Management Officer (WMO) to supervise and coordinate the waste management plan. The Head of Hospital retains overall responsibility for ensuring that health-care and other wastes are disposed of in accordance with national guidelines.
- Keeping the management plan up to date.
- Allocating sufficient financial and personnel resources to ensure effi-cient operation of the plan. For example, sufficient staff should be assigned to the Waste Management Officer to ensure efficient operation of the waste management plan.
- Ensuring that monitoring procedures are incorporated in the plan. The efficiency and effectiveness of the disposal system should be monitored so that the system can be updated and improved when necessary.
- Immediately appointing a successor in the event of personnel leaving key positions in the waste management team (or temporarily assigning responsibility to another staff member until a successor can be appointed).
- Ensuring adequate training for key staff members and designating the staff responsible for coordinating and implementing training courses.

Waste Management Officer (WMO)

The WMO is responsible for the day-to-day operation and monitoring of the waste management system. It is therefore essential that he or she has direct access to all members of the hospital staff.

The WMO is directly responsible to the Head of Hospital. He or she should liaise with the Infection Control Officer, the Chief Pharmacist, and the Radiation Officer in order to become familiar with the correct procedures for handling and disposing of pathological, pharmaceutical, chemical, and radioactive wastes.

In the area of waste collection, the WMO should:

- control internal collection of waste containers and their transport to the central waste storage facility of the hospital on a daily basis;
- liaise with the Supplies Department to ensure that an appropriate range of bags and containers for health-care waste, protective clothing, and collection trolleys are available at all times;
- ensure that hospital attendants and ancillary staff immediately replace used bags and containers with the correct new bags or containers;
- directly supervise hospital attendants and ancillary workers assigned to collect and transport health-care waste.

Concerning waste storage, the WMO should:

- ensure the correct use of the central storage facility for health-care waste, which should be kept locked but should always be accessible to authorized hospital staff;
- prevent all unsupervised dumping of waste containers on the hospital grounds.

To supervise collection and disposal of the waste, the WMO should:

- coordinate and monitor all waste disposal operations;
- monitor methods of transportation of wastes both on- and off-site and ensure that wastes collected from the hospital are transported by an appropriate vehicle to the designated treatment and disposal site;
- ensure that waste is not stored for longer than specified in the guidelines and that the transport organization (which may be the local authority or a private contractor) collects the waste with the required frequency.

For staff training and information, the WMO should:

- liaise with the Matron (or Senior Nursing Officer) and the Hospital Manager to ensure that the nursing staff and medical assistants are aware of their own

responsibilities for segregation and storage of waste and that the responsibilities of hospital attendants and ancillary staff are limited to the handling and transport of sealed waste bags and containers;

- liaise with Department Heads to ensure that all doctors and other qualified clinical staff are aware of their own responsibilities regarding segregation and storage of waste and that the responsibilities of hospital attendants and ancillary staff are limited to the handling and transport of sealed bags and containers;
- ensure that hospital attendants and ancillary staff are not involved in waste segregation and that they handle only waste bags and containers that have been sealed in the correct manner.

For incident management and control the WMO should:

- ensure that written emergency procedures are available, that they are in place at all times, and that personnel are aware of the action to be taken in the event of an emergency;
- investigate and review any reported incidents concerning the handling of health-care waste.

In addition, the WMO should continuously monitor certain parameters.

Department Heads

Department Heads are responsible for the segregation, storage, and disposal of waste generated in their departments. They should:

- ensure that all doctors, nurses, and clinical and non-clinical professional staff in their departments are aware of the segregation and storage procedures and that all personnel comply with the highest standards;
- continuously liaise with the WMO to monitor working practices for failures or mistakes;
- ensure that key staff members in their departments are given training in waste segregation and disposal procedures;

- encourage medical and nursing staff to be vigilant so as to ensure that hospital attendants and ancillary staff follow correct procedures at all times.

Matron and Hospital Manager

The Matron (or Senior Nursing Officer) and the Hospital Manager are responsible for training nursing staff, medical assistants, hospital attendants, and ancillary staff in the correct procedures for segregation, storage, transport, and disposal of waste. They should therefore:

- liaise with the WMO and the advisers (Infection Control Officer, Chief Pharmacist, and Radiation Officer) to maintain the highest standards;
- participate in staff introduction to, and continuous training in, the handling and disposal of health-care waste;
- liaise with Department Heads to ensure coordination of training activities, other waste management issues specific to particular departments, etc.

EVALUATING HEALTH CARE

The aim of this chapter is to draw these threads together, and consider both the costs of providing services and the benefits derived from such health care provision, in providing an overview of the processes of economic evaluation as applied to health care.

Health care professionals are fully aware of the pressures facing the health service and initiatives relating to cost-effective prescribing; for example, they have merely served to reinforce the notion that patients have to be treated and managed within the contexts of clinical governance, predetermined formularies, new contracts and their quality initiative schemes, plus the perennial budgetary constraints, which seem to intensify each year. So how can an awareness of economics help those who are charged with making decisions about whether to make available a new therapy or new service, or provide assistance for those trying to convince decision-makers

of the relative merit and worth of their products, therapies, interventions, programmes and services?

The influence and 'authority' of agencies, such as NICE, SMC and AWMSG in the UK context, which assess the relative merits of products within a treatment area in terms of clinical effectiveness and cost-effectiveness, has served to increase the importance attached to economic evaluations of therapies, programmes and services in health care provision. The websites of the agencies provide access to their specific requirements, but there are certain aspects that are common to them all, and this chapter aims to discuss these issues. Further discussion of their roles and requirements is contained in. Health economic evaluation determines the efficiency of a service or activity by comparison with an alternative or alternatives, which may include no service provision. The basic framework of health economic evaluation. Economic evaluation has been defined as a 'comparative analysis of alternative courses of action in terms of their costs and consequences'. From this definition it can be seen that evaluation involves some comparison between alternatives, which may include nothing, while the evaluation includes both the costs involved and the benefits that are derived from each of the alternatives.

Evaluating health care interventions from an economic perspective has been thoroughly covered in other books and articles and interested readers are encouraged to access these sources. This chapter seeks to highlight the process, how it is utilised by decision-makers and agencies, and how health care professionals can appreciate and understand the relevance of its concepts in their practice. In addition, some of the difficulties and problems involved in the evaluation process are discussed, while it must be emphasised from the outset that the economic perspective is but one of the factors that comprise the decision-making process and is not the sole determinant of whether a therapy is introduced or a service provided. In undertaking or assessing an economic evaluation of health care technologies or programmes, there are a number of requirements that must be dealt with or clearly stated. The first of these is to do with scope and context of the evaluation.

Scope and Context of the Evaluation

The scope and context of the evaluation must be clearly stated. This may be determined by the particular agency, which provides a clear specification of the treatment and therapeutic area. In other situations, such as in Scotland, where the onus is on the pharmaceutical company to submit a dossier of evidence to the Scottish Medicines Consortium as near as possible to the launch of a product, it must be made clear as to the role of the new therapy and where it fits in relation to existing products.

Perspective Employed in the Health Economic Evaluation

Since economic evaluations are used to assess the relative efficiency of alternative health care interventions, the perspective commonly taken is that of the health service. However, because of its foundations in welfare economics, it is preferable that economic evaluations should include the impact of an intervention on the welfare of the whole society, not just on the individuals or organisations directly involved, and adopt what is known as a social welfare perspective. One of the premises of economics is that individuals seek to maximise 'utility', and the aggregation of 'utility' across all individuals is known as social welfare, and it is assumed that governments, in taking decisions, aim to maximise social welfare. Thus, costs to the health service, to social services, to patients and their families and also to the rest of society, in the form of production losses etc., are included. However, in reality, narrower perspectives (e.g. the provider institution, the individual practitioner or professional organisation, the patient or patient group, the purchaser of health care, or third party payer) are usually employed, due to the difficulties involved in accessing relevant data or due to time constraints:

Costs/Inputs

Outcomes

Outputs

Benefits

Identification

Measurement

Valuation

Health care process

Therefore, if the health economic evaluation is undertaken from the perspective of the health service, or from the perspective of the health service, social services and patients, it should be explicitly stated and the exclusion of items must be made clear, explained and discussed in terms of their likely influence on the final results.

The Specification of Well-defined Alternative Courses of Action

The nature of the comparison being undertaken is vitally important, with a sound evidence base to support each claim and assumption. For example:

- Is a new product being compared with existing products and therapies?
- Is the comparison between a new technology and placebo?
- Is it a different dose or different route of administration?
- Does the product being awarded have a licence in an additional therapeutic area?

The relationship between the review of clinical effectiveness and review of cost-effectiveness must be readily apparent and provide a coherent argument for the clinical worth and value for money that the product seeks to represent.

In some cases, the choice of alternative is very clear, which could be no service or no intervention, or that which is currently held to be the most efficient method. Where this is not apparent, one way of identifying potential comparators is to consider the main objective of the intervention that is to be evaluated. Comparator programmes can be selected from other interventions that produce the same outcomes. The range of potential alternatives will be very large if the objective of the programme is broad and much smaller if the objective is narrow. For example, if the objective is to reduce smoking, specific

alternatives aimed at preventing uptake or achieving quitting should be used. It may be possible to access published sources to obtain information on the costs and effectiveness of the alternatives, but it is important to consider whether studies undertaken in different contexts and settings and in different population groups can be legitimately used as comparators.

The Nature of the Comparison and the Type of Analysis to be Undertaken

The type of benefit used informs the nature of the evaluation to be undertaken. Thus, cost-effectiveness analysis is used when outcomes are unidimensional and measured in terms of health effect, such as changes in blood pressure. When survival is the key measure of outcome, cost-effectiveness would assess the cost per life year gained from each of the alternatives with the lowest cost-effectiveness ratio indicating the best course of action. When the outcomes generated by the alternatives are equal, it is possible to use cost-minimisation analysis, where the choice of the best alternative is made purely on the basis of cost. However, it has been argued that levels of uncertainty around both estimates of costs and outcomes call into question the relevance of cost minimisation.

When outcomes are measured in terms of survival and QOL, such as QALYs, the technique used is that of cost-utility analysis. The beauty of costutility analysis is that it enables comparisons across different areas of health care - so that the cost per QALY of therapies designed to treat human immunodeficiency virus (HIV) and anti-immunodeficiency syndrome (AIDS) can be compared with those designed to treat people in advanced stages of cancer.

For example, the impact of a baby born with Edwards syndrome (a chromosomal disorder that causes multiple malformations, severe mental impairment and a uniformly fatal outcome) on the patients in a local hospice was highlighted in an account given by the father of the child:

Verity (the mother) sometimes used to visit the local hospice and take Christopher (the baby) round the wards. Here there were people who were dying and yet theywere able to hold a

baby whowas also dying and in need of terminal palliative care.And somehowthat shared experience between a baby who was dying and an adult who was dying was quite remarkable.

The criticisms of QALYs emphasise the need for caution in their use in the decision-making process in relation to resource allocation. While cost-utility analysis may well be the 'most sophisticated method of economic evaluation so far developed to aid such decisions', there remain many legitimate and important issues that illustrate the dangers of excessive reliance on economic evaluation, where 'this limited approach is followed by those who do not fully understand its basis and thus decisions are taken which neither reflect society's objectives nor its health beliefs'.

The technique of cost-benefit analysis is used when the costs and outcomes are expressed in monetary terms; thus, as well as being able to make comparisons across all areas of health care, comparisons can also be made with schemes in education, transport and the environment. For example, it has been shown that contraceptive provision is an efficient use of public funds and secures considerable returns on investment. The difficulty arises when trying to place a monetary value on the intangible benefits, where market prices do not exist. There are two main techniques that can be used here:

When the outcomes are multidimensional - for example, changes in risk of cardiac events, myocardial infarctions avoided, strokes prevented, changes in blood pressure - the technique employed is that of cost-consequences analysis, where the outcomes are quantified and related to the costs for each of the alternative courses of action. This approach is beginning to find increasing support among health economists, as it does not restrict the outcomes generated from health care interventions and programmes to a single measure, such as QALY. It is easier to understand and enables decision- makers (on behalf of society) to impute their own specific, local values to these costs and consequences, and incorporate other aspects in the portfolio of information with which to inform the decision-making process.

The Identification, Measurement and Valuation of Costs and Benefits

The perspective employed in the valuation will determine the type of costs and the extent to which they are included: a narrow health service perspective will not include patients' costs, productivity costs and intangibles, whereas if a societal perspective were to be employed, all costs would need to be identified, and wherever possible measured and valued. In reality, this would not be possible, but the decision-maker needs to be informed how the analysis has dealt with costs and benefits that have not been specifically included in the calculations and in determining cost-effectiveness or cost benefit. This process is referred to as the sensitivity analysis, which will be discussed later.

How are Costs and effects in the Future Dealt With?

The valuation of costs and benefits needs to reflect when costs are incurred and when benefits are realised. Individuals and societies are not indifferent to timing - preferring to delay costs as long as possible and to receive benefits as soon as possible. Most people prefer to delay costs as long as possible and receive benefits as soon as possible. Therefore, costs and benefits that occur today are valued more highly than those that will occur in the future, and the current value of any cost or benefit is lower the further in the future that it will arise. In order to allow for this, future costs and benefits are subjected to discounting.*

In other words, all future costs and benefits are discounted to:

* The approach is quite simple using the formula:

$$PV = K \_ \delta 1 = \delta 1 \, \text{þ} \, r \text{Þ} n \_ \text{Þ}$$

where, PV = present value, K = nominal value of the cost or benefit, r = discount rate and n = how many years in the future the cost or benefit will arise. If we expect to receive a benefit of £10 000 in 5 years' time, the present value, based on a discount rate of 5%, is equivalent to £7835.

Evaluating health care interventions from an economic perspective bring them into line with what are termed present values. There is ongoing debate as to whether non-financial gains should be discounted, and the current recommendation from NICE is that costs and benefits are discounted at 3.5% and that the rate should be varied between 0% and 6% in the sensitivity analysis.

Are Incremental Rather than Absolute Costs and Benefits Compared?

When a new treatment or service is being considered, it is unlikely that it will replace all existing and established therapies and services. Instead, some patients are switchedwhile others will remain on existing treatments and services. In the context of clinical trials, new therapies are compared with placebo or exiting alternatives. The issue therefore is what additional benefits are gained from the additional costs of the newtherapy? This approach is termed incremental analysis, where the difference in costs between the alternatives is divided by the difference in benefits. This provides a much more focused assessment of the impact of the new technology in context, rather than providing data relating to the total costs and benefits or the average cost and benefit generated by the new technology.

The incremental cost-effectiveness ratio (ICER) - difference in costs divided by the difference in benefits - is used to address this issue. The ICER can be placed on a cost-effectiveness plane.

Interventions whose cost-effectiveness ratios are located in the north-west quadrant should not be provided because they result in a reduction in health effects and require additional resources. Those interventions that are located in the south-west quadrant result in a reduction in health effects but also New treatment result in resource savings. They are therefore often termed 'questionable'.

Interventions with cost-effectiveness ratios in the south-east quadrant represent an improvement in health effects and at the same time provide additional financial resources to be

spent elsewhere in order to improve the health of the community; they are termed dominant. But what about new interventions that are placed in the north-east quadrant - those that improve health effects but at a cost? Interventions with ICERs in the north-east quadrant require some consideration.

They improve health but cost more than the alternative(s). The decision whether or not to choose them should be based on the level of additional resources available, or by viewing the ICER in the light of a specific acceptable threshold.30 For example, interventions with cost/QALY ratios between £3000 and £20 000 were adjudged costeffective when there was evidence of their effectiveness.

More recently, there has been discussion as to whether NICE has a threshold value of £30 000 per QALY gained - with interventions falling below this threshold value being approved and those falling above not being approved for use by the NHS.Onthe other hand, the claimthatNICEhasanabsolute threshold has been strongly refuted, with judgementsmade on a case-by-case basis.

Sensitivity Analysis

The next issue is whether sensitivity analysis has been undertaken and how it has affected the conclusions. Economic evaluation is not an exact science and findings fromsuch studies should be treated with caution.Uncertainty is a fact of life and no economic evaluation can do anything other than reach a conclusion on the basis of the best (most informed) assumptions possible. In undertaking economic evaluations there are four sources of potential uncertainty:

- methodological changes arising from different approaches and methods employed;
- potential variation in the estimates of the parameters used in the evaluation;
- extrapolation from observed events over time or from intermediate to final health outcomes;
- generalisability and transferability of results.

The wide variation in approaches and methods employed has led to the adoption of a reference case of core methods to be used when conducting economic evaluations. NICE does recognise that, in some instances, data required to present reference case results may not be available and that there may be important barriers to applying reference case methods. In such situations, NICE requires that submissions that are unable to meet the reference case requirements provide reasons that are clearly specified and justified, with the likely implications quantified. The NICE Appraisal Committee will then determine the weight it attaches to the results of such a non-reference case analysis.

It is also important to investigate how sensitive the findings of an evaluation are to changes in the assumptions used in the study and variations in the parameter estimates. Sensitivity analysis in such cases involves re-running the analysis with the assumptions changed and asking 'what if' type questions. 'One way' sensitivity analyses show the effects of varying each assumption separately. There are no rules regarding how much the original assumptions should be varied and a simple +50% is often used. This allows caveats to be made about the original conclusion; for example, the conclusion that A is more cost-effective than B is highly sensitive to assumption X but not to assumptions Y and Z. It is also possible to vary the assumptions together - for example, to put a new intervention in the worst possible light. If on the basis of these collective 'worst case' assumptions the new intervention is still more cost-effective than the old, a change in policy is clearly indicated.

NICE Reference Case

Perspective on costs National Health Service.

Personal Social Services.

Perspective on outcomes All health effects on individuals.

Type of economic evaluation Cost-effectiveness analysis.

Synthesis of evidence on outcomes.

Based on systematic review.

Measure of health benefits QALYs.

Description of health states for calculation of QALYs.

Health states described using a standardised and validated generic instrument:

Method of preference elicitation for health state valuation.

Choice-based method, e.g. time trade-off, standard gamble (not rating scale).

Source of preference data Representative sample of the public.

Discount rate An annual rate of 3.5% on both costs and health effects.

Equity position An additional QALY has the same weight regardless of the other characteristics of the individuals receiving the health benefit.

Another approach is to use threshold analysis where the variables are adjusted until the findings alter and the decision as to which therapy to adopt or reject is reversed. For example, to what extent do the costs of therapy A need to be increased to make therapy B cost-effective relative to A?

In recent years more sophisticated approaches have been employed to estimate the effect of uncertainty. For instance, different methods have been used to establish the confidence intervals for estimates of ICERs, with the non-parametric technique of bootstrapping increasing in popularity.

The bootstrapping method estimates the sampling distribution of the costeffectiveness ratio through a large number of simulations, based on sampling with replacement from the original data. The cost and effects data from both intervention and control groups are sampled, and estimates of the cost and effect differential are obtained to generate the cost-effectiveness ratio. This process is repeated many times (usually 1000 times) and a vector of costeffectiveness ratios obtained.

However, when the individual costs and effects are not statistically significant, the bootstrap replications can straddle

all four quadrants in the costeffectiveness plane, and it is difficult to determine whether a new treatment is more cost-effective than current practice. One solution is to represent the bootstrap replications in the form of a cost-effectiveness acceptability curve, in which the likelihood that the data are consistent with a true cost-effectiveness ratio falling below any given ceiling ratio, based on the observed size and variance of differences in the costs and effects in the trial, can be shown.

The problems associated with attempting to derive confidence intervals around the cost-effectiveness ratio have been overcome by the use of the net-benefit statistic where the ceiling ratio is brought into play by assigning the monetary value associated with it to determine the probability that the net benefit of the programme or intervention is greater than zero.

The third potential area for uncertainty is associated with predicting from observational data or in extrapolating from intermediate outcomes to final health outcomes. Further discussion relating to sensitivity analysis within the context of modelling is provided later. However, the fourth area - that of generalisability and transferability - is now considered.

The Relevance and Applicability of the Costs and Outcomes

The relevance and applicability of costs and outcomes for the assessment agency is now analysed. For example, the relative cost-effectiveness of an intervention in the USA carries rather limited weight from English, Scottish or Welsh perspectives and it would be preferable if local costs and outcomes generated from relevant populations were utilised in a health economic evaluation. However, this may not always be possible and the onus lies with the evaluator to link the available evidence base to the situation and location over which the agency has jurisdiction. There are examples where a cost-effectiveness study undertaken in one country can be adapted and adjusted to reflect situations in other countries, but there are many factors that can affect the findings when applied to specific countries. In a review, the unit costs associated with

particular resources and measures of effectiveness were identified as the most frequently cited factors generating variability in economic results between locations. While decision-analytic models have an important role to play in adapting the results between locations, evaluators need to ensure that sensitivity analysis reflects the range of confounding variables that exists and make explicit underlying assumptions used in studies which have crossed international and cultural boundaries.

Do the Results Indicate Value for Money?

The final component is to place the relative cost-effectiveness or cost benefit against accepted norms or benchmarks. This has been discussed in relation to cost per QALY league tables earlier, and there are examples of 'value for money thresholds' that have been advocated and used. However, no decision-making agency has provided explicit threshold limits, and is very unlikely to do so. The question as to whether NICE has a threshold of around £30 000 per QALY gained has been referred to earlier, and while there are some who argue that this may be too high, it is the case that they have approved interventions that exceed this amount and not approved interventions below this amount. Therefore, the general consensus is that £30 000 per QALY gained represents the 'value for money' threshold in the UK at present.

However, in situations where it is not possible to produce QALY estimates, it is much more difficult to pronounce what constitutes acceptable value for money. One approach is to estimate the payback period - that is, the time in which the initial cost is likely to be repaid. This assumes that the effects can readily be translated into monetary effects. For example, the costs of contraception, the effects of discontinuations and the costs of treating adverse effects were compared with the cost implications of avoiding unwanted pregnancies, and it was shown that the monetary benefits resulting from the avoidance of unwanted pregnancies would repay the costs of contraception and its management within a period of months. The limitations to such an approach are obvious but again it does provide

information for decision-makers with which to assess the extent to which investment in health care services will reap rewards to society.

The Role of Modelling

Health economic techniques assist decision-makers to assess the most efficient way to utilise these scarce resources for the maximum benefit of society.

In the evaluation of pharmaceutical interventions the most usual way to undertake economic assessments has been to piggyback clinical trials. However, the results of RCTs may have limited scope for generalisation to everyday patient management and may not represent the real world of clinical practice. In addition, the follow-up period within an RCT is often relatively short in relation to the natural progression of the disease. For example, while drug costs were the cheapest option when a relatively short-term perspective was employed, the cost of open or laparoscopic surgery was less than that of lifelong daily treatment with proton pump inhibitors (PPIs) or ranitidine for gastro-oesophageal reflux disease in Finland.

The issue of lifetime long-term modelling is a contentious one in health economics, which has occupied many pages in books and articles. However, the use of models 'is an important and necessary component of cost-effectiveness analysis' and therefore cannot be neglected. However, the nature of chronic diseases necessitates that such perspectives are at least considered, so as to assess the future effects of early interventions. For example, treatment in the early stages of rheumatoid arthritis that effectively reduces long-term disability has the potential to save substantial costs to society.

However, the nature of long-term is also conditioned by the nature of the disease and its progression. For example, a 20-year perspective is reasonable in relation to different hip prostheses, as is a study that considered outcomes between 5 and 15 years in HIV interventions.61 What may be somewhat surprising is a 10-year follow-up of patients with Alzheimer's and a 5- and 10-year modelling process for women aged 60, 65, 70 and 75 for the treatment of postmenopausal symptoms.63

However, these studies closely mirror the progression of the disease and the life expectancy of patients with such conditions. It therefore makes sense to adopt such time horizons. For other conditions, which occur earlier in life and yet which have consequences for the remainder of a person's life, it seems perfectly reasonable to utilise such time scales that reflect the duration of the disease across a person's whole life.

The use of discounting ensures that benefits that accrue many years down the line are afforded an appropriate degree of diminution to enable present-day valuations to be employed.

Furthermore, the fact is that as a condition deteriorates, the resource consequences are likely to increase exponentially, and it is therefore important from an economic as well as a clinical point of view, to delay disease progression as much as possible.

One fully recognises the potential tension between long-term benefits and short-term costs and their impact on budgets,64 but as long as decisionmakers are made aware of the issues and the need for possible trade-offs, the two approaches can live comfortably together.

Decision Analysis

Decision-analysis models are used to simplify situations to a level that describes the essential consequences and complications of different options for decision-makers. Two types of decision-analysis models are generally used in health economic evaluations: decision-tree and Markov.

Decision-tree models incorporate the choices that have to be made in deciding between options in patient management strategies, for example, the probability of events occurring, and their costs, as a result of the options being chosen and the probability of final outcomes occurring together with their respective utilities (if appropriate) and costs. In decision-tree models, decisions are represented as squares (decision nodes) and the branches form the relevant options. Circles are used to represent chance nodes, which are the events and outcomes resulting from the decision. Due to the uncertainty surrounding

these events and outcomes, probabilities are assigned to each of them - with the summation of all probabilities being equal to 1. The expected cost of each option is derived by multiplying the cost for each branch by the probability of that branch occurring and enabling the options to be compared in terms of their respective costs and outcomes.

The choice is between two analgesic agents, which have different levels of efficacy, safety and costs. The acquisition cost of Agent A is £350; it secures 50% reduction in pain at 6 h in 45% of patients with no adverse events recorded; and is associated with a 22% probability of any adverse event occurring in those for whom the agent is not effective. The acquisition cost of Agent B is £130; it secures 50% reduction in pain at 6 h in 27% of patients with no adverse events recorded; and is associated with a 38% probability of any adverse event occurring in those for whom the agent is not effective. The cost of treating an adverse event has been estimated at £500 on average.

Decision-tree models are often too simplistic to describe situations where there are many alternative scenarios or in the case of chronic disease where the same decisions are constantly repeated over time. In such situations, Markov models are usually used. These are a particular type of decision analysis that allows for the transfer between different health states over a period of time.

In a Markov model, the disease is categorised into a finite set of health states (referred to as Markov states), usually based on disease parameters, such as the severity of the disease, which are meaningful to clinicians and patients. Patients move between these health states over a clinically meaningful discrete period of time (e.g. 1 month, 1 year) according to a set of transition probabilities, which reflect disease progression and the effectiveness of interventions to reverse or reduce the extent of progression. These time periods, Markov cycles, must be relevant within the context of the specific disease - for example, weekly or monthly periods may be appropriate in a pain management programme, while for multiple sclerosis these

periods may be too short. Transition probabilities are derived from evidence gathered from systematic reviews, clinical trials or epidemiological studies, while costs and utilities are attached to each particular Markov state to estimate the longterm costs and outcomes for patient cohorts who have the disease and are receiving relevant health care interventions.

In order for the Markov process to terminate, it must have at least one 'absorbing state', which patients cannot leave. This is usually death in most examples of Markov models, and the process continues until all patients have been absorbed by this particular state. The length of the Markov process and number of Markov cycles is therefore conditioned by the nature of the disease and its progression. What is important is that Markov models closely mirror the progression of the disease and the life expectancy of patients with particular conditions, and for some diseases, which are diagnosed early in life and yet which have consequences for the remainder of a person's life, the model needs to reflect such time scales in the number of cycles it contains.

There are a few notes of caution when interpreting studies based on modelling:

(1) The quality of the model is highly dependent on the quality of the clinical data used to furnish the model. The use of data from small-scale trials to derive a model of the cost-effectiveness of an intervention across a broad population spectrum should be treated with suspicion.

(2) The use of observational data in models is subject to considerable bias and different interpretations and should be regarded with a large element of circumspection.

(3) The problems associated with extrapolation from clinical trials imply that models based on such data are by default subject to those very problems, and the incorporation of this type of data into a model does nothing to reduce its deficiencies.

(4) The scope for manipulation with models is much greater than with RCTs, given the nature of inclusion and

exclusion criteria in the latter, and therefore the need for a health warning on the interpretation of models cannot be overemphasised.

It may be that the term cost-efficacy models be used, rather than cost-effectiveness models, to describe models that have been developed and furnished with data from clinical trials of relatively short duration, in relation to the lifetime of a disease, and undertaken under conditions that do not always accurately portray everyday clinical practice. The increased use of models and reliance on them for assessing costeffectiveness have been accompanied by an increased awareness to ensure that variation and uncertainty in the model parameters are adequately dealt with. The use of probabilistic sensitivity analysis as a method for handling uncertainty in cost-effectiveness models is increasingly becoming the norm, as it enables the production of cost-effectiveness acceptability curves to assist the decision-making process. There is currently no 'gold standard' approach to modelling, but given the increasing importance and use of models in health economic evaluations and decisions relating to the adoption of new technologies, there is a need to ensure that best practice is employed and that the limitations of such approaches are clear and explicit in the reporting of such studies.

Currently, modelling cannot be a substitute for obtaining reliable and prospective evidence but should be regarded as a complement for real-time evaluation, which provides decision-makers with useful information to assess current and new therapies. It is important that their limitations be recognised, but in order to enhance the quality and accuracy of models used in health economic evaluations the following suggestions have been proposed:

- Models should be designed and conducted using the best available practices according to the objectives of the study.
- The methodology employed ought to be explicitly and transparently reported, to enable comparability among all analyses.

- The software package used to construct the model should be referenced and a copy of the model should be made available to relevant agencies.
- Financial arrangements between sponsor and investigators/modellers should be explicit.

The decision-making process in determining which services and treatments should be provided is highly complex and involves a number of different, often conflicting, factors. Health economic techniques can assist decisionmakers to utilise the information relating to the effectiveness and efficiency of an intervention. They can also go some way in contributing to the commissioning process in determining health care priorities and in seeking to ensure that the most efficient use is made of resources available within limited health care budgets. However, the cost and time required to undertake full-blown economic evaluations render them unfeasible in the context of many decisions. It has also been argued that the assumptions underlying the current methods fail to consider all society's health objectives and are too complex for policymakers to use. In addition, 'by generating a pseudoscientific aura around economic evaluation, they camouflage critical weaknesses in current techniques'. It is argued that the assumption that the aim of decision-makers is to maximise health benefits to society from available resources is highly questionable.

Even aside from doubts over the existence of this mythical decisionmaker with a clear set of objectives, the desire to maximise health seems to be largely the objective of economists rather than [of] society. It is unlikely that resource allocation decisions are solely based on the maximisation of health care benefits; if so, no resources would be allocated to services provided for extremely rare conditions, with poor survival and QOL outcomes. Rather decisions are based on many factors, of which the maximisation of health is but one alongside equity, need, access and so on.

In addition, attempts to restrict the benefits derived from health care services into a single outcome measure also fail to do justice to the wideranging impact that health care

improvements can have on patients, their families, their communities and society as a whole. Many of the recent developments in economic evaluation in health care have been encapsulated in the 'biggest bang per buck' philosophy, with the focus on the economics of health care and insufficient attention given to the other features of the determinants of health model.

The emphasis on cost-effectiveness may also lead to overspending. For example, therapies and treatments, which have been given the NICE stamp of approval, are recommended for use by the NHS and are expected to be made available within a 3-6-month period. While the introduction of such a therapy may not necessarily impose a significant additional burden on budgets per se, the aggregation of a number of therapies, all of which generate additional health benefits at relatively low cost, may well cause major financial problems for both providers and commissioners of health care services, and lead to a suboptimal allocation of resources as organisations, limited by the imposition of financial targets as well, are 'forced' into making cutbacks in other areas to finance the treatments approved by NICE. Another criticism levied at the door of NICE is that its focus on new technologies and relatively little attention devoted to existing and old technologies that 'may be redundant' has led to inflationary pressure, while the emphasis on incremental cost-effectiveness ratios in the shape of cost per QALY ratios is 'not compatible with the most basic principle in economics of opportunity costs'. Further explores some of the issues involved in the utilisation of economic evaluation techniques by decision-makers and outlines other approaches that can assist decision-makers as they struggle to balance the competing claims made on limited resources by a variety of parties, each of whom have strong and worthy rationales to underpin their particular case.

THE SUPPLY OF HEALTH CARE

Micro-economic Evaluation at Treatment Level

A large focus of health economics, particularly in the UK, is the microeconomic evaluation of individual treatments. In

the UK, the National Institute for Health and Clinical Excellence (NICE) appraises certain new and existing pharmaceuticals and devices using economic evaluation.

Economic evaluation is the comparison of two or more alternative courses of action in terms of both their costs and consequences (Drummond et al.). Economists usually distinguish several types of economic evaluation, differing in how consequences are measured:

- Cost minimisation analysis
- Cost benefit analysis
- Cost-effectiveness analysis
- Cost-utility analysis

In cost minimisation analysis (CMA), the effectiveness of the comparators in question must be proven to be equivalent. The 'cost-effective' comparator is simply the one which costs less (as it achieves the same outcome). In cost-benefit analysis (CBA), costs and benefits are both valued in cash terms.

Cost effectiveness analysis (CEA) measures outcomes in 'natural units', such as mmHg, symptom free days, life years gained. Finally cost-utility analysis (CUA) measures outcomes in a composite metric of both length and quality of life, the Quality Adjusted Life Year (QALY). (Note there is some international variation in the precise definitions of each type of analysis).

A final approach which is sometimes classed an economic evaluation is a cost of illness study. This is not a true economic evaluation as it does not compare the costs and outcomes of alternative courses of action. Instead, it attempts to measure all the costs associated with a particular disease or condition. These will include direct costs (where money actually changes hands, e.g. health service use, patient co-payments and out of pocket expenses), indirect costs (the value of lost productivity from time off work due to illness), and intangible costs (the 'disvalue' to an individual of pain and suffering). (Note specific definitions in health economics may vary slightly from other branches of economics.)

Market Equilibrium

The five health markets typically analyzed are:

- Healthcare financing market
- Physician and nurses services market
- Institutional services market
- Input factors market
- Professional education market

Although assumptions of textbook models of economic markets apply reasonably well to health care markets, there are important deviations. Insurance markets rely on risk pools, in which relatively healthy enrollees subsidize the care of the rest. Insurers must cope with "adverse selection" which occurs when they are unable to fully predict the medical expenses of enrollees; adverse selection can destroy the risk pool. Features of insurance markets, such as group purchases and preexisting condition exclusions are meant to cope with adverse selection.

Insured patients are naturally less concerned about health care costs than they would if they paid the full price of care. The resulting "moral hazard" drives up costs, as shown by the famous RAND Health Insurance Experiment. Insurers use several techniques to limit the costs of moral hazard, including imposing copayments on patients and limiting physician incentives to provide costly care. Insurers often compete by their choice of service offerings, cost sharing requirements, and limitations on physicians.

Consumers in health care markets often suffer from a lack of adequate information about what services they need to buy and which providers offer the best value proposition. Health economists have documented a problem with "supplier induced demand", whereby providers base treatment recommendations on economic, rather than medical criteria. Researchers have also documented substantial "practice variations", whereby the treatment a patient receives depends as much on which doctor they visit as it does on their condition. Both private insurers and government payers use a variety of controls on service availability to rein in inducement and practice

variations. The U.S. health care market has relied extensively on competition to control costs and improve quality. Critics question whether problems with adverse selection, moral hazard, information asymmetries, demand inducement, and practice variations can be addressed by private markets. Competition has fostered reductions in prices, but consolidation by providers and, to a lesser extent, insurers, has tempered this effect.

TREATMENT AND DISPOSAL TECHNOLOGIES FOR HEALTH-CARE WASTE

Incineration used to be the method of choice for most hazardous health-care wastes and is still widely used. However, recently developed alternative treatment methods are becoming increasingly popular. The final choice of treatment system should be made carefully, on the basis of various factors, many of which depend on local conditions:

- disinfection efficiency;
- health and environmental considerations;
- volume and mass reduction;
- occupational health and safety considerations;
- quantity of wastes for treatment and disposal/capacity of the system;
- types of waste for treatment and disposal;
- infrastructure requirements;
- locally available treatment options and technologies;
- options available for final disposal;
- training requirements for operation of the method;
- operation and maintenance considerations;
- available space;
- location and surroundings of the treatment site and disposal facility;
- investment and operating costs;
- public acceptability;

- regulatory requirements.

Certain treatment options presented in this chapter may effectively reduce the infectious hazards of health-care waste and prevent scavenging but, at the same time, give rise to other health and environmental hazards. For example, incineration of certain types of health-care waste, particularly those containing chlorine or heavy metals, may under certain conditions (such as insufficiently high incineration temperatures, inadequate control of emissions) release toxic material into the atmosphere. Land disposal may result in groundwater pollution if the landfill site is inadequately designed and/or operated. In choosing a treatment or disposal method for health-care waste, particularly if there is a risk of toxic emissions or other hazardous consequences, the relative risks, as well as the integration into the overall framework of comprehensive waste strategy, should therefore be carefully evaluated in the light of local circumstances.

PRINCIPLES OF INCINERATION

Incineration is a high-temperature dry oxidation process that reduces organic and combustible waste to inorganic, incombustible matter and results in a very significant reduction of waste volume and weight. This process is usually selected to treat wastes that cannot be recycled, reused, or disposed of in a landfill site.

The combustion of organic compounds produces mainly gaseous emissions, including steam, carbon dioxide, nitrogen oxides, and certain toxic substances (e.g. metals, halogenic acids), and particulate matter, plus solid residues in the form of ashes. If the conditions of combustion are not properly controlled, toxic carbon monoxide will also be produced. The ash and wastewater produced by the process also contain toxic compounds, which have to be treated to avoid adverse effects on health and the environment.

Most large, modern incinerators include energy-recovery facilities. In cold climates, steam and/or hot water from incinerators can be used to feed urban district-heating systems, and in warmer climates the steam from incinerators is used

to generate electricity. The heat recovered from small hospital incinerators is used for preheating of waste to be burnt.

Required Waste Characteristics

An input of appropriate fuel may overcome a slightly deficient heating value or a slightly excessive moisture content.

Incineration requires no pretreatment, provided that certain waste types are not included in the matter to be incinerated.

Types of Incinerator

Incinerators can range from extremely sophisticated, high-temperature operating plants to very basic combustion units that operate at much lower temperatures. All types of incinerator, if operated properly, eliminate pathogens from waste and reduce the waste to ashes. However, certain types of health-care wastes, e.g. pharmaceutical or chemical wastes, require higher temperatures for complete destruction. Higher operating temperatures and cleaning of exhaust gases limit the atmospheric pollution and odours produced by the incineration process.

Incineration equipment should be carefully chosen on the basis of the available resources and the local situation, and of risk-benefit considerations-balancing the public health benefits of pathogen elimination before waste disposal against the potential risks of air or groundwater pollution caused by inadequate destruction of certain wastes.

Three basic kinds of incineration technology are of interest for treating health-care waste:

- double-chamber pyrolytic incinerators, which may be especially designed to burn infectious health-care waste;
- single-chamber furnaces with static grate, which should be used only if pyrolytic incinerators are not affordable;
- rotary kilns operating at high temperature, capable of causing decomposition of genotoxic substances and heat-resistant chemicals.

Incinerators designed especially for treatment of health-care waste should operate at temperatures between 900 and

1200°C. Low-cost, high-temperature incinerators of simple design are currently being developed, and a system designed specifically for health-care and pharmaceutical waste in low-income countries is currently under test in England, at De Montfort University. Mobile incinerators for health-care waste have been tested in Brazil. These units permit on-site treatment in hospitals and clinics, thus avoiding the need to transport infectious waste through city streets. Test results for units with a capacity of 30kg/hour were satisfactory in terms of function, performance, and air pollution (Bartone, 1998).

High-temperature incineration of chemical and pharmaceutical waste in industrial cement or steel kilns is practised in many countries and is a valuable option; no additional investments are required and industry benefits from a supply of free combustible matter.

Assessment of Waste Parameters

Specific waste parameters should be assessed at the planning stage to determine the most suitable type and size of incinerator:

- current extent of waste production and types of health-care waste;
- estimated future waste production;
- production of incinerable waste per day (and per bed per day);
- all the physical parameters that determine the suitability of waste for incineration, such as low heating value and moisture content.

PYROLYTIC INCINERATORS

The most reliable and commonly used treatment process for health-care waste is pyrolytic incineration, also called controlled air incineration or double-chamber incineration. The main characteristics of pyrolytic incinerators, which may be especially designed for hospitals, are summarize. The pyrolytic incinerator comprises a pyrolytic chamber and a post-combustion chamber and functions as follows:

- In the pyrolytic chamber, the waste is thermally decomposed through an oxygen-deficient, medium-temperature combustion process (800-900°C), producing solid ashes and gases. The pyrolytic chamber includes a fuel burner, used to start the process. The waste is loaded in suitable waste bags or containers.
- The gases produced in this way are burned at high temperature (900-1200°C) by a fuel burner in the post-combustion chamber, using an excess of air to minimize smoke and odours.

Larger pyrolytic incinerators (capacity 1-8 tonnes/day) are usually designed to function on a continuous basis. They may also be capable of fully automatic operation, including loading of waste, removal of ashes, and internal movement of burning waste. Adequately maintained and operated pyrolytic incinerators of limited size, as commonly used in hospitals, do not require exhaust-gas cleaning equipment. Their ashes will contain less than 1% unburnt material, which can be disposed of in landfills. However, to avoid dioxin production, no chlorinated plastic bags (and preferably no other chlorinated compounds) should be introduced into the incinerator, and should therefore not be used for packaging waste before its incineration.

Design and Size of a Pyrolytic Incinerator

Optimal combustion conditions are essential if there is to be almost complete destruction of wastes without the generation of significant amounts of harmful solid, liquid, or gaseous outputs (e.g. dioxins, furans). The burning temperature, waste residence time inside the furnace, gas turbulence, and size of airflow inputs are therefore critical, and the incinerator should fulfil the following criteria:

- The temperature in the post-combustion chamber should reach at least 900°C, and gas residence time should be at least 2 seconds; air inflow with 100% excess oxygen and high turbulence should be ensured.
- The pyrolytic chamber should be of sufficient size to allow a residence time for the waste of 1 hour. It should

contain baffles or dampers to increase the mixing of waste with the air inflow.

- The pyrolytic and post-combustion chambers should be of steel with an internal lining of refractory bricks, resistant to corrosive waste or gas and to thermal shock.
- The feed opening should be large enough to allow the loading of packed waste. The size of the ash removal opening should be appropriate for the expected percentage of incombustibles in the waste. There should be provision for accumulated ashes to cool down before disposal.
- The incinerator should be operated, monitored, and regulated from a central console, which should include a continuous display of operating parameters and conditions (temperature, airflow, fuel flow, etc.).

A computerized facility for programming automatic operation is very useful-but not essential-for maintaining good operating conditions, in particular when the heating value varies widely as may be the case for health-care waste.

Operation and Maintenance of Pyrolytic Incinerators

The pyrolytic incinerator should be operated and monitored by a well trained technician who can maintain the required conditions, controlling the system manually if necessary. Correct operation is essential, not only to maximize treatment efficiency and minimize the environmental impact of emissions, but also to reduce maintenance costs and extend the life expectancy of the equipment. A careful operational balance needs to be maintained between the two combustion chambers. If this is not done, the following are the likely consequences:

- Too rapid combustion of waste will increase the flow of gas and decrease its residence time to below the minimum desired period of 2 seconds. This may result in partial, rather than complete, combustion of the gases and an increase in the soot and slag produced, which may clog the system and lead to major maintenance problems.

- If the pyrolytic combustion of waste is too slow, the flow speed of gases in the post-combustion chamber will be reduced. This may reduce air pollution, but will result in lower incinerating capacity and higher fuel consumption.

Fuel consumption of pyrolytic incinerators is between 0.03 and 0.08kg of fuel-oil per kg of waste, or between 0.04 and 0.1m^3 of gas fuel per kg of waste.

Periodic maintenance includes cleaning of the combustion chambers and declogging of air inflows and fuel burners, when necessary. Operators in charge of loading waste and removing ashes should wear protective equipment-masks, gloves, safety glasses, overalls, and safety shoes.

On-site and Off-site Facilities

The choice of on-site (i.e. at the hospital) or off-site (at a central location) incineration facilities should be in line with the national planning policies.

Small-scale incinerators used in hospitals, of capacity 200-1000kg/day, are operated on demand. They are manually loaded and de-ashed daily or every 2-3 days; a shovel or a vacuum cleaner should be used to remove the ashes. The combustion process is under automatic control and the services of an operator are therefore required for only part of a working day (e.g. 2 hours).

Off-site regional facilities will have large-scale incinerators of capacity 1-8 tonnes/day, operating continuously and equipped with automatic loading and de-ashing devices. Incinerators of this size would benefit from energy-recovery systems-at least for preheating of the waste to be incinerated-and exhaust-gas cleaning facilities. It may be possible to use the steam produced to generate electricity. Facilities should also be available for the treatment and final disposal of incineration by-products. Operation and maintenance of a large, centralized, pyrolytic incinerator of capacity 4-8 tonnes/day will require the full-time services of a waste disposal engineer. Ideally, large-scale incinerators should be located in industrial areas specially

designated for hazardous plants. Such areas have good road access and power and water supplies, and are usually remote from housing. In any case, incinerators must be located at a minimum distance of 500 metres from any human settlement.

Investment and Operating Costs

Capital costs for pyrolytic incinerators suitable for treating health-care waste vary widely. For illustrative purposes only, approximate costs of equipment available on the European market in 1996. In Europe, operating and maintenance costs for a small-scale hospital pyrolytic incinerator may reach about US$ 380 per tonne of waste incinerated.

Rotary Kilns

A rotary kiln, which comprises a rotating oven and a post-combustion chamber, may be specifically used to burn chemical wastes, and is also suited for use as a regional health-care waste incinerator. The axis of a rotary kiln is inclined at a slight angle to the vertical (3-5% slope). The kiln rotates 2 to 5 times per minute and is charged with waste at the top. Ashes are evacuated at the bottom end of the kiln. The gases produced in the kiln are heated to high temperatures to burn off gaseous organic compounds in the post-combustion chamber and typically have a residence time of 2 seconds. Rotary kilns may operate continuously and are adaptable to a wide range of loading devices. Those designed to treat toxic wastes should preferably be operated by specialist waste disposal agencies and should be located in industrial areas or “parks”.

4

Developmental Change and Human Health

HUMAN IMPACT ON THE NATURAL ENVIRONMENT

Natural environment is of crucial importance for social and economic life.

We use the living world as:

- A resource for food supply
- An energy source
- A source for recreation
- Amajor source of medicines
- Natural resources for industrial products

In this respect the diversity of nature not only offers man a vast power of choice for his current needs and desires. It also enhances the role of nature as a source of solutions for the future needs and challenges of mankind.

State of ecosystems, habitats and species

In the past, human interaction with nature, although often having a disruptive effect on nature, often also enriched the quality and variety of the living world and its habitats-*e.g.* through the creation of artificial landscapes and soil cultivation by local farmers. Today, however, human pressure on natural environments is greater than before in terms of magnitude and efficiency in disrupting nature and natural landscapes, most notably:

- Intensive agriculture replacing traditional farming; this combined with the subsidies of industrial farming has had an enormous effect on western rural landscapes and continues to be a threat.
- Mass tourism affecting mountains and coasts.
- The policies pursued in the industry, transport and energy sectors having a direct and damaging impact on the coasts, major rivers (dam construction and associated canal building) and mountain landscapes.
- The strong focus of forestry management on economic targets primarily causes the decline in biodiversity, soil erosion and other related effects.

The clearest manifestations of the degradation of the natural environment are:

- *Reduction and fragmentation of habitats and landscapes*: The expansion of humans activities into the natural environment, manifested by urbanisation, recreation, industrialisation, and agriculture, results in increasing uniformity in landscapes and consequential reduction, disappearance, fragmentation or isolation of habitats and landscapes. It is evident that the increasing exploitation of land for human use greatly reduces the area of each wildlife habitat as well as the total area surface throughout Europe.

  The consequences are:

  – A decreased species diversity, due to reduced habitable surface area which corresponds to a reduced “species carrying capacity”.
  – The reduction of the size of habitats also reduces the genetic diversity of the species living there. Smaller habitats can only accommodate smaller populations, this results in an impoverished gene pool.
  – The reduction of genetic resources of a species diminishes its flexibility and evolutionary adaptability to changing situations. This has significant negative impacts on its survival.

The conditions under which the reduction of habitats often occur prevent living organisms making use of their normal ways to flee their threatened habitat. Those escape routes include migration to other habitats, adaption to the changing environment, or genetic interchange with populations in nearby habitats. Of particular concern is:

  - The abrupt nature of human intervention; human projects are planned and implemented on a much shorter time scale than natural processes;
  - Furthermore human intervention, such as the construction of buildings, motorways or railways results in the fragmentation of habitats, which strongly limits the possibility for contact or migration among them;
  - In extreme cases even the smallest, narrowest connections between habitats are broken off. Such isolation is catastrophic for life in the habitat fragments.

- *Loss of Species of Fauna and Flora*: Although relatively few species of Europe's fauna and flora have actually become totally extinct during this century, the continent's biodiversity is affected by decreasing species numbers and the loss of habitats in many regions. Approximately 30% of the vertebrates and 20% of the higher plants are classified as "threatened". Threats are directly linked to the loss of habitats due to destruction, modification and fragmentation of ecosystems as well as from overuse of pesticides and herbicides, intensive farming methods, hunting and general human disturbance. The overall deterioration of Europe's air and water quality add to the detrimental influence.

Agriculture

Europe's natural environment is inextricably linked with agriculture and forestry. Since agriculture traditionally depends on sound environmental conditions, farmers have a special interest in the maintenance of natural resources and for centuries maintained a mosaic of landscapes which protected

and enriched the natural environment. As a result of needs for food production since the 1940s, policies have encouraged increased pro- duction through a variety of mechanisms, including price support, other subsidies and support for research and development.

The success achieved in agricultural production has however entailed increased impact on the environment. Modern agriculture is responsible for the loss of much wildlife and their habitats in Europe, through reduction and fragmentation of habitats and wildlife populations. The drainage of wetlands, the destruction of hedgerows and the intensive use of fertilizers and pesticides can all pose a threat to wildlife.

Highly specialised monoculture are causing significant loss in species abundance and diversity. On the other hand increased production per hectare in intensive areas, raising of livestock volume, and lower prices for agricultural products also caused marginalization of agricultural land, changing the diversity of European landscapes into the direction of two main types: Intensive Agriculture and Abandoned land.

Energy

Abandonment can be positive for nature, but this is not necessarily so. Land abandonment increases the risk of fire in the Mediterranean Region, causes a decline of small-scale landscape diversity and can also cause decrease in species diversity. All energy types have potential impacts on the natural environment to varying degrees at all stages of use, from extraction through processing to end use.

Generating energy from any source involves making the choices between impacts and how far those impacts can be tolerated at the local and global scale. This is especially of importance for nuclear power, where there are significant risks of radioactive pollution such as at Chernobyl.

Shell Oil Company and IUCN have jointly drafted environmental regulations for oil-exploitation in Arctic areas of Siberia. Other oil companies are aware of this and use these environmental regula- tions voluntarily for developing oil fields. Into the future the sustainability of the natural environment will be improved as trends away from damaging energy uses

and extractive methods reduce and whilst real cost market forces and the polluter pays principle take effect.

Fisheries

The principle of the fisheries sector is towards sustainable catches of wild aquatic fauna. The principle environmental impact associated with fisheries activities is the unsustainable har- vesting of fish stocks and shellfish and has consequences for the ecological balance of the aquatic environment. The sector is in a state of "crisis", with over capacity of the fleet, overexploitation of stocks, debt, and marketing problems. Growing aquaculture industry may increase water pollution in western Europe, and is appearing to be a rising trend in the Mediterranean and Central/East Europe. Fishing activities have an impact on cetaceans and there is concern that large numbers of dolphins, and even the globally endangered Monk seal, are being killed.

Forestry

Compared to other landuses, forest management has the longest tradition in following sustainable principles due to which over 30% of Europe is still covered with trees. Without such an organised approach, forests are likely to have already disappeared from Europe's lowlands. However, as an economic sector, forestry has also impacted severely on the naturalness of Europe's forests: soils have been drained, pesticides and fertilizers applied, and exotic species planted. In many areas monocultures have replaced the original diverse forest composition. Monocultures are extremely sensitive to insect infestations, fires or wind, and so can lead to financial losses as well as biological decline. The inadequate afforestation practices characterize new trends in impacting on the sustainability of the natural environment.

Industry

Almost all forms of industry have an impact on the natural environment and its sustainability. The impact varies at different stages in the life cycle of a product, depending upon the raw materials used through to the final end use of the product for waste residue, re-use or recycling. Industrial

accidents and war damage to industrial plants can also endanger the natural environment.

Tourism and Recreation

Tourism and recreation impact in various ways on the natural environment. On the one hand, natural areas form the very basis of many touristic attractions by highlighting scenic value or exceptional encounters with fauna and flora. However, some forms of tourism can be extremely detrimental to ecologically sensitive areas, resulting in habitat degeneration or destruction, in the disturbance or hunting even rare or threatened species. The pressure from short holiday seasons and specific, sometimes small, locations of touristic interest result in conflicting land-uses, such as in the Alpine regions, at Mediterranean beaches and along many banks of inland waters.

Transport and Infrastructure

Transport is perhaps the major contributor to pollution in the world today, particularly global envi- ronmental issues such as the greenhouse effect. The key impacts of transportation include frag- mentation of habitats and species and genetic populations, disruption of migration and traffic mortalities to wildlife. Since the 1970s transport has become a major consumer of non-renewable resources, 80% of oil consumption coming from road transport.

Human Impact on Soils

Ecosystems can normally cope with most types of disturbance. However, human disturbance often occurs too quickly for the environment to respond, negatively affecting the soils and the plants and animals that depend upon them. Soils are living environments, providing habitat for a host of microorganisms necessary for plant growth. Impacts on soils, therefore, can affect the entire ecosystem.

History

The human invention that probably has had the greatest impact on soils is the John Deere self-scouring steel plow, introduced in 1837. The once impenetrable prairies were plowed

and tilled, becoming vast farm lands. Today, only 5 per cent of the original native prairie remains in the United States. Similar losses occurred in other habitat types such as wetlands, negatively impacting their water-loving soils and disturbing layers of buried sediment. The U.S. Geological Survey, more than 50 per cent of the aquatic habitats of the lower 48 states have been drained.

Dust Bowls

The greatest human impact to soils in the 20th century was the 1930s Dust Bowl Drought, which lasted 8 years overall. The drought, along with improper farming practices, created a deadly scenario, resulting in the loss of tons of precious topsoil. Soils whirled around in the air, creating the so-called "black blizzards." Texas, Kansas, Oklahoma and Colorado saw losses of over 30 million hectares of farmlands alone.

Soil Erosion and Urban Development

Agriculture is the primary source of negative human impact on soils. However, the urban landscape is not exempt. Urban environments include vast regions of impervious surfaces which water cannot penetrate. During a severe weather event, water washes over these impenetrable surfaces, eroding stream banks and displacing soils. Depending upon the adjacent land use, these soils may contain toxins which can negatively impact surface water and groundwater resources. Soil erosion feeds upon itself. As stream banks erode, water flow increases during floods, causing more soil erosion in the process.

Pollution

Even human activity not directly associated with soils can affect these natural resources. Air pollution releases contaminants such as sulfur dioxide into the atmosphere. This compound combines with moisture present in the air to create acidic precipitation.

Soils receiving this acid rain become acidic. Microorganisms die off, impacting the health of the soils. Left unchecked, soils become ecological dead zones, unable to support neither plant nor animal life.

Prevention/Solution

Many human impacts on soils can be prevented. For example, planting grass or other clumping vegetation along stream banks can prevent soil erosion. More stringent pollution control regulations can mitigate the environmental effects by preventing the introduction of toxins into the environment and soils. Finally, individuals can lessen their impact on soils by the proper use of pesticides and fertilizers.

Human Impacts on Water Quality

The Human impact of climate change refers to the effects of climate change (including global warming, the current climate change) on human civilization and human beings as distinct from direct effects on the natural environment, including non-human animal life and species. Such impacts have been understood to be responsible today, or predicted to be responsible in the future, for significant economic losses, as well as loss of life and wellbeing or health. In unstable or fragile regions or communities, the additional burden of climatic changes triggered by global warming may have further negative impacts in social, political or security terms. Traditionally a neglected aspect of the climate change debate, much less research has been conducted on the impacts of climate change on health, food supply, economic growth, migration, security, societal change, and public goods, such as drinking water, than on the geo-physical changes related to global warming. Human impacts can be both negative and positive. Climatic changes in Siberia, for instance, are expected to improve food production and local economic activity at least in the short to medium term.

Numerous studies suggest today, however, that the current and future impacts of climate change on human society are and will continue to be overwhelmingly negative. The majority of the adverse effects of climate change are experienced by poor and low-income communities around the world, who have much higher levels of vulnerability to environmental determinants of health, wealth and other factors, and much lower levels of capacity available for coping with environmental change. A report on the global human impact of climate change published by the Global Humanitarian Forum in 2009 indicated that

developing countries suffer 99% of the casualties attributable to climate change.

This also raises questions of climate justice, since the 50 least developed countries of the world account for around or less than 1% of worldwide emissions of greenhouse gases that cause global warming. While developing countries are worst affected, the impacts of climate change are not limited to lower-income communities. Increasing tropical storm activity, extreme weather, temperatures and drought or water stress are being experienced in every region of the world.

It has been estimated that 4 billion people today live in areas at risk to climate impacts. Since so little research has been conducted into the human impact of climate change and because of the difficulty in separating out the influence of climate change from other contributing factors, statistics relating to the human impact of climate change carry significant margins of error. Particularly on a global level, statistical data on the human impact of climate change should only be considered indicative of orders of magnitude, and not exact. Though the human impact of climate change has traditionally been understudied, a number of organizations are raising the profile of this issue by organizing various high-level meetings and publishing reports on the topic.

Now list the human facter that change the climate, Such organizations include Oxfam, the United Nations Development Programme, the United Nations Environment Programme, the Office of the High Commissioner for Human Rights, the United Nations High Commissioner for Refugees, the Office for the Coordination of Humanitarian Affairs, the World Health Organization, the Global Humanitarian Forum, Care International, Greenpeace, Maplecroft, the World Bank, and the International Federation of Red Cross and Red Crescent Societies. Climate change threatens to slow, halt or reverse progress towards reducing the spread of diseases and aggravates already enormous health problems, especially in the poorest parts of the world.

Current weather conditions heavily impact the health of poor people in developing nations, and climate change has a

multiplying effect. A changing climate further affects the essential ingredients of maintaining good health: clean air and water, sufficient food and adequate shelter. A warmer and more variable climate leads to higher levels of some air pollutants and increases transmission of diseases through unclean water and contaminated food. It compromises agricultural production in some of the least developed countries, and it increases the hazards of weather-related disasters.

Therefore global warming, together with the changes in food and water supplies it causes, can indirectly spur increases in such diseases as malnutrition, diarrhea, cardiovascular and respiratory diseases, and water borne and insect-transmitted diseases.

Health equity and climate change have a major impact on human health and quality of life, and are interlinked in a number of ways. The report of the WHO Commission on Social Determinants of Health points out that disadvantaged communities are likely to shoulder a disproportionate share of the burden of climate change because of their increased exposure and vulnerability to health threats. Over 90 per cent of malaria and diarrhea deaths are borne by children aged 5 years or younger, mostly in developing countries.

Other severely affected population groups include women, the elderly and people living in small island developing states and other coastal regions, mega-cities or mountainous areas. Because the poor tend to live in geographical and climatic regions that are naturally most vulnerable to climate change, their capacity to adapt is easily overwhelmed by the impact of the hanging conditions. They have the least assets to rely on in the event of a shock—whether it be a weather-related disaster, a bad harvest or a family member falling ill.

These factors build on each other and create a perpetuating cycle of poverty that is difficult to break. Safety net structures like insurance are also largely unavailable to the world's poor. Many are subsistence farmers or fishermen, or have jobs in the tourism industry—vocations highly dependent on natural resources such as the ocean, forests and land for their livelihoods. Climate change compounds existing poverty by destroying livelihoods.

Climate change is expected to reduce the earning potential of the next generation because it decreases family income and increases the number of hungry children. Economists estimate that every child whose physical and mental development is stunted by hunger and malnutrition stands to lose 5 to 10 per cent in lifetime earnings. As incomes drop, poor families might be forced to send their children to work to bring in extra income.

Consequently, climate change affects educational opportunities and thereby income potential of the next generation.As the climate warms, it changes the nature of global rainfall, evaporation, snow, stream flow and other factors that affect water supply and quality. Freshwater resources are highly sensitive to variations in weather and climate. Climate change is projected to affect water availability. Growing evidence suggests that it speeds up the water cycle, which can bring longer droughts and more intense periods of rain. This makes wet regions even wetter and arid areas drier. In areas where the amount of water in rivers and streams depends on snow melting, warmer temperatures increase the fraction of precipitation falling as rain rather than as snow, causing the annual spring peak in water runoff to occur earlier in the year. This can lead to an increased likelihood of winter flooding and reduced late summer river flows.

Rising sea levels cause saltwater to enter into fresh underground water and freshwater streams. This reduces the amount of freshwater available for drinking and farming. Warmer water temperatures also affect water quality and accelerate water pollution. Climate change causes displacement of people in several ways, the most obvious—and dramatic—being through the increased number and severity of weather-related disasters which destroy homes and habitats forcing people to seek shelter or livelihoods elsewhere. In the long term, such environmental effects of climate change as desertification and rising sea levels gradually doom livelihoods and force communities to abandon traditional homelands for more accommodating environments.

This is currently happening in areas of Africa's Sahel, the semi-arid belt that spans the continent just below its northern

deserts. Deteriorating environments triggered by climate change can also lead to increased conflict over resources which in turn can displace people. However, the links between the gradual environmental degradation of climate change and displacement are complex: When individuals decide over time to leave, it is impossible to single out the influence of climate change in these decisions from other factors, such as poverty, population growth or employment options. The UN High Commissioner for Refugees, it will become increasingly difficult to categorize any displaced people by separate causes, which may include any combination of conflict, economic, environmental, climate or other factors. Neither the UN Framework Convention on Climate Change nor its Kyoto Protocol, an international agreement on climate change, includes any provisions concerning specific assistance or protection for those who will be directly affected by climate change. Conflicts are typically extremely complex with multiple inter-dependent causalities, often referred to as 'complex emergencies.'

Climate change has the potential to exacerbate existing tensions or create new ones—serving as a threat multiplier. It can be a catalyst for violent conflict and a threat to international security. The United Nations Security Council held its first-ever debate on the impact of climate change in 2007. The links between climate change and security have been the subject of numerous high-profile reports since 2007 by leading security figures in the United States, United Kingdom and the European Union.

The G77 group of developing nations also considers climate change to be a major security threat which is expected to hit developing nations particularly hard. The links between the human impact of climate change and the threat of violence and armed conflict are particularly important because multiple destabilizing conditions are affected simultaneously. The consequences of climate change and poverty are not distributed uniformly within communities. Individual and social factors such as gender, age, education, ethnicity, geography and language lead to differential vulnerability and capacity to adapt to the effects of climate change.

Climate change effects such as hunger, poverty and diseases like diarrhea and malaria, disproportionately impact children, *i.e.* about 90 per cent of malaria and diarrhea deaths are among young children. Furthermore, in times of hardship young girls are particularly likely to be taken out of school to care for sick relatives or earn extra income. The elderly have weakened immune systems making them more susceptible to diseases and changing weather conditions, especially heat waves, along with being highly vulnerable to weather-related disasters due to reduced mobility.

HUMAN ACTIVITIES

Mass extinctions have occurred many times in the past, but the current extinctions are the first that can be attributed to the actions of a single species, humans. In a broad sense our effect is due to three factors:

(1) The growth in our population,

(2) Our policies that value our own well being over that of the environmental system that support us,

(3) Our ever increasing appetite for natural resources.

More specifically, our effect on the rate of extinction can be attributed to the following:

Destruction and fragmentation of habitat-Since humans first began to farm, we have been disrupting natural lands in order to supply ourselves with food and other resources. Logging, road construction, housing, and mining all destroy or subdivide former habitats for wildlife.

In the 48 contiguous United States 98% of the tall-grass prairies have been plowed, 90% of old-growth forests have been cut, and the total amount of forest cover has been reduced by 33%. It has been estimated that these changes have led to the extinction of at least 500 species.

National Parks and other preserves serve as small protected habitats, but often the space is too limited to support a breeding population, or the distance between safe areas is too great to allow growing populations to colonize new area and return to breed.

- *Commercial Hunting and Poaching:* International trade in exotic plants and animals is a large and lucrative business. A live mountain gorilla is worth $150,000, a Bengal tiger skin sells for $100,000, and rhinoceros horn will bring $28,000 per kilogram. Over 600 species of plants and animals are severely threatened because of illegal trade. Unfortunately most penalties are small and enforcement is difficult. The U.S. Customs Service believes it catches less than 10% of the illegal wildlife trade coming into this country.
- *Overfishing:* Humans have become very adept at catching fish. As our boats, nets, and location devices have become more sophisticated; the fish have become more scarce. From 1950 to 1990 the worldwide harvest of fish increased from 20 million tons per year to 100 million tons. Despite a continuing increase in the size and power of the world's fishing fleets, the catch during the 1990 has leveled off. The UN Food and Agricultural Organization estimates that since 1993, 15 of the world's 17 major fishing areas are being fished at or beyond their estimated sustainable yields.
- *Control of Predators and Pests:* For years people have tried to eliminate plants and animals that compete with us for food in one way or another. In the U.S. 99% of the prairie dogs have been eliminated because their borrows injure horses and cattle. In Africa large numbers of elephant are killed because they trample crops. The Carolina parakeet was eliminated because it ate fruit, and wolves and coyotes have been killed because the attach livestock.
- *Pollution:* Pollution of air, water, and soil has been harmful to wild plants and animals just as it has been to humans. Some air pollution is believed to have a direct effect on climate which is the primary cause of extinction.
- Non-Indigenous Species.

According to several studies, approximately 32% of the known species in the US are vulnerable to extinction as a

result of human activities. The 10 states in which the treat is particularly severe include California, Hawaii, Texas, Florida, and most other southeastern states.

Solutions: There are basically two ways to protect wildlife. Most biologists believe that the most effective approach is to protect the ecosystems in which the plants and animals belong. This involves establishing and protecting natural wildlife areas in which the native species are balanced and preserved, while the non-native species are removed. The primary problem with this system is that only 6% of the world's land area is currently protected as wildlife sanctuary, and with a rapidly growing human population, is it not likely that other land can set aside for this purpose.

The more common method to protect wildlife is to identify and protect specific species that are at risk. A species is said to be "endangered" if so few individual exist that it may become extinct over all or some of its natural range. Examples of endangered animals are the condor in California, the black rhinoceros in Africa, and the giant panda in China. A species is classified as "threatened" if it is still abundant in its natural range, but its numbers are declining such that it may become endangered. Examples of animals in this category include the bald eagle, the grizzly bear and the alligator.

The Convention on International Trade in Endangered Species was established in 1975 and lists over 600 species that cannot be commercially traded as specimens or products because they are threatened or endangered. In the United States, the Endangered Species Act of 1973 (amended in 1982 and 1988) is one the world's toughest environmental regulations. The act does not allow Americans to import any product made from an endangered or threatened species.

In addition, the act authorizes the U.S. Fish and Wildlife Service and the National Marine Fisheries Service to identify threatened and endangered species that cannot be hunted, killed, collected or injured in the United States. To date about 960 species have been identified. Once a species is identified, the Endangered Species Act requires that a plan be developed

to help the species recover. Due to lack of funding, only about 600 plans have been devised, and most of these have not yet been put into practice.

Throughout most of its existence, the Endangered Species Act has been under pressure from groups that believe it unfairly restricts their ability to do business. Many logging companies, developers, miners, and others argue that the Act is ineffective and an unnecessary expense since it has removed only seven species from the list and only 20 have recovered sufficiently to be reclassified from endangered to threatened. Senator Slade Gordon from Washington has suggested that all endangered species should be removed from the wild and bred in zoos so that endangered plants and animals can be protected without blocking economic development. Those who support the Act point out that recovery is a slow process, and 20 years is a very short time in which to expect results. Supporters also note that the total budget for the Endangered Species Program in the U.S. in 1996 was $57 million, about equal to the cost of 1.5 miles of urban interstate highway.

Concerns: If extinction is a natural process, and the competition between species for space and food is natural as well, why should we be concerned if humans are currently winning the battle against almost all other organisms and some of them are becoming extinct? The answer, according to many people, has three parts. The first is very selfish. The vast majority of our food, shelter, and medicine has been derived from wild plants. Many wild plants and animals recycle nutrients, build soil, and remove toxic materials from the air and water. So far we have examined very few of the thousands of known species. If we allow them to become extinct before we know how important they are to our survival, we may lose a great deal. The second is slightly less selfish. Humans enjoy wildlife and spend millions of dollars each year to visit natural areas, see beautiful plants, and watch interesting animals. Biologist Edward Wilson refers to our affinity for nature as "biophilia," and claims that it is an imprint in our genes that reflects our "roots in nature." The third part of the answer is that as intelligent and thinking organisms, people are obliged

to look beyond their immediate needs to the rights of other organisms. Many people believe that all species have an equal right to compete for a place on earth, and we are obliged to make sure that the competition is fair.

GLOBALIZATION AND SOCIAL DETERMINANTS OF HEALTH

As background to a discussion of research methods and strategies, it is worthwhile to provide a selective overview of previous conceptual milestones that have contributed to understanding the influences on SDH. A 1987 UNICEF publication on *Adjustment with a Human Face* reported early and important findings on how what we would now call globalization was affecting SDH. The study involved 10 countries (Botswana, Brazil, Chile, Ghana, Jamaica, Peru, Philippines, South Korea, Sri Lanka, Zimbabwe) that had adopted policies of domestic economic adjustment in response to economic crises that led them to rely on loans from the IMF – a dynamic that is described in the second article of the series. In many cases the policies adopted had resulted in deterioration in key indicators of child health (e.g. infant mortality, child survival, malnutrition, educational status) and in access to SDH (e.g. availability and use of food and social services), with reductions in government expenditure on basic services emerging as a key intervening variable.

The study situated these national cases within an analytical framework that linked changes in government policies (e.g. expenditures on education, food subsidies, health, water, sewage, housing and child care services) with selected economic determinants of health at the household level (e.g. food prices, household income, mothers' time) and selected indicators of child welfare. Based on that analysis, the study identified a generic package of policies that would minimize the negative effects of economic adjustment by protecting the basic incomes, living standards, health and nutrition of the poor or otherwise vulnerable – priorities that have similarly been stressed in subsequent policy analyses. However, in the context of globalization an important limitation is that only the final chapter of the UNICEF study addressed elements of the

international policy environment that might facilitate implementation of “adjustment with a human face” in some countries while obstructing it in others, and the study as a whole did not directly address the comparative merits of “compensating for adjustment” in health policies and programs and rethinking the adjustment process itself. In work for WHO, Woodward and colleagues devised an explanatory model that focused on “five key linkages from globalization to health,” three direct and two indirect.

Direct effects included impacts on health systems, health policies, and exposure to certain kinds of hazards such as infectious disease and tobacco marketing; indirect effects were those “operating through the national economy on the health sector (e.g. effects of trade liberalization and financial flows on the availability of resources for public expenditure on health, and on the cost of inputs); and on population risks (particularly the effects on nutrition and living conditions resulting from impacts on household income).”

Here, again, we see an emphasis on the economic aspects both of globalization and of SDH. This model has the advantage of focusing on the range of policy choices (by both governmental and private actors) that operate at the supranational level to affect health, while being limited in its focus primarily on health systems relative to other SDH. A subsequent WHO-supported systematic review examined numerous models of the relations between globalization and health, generating a diagrammatic synthesis hierarchically organized around various levels of analysis ranging from the supranational to the household. Key strengths of this synthesis are its recognition of the importance of environmental pathways (reflected in the discussion of this topic in the second article in the series); its attention to how globalization influences the context within which national and subnational govenrnments make and implement policy; and its acknowledgment of the role of political systems and processes and pre-existing endowments (natural resources, geographic location, levels of education) as mediators of that influence.

Conversely, a limitation is a lack of focus on the specific pathways that lead to changes in individual and population health status by way of SDH. In a conceptual framework developed specifically for analysing those pathways, Diderichsen and colleagues identify "four main mechanisms – social stratification, differential exposure, differential susceptibility, and differential consequences – that play a role in generating health inequities." Globalization can affect health outcomes by way of each of these mechanisms, and the authors' reference to the influence on stratification of "those central engines in society that generate and distribute power, wealth and risks" is especially apposite in this context. A variant of this model was provisionally adopted as an organizing framework in a concept paper for the Commission on Social Determinants of Health, and has been further modified for purposes of the Globalization Knowledge Network.

A stylized example shows the model's relevance. Import liberalization may reduce the incomes of some workers in sectors serving the domestic market, or shift them into the informal economy, thereby affecting social stratification, differential exposure (e.g. as workers are exposed to new hazards) and differential vulnerability (e.g. as income loss means adequate nutrition or essential health care become harder to afford, or in the extreme cases in which women are driven to reliance on "survival sex"). Increased vulnerability may also magnify the negative consequences of ill health by reducing the resources available to households to pay for health care or absorb earnings losses, increasing the chance of falling into "poverty traps" (hence the feedback loop to social stratification). Import liberalization may also reduce tariff revenues (and therefore funds available for public expenditures on income support or health care) in advance of any offsetting increases from income and consumption taxes. In countries with high levels of external debt, the need to conserve funds for repaying external creditors, perhaps by initiating or increasing user fees for health and education, may create a further constraint. (The rationale for including health systems as a separate element of the diagram now becomes apparent.)

Conversely, if import liberalization is matched by improved access to export markets, new employment opportunities may be created for specific groups, such as women working in export processing zones, who are thereby empowered to escape patriarchal social structures (social stratification) and reduce their economic vulnerability.

Methodological Issues

Despite the sense of simplicity created by diagrammatic representations, no single such representation will be adequate to capture the complexities of globalization and its influences in more than a limited number of situations. Globalization comprises multiple, interacting policy dynamics or processes the effects of which may be difficult if not impossible to separate. Pathways from globalization to changes in SDH are not always linear, do not operate in isolation from one another, and may involve multiple stages and feedback loops. Similarities exist with the task of analysing causal links between environmental change and human health, which "are complex because often they are indirect, displaced in space and time, and dependent on a number of modifying forces," in the words of WHO's synthesis of the health implications of the findings of the Millennium Ecosystem Assessment project. It is therefore necessary to rely on evidence generated by multiple disciplines, research designs and methodologies – the approach now widely described as transdisciplinary – comprising both qualitative and quantitative findings.

Issues of scale are also relevant: for example, research that situates data from local-scale survey research in the context of structural adjustment in Zimbabwe and that identifies globalization-related influences on health in South Africa demonstrates the need to integrate work using different units of analysis (e.g. the household, the region, the national economy) in order to describe relevant mechanisms of action in sufficient detail, and to reflect intra-national disparities (e.g. by region, class and gender) that are not apparent from national level data. The evidence base for assessing globalization's effects on SDH and identifying opportunities for intervention is therefore

different from, and more heterogeneous than, the body of research that is available with respect to clinical and (many) public health interventions.

Notably, qualitative research provides information about differential impacts (e.g. by region, gender, kind of employment) that are not revealed by standard indicators, and about such matters as the problems created by the imposition of user charges and cost recovery in water and sanitation systems. Within the ethnographic literature, Schoepf demonstrates the value of qualitative evidence about the relations between micro-level outcomes and such macro-level factors as falling commodity prices, domestic austerity policies that involved cuts in public sector employment and in subsidized access to health care, and migration driven by economic desperation.

For further illustrations of the value of qualitative research see e.g. the World Bank's Voices of the Poor study; the report of the Structural Adjustment Participatory Review International Network; and a summary of studies of sources of livelihood in KwaZulu-Natal, South Africa by Lund.

Policy-relevant linkages between globalization and SDH are therefore best described, and the strength of evidence evaluated, by way of syntheses that incorporate several elements, including (but not limited to): (a) description of the national and international policy context and its history; (b) country-or region-specific studies that describe changes in determinants of health, such as the level and composition of household income, labour market changes, access to education and health services; (c) evidence from clinical and epidemiological studies that relates to demonstrated or probable changes in health outcomes arising from those impacts; (d) ethnographic research, field observations, and other first-hand accounts of experience 'on the ground'.

This choice of elements is not random; it recognizes the need for study at the various levels, and the need not only to connect contextual factors with changes in SDH and their distribution, but also to demonstrate where feasible a relation between changes in SDH and changes in health outcomes. At

the same time, the complexity of the evidence base and the relevant causal chains means that rarely will it be possible to state conclusions with the degree of conclusiveness that may be possible in a laboratory situation or even in many epidemiological study designs, where almost all variables can be controlled.

In the words of social epidemiologist Michael Marmot, who now chairs the CSDH: "The further upstream we go in our search for causes," and globalization is the quintessential upstream variable, the greater the need to rely on "observational evidence and judgment in formulating policies to reduce inequalities in health".

The choice and defence of a standard of proof – how much evidence is enough – is also important. As in the context of national public health and regulatory policy, the decision must be made with explicit reference to the underlying, potentially competing values. Excessive concern with avoiding false positive findings (Type I errors, or the incorrect rejection of the null hypothesis) can supply, as in other contexts, a credible and convenient rationale for doing nothing.

This is the "tobacco industry standard of proof" – so demanding that there is always room to claim that evidence is less than conclusive. In the environmental policy context, Page has convincingly demonstrated the negative health outcomes that may result when standards of proof are set without explicit reference to the possible consequences of being wrong in different kinds of ways. On this point, it cannot be emphasized too strongly that the choice of a standard of proof is inescapably value-driven, and is not always a choice with respect to which scientific researchers have any special competence.

In a study that illustrates application of the preceding insights about explanation, De Vogli and Birbeck identify five multi-step pathways that lead from globalization to increased vulnerability to HIV infection and its consequences among women and children in sub-Saharan Africa by way of: currency devaluations, privatization, financial and trade liberalization,

implementation of user charges for health services and implementation of user charges for education. The first two pathways operate by way of reducing women's access to basic needs, either because of rising prices or reduced opportunities for waged employment.

The third operates by way of increasing migration to urban areas, which simultaneously may reduce women's access to basic needs and increase their exposure to risky consensual sex. The fourth pathway (health user fees) reduces both women's and youth's access to HIV-related services, and the fifth (education user fees) increases vulnerability to risky consensual sex, commercial sex and sexual abuse by reducing access to education.

The explanatory approach adopted is congruent with recent reviews of research on HIV/AIDS, tuberculosis and malaria which concluded that vulnerability to all three diseases is closely linked; that poverty, gender inequality, development policy and health sector 'reforms' that involve user fees and reduced access to care are important determinants of vulnerability; and that " [c]omplicated interactions between these factors, many of which lie outside the health sector, make unravelling of their individual roles and therefore appropriate targeting of interventions difficult".

A choice must also be made about the time frame of concern. In the long run wealthier societies are healthier, albeit with wide variations in health status at a given level of income per capita. It can be argued that the optimal, or at least most realistic, approach to improving SDH is the one that will maximize economic growth in the countries or regions of concern, even at the cost of substantial short-term deteriorations in health status or increases in health disparities.

This argument is implicit in a widely cited article claiming that "Globalization is good for your health, mostly," and was stated explicitly by a team of World Bank economists with respect to the transition economies of the former Soviet bloc. However, the empirical uncertainties associated with this position lead Angus Deaton, one of the leading researchers on

the relations between economic growth and health, to warn flatly that “economic growth, by itself, will not be enough to improve population health, at least in any acceptable time.” The issue of acceptable time raises the ethical question of how long is too long. As suggested by Deaton, diffusion of the benefits of economic growth in ways that lead to widespread improvements in population health is neither automatic nor rapid: it took more than 50 years in the industrial cities of nineteenth-century England, for example. Given the frequency with which globalization has resulted in deterioration in SDH for substantial segments of national populations, despite impressive economic growth as measured by national indicators, this is not just an academic point. We return to it in the third article in the series.

5

The Human Ecology of Disease

ECOLOGY

Ecology, œcology or ecological science, is the scientific study of the distribution and abundance of living organisms and how the distribution and abundance are affected by interactions between the organisms and their environment.

The environment of an organism includes both physical properties, which can be described as the sum of local abiotic factors such as insolation (sunlight), climate, and geology, as well as the other organisms that share its habitat. The term oekologie was coined in 1866 by the German biologist Ernst Haeckel the word is derived from the Greek and therefore "ecology" means the "study of the household [of nature]".

The word "ecology" is often used in common parlance as a synonym for the natural environment or environmentalism. Likewise "ecologic" or "ecological" is often taken in the sense of environmentally friendly.

Scope

Ecology is usually considered a branch of biology, the general science that studies living organisms. Organisms can be studied at many different levels, from proteins and nucleic acids (in biochemistry and molecular biology), to cells (in cellular biology), to individuals (in botany, zoology, and other similar disciplines), and finally at the level of populations, communities, and ecosystems, to the biosphere as a whole; these latter strata are

the primary subjects of ecological inquiries. Ecology is a multi-disciplinary science.

Because of its focus on the higher levels of the organization of life on earth and on the interrelations between organisms and their environment, ecology draws heavily on many other branches of science, especially geology and geography, meteorology, pedology, genetics, chemistry, and physics.

Thus, ecology is considered by some to be a holistic science, one that over-arches older disciplines such as biology which in this view become sub-disciplines contributing to ecological knowledge.

Agriculture, fisheries, forestry, medicine and urban development are among human activities that would fall within Krebs' (1972: 4) explanation of his definition of ecology: "where organisms are found, how many occur there, and why".

As a scientific discipline, ecology does not dictate what is "right" or "wrong". However, ecological knowledge such as the quantification of biodiversity and population dynamics have provided a scientific basis for expressing the aims of environmentalism and evaluating its goals and policies. Additionally, a holistic view of nature is stressed in both ecology and environmentalism. Consider the ways an ecologist might approach studying the life of honeybees:

- The behavioral relationship between individuals of a species is behavioral ecology-for example, the study of the queen bee, and how she relates to the worker bees and the drones.
- The organized activity of a species is community ecology; for example, the activity of bees assures the pollination of flowering plants. Bee hives additionally produce honey which is consumed by still other species, such as bears.
- The relationship between the environment and a species is environmental ecology-for example, the consequences of environmental change on bee activity. Bees may die out due to environmental changes. The environment simultaneously affects and is a consequence of this

activity and is thus intertwined with the survival of the species.

Disciplines of Ecology

Ecology is a broad discipline comprised of many sub-disciplines. A common, broad classification, moving from lowest to highest complexity, where complexity is defined as the number of entities and processes in the system under study, is:

- Ecophysiology and Behavioral ecology examine adaptations of the individual to its environment.
- Autecology studies the dynamics of populations of a single species.
- Community ecology (or synecology) focuses on the interactions between species within an ecological community.
- Ecosystem ecology studies the flows of energy and matter through the biotic and abiotic components of ecosystems.
- Landscape ecology examines processes and relationship across multiple ecosystems or very large geographic areas.

Ecology can also be sub-divided according to the species of interest into fields such as animal ecology, plant ecology, insect ecology, and so on. Another frequent method of subdivision is by biome studied, e.g., Arctic ecology (or polar ecology), tropical ecology, desert ecology, etc. The primary technique used for investigation is often used to subdivide the discipline into groups such as chemical ecology, genetic ecology, field ecology, statistical ecology, theoretical ecology, and so forth. Note that these different systems are unrelated and often applied at the same time; one could be a theoretical plant community ecologist, or a polar ecologist interested in animal genetics.

CONTROL OF COMMUNICABLE DISEASES

Advances in the development of vaccines and chemotherapeutic agents have brought many communicable diseases under control. However, there remain many important

communicable diseases for which environmental control measures are indispensable, especially in the field of water supply and sanitation. Such diseases include cholera, diarrhoeal diseases, leishmaniasis, malaria and schistosomiasis. In all such instances, the environmental measures, either as an integral part of primary health care or undertaken outside the health sector, form an indispensable component of overall disease control strategies, together with health and hygiene education, and in some cases, are the only component.

With HIV infection levels estimated to increase to 30-40 million by the year 2000, the socio-economic impact of the pandemic is expected to be devastating for all countries, and increasingly for women and children. While direct health costs will be substantial, they will be dwarfed by the indirect costs of the pandemic - mainly costs associated with the loss of income and decreased productivity of the workforce. The pandemic will inhibit growth of the service and industrial sectors and significantly increase the costs of human capacity-building and retraining. The agricultural sector is particularly affected where production is labour-intensive.

Objectives

A number of goals have been formulated through extensive consultations in various international forums attended by virtually all Governments, relevant United Nations organizations (including WHO, UNICEF, UNFPA, UNESCO, UNDP and the World Bank) and a number of non-governmental organizations. Goals (including but not limited to those listed below) are recommended for implementation by all countries where they are applicable, with appropriate adaptation to the specific situation of each country in terms of phasing, standards, priorities and availability of resources, with respect for cultural, religious and social aspects, in keeping with freedom, dignity and personally held values and taking into account ethical considerations.

Additional goals that are particularly relevant to a country's specific situation should be added in the country's national plan of action (Plan of Action for Implementing the World

Declaration on the Survival, Protection and Development of Children in the 1990s). 1/ Such national level action plans should be coordinated and monitored from within the public health sector. Some major goals are:

(a) By the year 2000, to eliminate guinea worm disease (dracunculiasis);

(b) By the year 2000, eradicate polio;

(c) By the year 2000, to effectively control onchocerciasis (river blindness) and leprosy;

(d) By 1995, to reduce measles deaths by 95 per cent and reduce measles cases by 90 per cent compared with pre-immunization levels;

(e) By continued efforts, to provide health and hygiene education and to ensure universal access to safe drinking water and universal access to sanitary measures of excreta disposal, thereby markedly reducing waterborne diseases such as cholera and schistosomiasis and reducing:

   i. By the year 2000, the number of deaths from childhood diarrhoea in developing countries by 50 to 70 per cent;

   ii. By the year 2000, the incidence of childhood diarrhoea in developing countries by at least 25 to 50 per cent.

(f) By the year 2000, to initiate comprehensive programmes to reduce mortality from acute respiratory infections in children under five years by at least one third, particularly in countries with high infant mortality;

(g) By the year 2000, to provide 95 per cent of the world's child population with access to appropriate care for acute respiratory infections within the community and at first referral level;

(h) By the year 2000, to institute anti-malaria programmes in all countries where malaria presents a significant health problem and maintain the transmission-free status of areas freed from endemic malaria;

(i) By the year 2000, to implement control programmes in countries where major human parasitic infections are endemic and achieve an overall reduction in the prevalence of schistosomiasis and of other trematode infections by 40 per cent and 25 per cent, respectively, from a 1984 baseline, as well as a marked reduction in incidence, prevalence and intensity of filarial infections;

(j) To mobilize and unify national and international efforts against AIDS to prevent infection and to reduce the personal and social impact of HIV infection;

(k) To contain the resurgence of tuberculosis, with particular emphasis on multiple antibiotic resistant forms;

(l) To accelerate research on improved vaccines and implement to the fullest extent possible the use of vaccines in the prevention of disease.

Activities

Each national Government, in accordance with national plans for public health, priorities and objectives, should consider developing a national health action plan with appropriate international assistance and support, including, at a minimum, the following components:

(a) National public health systems:

i. Programmes to identify environmental hazards in the causation of communicable diseases;

ii. Monitoring systems of epidemiological data to ensure adequate forecasting of the introduction, spread or aggravation of communicable diseases;

iii. Intervention programmes, including measures consistent with the principles of the global AIDS strategy;

iv. Vaccines for the prevention of communicable diseases.

(b) Public information and health education: Provide education and disseminate information on the risks of endemic communicable diseases and build awareness

on environmental methods for control of communicable diseases to enable communities to play a role in the control of communicable diseases;

(c) Intersectoral cooperation and coordination:

i. Second experienced health professionals to relevant sectors, such as planning, housing and agriculture;

ii. Develop guidelines for effective coordination in the areas of professional training, assessment of risks and development of control technology.

(d) Control of environmental factors that influence the spread of communicable diseases: Apply methods for the prevention and control of communicable diseases, including water supply and sanitation control, water pollution control, food quality control, integrated vector control, garbage collection and disposal and environmentally sound irrigation practices;

(e) Primary health care system:

i. Strengthen prevention programmes, with particular emphasis on adequate and balanced nutrition;

ii. Strengthen early diagnostic programmes and improve capacities for early preventative/treatment action;

iii. Reduce the vulnerability to HIV infection of women and their offspring.

(f) Support for research and methodology development:

i. Intensify and expand multidisciplinary research, including focused efforts on the mitigation and environmental control of tropical diseases;

ii. Carry out intervention studies to provide a solid epidemiological basis for control policies and to evaluate the efficiency of alternative approaches;

iii. Undertake studies in the population and among health workers to determine the influence of cultural, behavioural and social factors on control policies.

(g) Development and dissemination of technology:

i. Develop new technologies for the effective control of communicable diseases;

ii. Promote studies to determine how to optimally disseminate results from research;

iii. Ensure technical assistance, including the sharing of knowledge and know-how.

MEETING THE URBAN HEALTH CHALLENGE

Basis for Action

For hundreds of millions of people, the poor living conditions in urban and peri-urban areas are destroying lives, health, and social and moral values. Urban growth has outstripped society's capacity to meet human needs, leaving hundreds of millions of people with inadequate incomes, diets, housing and services. Urban growth exposes populations to serious environmental hazards and has outstripped the capacity of municipal and local governments to provide the environmental health services that the people need.

All too often, urban development is associated with destructive effects on the physical environment and the resource base needed for sustainable development. Environmental pollution in urban areas is associated with excess morbidity and mortality. Overcrowding and inadequate housing contribute to respiratory diseases, tuberculosis, meningitis and other diseases. In urban environments, many factors that affect human health are outside the health sector. Improvements in urban health therefore will depend on coordinated action by all levels of government, health care providers, businesses, religious groups, social and educational institutions and citizens.

Objectives

The health and well-being of all urban dwellers must be improved so that they can contribute to economic and social development. The global objective is to achieve a 10 to 40 per cent improvement in health indicators by the year 2000. The same rate of improvement should be achieved for environmental,

housing and health service indicators. These include the development of quantitative objectives for infant mortality, maternal mortality, percentage of low birth weight newborns and specific indicators (e.g. tuberculosis as an indicator of crowded housing, diarrhoeal diseases as indicators of inadequate water and sanitation, rates of industrial and transportation accidents that indicate possible opportunities for prevention of injury, and social problems such as drug abuse, violence and crime that indicate underlying social disorders).

Activities

Local authorities, with the appropriate support of national Governments and international organizations should be encouraged to take effective measures to initiate or strengthen the following activities:

(a) Develop and implement municipal and local health plans:

i. Establish or strengthen intersectoral committees at both the political and technical level, including active collaboration on linkages with scientific, cultural, religious, medical, business, social and other city institutions, using networking arrangements;

ii. Adopt or strengthen municipal or local "enabling strategies" that emphasize "doing with" rather than "doing for" and create supportive environments for health;

iii. Ensure that public health education in schools, workplace, mass media etc. is provided or strengthened;

iv. Encourage communities to develop personal skills and awareness of primary health care;

v. Promote and strengthen community-based rehabilitation activities for the urban and peri-urban disabled and the elderly.

(b) Survey, where necessary, the existing health, social and environmental conditions in cities, including documentation of intra-urban differences;

(c) Strengthen environmental health services:

i. Adopt health impact and environmental impact assessment procedures;

ii. Provide basic and in-service training for new and existing personnel.

(d) Establish and maintain city networks for collaboration and exchange of models of good practice.

MEANS OF IMPLEMENTATION

Financing and Cost Evaluation

The Conference secretariat has estimated the average total annual cost (1993-2000) of implementing the activities of this programme to be about $222 million, including about $22 million from the international community on grant or concessional terms. These are indicative and order-of-magnitude estimates only and have not been reviewed by Governments. Actual costs and financial terms, including any that are non-concessional, will depend upon, inter alia, the specific strategies and programmes Governments decide upon for implementation.

Scientific and Technological Means

Decision-making models should be further developed and more widely used to assess the costs and the health and environment impacts of alternative technologies and strategies. Improvement in urban development and management requires better national and municipal statistics based on practical, standardized indicators.

Development of methods is a priority for the measurement of intra-urban and intra-district variations in health status and environmental conditions, and for the application of this information in planning and management.

Human Resource Development

Programmes must supply the orientation and basic training of municipal staff required for the healthy city processes. Basic and in-service training of environmental health personnel will also be needed.

Capacity-building

The programme is aimed towards improved planning and management capabilities in the municipal and local government and its partners in central Government, the private sector and universities. Capacity development should be focused on obtaining sufficient information, improving coordination mechanisms linking all the key actors, and making better use of available instruments and resources for implementation.

REDUCING HEALTH RISKS FROM ENVIRONMENTAL POLLUTION AND HAZARDS

In many locations around the world the general environment (air, water and land), workplaces and even individual dwellings are so badly polluted that the health of hundreds of millions of people is adversely affected. This is, inter alia, due to past and present developments in consumption and production patterns and lifestyles, in energy production and use, in industry, in transportation etc., with little or no regard for environmental protection. There have been notable improvements in some countries, but deterioration of the environment continues.

The ability of countries to tackle pollution and health problems is greatly restrained because of lack of resources. Pollution control and health protection measures have often not kept pace with economic development. Considerable development-related environmental health hazards exist in the newly industrializing countries. Furthermore, the recent analysis of WHO has clearly established the interdependence among the factors of health, environment and development and has revealed that most countries are lacking such integration as would lead to an effective pollution control mechanism.

Without prejudice to such criteria as may be agreed upon by the international community, or to standards which will have to be determined nationally, it will be essential in all cases to consider the systems of values prevailing in each country and the extent of the applicability of standards that are valid for the most advanced countries but may be

inappropriate and of unwarranted social cost for the developing countries.

Objectives

The overall objective is to minimize hazards and maintain the environment to a degree that human health and safety is not impaired or endangered and yet encourage development to proceed. Specific programme objectives are:

(a) By the year 2000, to incorporate appropriate environmental and health safeguards as part of national development programmes in all countries;

(b) By the year 2000, to establish, as appropriate, adequate national infrastructure and programmes for providing environmental injury, hazard surveillance and the basis for abatement in all countries;

(c) By the year 2000, to establish, as appropriate, integrated programmes for tackling pollution at the source and at the disposal site, with a focus on abatement actions in all countries;

(d) To identify and compile, as appropriate, the necessary statistical information on health effects to support cost/ benefit analysis, including environmental health impact assessment for pollution control, prevention and abatement measures.

Activities

Nationally determined action programmes, with international assistance, support and coordination, where necessary, in this area should include:

(a) Urban air pollution:

i. Develop appropriate pollution control technology on the basis of risk assessment and epidemiological research for the introduction of environmentally sound production processes and suitable safe mass transport;

ii. Develop air pollution control capacities in large cities, emphasizing enforcement programmes and using monitoring networks, as appropriate;

(b) Indoor air pollution:

i. Support research and develop programmes for applying prevention and control methods to reducing indoor air pollution, including the provision of economic incentives for the installation of appropriate technology;

ii. Develop and implement health education campaigns, particularly in developing countries, to reduce the health impact of domestic use of biomass and coal;

(c) Water pollution:

i. Develop appropriate water pollution control technologies on the basis of health risk assessment;

ii. Develop water pollution control capacities in large cities;

(d) Pesticides: Develop mechanisms to control the distribution and use of pesticides in order to minimize the risks to human health by transportation, storage, application and residual effects of pesticides used in agriculture and preservation of wood;

(e) Solid waste:

i. Develop appropriate solid waste disposal technologies on the basis of health risk assessment;

ii. Develop appropriate solid waste disposal capacities in large cities;

(f) Human settlements: Develop programmes for improving health conditions in human settlements, in particular within slums and non-tenured settlements, on the basis of health risk assessment;

(g) Noise: Develop criteria for maximum permitted safe noise exposure levels and promote noise assessment and control as part of environmental health programmes;

(h) Ionizing and non-ionizing radiation: Develop and implement appropriate national legislation, standards and enforcement procedures on the basis of existing international guidelines;

(i) Effects of ultraviolet radiation:

i. Effects of ultraviolet radiation: Undertake, as a matter of urgency, research on the effects on human health of the increasing ultraviolet radiation reaching the earth's surface as a consequence of depletion of the stratospheric ozone layer;

ii. On the basis of the outcome of this research, consider taking appropriate remedial measures to mitigate the above-mentioned effects on human beings;

(j) Industry and energy production:

i. Establish environmental health impact assessment procedures for the planning and development of new industries and energy facilities;

ii. Incorporate appropriate health risk analysis in all national programmes for pollution control and management, with particular emphasis on toxic compounds such as lead;

iii. Establish industrial hygiene programmes in all major industries for the surveillance of workers' exposure to health hazards;

iv. Promote the introduction of environmentally sound technologies within the industry and energy sectors;

(k) Monitoring and assessment: Establish, as appropriate, adequate environmental monitoring capacities for the surveillance of environmental quality and the health status of populations;

(l) Injury monitoring and reduction:

i. Support, as appropriate, the development of systems to monitor the incidence and cause of injury to allow well-targeted intervention/prevention strategies;

ii. Develop, in accordance with national plans, strategies in all sectors (industry, traffic and others) consistent with the WHO safe cities and safe communities programmes, to reduce the frequency and severity of injury;

iii. Emphasize preventive strategies to reduce occupationally derived diseases and diseases caused by environmental and occupational toxins to enhance worker safety;

(m) Research promotion and methodology development:

i. Support the development of new methods for the quantitative assessment of health benefits and cost associated with different pollution control strategies;

ii. Develop and carry out interdisciplinary research on the combined health effects of exposure to multiple environmental hazards, including epidemiological investigations of long-term exposures to low levels of pollutants and the use of biological markers capable of estimating human exposures, adverse effects and susceptibility to environmental agents.

6

Environment and Health

ENVIRONMENTAL REMEDIATION

Environmental remediation deals with the removal of pollution or contaminants from environmental media such as soil, groundwater, sediment, or surface water for the general protection of human health and the environment or from a brownfield site intended for redevelopment. Remediation is generally subject to an array of regulatory requirements, and also can be based on assessments of human health and ecological risks where no legislated standards exist or where standards are advisory.

Remediation Standards

In the USA the most comprehensive set of Preliminary Remediation Goals (PRGs) is from the Environmental Protection Agency (EPA) Region 9. A set of standards used in Europe exists and is often called the Dutch standards. The European Union (EU) is rapidly moving towards Europe-wide standards, although most of the industrialised nations in Europe have their own standards at present. In Canada, most standards for remediation are set by the provinces individually, but the Canadian Council of Ministers of the Environment provides guidance at a federal level in the form of the *Canadian Environmental Quality Guidelines* and the *Canada-Wide Standards*|*Canada-Wide Standard for Petroleum Hydrocarbons in Soil*.

Site Assessment

Once a site is suspected of being contaminated there is a need to assess the contamination. Often the assessment begins with preparation of a Phase I Environmental Site Assessment. The historical use of the site and the materials used and produced on site will guide the assessment strategy and type of sampling and chemical analysis to be done. Often nearby sites owned by the same company or which are nearby and have been reclaimed, levelled or filled are also contaminated even where the current land use seems innocuous. For example, a car park may have been levelled by using contaminated waste in the fill. Also important is to consider off site contamination of nearby sites often through decades of emissions to soil, groundwater, and air. Ceiling dust, topsoil, surface and groundwater of nearby properties should also be tested, both before and after any remediation. This is a controversial step as:

1. No one wants to have to pay for the clean up of the site;
2. If nearby properties are found to be contaminated it may have to be noted on their property title, potentially affecting the value;
3. No one wants to pay for the cost of assessment.

Often corporations which do voluntary testing of their sites are protected from the reports to environmental agencies becoming public under Freedom of Information Acts, however a “Freedom of Information” inquiry will often produce other documents that are not protected or will produce references to the reports.

Funding and Mapping Remediation

In the US there has been a mechanism for taxing polluting industries to form a Superfund to remediate abandoned sites, or to litigate to force corporations to remediate their contaminated sites. Other countries have other mechanisms and commonly sites are rezoned to “higher” uses such as high density housing, to give the land a higher value so that after deducting clean up costs there is still an incentive for a developer

to purchase the land, clean it up, redevelop it and sell it on, often as apartments (home units). There are several tools for mapping these sites and which allow the user to view additional information. One such tool is TOXMAP, a Geographic Information System (GIS) from the Division of Specialized Information Services of the United States National Library of Medicine (NLM) that uses maps of the United States to help users visually explore data from the United States Environmental Protection Agency's (EPA) Superfund and Toxics Release Inventory programs.

Remediation Technologies

Remediation technologies are many and varied but can be categorised into ex-situ and in-situ methods. Ex-situ methods involve excavation of effected soils and subsequent treatment at the surface, In-situ methods seek to treat the contamination without removing the soils.

The more traditional remediation approach (used almost exclusively on contaminated sites from the 1970s to the 1990s) consists primarily of soil excavation and disposal to landfill "dig and dump" and groundwater "pump and treat". In situ technologies include Solidification and Stabilization and have been used extensively in the USA.

Excavation or Dredging

Excavation processes can be as simple as hauling the contaminated soil to a regulated landfill, but can also involve aerating the excavated material in the case of volatile organic compounds (VOCs). Recent advancements in bioaugmentation and biostimulation of the excavated material have also proven to be able to remediate semi-volatile organic compounds (SVOCs) onsite. If the contamination affects a river or bay bottom, then dredging of bay mud or other silty clays containing contaminants may be conducted. Recently, ExSitu Chemical oxidation has also been utilized in the remediation of contaminated soil. This process involves the excavation of the contaminated area into large burmmed areas where they are treated using chemical oxidation methods.

SEAR

Also known as Solubilization and recovery, the *Surfactant Enhanced Aquifer Remediation* process involves the injection of hydrocarbon mitigation agents or specialty surfactants into the subsurface to enhance desorption and recovery of bound up otherwise recalcitrant non aqueous phase liquid (NAPL).

In geologic formations that allow delivery of hydrocarbon mitigation agents or specialty surfactants, this approach provides a cost effective and permanent solution to sites that have been previously unsuccessful utilizing other remedial approaches. This technology is also successful when utilized as the initial step in a multi faceted remedial approach utilizing SEAR then In situ Oxidation, bioremediation enhancement or soil vapour extraction (SVE).

Pump and Treat

Pump and treat involves pumping out contaminated groundwater with the use of a submersible or vacuum pump, and allowing the extracted groundwater to be purified by slowly proceeding through a series of vessels that contain materials designed to adsorb the contaminants from the groundwater. For petroleum-contaminated sites this material is usually activated carbon in granular form. Chemical reagents such as flocculants followed by sand filters may also be used to decrease the contamination of groundwater. Air stripping is a method that can be effective for volatile pollutants such as BTEX compounds found in gasoline.

For most biodegradable materials like BTEX, MTBE and most hydrocarbons, bioreactors can be used to clean the contaminated water to non-detectable levels. With fluidized bed bioreactors it is possible to achieve very low discharge concentrations which will meet or exceed discharge standards for most pollutants.

Depending on geology and soil type, pump and treat may be a good method to quickly reduce high concentrations of pollutants. It is more difficult to reach sufficiently low concentrations to satisfy remediation standards, due to the

equilibrium of absorption (chemistry)/desorption processes in the soil.

Solidification and Stabilization

Solidification/stabilization work has a reasonably good track record but also a set off serious deficiencies related to durability of solutions and potential longterm effects. In addition CO_2 emission due to the use of cement are also becoming a major obstacle to its wide spread use in solidification/stabilization projects.

Stabilization/solidification (S/S) is a remediation/treatment technology that relies on the reaction between a binder and soil to stop/prevent or reduce the mobility of contaminants.

- Stabilization-involves the addition of reagents to a contaminated material (e.g. soil or sludge) to produce more chemically stable constituents;
- Solidification-involves the addition of reagents to a contaminated material to impart physical/dimensional stability to contain contaminants in a solid product and reduce access by external agents (e.g. air, rainfall).

Conventional S/S is an established remediation technology for contaminated soils and treatment technology for hazardous wastes in many countries in the world. However, the uptake of S/S technologies has been relatively modest, and a number of barriers have been identified including:

- the relatively low cost and widespread use of disposal to landfill;
- the lack of authoritative technical guidance on S/S;
- uncertainty over the durability and rate of contaminant release from S/S-treated material;
- experiences of past poor practice in the application of cement stabilization processes used in waste disposal in the 1980s and 1990s (ENDS, 1992);
- residual liability associated with immobilized contaminants remaining on-site, rather than their removal or destruction.

In Situ Oxidation

New *in situ oxidation* technologies have become popular, for remediation of a wide range of soil and groundwater contaminants. Remediation by chemical oxidation involves the injection of strong oxidants such as hydrogen peroxide, ozone gas, potassium permanganate or persulfates.

Oxygen gas or ambient air can also be injected to promote growth of aerobic bacteria which accelerate natural attenuation of organic contaminants. One disadvantage of this approach is the possibility of decreasing anaerobic contaminant destruction natural attenuation where existing conditions enhance anaerobic bacteria which normally live in the soil prefer a reducing environment. In general though, aerobic activity is much faster than anaerobic and overall destruction rates are typically greater when aerobic activity can be successfully promoted.

The injection of gases into the groundwater may also cause contamination to spread faster than normal depending on the site's hydrogeology. In these cases, injections downgradient of groundwater flow may provide adequate microbial destruction of contaminants prior to exposure to surface waters or drinking water supply wells.

Migration of metal contaminants must also be considered whenever modifying subsurface oxidation-reduction potential. Certain metals are more soluble in oxidizing environments while others are more mobile in reducing environments.

Soil Vapour Extraction

Soil vapour extraction (SVE) is an effective remediation technology for soil. "Multi Phase Extraction" (MPE) is also an effective remediation technology when soil and groundwater are to be remediated coincidentally. SVE and MPE utilize different technologies to treat the off-gas volatile organic compounds (VOCs) generated after vacuum removal of air and vapors (and VOCs) from the subsurface and include granular activated carbon (most commonly used historically), thermal and/or catalytic oxidation and vapour condensation. Generally,

carbon is used for low (<500ppmV) VOC concentration vapour streams, oxidation is used for moderate (up to 4,000 ppmV) VOC concentration streams, and vapour condensation is used for high (>4,000 ppmV) VOC concentration vapour streams. Below is a brief summary of each technology.

1. Granular activated carbon (GAC) is used as a filter for air or water. Commonly used to filter tap water in household sinks. GAC is a highly porous adsorbent material, produced by heating organic matter, such as coal, wood and coconut shell, in the absence of air, which is then crushed into granules. Activated carbon is positively charged and therefore able to remove negative ions from the water such as organic ions, ozone, chlorine, fluorides and dissolved organic solutes by adsorption onto the activated carbon. The activated carbon must be replaced periodically as it may become saturated and unable to adsorb (i.e. reduced absorption efficiency with loading). Activated carbon is not effective in removing heavy metals.
2. Thermal oxidation (or incineration) can also be an effective remediation technology. This approach is somewhat controversial because of the risks of dioxins released in the atmosphere through the exhaust gases or effluent off-gas. Controlled, high temperature incineration with filtering of exhaust gases however should not pose any risks. Two different technologies can be employed to oxidize the contaminants of an extracted vapour stream. The selection of either thermal or catalytic depends on the type and concentration in parts per million by volume of constituent in the vapour stream. Thermal oxidation is more useful for higher concentration (~4,000 ppmV) influent vapour streams (which require less natural gas usage) than catalytic oxidation at ~2,000 ppmV.
    - Thermal oxidation which uses a system that acts as a furnace and maintains temperatures ranging from 1350°F to 1500°F (730°C-815°C).

- Catalytic oxidation which uses a catalyst on a support to facilitate a lower temperature oxidation. This system usually maintains temperatures ranging from 600°F to 800°F (315°C-430°C).

3. Vapour condensation is the most effective off-gas treatment technology for high (>4,000 ppmV) VOC concentration vapour streams. The process involves cryogenically cooling the vapour stream to below 40 degrees C such that the VOCs condensate out of the vapour stream and into liquid form where it is collected in steel containers. The liquid form of the VOCs is referred to as dense non-aqueous phase liquids (DNAPL) when the source of the liquid consists predominantly of solvents or light non-aqueous phase liquids (LNAPL) when the source of the liquid consists predominantly of petroleum or fuel products. This recovered chemical can then be reused or recycled in a more environmentally sustainable or green manner than the alternatives described above. This technology is also known as cryogenic cooling and compression (C3-Technology).

Other Technologies

The treatment of environmental problems through biological means is known as *bioremediation* and the specific use of plants for example by using phytoremediation. Bioremediation is sometimes used in conjunction with a pump and treat system. In bioremediation, either naturally occurring or specially bred bacteria are used to consume contaminants from extracted groundwater. This is sometimes referred to as a bio-gac system. Many times the groundwater is recycled to allow for continuously flowing water and enhanced bacteria population growth. Occasionally the bacteria can build up to such a point that they can affect filtration and pumping. The vessel should then be partially drained. Care must be taken to ensure that a sharp change in the groundwater chemistry does not kill the bacteria (such as a sudden change in pH).

Dual-phase extraction utilizes a soil vapour extraction system that produces a high vacuum resulting in the extraction

of both contaminated vapors as well as a limited amount of contaminated groundwater. This method is somewhat inefficient due to large amount of energy required by pulling water by vacuum compared to pushing water with a submersible pump. Mycoremediation is a form of bioremediation, the process of using fungi to return an environment (usually soil) contaminated by pollutants to a less contaminated state.

In an experiment conducted in conjunction with Batelle, a major contributor in the bioremediation industry, a plot of soil contaminated with diesel oil was inoculated with mycelia of oyster mushrooms; traditional bioremediation techniques (bacteria) were used on control plots. After four weeks, more than 95% of many of the PAH (polycyclic aromatic hydrocarbons) had been reduced to non-toxic components in the mycelial-inoculated plots. It appears that the natural microbial community participates with the fungi to break down contaminants into carbon dioxide and water. Wood-degrading fungi are particularly effective in breaking down aromatic pollutants (toxic components of petroleum), as well as chlorinated compounds (certain persistent pesticides; Battelle, 2000). Hair mats inocculated with oyster mushrooms were successfully employed in the clean-up of the San Francisco Bay area oil spill in 2007.

The key to mycoremediation is determining the right fungal species to target a specific pollutant. Certain strains have also been reported to successfully degrade the nerve gases VX and sarin.

Mycofiltration is a very similar process, using mycelial mats to filter toxic waste and microorganisms from polluted water.

ENVIRONMENTAL AND ECOLOGICAL CONSEQUENCES

The already densely populated developing countries contribute to over 95% of the population growth and rapid population growth could lead to environmental deterioration. Developed countries are less densely populated and contribute very little to population growth; however, they cause massive ecological damage by the wasteful, unnecessary and unbalanced

consumption the consequences of which could adversely affect both the developed and the developing countries.

The review on "Promotion of sustainable development: challenges for environmental policies" in the Economic Survey 1998-99 had covered in detail the major environmental problems, and policy options for improvement; the present review will only briefly touch upon some of the important ecological consequences of demographic transition. In many developing countries continued population growth has resulted in pressure on land, fragmentation of land holding, collapsing fisheries, shrinking forests, rising temperatures, loss of plant and animal species.

Global warming due to increasing use of fossil fuels could have serious effects on the populous coastal regions in developing countries, their food production and essential water supplies.

The Intergovernmental Panel on Climate Change has projected that, if current greenhouse gas emission trends continue, the mean global surface temperature will rise from 1 to 3.5 degrees Celsius in the next century. The panel's best estimate scenario projects a sea-level rise of 15 to 95 centimeters by 2100. The ecological impact of rising oceans would include increased flooding, coastal erosion, salination of aquifers and coastal crop land and displacement of millions of people living near the coast.

Patterns of precipitation are also likely to change, which combined with increased average temperatures, could substantially alter the relative agricultural productivity of different regions. Greenhouse gas emissions are closely linked to both population growth and development. Slower population growth in developing countries and ecologically sustainable lifestyles in developed countries would make reduction in green house gas emission easier to achieve and provide more time and options for adaptation to climate change. Rapid population growth, developmental activities either to meet the growing population or the growing needs of the population as well as changing lifestyles and consumption patterns pose major challenge to preservation and promotion of ecological balance in India.

Some of the major ecological adverse effects reported in India include:

- Severe pressure on the forests due to both the rate of resource use and the nature of use. The per capita forest biomass in the country is only about 6 tons as against the global average of 82 tons.
- Adverse effect on species diversity.
- Conversion of habitat to some other land use such as agriculture, urban development, forestry operation. Some 70-80% of fresh water marshes and lakes in the Gangetic flood plains has been lost in the last 50 years.
- Tropical deforestation and destruction of mangroves for commercial needs and fuel wood. The country's mangrove areas have reduced from 700,000 ha to 453,000 ha in the last 50 years.
- Intense grazing by domestic livestock Poaching and illegal harvesting of wildlife.
- Increase in agricultural area, high use of chemical fertilizers pesticides and weedicides; water stagnation, soil erosion, soil salinity and low productivity.
- High level of biomass burning causing large-scale indoor pollution.
- Encroachment on habitat for rail and road construction thereby fragmenting the habitat. increase in commercial activities such as mining and unsustainable resource extraction.
- Degradation of coastal and other aquatic ecosystems from domestic sewage, pesticides, fertilizers and industrial effluents.
- Over fishing in water bodies and introduction of weeds and exotic species.
- Diversion of water for domestic, industrial and agricultural uses leading to increased river pollution and decrease in self-cleaning properties of rivers.
- Increasing water requirement leading to tapping deeper aquifers which have high content of arsenic or fluoride resulting health problems.

- Disturbance from increased recreational activity and tourism causing pollution of natural ecosystems with wastes left behind by people.

The United Nations Conference on Environment and Development acknowledged population growth, rising income levels, changing technologies, increasing consumption pattern will all have adverse impact on environment. Ensuring that there is no further deterioration depends on choices made by the population about family size, life styles, environmental protection and equity. Availability of appropriate technology and commitment towards ensuring sustainable development is increasing throughout the world. Because of these, it might be possible to initiate steps to see that the natural carrying capacity of the environment is not damaged beyond recovery and ecological balance is to a large extent maintained. It is imperative that the environmental sustainability of all developmental projects is taken care of by appropriate inputs at the planning, implementation, monitoring and evaluation stages.

Urbanization

The proportion of people in developing countries who live in cities has almost doubled since 1960, while in more developed regions the urban share has grown from 61 per cent to 76 per cent. Urbanization is projected to continue well into the next century. By 2030, it is expected that nearly 5 billion of the world's 8.1 billion people will live in cities. India shares this global trend towards urbanisation.

Globally, the number of cities with 10 million or more inhabitants is increasing rapidly, and most of these new "megacities" are in developing regions. In 1960, only New York and Tokyo had more than 10 million people. By 1999, the number of megacities had grown to 17. It is projected that there will be 26 megacities by 2015; more than 10 per cent of the world's population will live in these cities. India's urban population has doubled from 109 million to 218 million during the last two decades and is estimated to reach 300 million by 2000 AD. As a consequence cities are facing the problem of expanding urban slums. Like many other demographic changes,

urbanization has both positive and negative effects. Cities and towns have become the engines of social change and rapid economic development.

Urbanisation is associated with improved access to education, employment, health care; these result in increase in age at marriage, reduction in family size and improvement in health indices. As people have moved towards and into cities, information has flowed outward. Better communication and transportation now link urban and rural areas both economically and socially creating an urban-rural continuum of communities with improvement in some aspects of lifestyle of both. The ever increasing reach of mass media communicate new ideas, points of reference, and available options are becoming more widely recognized, appreciated and sought. This phenomenon has affected health care, including reproductive health, in many ways.

For instance, radio and television programmes that discuss gender equity, family size preference and family planning options are now reaching formerly isolated rural populations. This can create demand for services for mothers and children, higher contraceptive use, and fewer unwanted pregnancies, smaller healthier families and lead to more rapid population stabilisation. But the rapid growth of urban population also poses some serious challenges.

Urban population growth has outpaced the development of basic minimum services; housing, water supply, sewerage and solid waste disposal are far from adequate; increasing waste generation at home, offices and industries, coupled with poor waste disposal facilities result in rapid environmental deterioration. Increasing automobiles add to air pollution. All these have adverse effect on ecology and health. Poverty persists in urban and peri-urban areas; awareness about the glaring inequities in close urban setting may lead to social unrest.

Health Implication of the demographic transition

It was earlier assumed that population growth during demographic transition will lead to overcrowding, poverty, undernutrition, environmental deterioration, poor quality of life and increase in disease burden. Experience in the last few

decades have shown that this may not always be correct. India is currently in the phase of demographic transition when the increase in population is mainly among younger, better educated and healthy population with low morbidity and mortality rate. The challenge for the health sector is to promote healthy life styles, improve access to and utilisation of health care so that the country can achieve substantial reduction in mortality and morbidity.

Occupational health and environmental health programme need be augmented to ensure that working population remain healthy and productive.

If these challenges are fully met, it is possible to accelerate reduction in morbidity and mortality rate in this age group and improve health indices of the country. With growing number of senior citizens there may be substantial increase in health care needs especially for management of non-communicable diseases. Increasing availability and awareness about technological advances for management of these problems, rising expectations of the population and the ever escalating cost of health care are some of the problems that the health care system has to cope with. Health care delivery systems will have to gear up to taking up necessary preventive, promotive, curative and rehabilitative care for growing population of senior citizens.

Population projections

There will be a marginal decline in the population less than 15 years of age. The health care infrastructure will therefore be not grappling with ever increasing number of children for providing care and they will be able to concentrate on:

- Improving quality of care;
- Focus on antenatal, intranatal and neonatal care aimed at reducing neonatal morbidity and mortality;
- Improve coverage and quality of health care to vulnerable and underserved adolescents;
- Promote intersectoral coordination especially with ICDS programme so that there is improvement in health and nutritional status;

- Improve coverage for immunization against vaccine preventable diseases.

The economic challenge is to provide needed funds so that these children have access to nutrition, education and skill development. The challenge faced by the health sector is to achieve reduction in morbidity and mortality rate in infancy and childhood, to improve nutritional status and eliminate ill-effects of gender bias. There will be a massive increase of population in the 15-59 age group. The persons in this age group will be more literate and have greater access to information; they will therefore have greater awareness and expectation regarding both the access to a wide spectrum of health care related services and the quality of these services.

Under the Reproductive and child health care programme efforts are underway to provide:

- Needed services for this rapid growing population.
- To broaden the spectrum of services available.
- To improve quality and coverage of health care to women, children and adolescents, so that their felt needs for health care are fully met.
- To improve the participation of men in the planned parenthood movement.

The components of the comprehensive RCH services are given in the text box.

While providing the package of services, efforts will have to be made to improve the quality of services, make services more responsive to users' needs, ensure that health workers and health care providers have the necessary skills and supplies they need and there is a strong and effective referral system to manage all the risk cases.

Family welfare Programme is attempting to improve the logistics of supply of drugs and vaccine to make sure good quality drugs are available at appropriate time.

Simultaneously the IEC efforts are being directed to:

- Ensure responsible reproductive/sexual behaviour;
- Improve awareness about reproductive health needs;

- Promote community participation and optimal utilisation of available services.

Essential Reproductive and Child Health Services

Though it is desirable that the entire package of services indicated under comprehensive RCH care is made available to all those who need it, it will not be possible to immediately implement such a comprehensive package at primary health care level on a nationwide basis. After consultation with experts a package of essential reproductive health services for nationwide implementation at primary health care settings has been identified.

Essential components recommended for nationwide implementation include:

- Prevention and management of unwanted pregnancy,
- Services to provide antenatal, intra-natal and post-natal, and neo-natal care,
- Services to promote child health and survival,
- Prevention and treatment of RTI/STD.

Most of these services are already being delivered under the Family Welfare Programme. However, there are wide variations in the quality and coverage of services not only between states but also between districts in the same state.

The focus under RCH Programme is therefore on the improvement in the quality and coverage of the services over and above the existing level in all districts/states in an incremental manner so that there is over all improvement maternal and child health indices.

URBANIZATION AND ENVIRONMENTAL DEGRADATION

Rapid urbanization has caused wide spread environmental degradation in the country. The government has conceded that despite imposition of regulatory measures, the magnitude of pollution from industrial sources in the country has not shown any appreciable decrease during the last two decades. Increase in pollution levels in urban areas is also fuelled by ever-growing traffic. The number of registered automobiles in the country,

mostly concentrated in the cities, has increased from 1.87 million in 1971 to 5.39 million in 1981 and 25.28 million in 1993. These figures show an extraordinary high annual (exponential) growth rate of 10.6 percent during 1971-81 and 12.9 percent during 1981-93, while the urban population grew only by about four percent annually during this period. Thus, the growth in the number of vehicles per capita in the past 12 years has been very high in the country. The highest growth rate has been recorded in the number of two-wheelers, at 15.1 percent during 1971-81 and 15.6 percent during 1981-93. These vehicles contribute the most to air pollution levels. Poor maintenance of vehicles and traffic congestion have been found to be critical factors of air pollution problems in urban areas. Most vehicles do not confirm to permissible emission limits.

It has been revealed by a survey of ten major cities of India by the National Environmental Engineering Research Institute (NEERI), Nagpur that there has been a substantial increase of the suspended particulate matter (SPM) in the air, which suggests the presence of dust and carbon particles coated with toxic gases. The highest level of SPM is reported to be in Delhi and Calcutta. It is as high as 460. The other metropolises, which cross the maximum, prescribed for SPM by WHO (200 micrograms per cubic meter of air) are Kanpur, Nagpur, Jaipur, Mumbai and Ahmedabad. The high levels of air pollution in these cities are largely attributable to incomplete combustion of diesel and leaded petrol, particularly in case of two-and three-wheelers, which use inefficient two-stroke engines and indirect fuel injection. The study has revealed that the SPM levels in the residential areas of all industrial cities have reached a critical level. Rapid urbanization together with other associated problems of shelter and provision of infrastructural facilities has caused a pernicious effect on the eco-stability of the country.

Yet, another serious problem is related to treatment of sewage collection and disposal of waste materials. Hardly any city in India has 100 percent sewage collection treatment and waste disposal facilities. Incidentally, of all the capital cities of different states and union territories Patna (the capital city

of the State of Bihar) is considered to be the worst of all. The untreated and partially treated wastewater ultimately contaminates rivers, lakes and reservoirs causing manifold pollution problems. Rivers passing through cities such as Ganga, Yamuna, Krishna, Kaveri, Godavari, Hoogly, Damodar, Kshipra, Gomti, Mahanadi, Narmada, Tapti, Betwa, etc. are reported to be heavily polluted. Urbanization had also enhanced the solid waste problem in the country. With the present culture of use and throw and increasing use of biodegradable packing material, the quantity and composition of waste is likely to change in the coming decades.

Indian cities also have serious problem of noise pollution. It is considered to be a very big health hazard. Noise affects man physically, psychologically and socially. Intense noise or long stay in a noisy environment can cause permanent reduction of hearing sensitivity by damaging sensory organs of the inner ear. It can also influence blood circulation, cause stress and other psychological effects and could also be an accident risk by drowning warning signals.

RELATIONSHIP BETWEEN SUSTAINABLE DEVELOPMENT, URBANIZATION AND SLUMS

There are two axes of power struggle within the world development community. One is the struggle between those who control the resources and those who need them, in other words, between the developed and the developing world. The tension in question has become the subject to myriads of UN General Assembly Resolutions, the Millennium Declaration which emphasizes international partnerships, and the World Summit on Sustainable Development in Johannesburg.

The second axis of struggle occurs between different development sub-cultures. That is, the tension between those stakeholders who are proponents of different mandates of development. Those who follow the development literature can without difficulty detect the covert, if not overt efforts to refute the thesis of the “other” development sub-culture, either empirically or theoretically. Juxtaposed against each other, these themes are packaged in dichotomous relationships, such

as rural versus urban development, health versus education, economic development versus social development, and the like. Each development sub-cult argues that, *its* specific development problem causes the highest suffering to humanity, and therefore should not be neglected by the international community.

This paper revolves around the mainstream debates held within the international development community around the relationship between urbanization, slums, and sustainable development.

One such debate revolves around the juxtaposition between urbanization and sustainable development. The UNEP-UN-HABITAT joint initiative, the Sustainable Cities Programme, in effect for over a decade, has demonstrated that the two sub-cultures, urban development and sustainable development are *not* contradictory. There are recent efforts to show that urban growth and development can be managed to both make cities more livable and to curb the destruction of the environment. Yet, the tendency to think that urbanization is primarily responsible for unsustainable development is still predominant.

The logical reasoning of these arguments follow the below premises, 'if-then' connections and sequences:

The starting premise is that, rapid urbanization is a major determinant behind the destruction of forests, reduction of biodiversity and high emission of CFCs. If the world community wants to protect the environment, then urbanization should be curbed. If the world community wants to curb urbanization, then it should invest more in areas of environment and rural development, rather than in making cities livable and in improving the lives of slum dwellers. This is the reasoning behind most donor policies whose thrust is to invest in 'preventive' measures, such as on rural development or environment, rather than 'curative' ones, that is, urban development and slum upgrading. It is believed that slum upgrading especially, can *encourage* rapid urbanization rather than curb it, and jeopardize sustainable development. This think piece aims to address some of the above links and assumptions. Our arguments include the following:

It is true that rapid urbanization can bring many environmental hazards and problems as documented in many flagship publications of the agency. The disagreement starts at how each party perceives 'prevention'. The point of this paper is that rapid urbanization is not preventable, as it has become an irreversible trend.

Urbanization is irreversible: It is not a value judgment to say that the world is inevitably becoming more urban day by day. Very soon, for every villager, there will be one citizen. In three decades from now, for every one villager there will be two citizens. With Latin America where 70 percent of the population already resides in cities, Africa, making up for slow rates of urbanization of the previous decades and China pursuing a high urbanization policy, virtually all the population growth expected at the world level during 2000-2030 would concentrate in urban areas. The vast majority, 95%, of the population increase, forecast for the same period, will be absorbed by the urban areas of the less developed regions. A substantial proportion of these people will be residents of mega-cities of the third world. Considering the overwhelming figures, time is ripe to take the urban revolution of the last two centuries, as a given. We assert that by weaving this demographic and human settlements reality into development policies, sustainability will be better achieved.

Rapid urbanization is increasingly caused by natural population increase in cities and annexation and reclassification of human settlements, as well as by rural to urban migration:

Another pillar of the pro-rural development argument is that high concentration of population in cities is due to migration flows from villages to cities, which cause the urban sprawl, which in turn puts a pressure on natural resources. Addressing the first thesis, on migration being the cause of high urban growth, we should note that there is abundant evidence that urban population increase is due to multiple factors which embrace migration, natural population increase, and reclassification and annexation of human settlements. Migration can originate not only from rural areas, but also

from other urban settlements and other countries, international migration.

The second point is that the role of migration in causing high urbanization depends on the historical stage at which countries or human settlements are undergoing the demographic transition. At initial stages of demographic transition which the Western world and Latin America went through, the increasing urban population was mostly due to migrants streaming from rural areas to cities. Historically, in Europe, the first stage of transition occurred at the late 19th century and lasted until the post Second World War era. For Latin America the demographic transition started during 1940s and lasted until 1980s for most highly populated countries of the continent. The second stage of demographic transition is when rural-urban migration comes to a standstill, and cities start increasing either due to natural population increase or due to reclassification and annexation. For decades, spatial population movements of Latin America were dominated by rural-urban migration, however, currently the places of origin have changed. The predominant form of migration is now, from urban to urban. The intra-metropolitan migration flows have gained significance among other population movements. Scholars of Latin America estimate that the rural-urban population transfer becomes less important in explaining urban growth. “If during 1950s, 46% of urban growth was explained by rural-urban migration, between 1990-2000 it accounts for 35%”.

Africa is the continent where most countries, especially those in the Sub-Saharan, have gone through their initial stages of demographic increase during and post-independence eras of 1960s and 1970s. Although the rural population still outnumbers their urban counterparts, and thereby are potential migrants/slum dwellers, it is interesting to see that natural increase contributes highest to the growth of urban areas. A UN study showed that the contribution of natural growth to urban growth is much more substantial in West Africa than in other parts of the world: in this continent natural growth represents 75% of urban growth while this share was only 50%

in Asia (excluding China) in the 1980s. The share of natural growth in rapid urban growth is higher, because the overall natural increase, is still very high, 2.7% as opposed to the 1.9% for the developing world as a whole. The traces of this macro demographical phenomenon in the slum neighborhoods of the cities are seen in the residential histories of people. To illustrate, the average resident of Kibera, Africa's largest slum in Nairobi, has been living and reproducing the second and the third generation slum dwellers, over the last 20-30 years.

The biggest of all continents, Asia, brings together a mosaic of countries at their various stages of demographic transition. "Asia is the only developing region where share of urban growth is attributed to migration/reclassification increased over the decades 1960-1990. ESCAP (2000) projections foretell that the role of migration in urban growth will increase over the first decade of the 21st century, with almost two thirds of urban growth in the period 2010-2020 attributable to net migration, reclassification and annexation; compared to only 51 percent in 1990-2000. In all sub-regions, except for the highly urbanized Pacific sub-region, net migration is projected to account for over 60% of urban growth." The share of reclassification of rural settlements as urban, and of annexation of fringe villages to metropolitan regions, in explaining high urbanization needs to be better documented. The higher rates of urbanization, in such cases are not accounted for, by population movements, but by socioeconomic change within the same human settlement which metamorphosed from a village to a town, or by a policy decision on definition of what rural and urban means.

Among other regions, it can be concluded that migration contributed more to urban growth for Asia than for either Latin American or African countries. Fallacies about individual decisionmaking dynamics of the rural and urban poor, on where and when to migrate.

Another assumption made by the pro-rural development community is a behavioural one. According to this thought, rural migrants/slum dwellers would be deterred from living in cities, if cities lose their appeal for them. Or, it is believed that

they would return back to their villages, if rural development takes effect. In sum, by encouraging policies that would reverse the 'push of the village and pull of the city' dynamic, they are convinced that sustainable development would be attained. There are two kinds of fallacy behind this argument. One is that most slum dwellers are not current migrants. They are second or third generation rural migrants, whose current home is the city itself. Most slum settlements in India, Pakistan, Kenya and Egypt, if not others, fall under this category. Thus, any argument which supposes that second-third generation migrants would return home, if the international community makes the politically correct development decisions, is sociologically and demographically incorrect, because the second-third-fourth generation villagers would *not* behave the same way that a current migrant would, that is return home, if rural development is guaranteed.

Another hypothesis promoted by the pro-rural community is that rural-urban migration can be curbed if development investments are channelled to rural areas rather than upgrading slums with infrastructure, services and security of tenure. Many migration studies indicate, however, the pull of the city could be as powerful as the push of the villages. There are many reasons why villagers find cities more attractive, aside from access to secure shelter, furbished with infrastructure. One such reason is the hope of finding better livelihoods. Over a generation of studies indicate that it is the high population concentration of cities itself that draws in migrants from villages. Because, in the eyes of migrants, big numbers of people is a swarming market for informal business, that the they will not be able to find in any 'developed' village. Especially in the case of Africa, the thesis that migration into cities can be discouraged if slums are not upgraded, can be refuted by evidence, as most households in African cities lack durable housing, water, sanitation and adequate living space, as well as lack security of housing tenure. Lack of such services neither prevents new migrants from settling in these slums, nor the old slum dwellers to move. The slum dwellers of Accra note that the reason they migrated to the city was not that

the infrastructure and services were adequate and accessible, but the "hustle and bustle of city", that is, its capacity to create opportunities for informal business.

The Urban Sprawl: Middle Class Expansion or Slum Invasions?

The general tendency is to think that rapid urbanization and urban sprawl in the third world is held identical with slum formation, which, in turn is seen as the main factor behind the destruction of the environment. An often-quoted example is that the urban poor cut the trees for heating and cooking, among others. It is often asserted that the need to 'build' infrastructure, shelter and other services, by itself is what consumes the natural flora.

Our first point is that formation of new slums is only partially responsible for urban sprawl.

An examination of a few cases of land-use patterns indicate that while in some cities, two being, Dar es Salaam of Tanzania and the Villavicencio of Colombia, the growth of informal areas are much faster than that of formal areas, the opposite is true in a number of other cities. It is argued that the emergence of the new middle classes, and dynamics of the global economy are equally, if not more, responsible for the expansion of urban areas at the cost of forests. It is acknowledged by a number of studies that the urban middle and rich classes and their consumption patterns have transformed to be less and less sustainable day by day.

A number of cases from the cities of the developing world strongly suggest that the land consumption by those who settle in the planned areas, that is, the middle and rich classes, has increased, although a global study yet, needs to be carried out. A study in the capital of Honduras, Tegucigalpa, shows that the land consumption (ha per person) has increased by approximately 40%, from 0.0074 to 0.103, in a matter of 12 years. Since the slum dwellers in this city inhabit the inner city, due to access reasons and the hazard-prone steep locations, it can be suggested that the sprawl occurs from the increasing

number and the growing sizes of plots, in the planned areas where middle and wealthy classes live.

An example from Eastern Africa, Nairobi, indicates that the residential land availability between different sub-locations settled on by different socioeconomic classes varies considerably. A research combining the GIS and the census information reveals that 60% of the population of Nairobi, lives on 8.7% of the land. The maps attached also illustrates that the sub-locations where slum incidence is high, occupy only a fraction of the urban residential land, which is mostly occupied by middle and or rich classes, settling on planned plots of land.

A similar example is the capital of Turkey, Ankara, where expansion of residential built area in the early phases of urban growth during 1950-75, was formed by the informal settlements. Since the last three decades, however, the demand for living outside the city and the resultant emergence of middle-class suburbs was the main factor explaining urban sprawl.

Although global land-use studies are needed to generalize this point, what is acknowledged universally by both slum dwellers themselves, and by the practitioners as well as city managers is that 'overcrowding', both within slum neighborhoods, and within dwelling is one of the distinguishing markers of slums in Latin America, Asia and Africa.

In other words, the land area consumed by an average slum dweller is much less than that of other urban citizens. Another point worth noting, is to differentiate between type of land invaded. It is generally assumed that slums occupy land which could otherwise have been conserved. Research indicates that slums invade many other types of areas as well. Two locations predominate settlement decision of most slums inhabitants. One location is to settle on hazardous, landslide, flood prone areas. In such cases slum dwellers could be considered as the potential victims of environmental destruction, rather than being the cause of it. The other location for building clusters of makeshift shacks is, around public works, urban land that is already used for development, such as railroad slums in Mumbai and Dhaka, or clusters of shacks squatting

under flyovers, as in Sao Paolo and Manila. In sum, the common belief that slum formation destroys the barren natural resources by invasion of land, need to be inspected much closer.

URBAN POVERTY AND CHILD HEALTH IN RAJASTHAN

The chapter is concerned with the high levels of infant and child illness and death amongst poor urban slum communities in Rajasthan, a state with one of the highest infant mortality rates in India. Urban poverty is significant in Rajasthan with a fifth of the urban population living below the poverty line and in slums (UHRC 2006). Increasing numbers of poor migrants in search of employment contribute to the rising levels of urban poverty in cities such as Jaipur, where the present study is based.

The research presented in this paper specifically focuses on the positive and negative roles of migration for the survival prospects of children in Rajasthan. While migration is an increasing feature which defines the lives of the rural and urban poor in India, few studies have considered its effects on the health of migrants and their families. A key point we make in the paper is that many poor people are forced to move on a regular and chronic basis and that this movement has both negative and positive consequences for their health and nutritional status.

The paper examines the consequences of internal migration for women's reproductive experiences and for their children's health and is based on work between 2002-2004 carried out by Unnithan-Kumar in two urban slums (basti) in Jaipur city, the capital of Rajasthan in NW India (wherever 'I' is used in the paper it refers specifically to her experience and interpretation). It draws on collaborative quantitative work with McNay and Castaldo, where we focus on the migration experiences of approximately 100 women from their birth (rather than on their last move, as is common in migration literature), their experiences of giving birth and the loss of their children. It also draws on Unnithan-Kumar's long term knowledge of the field, including an ethnographic study where she found ambivalence in the effects of migration on poor rural

women's reproductive choices in Jaipur: enhanced access to health services in the city both expanded possibilities for reproductive autonomy but also placed women under new types of biomedical control (Unnithan-Kumar 2004).

In the context of poverty-related migration in Rajasthan, health was not the primary factor or even a secondary consideration underlying migration. Rather, migration was undertaken, or indeed forced upon individuals and families as a means to gain employment, income and related economic well-being and security. Health and physical well-being were regarded as a consequence of economic well-being (also noted by Sinha 2005), rather than contributing to it.

The connection between health and migration then emerges as an indirect consequence of migration rather than being directly related to it. The health consequences of migration result from the changing social relationships, economic conditions and related health-seeking behaviour, as discussed below. In Rajasthan, the contradiction which migrants faced between an increased availability of health services, and their inability to access these services, was particularly reflected in the ambivalent ways in which migrants viewed their moves to the city. Migrants living in poor urban slums suffer from the lack of basic public provisions such as sanitation and water such that health is not the only service they miss out on.

Moreover, it is not enough that migration brings migrants to a place where there are more health services available; the question is whether their changed social and economic conditions enable them to take advantage of such services. Mobility in the context of such insecurity presents a particular challenge for the poor and for policy makers. Migration itself has to be understood in the distinctive context of Rajasthan, a dominantly poor agrarian economy, where strict social rules define women's marital and reproductive roles and relationships, great social pressure for producing children, and a high infant and maternal mortality rate. In gender terms, women experience migration differently from men and almost universally at the time of their marriage. Migrant women in

Rajasthan often move greater distances at marriage or shortly thereafter than non-migrant women.

The economic roles of migrant women change and so does their relationship with members of their immediate and extended families. The relationships with women, outside those defined by kinship, expand, and combined with a change in their access to health-services, alters the social and medical setting in which migrant women experience birthing and motherhood. This has further implications for the quality of life that their children will experience.

The shifts in mothers' work and nutrition and the environmental conditions in the basti (slum) in which they live, are perhaps the two most important migration-related factors to have a profound impact on the health and survival of their infants and children. Overall, there seems to be a greater tendency for the more recently migrated women to experience increased child mortality and make poorer use of preventive health services than longer term residents. These findings complement the works of Brockerhoff (1994) and Stephenson et al (2003) which suggest that the rates of child mortality experienced by rural migrants lies between that of rural and urban non-migrants. In the work presented here we suggest some reasons why this may be the case (unlike the demographic studies mentioned which highlight the pattern but not the reasons for the increase noted), as well as describe other occasions where straightforward patterns are more difficult to discern.

The high rate of child mortality among poor families in rural and urban areas in Rajasthan is a well known, and a well documented demographic fact. Rajasthan is among the states in India which has the highest rates of infant mortality at 80 deaths per 1000 live births and an under 5 mortality rate of 114.9. The infant mortality rate among the urban poor in Rajasthan is 98.2 deaths per 1000 live births with an under 5 mortality rate at 162.3 which are significantly higher than the average for the state (UHRC 2006). At an all-India level, the infant and child mortality rates are currently estimated

to be at the level of 72 deaths and 105 deaths per 1000 live births respectively, and considered to be stabilising after a rate of decline noted in the 1990s.

There is, however, significant regional variation within and between the Indian states with regard to these figures. Kerala has an IMR of 14 which is comparable to developed countries, while Rajasthan's figure of 80 brings it close to the high infant mortality experienced in some of the worst affected parts of the world such as in sub-Saharan Africa. Infant deaths have been further analysed in the NFHS-2 Rajasthan report according to place of residence (rural/urban), religion, socioeconomic factors, the age of the mother, birth interval and the sex of the child.

Migration is not a specified category of analysis and in this sense the material provided in this chapter builds upon and is additional to that provided in the NFHS reports. The latest report notes that there is a significant rural-urban differential in the mortality figures, with neonatal, post-neonatal and child mortality figures for rural areas all being higher by 12%, 33% and 69% respectively, compared to the urban figures. With the exception of child mortality figures, all mortality rates are higher (by 22%) for Hindus than for Muslims (ibid, 121). All mortality figures are high for children born with a birth interval of less than 24 months and for children of very young and older mothers (taken to be at the ages of 15 years and 49 years respectively).

Of further relevance to this paper is the observation of the report that children in households of low standards of living have twice as high rates of infant and child mortality than children living in households of higher economic standards. In general, child mortality is found to be inversely related to socioeconomic status (for example, Dasgupta, 1997). Socioeconomic factors may thus negate the effects of migration. Stephenson, Mathews and Macdonald (2003), for example, found this to be the case in their statistical survey of the NFHS (1991/1992) data on the impact of rural-urban migration for under 2 child mortality in India.

The NFHS-2 figures and studies based on it are a useful guide to understanding the scale of mortality and poverty-related trends which define the region of Rajasthan, the focus of this chapter. However, the NFHS reports are too general, as they lack district-level information (Bose, 2006), and along with similar statistical tabulations are often insufficient in explaining the reasons underlying the figures that are presented or the direction of causality. So, for example, while short birth intervals are connected to higher child loss, it is not clear whether they act as cause or effect. In fact, as Dasgupta (1997) shows for rural Punjab, and the material in this chapter also suggests, short birth intervals are caused by child loss rather than a reason for their occurrence. This is because, 'those who have lost children are pushed into more stressful reproductive cycles of shorter birth intervals and higher fertility' (1997:201).

The NFHS studies are also unable to convey a sense of scale regarding the morbidities (illness which has the potential of resulting in death) affecting the wider population, or how such morbidities are perceived, experienced, negotiated and shift with migration. The work presented in the following sections is an attempt to redress these gaps by focusing on migrant perceptions, and is based on detailed personal accounts of residents of a basti (slum) in Jaipur city, the capital of Rajasthan. Child health is approached in terms of women's experiences of migration and its impact on the birthing and nurturing of their children. To my knowledge this perspective has not been undertaken before. The advantages of anemic-based, interpretive, anthropological approach, focussing on differently positioned women's perceptions of migration, are that it enables announced understanding of the diverse meanings associated with mobility and with health as embodied and lived experiences.

RADIATION AND HEALTH

It was noted earlier that radiation can produce biological effects. Around the turn of the century a number of experiments were carried out, which, would be characterized today as dangerous and foolhardy. It was found that ionizing radiation

was capable of developing skin burns and could cause hair to fall out. In 1899, Stenbeck and Sjögren from Sweden used radiation to remove a tumor from the nose of a patient. This showed that radiation in large doses could be used to kill cancer cells.

In the early years, when radium was used for treatment, the sources were made in the form of capsules or small tubes. The procedure for radium treatment was either to use a large source of radium (teletherapy) or to use a number of small sources for brachytherapy. In the latter case, paraffin wax was often used and formed to suit the part of the body to be irradiated. Small needles of radium were then sealed into the wax. This procedure gave a good dose distribution when skin ailments and tumors were treated. The general view at that time was that the radiation from radioactive sources was healthy and was a good treatment for most sufferings. Figure 10.1 (next page) shows an advertisement from 1913. Some people made good money by producing radioactive drinking water. A number of small towns in middle Europe such as Badgastein, Baden-Baden, Marienbad, and Karlovy Vary had radioactivity in their water and were considered to be healthy places.

With the use of a jar and some radium salt, the water was saturated with radon when radium disintegrated. The belief was that by drinking this water you received “curative” radioactivity. In those days, like today, some people voluntarily tried out methods that had not been tested or proved effective.

In the early years, people were careless in the use of radiation and the handling of radioactive sources. The reason for this negligence was a lack of knowledge about radiation and its biological effects.

Today, there is great deal of information about the effects of ionizing radiation, a great contrast to the lack of knowledge about the many chemicals in use. However, researchers in the radiation field have not been able to transmit this information to the public. The result is that the public has only an incomplete

knowledge about radiation and radiation health effects. In spite of the fact that other human activities are far more hazardous than radiation, many people are unnecessarily afraid.

Because large doses of radiation are known to kill cells, there is the possibilty of using radiation to treat cancer when localized to a small area of the body. Similar large whole-body doses can lead to death, which occurs in the course of days or weeks.

When considering medium and small doses, the biological effect is considerably more difficult to predict. The reason for this is the time lag between the exposure and the observable biological effect. For solid cancers it may be several decades. Marie Curie, and a number of the other radiation pioneers died from cancer; thus, there are reasons to believe that their work with radiation was involved. On the other hand, recent experiments have claimed that small doses may even have a positive health effect.

In all discussions on the biological effects of radiation, the radiation dose is a key issue. Without knowledge about the size of the dose it is meaningless to discuss the effects. The relationship between the dose and effect is also a hot issue in the community of research scientists. Knowledge about the dose–effect curve is a requirement when discussing mechanisms and health risks of radiation.

Dose–Effect Curves

The effect of radiation depends upon the dose. The larger the dose, the larger the effect. This relationship is called the *dose–effect curve* and may be demonstrated with a simple example.

When using an ordinary camera, you know that it is important that the film be exposed to the right amount of light. When exposed to a lot of light, the film becomes black, and when exposed to very little light,the film is hardly darkened.

The blackening of the film depends on the amount of light (i.e. the dose).

THE AMOUNT OF LIGHT WHICH YIELDS THE BEST

In work with radiation and biological effects, the results are often given by such dose–effect curves. In radiobiology a lot of interest is concentrated on the form of dose–effect curves and, in particular, the form of the curves at small doses. Small doses will be discussed in the next chapter; here the discussion will deal with the effect of large doses.

What is a Large Dose?

In a discussion about the biological or health effects of radiation, the equivalent dose unit, the sievert, is often used. Again, the equivalent dose (Sv) is equal to the physical dose (Gy) multiplied by a radiation weighting factor (w_R). In the case of x- and ã-rays the weighting factor is 1. The dose in gray and the equivalent dose in sievert have the same value. However, in the case of radon and its daughter products which emit á-particles, a radiation weighting factor of 20 is used. Neutrons and other high energy particles have weighting factors larger than 1.

The large dose region can be characterized in the following way:

A dose of more than 1 to 2 Gy is considered to be large and a dose smaller than 0.1 to 0.2 Gy (100 to 200 mGy) is considered to be small.

Annual doses of 2 mGy to 5 mGy (such as those attained from natural background radiation) are considered to be very small.

The Use of Large Doses

Large radiation doses are used for:

Sterilization of medical equipment

Co-60 and Cs-137 ã-radiation are used to sterilize medical equipment. The doses delivered are on the order of 20 to 40 kGy. The purpose of the radiation is to kill bacteria, viruses, and fungi that contaminate equipment.

Radiation of food products

The purpose is almost the same as for sterilizing equipment. The doses are, however, smaller, on the order of 5 to 10 kGy. Larger doses may change the taste of certain foods.

Radiation therapy

In the radiation treatment of cancer, the purpose is to kill the cancer cells while allowing nearby healthy cells to survive. Much effort is carried out to achieve treatment protocols that will give the most effective treatments. The total dose given to a tumor is 10 to 80 Gy. A treatment protocol may include daily doses of 2 Gy, given 5 days per week. The type of radiation is usually in the form of high energy x-rays from linear accelerators (energies up to 30 MeV) which yield suitable depth dose curves. It is also possible to use electron irradiation but the dosimetry becomes more complicated. The treatment is more effective when the radiation dose is split up into a number of smaller doses rather than giving the same total dose all at once.

The "fractioned dose treatment protocol" has the advantage of partly solving the problems with hypoxic cells in a tumor. Experience has shown that fractionated dose treatment yields the best results for tumor destruction while minimizing damage to healthy tissue.

Bone marrow transplantation

In combination with bone marrow transplantation which is used for the treatment of certain illnesses, whole-body radiation is sometimes used with chemotherapy to deplete the original bone marrow. The dose used is about 12 Gy (6 days with a daily dose of 2 Gy). This dose is sufficient to completely destroy the bone marrow and would kill the patient if it were not for the immediate transplant of new compatible bone marrow. A number of people have been treated in this way.

LD_{50} Dose

By definition, an LD_{50} dose (abbreviation for "Lethal Dose to 50 percent") is the dose that could kill 50 percent of the individuals exposed within 30 days. To arrive at a determination of the LD_{50} dose, experiments like the following must be carried out. In typical experiments, rats, about 15 animals in each

group, were given different whole-body doses. The number of animals dying in the course of 30 days was observed for each group.

The dose is given along the horizontal axis and the number of animals dying (in percent for each group) is given along the vertical axis. The results show that no animals survived a dose of 10 Gy, whereas all rats survived a dose of 5 Gy. It can be seen that the LD_{50} dose is approximately 7.5 Gy. When humans and animals are irradiated, the blood-forming organs (in the bone marrow) will be the first to react. For doses of the order 1 to 2 Gy the number of white and red blood cells will decrease as shown in Figure 10.4. As a result of this, the immune system will fail and, after one to two weeks, life threatening infections may occur. If the radiation doses are smaller than 4 to 5 Gy, there is a good chance the bone marrow will recover and resume the production of blood cells. This takes place after 3 to 4 weeks and, consequently, 30 days is a reasonably chosen limit for the name *acute radiation death*. Single cell organisms (for example bacteria, paramecium, etc.) may survive doses of the order 2,000 to 3,000 Gy. (This is taken into consideration in radiation treatment of food).

In the case of humans there is not enough information to determine a precise LD_{50} dose. The only information available has come from radiation accidents and the lethality depends not only on the dose and dose rate but also the post-exposure treatment given to the victims.

Acute Radiation Sickness

In 1906, Bergonie and Tribondeau found that there were different radiation sensitivities for different types of mammalian cells. Cells which grow rapidly (high mitotic rate), as well as undifferentiated cells, are the most sensitive. This implies that bone marrow, testes, ovaries and epithelial tissue are more sensitive than liver, kidney, muscles, brain and bone. Knowledge about this is of great importance for those exposed to ionizing radiation. The bone marrow and the epithelial cells of the intestine and the stomach as well as the gonads, the lymphocytes and skin develop the greatest damage. Damage to the bone marrow is the cause of death for whole-body doses in the region

3 to 10 Gy, whereas damage to the epithelial cells of the stomach and intestine is the cause of death for doses in the range from 10 to 100 Gy. For large doses, above100 Gy, damage to the central nervous system causes death.

Hematopoietic syndrome

As mentioned above, the failure of the bone marrow is the cause of death for whole-body doses in the range of 3 to 10 Gy. The radiation may either kill these cells or arrest their development. A dose of 5 Gy will kill about 99% of the hematopoietic stem cells in mice. These stem cells are necessary for the production of circulating blood cells (erythrocytes, granulocytes and platelets). A reduction of these cells will result in anemia, bleeding and infections. The first sign of such radiation sickness is nausea, vomiting and diarrhea. This situation may disappear after a couple of days. Then, the consequences of lost blood cells become evident. Again, significant diarrhea may take place, often bloody, and a fluid imbalance may occur. This, together with bleeding, occurs in all organs. In addition, if infections occur, death may take place in the course of a few weeks.

Gastrointestinal syndrome

For whole body doses of 10 to 100 Gy, the survival time is rarely more than one week. Damage to the epithelium of the intestine results in significant infections from the bacteria in the intestine itself. The production of blood cells is almost completely stopped, and those remaining in the blood disappear in the course of a few days. After 2 to 3 days almost all granulocytes will have disappeared from the circulation. The symptoms are pain in the stomach and intestine, nausea, vomiting and increasing diarrhea. A considerable loss of liquids and electrolytes will change the blood serum composition. There is an increased chance of infections.

Central nervous system syndrome

For radiation doses above 100 Gy, the majority may die within 48 hours as the result of the central nervous system syndrome. The symptoms are irritability and hyperactive responses (almost like epileptic attacks) which are followed

rapidly by fatigue, vomiting and diarrhea. The ability to coordinate motion is lost and shivering occurs followed by coma. Then respiratory problems occur which eventually lead to death. The symptoms described are due to damage to the brain, nerve cells and blood vessels. Immediately, permeability changes take place in the blood vessels resulting in changes in the electrolyte balance. The loss of liquid from the blood vessels leads to increased pressure in the brain. It is possible that the respiration center in the brain is particularly damaged. Autopsies have shown that some animals die without visible damage to the brain.

A radiation accident

In September 1982 a fatal radiation accident occured in a laboratory for radiation-induced sterilization of medical equipment in Norway. An employee was exposed to a large ã-dose. He was the only person at work when the accident happened. A coincidence of technical failures with a safety lock and an alarm light, together with neglect of the safety routines, resulted in the fact that he entered the room with the source in the exposure position. The drawing below shows the radiation facility. The source is Co-60 with an activity of 2430 TBq.

DOSE DETERMINATION AND RADIATION ACCIDENTS

It is a great challenge to determine the doses in radiation accidents. The reason is obvious because accidents take place without warning and mainly without adequate equipment for dose determination. Radiation workers usually have a dosimeter and, in the accident described above, the employees used film dosimeters. The film can be used for doses up to about 1 Gy but is not applicable for fatal or near fatal doses. Below, we demonstrate how the radiation dose was determined for this accident.

STRATEGIC RESPONSES TO THE ENVIRONMENTAL CHALLENGE

Given the internal and external demands to improve the environmental performance of a company, those companies that achieve high standards of environmental performance will benefit in a number of ways. Many of these benefits are directly related to cost reduction and as such are not inconsistent

with principles of profit maximization. But those benefits also reflect a more ethical approach to business where profits will not be the sole motivation and where due care and responsibility towards the environment are integral parts of doing business. In order to realize a competitive advantage based on environmental management, companies must seek to develop strategies which translate actions into benefits, improving their environmental performance and addressing the environmental demands placed upon them by government and stakeholders.

By incorporating the increasingly important environmental dimension into the decision-making processes and strategies of the firm, managers can seek to reduce costs and exploit the opportunities offered by increased public environmental concern within a dynamic market-place. Such a strategy must be proactive and honest.

It may also be evangelical, educating and campaigning. But more than anything it must be ethical. The environment is too important an issue to be treated as a gimmick for short-term advantage. The general principles of such a strategy are embodied within the International Chamber of Commerce's *Business Charter for Sustainable Development.* The key elements to this strategy are embodied in sixteen 'Principles for Environmental Management'. Companies are therefore encouraged to endorse the following aims:

1. Corporate priority: To recognize environmental management as among the highest corporate priorities and as a key determinant to sustainable development; to establish policies, programmes and practices for conducting operations in an environmentally sound manner.
2. Integrated management: To integrate these policies, programmes and practices fully into each business as an essential element of management in all its functions.
3. Process of improvement: To continue to improve corporate policies, programmes and environmental performance, taking into account technical developments, scientific understanding, consumer needs and community expectations, with legal regulations as

a starting point; and to apply the same environmental criteria internationally.

4. Employee education: To educate, train and motivate employees to conduct their activities in an environmentally responsible manner.
5. Prior assessment: To assess environmental impacts before starting a new activity or project and before decommissioning a facility or leaving a site.
6. Products and services: To develop and provide products and services that have no undue environmental impact and are safe in their intended use, that are efficient in their consumption of energy and natural resources, and that can be recycled, reused, or disposed of safely.
7. Customer advice: To advise, and where relevant educate, customers, distributors and the public in the safe use, transportation, storage and disposal of products provided; and to apply similar considerations to the provision of services.
8. Facilities and operations: To develop, design and operate facilities and conduct activities taking into consideration the efficient use of energy and raw materials, the sustainable use of renewable resources, the minimisation of adverse environmental impact and waste generation, and the safe and responsible disposal of residual wastes.
9. Research: To conduct or support research on the environmental impacts of raw materials, products, processes, emissions and wastes associated with the enterprise and on the means of minimising such adverse impacts.
10. Precautionary approach: To modify the manufacture, marketing or use of products or services to the conduct of activities, consistent with scientific and technical understanding, to prevent serious or irreversible environmental degradation.
11. Contractors and suppliers: To promote the adoption of these principles by contractors acting on behalf of the enterprise, encouraging and, where appropriate, requiring improvements in their practices to make them

consistent with those of the enterprise; and to encourage the wider adoption of these principles by suppliers.

12. Emergency preparedness: To develop and maintain, where appropriate hazards exist, emergency preparedness plans in conjunction with the emergency services, relevant authorities and the local community, recognising potential cross-boundary impacts.
13. Transfer of technology: To contribute to the transfer of environmentally sound technology and management methods throughout the industrial and public sectors.
14. Contributing to the common effort: To contribute to the development of public policy and to business, governmental and intergovernmental programmes and educational initiatives that will enhance environmental awareness and protection.
15. Compliance and reporting: To measure environmental performance; to conduct regular environmental audits and assessments of compliance with company requirements and these principles; and periodically to provide appropriate information to the Board of Directors, shareholders, employees, the authorities and the public.

The key to environmental strategy must be integration. This is not only reflected in the ICC Charter but is also implicit in the Environmental Protection Act (1990) in the UK and within the EC's Fifth Environmental Action Programme. This common element of integration implies that a firm must examine every aspect of its environmental performance.