



ENVIRONMENTAL HEALTH PROJECT

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PREVENTION:
Environmental Health Interventions
to Sustain Child Survival

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PREFACE

In the last year, the Environmental Health Project (EHP) has been working under the direction of the Office of Health and Nutrition to articulate the new role of environment-related prevention in promoting Child Survival. The following are among the questions that must be considered: What is meant by “prevention” in an environmental health context? How can environment-related preventive activities complement and strengthen the current array of Child Survival preventive activities, such as immunization and nutritional supplementation? Are environment-related preventive interventions intrinsically more expensive than curative therapies? And what is the evidence for their effectiveness?

This concept paper begins to address those questions. Currently most Child Survival programs emphasize case management. This paper outlines a wellness paradigm, advocating the incorporation into such programs of interventions that would be put in place before the child becomes sick, that would prevent disease by protecting the child from the agents of disease.

The concept is presented visually in a framework diagram in Chapter 3. This framework is not meant to be rigid. Rather it is presented as a work-in-progress that is intended to stimulate discussion and debate. A principal gap is the absence of any real consideration of the role of policy and institutional behavior change in prevention. The concept and framework will be developed further in the coming years as EHP benefits from collegial feedback and implements preventive approaches with developing country partners.

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EXECUTIVE SUMMARY

This concept paper advocates a paradigm shift in Child Survival from an exclusive focus on case management and facility-based service to include a focus on environmentally based prevention, particularly on the household and community level. Such a shift in paradigm could be made incrementally as preventive interventions are integrated with Child Survival programs.

The USAID approach to Child Survival, which stressed childhood immunizable diseases and the treatment of diarrhea through oral rehydration, has undoubtedly contributed to the substantial decline in infant and childhood mortality globally in the last twenty years. However, today many fear that a ceiling has been reached with regard to Child Survival successes. Because Child Survival interventions were designed to cure children of illnesses, not to prevent the onset of illness, the burden on the health care system has not declined. Fewer resources are available globally, and at the same time national Child Survival programs have not become less expensive, as originally envisioned.

In recent years, integrated case management was introduced to overcome some of the limitations of Child Survival programs, but by definition it did not change their essentially curative nature. A purely curative approach is not as effective as eliminating the problem through prevention. But, to be effective, preventive interventions need to be closely integrated with case management.

This paper presents a conceptual framework for how such integration might be achieved. The framework is based on an understanding of the epidemiological pathway to illness beginning with a disease agent (such as a bacterium) or a vector (such as a mosquito) and moving through three stages: (1) breeding, multiplication, and production, (2) transmission or emission, and (3) exposure. In environmental health terms, "primary prevention" consists of interventions that block this pathway to illness, that prevent the disease agent from infecting the child. The framework lists representative community and household-based interventions to block or inhibit each of the three stages to illness. For example, excreta disposal effectively inhibits the *breeding and multiplication* of diarrheal-causing bacteria; handwashing interrupts *transmission* of the offending bacteria (if measures to inhibit breeding and multiplication are not complete); and purification of drinking water, perhaps through adding chlorine, reduces *exposure* (if measures to inhibit breeding and to interrupt transmission are not complete). All three provide a higher level of risk reduction.

The diseases considered in the framework are the three childhood diseases with environmental links and significance for promoting child survival: diarrheal disease, malaria, and acute respiratory infection (ARI). For each the paper discusses the range of household and community-level environmental health interventions and presents the evidence for their effectiveness in the technical literature. Interventions for diarrhea prevention include excreta containment and treatment, food safety and

hygiene, water source protection and handling, and personal and domestic hygiene; those for malaria prevention include land use and management, residual spraying, surveillance, personal protection, larvicides, source reduction, and malaria health education; those for ARI include substitution of biomass fuels, use of fuel-efficient stoves, and improved household ventilation.

The key to incorporating environmental health in primary health care and Child Survival is to develop partnerships with non-health sectors. For example, the health, agriculture, education, public works and housing sectors and the private sector can be involved in diarrheal disease control: agriculture through food safety, education through school programs in hygiene, public works and housing through construction of excreta disposal and treatment systems, and the private sector through manufacturing inexpensive, safe water storage containers.

The health sector should not see the construction of physical infrastructure as a primary preventive intervention. Promoting hygiene behaviors that yield more effective utilization of infrastructure, however, is part of primary prevention. Strategies that improve household food handling and preparation, designs to maximize latrine utilization by all household members, and simple handwashing campaigns are well within the purview of the health care system.

The current generation of USAID-funded facility-based Child Survival projects generally do not include the type of preventive activities discussed in this document, but it would not be difficult to add a prevention component to existing projects in selected sites. This component could be a package of preventive interventions that are consistent with the goals of the existing project. Implementation could take place in four phases. The first phase is site selection and introduction of the concept of primary prevention. In this phase, partners and intervention areas are identified, district staff are oriented, and target communities are selected. The second phase is health problem identification: health profiles of the communities are prepared and presented to the communities, followed by a community self-assessment of priority health problems. The third phase is selecting and testing interventions: environmental and behavioral hazards causing the health problems are identified, options for removing or reducing the hazards are discussed, and interventions are chosen, assessed as to their economic feasibility, and tested. In the final phase, evaluation and replication, the community evaluates the effectiveness of the intervention and disseminates the results.

The strategies for integration and implementation put forward are meant to be flexible and adapted to particular circumstances.

The goal of this paper will be achieved if USAID mission personnel are persuaded that primary prevention presents an opportunity for USAID to make a larger impact on the serious, and in some regions, growing, health problems of children.

INTRODUCTION

1

USAID and others in the development community can be justly proud of the accomplishments of Child Survival. In just over a generation, infant mortality rates have been brought down significantly in all regions. This paper argues that a change in the Child Survival paradigm, from a focus on case management and facility-based services to a focus on household and community-level environmentally based prevention, will make it possible for Child Survival programs to achieve better, more sustainable results. Shifting to a focus on prevention brings about a corresponding shift of focus from mortality to morbidity. The new Child Survival paradigm proposed in this paper seeks to promote wellness, to put in place environmental barriers to protect children from the repeated bouts of illness that jeopardize their full development.

The paradigm shift calls for a broader concept of prevention and an expansion of activities outside the health sector so that other sectors, private enterprise, and community members work together to achieve Child Survival goals. The paradigm shift is not suggested as a way to substitute one set of Child Survival interventions for another. Rather, its aim is to add preventive interventions to current or planned Child Survival programs as a way to strengthen those programs. The key is for health workers to be alert to opportunities for collaboration with other sectors and with private enterprise and to help communities move from passively accepting conditions that affect their health to taking action to change them.

The paper suggests that the paradigm shift be made incrementally, that appropriate “packages” of preventive activities be added as components to existing Child Survival programs in a few countries on a trial basis. Many suggestions of the types of interventions envisioned are given in this paper, but the precise packages depend on the locale and available resources. Some interventions call for introducing new “technologies,” such as water storage containers, but virtually all necessitate changes in behavior.

This paper is divided into six sections in addition to this introduction. Section two reviews the history of primary health care, its evolution into Child Survival, the successes and limitations of Child Survival, the advent of integrated case management, and the need to add prevention to the Sick Child Initiative. Section three provides a conceptual framework for understanding environmentally based prevention. The next three sections focus on the three major Child Survival diseases—diarrhea, malaria, and acute respiratory infection or ARI—and suggest specific environmental health interventions that can be integrated into current Child Survival programs. What is known from the literature regarding the effectiveness of these measures is summarized, and ideas are provided as to how the measures can be packaged. Section seven discusses methods for integrating environmental health interventions into Child Survival programming.

The new Child Survival paradigm seeks to promote wellness, to put in place environmental barriers to protect children from the repeated bouts of illness that jeopardize their full development.

Virtually all preventive interventions necessitate changes in behavior.

A BRIEF REVIEW OF CHILD SURVIVAL

2

2.1 The Child Survival Initiative

Prior to the 1980s, international assistance for health tended to be dispersed across a wide range of ages, diseases, and levels of clinical care, with considerable emphasis on health infrastructure. During the 1980s, primary health care as proposed at the Alma Ata conference (WHO 1978), and the concept of epidemiologic targeting (Walsh and Warren 1979) led health professionals to a greater concern about cost-effectiveness and to a new strategy of targeting a few diseases which were responsible for a high percentage of mortality (and morbidity) and for which effective prevention/treatment measures existed. Moreover, health resources were increasingly directed to children and infants because of the disproportionately high mortality rates among this age group and the potential for a significant impact on life expectancy.

USAID developed a “twin-engine” approach to Child Survival through the REACH (Resources for Child Health) and PRITECH (Technology for Primary Health Care) projects, which addressed childhood immunizable diseases (polio, diphtheria, tetanus, pertussis, measles, and tuberculosis) and diarrhea (through oral rehydration therapy—ORT), respectively.

Among the successes enjoyed by the focused approach were substantial declines in infant and childhood mortality globally. For example, by the end of the 1980s, the infant mortality rate had decreased from 62 to 15 in Europe, from 126 to 63 in Latin America, from 187 to 116 in Africa, and from 189 to 113 in South Asia (Roemer and Roemer 1990; UNICEF 1991). Additionally health infrastructure in many countries improved substantially, and an awareness of the importance of behavior change on the part of both health care providers and mothers also emerged.

The vertical programs that evolved through the twin-engine approach allowed countries to concentrate on specific aspects of a problem. By taking small bites, countries were able to make and track progress and to save health care workers from becoming overextended. Along the same lines, the focused approach generated inter- and intracountry longitudinal and cross-sectional surveys which made it possible for health professionals to identify and monitor key diseases more effectively.

The focused approach has its limitations, however, primarily related to the vertical nature of the Child Survival Initiative. Addressing one problem at a time means that vital opportunities to treat the whole child may be missed. Thus, a child presenting with ARI may not be assessed as to his or her immunization status or increased risk of malnutrition as a result of repeated bouts of diarrheal disease. Also, vertical programs encourage redundancy and are expensive to maintain. In many countries, Child Survival programs are vertical at the top but functionally integrated at the field level. While such functional integration has many advantages, it is achieved by leaving important decisions regarding prioritization to a single health care worker with little or no training in the integration of activities.

The vertical programs that evolved through the twin-engine approach to child survival allowed countries to concentrate on specific aspects of a problem. However, addressing one problem at a time means that vital opportunities to treat the whole child may be missed.

In spite of global improvements in health, the disparities between the wealthier and the less-developed nations have actually increased in the past three decades.

With a global reduction of available resources, many observers fear that a ceiling has been reached with regard to Child Survival successes. National Child Survival programs have not become less expensive over time, as originally envisioned. Because Child Survival efforts were designed to cure children of one or more illnesses, not to prevent the onset of illness, the burden on the health care system has not declined (Okun 1987; 1988). Resources needed to maintain the status quo for diseases targeted in Child Survival cannot be rechanneled to new programs addressing emerging health problems. Of even greater concern is the possibility that with fewer resources available globally, we may lose the gains already made in reducing infant and childhood mortality rates. Finally, there is substantial evidence that in spite of global improvements in health, the disparities between the wealthier and the less-developed nations have actually increased in the past three decades. In 1960, there was a tenfold difference in the mortality rates for under-fives in countries in the highest and lowest quartiles; by 1989, this disparity had doubled (Stanton 1994).

2.2 Integrating Case Management Strategies

In an attempt to maintain the substantial benefits of a focused case management approach and to overcome some recognized limitations, health professionals began to experiment cautiously with selective integration of case management strategies. Programs formerly targeting single diseases began to focus on disease complexes. Thus, for example, PRITECH, which originally focused on case management of diarrhea, added malnutrition and some ARI activity to its portfolio of programs. Likewise, some prevention activities were incorporated into case management; under the direction of PRITECH, several Sahelian countries incorporated basic food hygiene education into their diarrhea case management strategies.

The success of these efforts encouraged the current, more complex integration efforts. For example, under the leadership of the World Health Organization (WHO), health professionals have developed an integrated approach to the five major causes of infant and childhood mortality: diarrhea, ARI, measles, malnutrition, and malaria. This approach culminated in the algorithm of the “Sick Child” Initiative. The importance of such integrated efforts was echoed in the World Bank’s 1993 *World Development Report (Investing in Health)*, which identified integrated management of childhood illness is one of the most cost-effective public health actions. Consistent with these efforts was USAID’s amalgamation in 1993 of its diarrhea, immunization, ARI, and health education programs (PRITECH, REACH, HEALTHCOM—Communications for Child Survival) into a single new project: BASICS (Basic Support for Institutionalizing Child Survival). BASICS expanded the Sick Child algorithm to include case management within the household in its Integrated Childhood Illness Management strategy.

2.3 Prevention: The Missing Element of Integrated Case Management

Integrated case management was intended to bring about a further decline in mortality but did not necessarily address the sustainability issue. A purely curative approach, by “chasing” the problem, is not as effective as eliminating the problem. Thus, even as these expanded case management algorithms were being developed, their architects

Integrated management of childhood illness is one of the most cost-effective public health actions, according to World Bank, WHO, and USAID policy planners.

A purely curative approach is not as effective as eliminating the problem.

were aware of the need for a more formalized integration of prevention into the efforts. The impulse to look towards “prevention” is time-honored. But, to be effective and to lower overall health care costs, it is probable that preventive interventions will need to be more closely integrated with case management and to take place both within and outside of the health sector.

Integrated Childhood Illness Management views case management from the perspective of the individual patient, not of the whole population. The individual patient perspective tends to view environmental conditions within the context of existing (or absent) health infrastructure, as risk or protective factors that either facilitate or impede the child’s “pathway to health.” That is, existing services and certain practices and customs may help the patient maintain good health (including facilitating the child’s access to health care), while others or the absence of certain infrastructure or resources may hinder the child’s growth and development. By contrast, a public health model is primarily concerned with the environment (both physical and behavioral) and existing infrastructure and resources. Specific services and specific individuals are important in their relative contribution to this system (components that make the system more “cost-effective” as measured by decreased rates of morbidity/mortality, etc.). These two perspectives differ, but both are necessary to health planning and should be closely integrated.

How can this be done? How can the population-based perspective (the physical and behavioral conditions within the household and community) be integrated with individual-based case management? The answer is by promoting packages of interventions which include both population-based preventive measures and integrated case management.

Case management (of the individual patient) and the public health model are two differing perspectives, but both are necessary to health planning and should be closely integrated.

CONCEPTUAL FRAMEWORK FOR INTERVENTIONS

3

To understand the conceptual framework for environmental health interventions, it is necessary to make a distinction between the conventional primary health care definition of “prevention” and the broader environmental health definition of the term.

Environmental health departs from the conventional definitions of *primary*, *secondary*, and *tertiary* prevention. The classic epidemiological interpretation includes, under *primary prevention*, measures to maintain good nutrition, physical fitness, emotional well-being, and a safe environment, as well as immunization against infectious diseases. *Secondary prevention* consists of early detection and treatment of conditions that cause ill health, to decrease the prevalence of disease. *Tertiary prevention* aims to limit and reduce the complications of illness, extending into the field of rehabilitation (Lash 1988).

The environmental approach to prevention put forward in this paper places more emphasis on preventing the initial occurrence of disease. Thus, *primary preventive* interventions are those that block the generation and transmission of and human contact with the agents, vectors, or risk factors associated with illnesses (e.g., pathogens, vectors carrying pathogens, or pollutants). *Secondary prevention* consists of measures that increase host resistance, to reduce the chance of developing clinical illness once the human host comes in contact with the offending disease agent, vector, or factor. *Tertiary prevention* focuses on treatment, pre-clinical or clinical, once disease has occurred, to prevent morbidity.

Currently Child Survival programs focus principally on mortality. Prevention from the primary health care perspective is limited to immunization, improved nutrition and the provision of micronutrients, promotion of breastfeeding, and measures to decrease low birth weight, including birth spacing. These strategies all are intended to increase the ability of the host to resist infection once exposure has occurred, but they do not attempt to address the environmental determinants of ill health.

The conceptual framework for environmental health interventions is shown graphically in Figure 1. The top bar is based on the epidemiological pathway to illness in which disease agents (such as bacteria), vectors (such as mosquitos), or risk factors (such as polluted air) first are generated or bred, then are transmitted or emitted, and finally reach a host.

Prevention, in environmental health terms, consists of interventions to promote wellness by *inhibiting* the generation and *interrupting* the transmission of disease agents and by *reducing* people’s exposure to them. Representative interventions for each stage of the pathway are listed. Note that the *primary* prevention interventions, i.e., those on the three panels, are all community- or household-based. They consist of low-cost technologies and behavioral change approaches. Wellness can be achieved

The continuum of primary, secondary, and tertiary prevention, as defined in the environmental approach, begins with household and community efforts.

Figure 1

Prevention Preserves Wellness

Environmental Pathways to Child Survival and Maternal Health

Preventing Diarrheal Disease

Inhibiting Generation of Disease Agents

- Proper maintenance of water supplies
- Protection of food supply
- Proper food storage
- Excreta disposal



Interrupting Transmission of Disease Agents

- Protection of drinking water
- Disposal of food that might be contaminated
- Handwashing
- Reduction of solid waste transmission
- Corraling livestock to limit transmission
- Reduction of fly breeding sites



Reducing Exposure to Disease Agents

- Purification of drinking water
- Proper cooking: time & temperature
- Proper infant feeding practices
- Personal protection: wearing shoes

Preventing Malaria

- Application of larvicides
- Reduction of breeding sites
- Appropriate agricultural practices
- Proper maintenance of water supplies



- Vector diversion
- Residual spraying
- Surveillance/early treatment to reduce disease reservoir

- Domestic protection: screening
- Personal protection: bednets, protective clothes, insect repellents

Preventing Acute Respiratory Infection (ARI)

- Use cleaner fuels
- Reduce burning of solid waste
- Reduce agricultural burning

- Improve household ventilation
- Use of efficient, vented household stoves
- Street sweeping

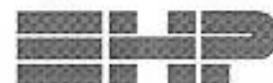


- Reduce activity on high pollution days
- Move cooking fires outdoors
- Keep children away from smoky cooking stoves

This chart illustrates environmental health contributions to an integrated approach to child and maternal health. Other components include:

- Immunizations
- Oral rehydration
- Breastfeeding
- Safe delivery
- Birth spacing
- Micronutrients
- Prompt diagnosis and treatment

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by combining preventive interventions that seek to interrupt the environmental pathways to disease and those that strengthen the host. Said another way, Child Survival programs could be strengthened by incorporating environment-based primary preventive activities.

Figure 1 provides a framework for the wellness paradigm, but it is only a starting point. As the framework is elaborated in various developing country settings and tailored to local needs, missing elements will be incorporated. For example, the lists of representative interventions could be fleshed out to include problems associated with heavy metals or pesticides or municipal-level interventions, such as construction of wastewater systems or piped water. However, such problems and interventions were intentionally omitted in this version, which stresses low-cost household- and community-level interventions with proven effectiveness. Most important, as currently developed, the framework does not convey the important role of policy change and institutional capacity building in sustainable Child Survival.

Even considering its limitations, this new prevention, or “wellness,” paradigm suggests how environmental health strategies can be integrated with Child Survival to reduce the continuing costs of health care services incurred by facility-based secondary and tertiary preventive measures. Community- and household-generated measures that promote a cleaner environment and modify behaviors to diminish human contact with disease agents have a great potential for making Child Survival more sustainable. The new paradigm can be implemented by generating community collaboration to control environmental hazards and modify human interactions with environmental hazards. Further, community environmental health strategies can be packaged and implemented at low cost in concert with existing primary health care.

The priority areas proposed are those three childhood diseases that have environmental links: diarrheal diseases, malaria, and acute respiratory infections. In the next sections the effectiveness of environmental health interventions to address each of these diseases is discussed.

Community- and household-generated measures that promote a cleaner environment have a great potential for making Child Survival more sustainable.

DIARRHEAL DISEASE

4

4.1 Environmental Health Interventions

The proposed environmental health interventions to control diarrheal diseases do not necessarily involve infrastructure investments. Rather, they involve low-cost measures that communities and households can implement on their own. They may be thought of as the “software” that increases the efficiency and health impact of infrastructure investments.

4.1.1 Excreta Containment and Treatment

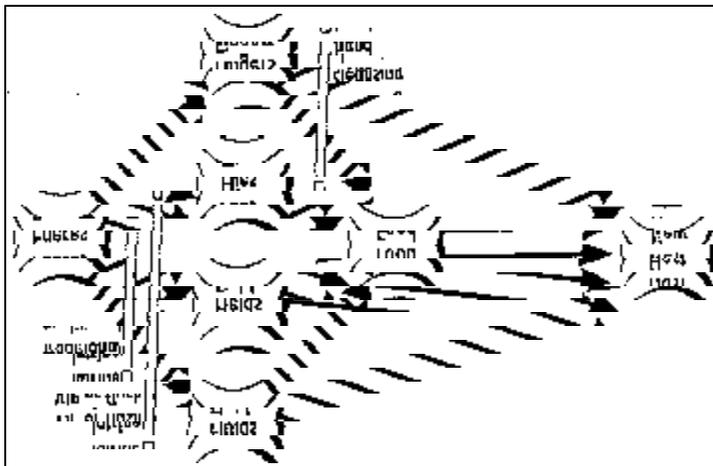
Excreta is the primary source of diarrheal disease agents, which are further transmitted through foods, fingers, fluids, and fields (night soil contamination of crops) (see Figure 2). The containment and treatment of excreta is therefore the best means to prevent diarrheal disease agents from proliferating and being transmitted. Children’s feces are often viewed as harmless even though they are highly contaminated. Therefore, educating caretakers in the safe disposal of children’s feces is critical in the prevention of diarrheal disease.

The appropriate use of excreta disposal systems is a more critical determinant of diarrheal disease transmission than water supply alone; furthermore, community-wide sanitation coverage is more important than individual household coverage. Without effective community-wide methods to contain excrement, the full health impacts of a plentiful water supply will not be appreciated (VanDerslice and Briscoe, 1995).

Preventive measures include the following:

Children’s feces are often viewed as harmless even though they are highly contaminated. Therefore, educating caretakers in the safe disposal of children’s feces is critical in the prevention of diarrheal disease.

Figure 2: Potential Barriers to Transmission of Disease from Excreta



Source: Wagner and Lanoix, 1958, modified by Winblad, 1993.

- Culturally appropriate excreta disposal containment systems. The design must be based on available resources (e.g., water), customs (e.g., anal cleansing habits), and consumer preferences to insure utilization by all community members.
- Child-friendly systems. Children commonly do not use latrines for fear of darkness, odors, falling in, and vectors. Construction of “pedi-pits” or potties without walls and with small holes can encourage use.

4.1.2 Food Safety and Hygiene

The Food Safety Unit of the World Health Organization estimated that up to 70% of childhood diarrheal episodes in developing countries are related to pathogens transmitted through food. Most of this transmission likely occurs within the home because it is there that most young children are fed and low incomes may limit the number of meals people take elsewhere (WHO Food Supply Unit 1993). Food has also been implicated as one of the transmission routes in the cholera epidemic in South and Central America (Tauxe 1992). While street vendors have played a role in the transmission of cholera among index cases, household food handlers may contribute to its spread within family units.

Foods can become contaminated and transmit illnesses within the household through multiple means. The sources and vehicles of contamination include nightsoil, polluted water, flies, pests, domestic animals, unclean utensils and pots, foodhandlers (e.g., soiled hands), dust, and dirt. Additionally, raw foods can be contaminated if they are derived from infected animals or, in the case of cholera, from fish and shellfish. Cross-contamination can also occur during food preparation and storage when raw foods come into contact with cooked products. Contaminants are difficult to control in settings where resources are limited.

Once contaminated, food left at ambient temperature for extended periods of time frequently serves as a culture medium allowing rapid multiplication of organisms in doses high enough to cause clinical illness. Children under five are the most vulnerable. Even when other measures are taken to diminish primary food contamination, control of cooking temperature and time during food preparation should be promoted as the most effective means of blocking foodborne disease transmission. Foods should be cooked at a sufficient temperature for a sufficient amount of time to kill offending bacteria.

Most of the measures listed below can be carried out within the household or compound.

- Protecting the food supply from contamination by
 - √ avoiding cross-contamination of raw foods with cooked foods,
 - √ use of safe water in food preparation, and
 - √ protecting foods from vectors (flies, pests, domestic animals).
- Preventing the multiplication of pathogens in food by
 - √ adequate holding temperature for foods and
 - √ use of effective food preservatives.

Foods can become contaminated and transmit illnesses within the household through multiple means. Contaminants are difficult to control in settings where resources are limited.

- Improving the hygiene (handwashing before food preparation) and cooking practices (use of clean cooking utensils) of food handlers.
- Reducing exposure to contaminated food products by
 - √ adequate cleaning of raw foods,
 - √ cooking food at a high enough temperature for a long enough time to kill disease agents, and
 - √ promotion of exclusive breastfeeding and the use of a cup and spoon for weaning infants.

4.1.3 Water Source Protection and Handling

Providing an adequate water supply (15-20 liters per capita per day) is generally outside the control of the health sector, and the rationale for direct subsidization of water supply by the health sector is weak. In most developing countries, the demand for water is high, as shown by the high prices the unserved poor pay to water vendors and by the less obvious hidden costs of time spent coping with low or nonexistent supply. In most circumstances, the primary constraints to improving water supply are not financial. Even among the poor, demand for the first 15-20 liters/day is high. The primary constraint is the lack of appropriate political, institutional, and managerial responses—already the subject of many water and sanitation programs.

Nonetheless, investment in demonstration hardware by the health sector could be cost-effective in terms of subsequent health outcomes. The cost effectiveness principle that should be followed in the public health sector is to ensure the proper utilization of existing and planned infrastructure so as to maximize health impact for a given outlay from health sector funds.

Water supply interventions have generally concentrated on providing either adequate *quantity* of water (thereby increasing personal and/or domestic hygiene) or adequate *quality* of water (thereby decreasing the likelihood of ingestion of pathogens). Relatively simple means are available on the community and household level to protect the safety of a water supply system:

- Protecting water sources through installation of fences and pump aprons, maintenance of proper drainage, well capping, and community maintenance.
- Safe water storage and handling practices, including use and proper maintenance of contamination-proof water storage containers and water-delivery mechanisms that reduce hand contact.
- Household level water disinfection with chlorine.

4.1.4 Personal and Domestic Hygiene

Hygiene is the safe handling of excreta, water, and food, as discussed above, plus personal and domestic hygiene.

In most developing countries, the poor pay high prices to water vendors as well as hidden costs of time spent coping with low or nonexistent supply.

Relatively simple measures can protect the quality of household and community water supplies.

Of the personal hygiene behaviors, handwashing is the most critical determinant of diarrheal diseases. Handwashing with soap or other abrasives at critical times can significantly decrease transmission.

Personal Hygiene. Of the personal hygiene behaviors, handwashing is the most critical determinant of diarrheal diseases. The use of soap has appeared as a significant determinant in the transmission of cholera as well (Quick et al. 1995). Hands are an important pathway for fecal-oral transmission (Aziz et al. 1981). The contamination points are contact with feces during defecation, handling children's feces, touching other contaminated hands, preparing or consuming foods with contaminated hands, and placing soiled hands in the mouth. Handwashing with soap or other abrasives at these critical times—after defecation, after handling children's feces, before preparing meals, and before consuming foods—can significantly decrease transmission of diarrheal diseases.

Domestic Hygiene. The proper disposal of organic and animal waste to diminish flies, which are potential vectors for diarrheal disease pathogens, is an important domestic hygiene intervention. Corraling animals outside domestic compounds to limit their ability to contaminate food and water supplies is also important. Coralling has the added advantage of providing a collection point for the safe containment and recycling of animal feces used for fuel or fertilizer.

4.2 Evidence of Effectiveness

4.2.1 Improved Water Supply

Esrey et al. (1985; 1991) reviewed 43 studies of the impact of water supply on diarrheal disease. Twenty-two studies reported a reduction in diarrheal disease morbidity from improved water supply, with a median reduction of 16%. In nine studies assessing the impact of water supply on mortality, small reductions were found for selected age groups (but not all). In studies reporting a positive health benefit, the water supply was piped into or near to the house, while in those finding no benefit, water was supplied through protected wells, tubewells, or standpipes.

Of the 16 studies assessing water *quality* alone, 10 found positive impacts on health, with a median reduction in disease prevalence of 17%. In areas with high fecal environmental contamination, there was little intervention impact from water supply, probably because in those areas water quality contributed minimally to a lessening of the total disease burden. Of the 15 studies assessing water *quantity* alone, 14 reported positive impacts, with a median reduction in disease prevalence of 27%. Quantity of water appears to be more important than quality (Esrey et al. 1985; 1991).

4.2.2 Improved Sanitation

In the same reviews Esrey found some reduction in diarrheal disease in 21 of 30 studies examining the impact of sanitation. The median reduction was 22%. Reductions were greatest for flush toilets, although pit latrines also had positive impacts. The introduction of proper sanitation was especially important among non-breastfed infants. The findings of subsequent studies have been consistent with Esrey's review. For example, Daniels et al. (1990) found a 24% reduction in diarrheal prevalence associated with latrines in Lesotho.

Published studies documented little impact from improved or increased water supply in areas with high fecal contamination.

4.2.3 Hygiene

The definition of “hygiene” has varied greatly among studies. Some have looked at “personal hygiene” (body, face, and/or hands), others at “domestic hygiene” (home, cleaning and eating utensils, floors), and still others at “food hygiene” (adequacy of cooking, cleanliness of cooking/serving utensils). Moreover, while a few studies have examined one behavior or only a single category of hygienic behavior, the majority have examined the effect of packages of hygiene interventions (Esrey et al. 1990; Stanton and Clemens 1987). Likewise, many hygiene interventions have been conducted in combination with water and/or sanitation interventions.

Handwashing Interventions. In the reviews by Esrey et al. (1985, 1990, 1991), six studies assessing hygiene interventions (with or without other components in the package) showed reduction in diarrheal disease prevalence, with a median reduction of 33%. Reductions in diarrheal diseases of 32-43% have been documented from improvements in personal hygiene behavior through handwashing with soap in a variety of settings: dysentery (genus *shigella*) by 35% and non-dysentery by 37% among all age groups in urban Bangladesh, diarrhea in day-care center children in the United States by 43%, and diarrhea during peak season among children under five in Guatemala by 32-36% (Feachem 1984). In the three studies assessing only handwashing (education and soap), the reduction ranged from 30% to 48% (Boot and Cairncross 1993). Using a pre/post assessment design, a study conducted in Indonesia reported an 89% reduction in diarrheal episodes (Wilson et al. 1991). Few studies have assessed the sustainability of either the improved behavior or the effect of the behavior on diarrheal rates after the intervention. One small handwashing intervention conducted among 65 women in Indonesia found that two years after the intervention ended, 79% of the women were still using soap for handwashing (Wilson and Chandler 1993).

Food Hygiene Interventions. While it is estimated that food-borne pathogens may account for 15 to 70% of diarrhea disease incidence, data examining the association between contaminated food products and diarrhea are mixed due to a number of study design issues (Esrey and Feachem 1989). Because there are multiple routes of transmission, it is difficult to disaggregate cases of diarrhea attributed to contaminated foods. Furthermore, food categorized in studies as “contaminated” may not necessarily induce illness; the bacterial count may not be high enough and the *E. coli* found may not necessarily be fecal in origin. Nevertheless, there is evidence of strong correlations: in one study, persons in households where food handlers had had recent cases of diarrhea appeared to be at increased risk of diarrhea (Holmberg et al. 1984); in another study, the risk of diarrhea appeared to decrease in families where mothers washed their hands prior to food handling (Clemens and Stanton 1987); and a third study showed a relationship between the number of food samples containing *E. coli* and the annual incidence of enterotoxigenic *E. coli* (Black et al. 1982). Studies that assess the impact of food hygiene programs on diarrheal disease are lacking, with the exception of many that demonstrate the effectiveness of weaning education programs (Ashworth and Feachem 1986). Only U.S. investigations have collected data on the practices most commonly responsible for bacterial food-borne diarrhea outbreaks. In order of frequency, they are improper holding temperatures (43%), inadequate cooking (21%), poor hygiene by food handlers (15%), contaminated equipment (9%), and unsafe food source (7%) (McDonald and Griffin 1986). Measures to improve food hygiene cannot be implemented in isolation from other diarrheal disease control

A study (of handwashing and use of soap) in Indonesia reported an 89% reduction in diarrheal episodes.

Food hygiene measures cannot be isolated from the many other risk factors associated with diarrheal disease: sanitation, water supply, and personal and domestic hygiene, including fly control.

efforts because of the tremendous interaction among risk factors, such as sanitation, water supply, and personal and domestic hygiene, including fly control.

Interventions to Reduce Fly Populations. In a review by Esrey (1991) of studies attempting to measure the impact of fly control on the frequency of diarrhea, data from seven studies revealed a median reduction of 40%; however, Esrey pointed out that many of the studies were flawed and argued that fly control was not sustainable in spite of these promising results. Levine and Levine (1991) reviewed the same studies and concluded that there was sufficient evidence of the transmission of shigellosis by flies to justify further studies to explore sustainable fly control measures. Since this second review, a study among Israeli soldiers using simple yeast-baited fly traps demonstrated a 64% reduction in housefly density, a 42% reduction in clinic visits for diarrhea, and an 85% reduction of shigellosis (Cohen et al. 1991). A similarly well-designed study is currently underway in rural Pakistan villages to assess childhood diarrhea incidence using the same simple household technology (Chavasse et al. n.d.).

4.2.4 Water Supply, Sanitation, and Hygiene Packages

Reviews by Esrey et al. (1985;1990;1991) included 11 articles assessing *both water supply and sanitation*; 7 found positive results, with a median reduction of diarrheal disease prevalence of 20%. The only study examining the effect of water and sanitation on mortality found an 82% reduction in infant mortality in homes where water and toilets had been introduced, as compared to homes without these facilities (Habicht et al. 1988).

Several studies have demonstrated that the effect of improved sanitation/water facilities is greatest among infants who are not breastfed (and vice versa) (Clemens et al. 1990; Butz et al. 1984; Habicht et al. 1988; VanDerslice et al. 1994).

In one analysis of secondary data comparing the importance of sanitation versus water (in this case, using nutritional status as an outcome), the authors concluded that both were important, although sanitation was possibly, albeit not statistically significantly, more important (Bateman and Smith 1991). The impact of sanitation commonly looks greater because sanitation is usually added to an existing water program. Any initial improvement in health status reflects the effect of water alone, while the measurement of sanitation impact includes the combined effects of both interventions plus the effect of sanitation itself. In actuality, because water is in higher demand than sanitation, it is usually provided first. If water were an add-on to sanitation, neglecting the combined effects could lead one to conclude that water, not sanitation, was more effective. Where complementarity is high, the most cost-effective course of action may be a package of interventions—in this example, both water supply and sanitation (VanDerslice and Briscoe 1995).

Studies assessing the impact of combined water, sanitation, and hygiene interventions have found decreases in the rate of diarrheal diseases in the order of 25% (e.g., Aziz et al. 1990). That is the same order of magnitude of hygiene interventions alone and water or sanitation interventions alone. To our knowledge, no single study has tried to find out whether combined packages offer substantially greater efficacy than single interventions.

Where complementarity is high, the most cost-effective course of action may be a package of interventions: water, sanitation, and hygiene education.

5.1 Environmental Health Interventions

In addition to case management, a variety of malaria control measures are available. Depending on geographic conditions and vector habitat and behavior, these measures may include attacking the root cause by eliminating the vectors and their breeding sites, reducing transmission through vector diversion and early treatment of human cases, and curtailing man-vector contact. Because the WHO-promoted and USAID-supported eradication strategy for malaria, based largely on house spraying, failed to meet its 1963 goal, international donor funds were largely cut off. Environmental strategies that focused on source reduction also lost ground. The current focus of malaria control is limited to case management, environmental management, chemoprophylaxis of pregnant women, and the newly tested insecticide-impregnated mosquito nets (IMNs), also known as bednets.

5.1.1 Land Planning and Management

Environmental changes brought about by expanded land use for agriculture, forestry, and human settlement have increased malaria outbreaks and endemicity in many areas. Health risks may arise even before there is any awareness of danger and before preventive measures have been taken (Burgis and Morris 1987; Carpenter 1990). Land planning and management, both at the community level and in connection with large-scale development projects, must avoid creating vector breeding areas and curb indiscriminate land use. At the micro level, local health care providers and the non-health sectors such as agricultural extension, irrigation, and forestry should be made aware of the effect of agricultural land practices on malaria transmission. At the macro level, Environmental Impact Assessments (EIAs) should include health issues, particularly malaria, and ensure that there are appropriate safeguards against the proliferation of anopheline vector breeding sources when land-use and water resource development project plans are reviewed.

Environmental changes brought about by expanded land use for agriculture, forestry, and human settlement have increased malaria outbreaks and endemicity in many areas.

5.1.2 Residual Spraying

Residual, or long-lasting, spraying has been the traditional method of mosquito control since the 1940s, when insecticides such as DDT, which were relatively cheap and had low mammalian toxicity, were introduced. Spraying is usually done once or twice a year, depending on the insecticide and the climatic conditions. In temperate zones, where vector breeding takes place only part of the year and only one vector may transmit the disease, residual spraying, if done properly, is highly effective. In tropical areas that have a reasonable infrastructure, like Latin America and Sri Lanka, programs have been successful, though costly. The spraying of homes is most effective when carried out through a vertical program. For this reason, many malaria control campaigns have remained outside the general health delivery system and have

been, or are being, abandoned because of cost. In most of Africa, residual spraying has never been a major element in malaria control, chiefly because of poor infrastructure and high cost, but it has been successful in some more-temperate African countries such as the Republic of South Africa and Zimbabwe. Residual spraying can be combined with community- or household-level programs to eliminate breeding sites.

5.1.3 Surveillance/Screening

Epidemiological surveillance and screening give planners of prevention programs a better understanding of the prevalence of malaria and thus help them select strategies for highly endemic areas and institute prompt treatment to reduce transmission. The four basic components of surveillance and screening are discussed below.

Diagnosis. Traditionally, a malaria case has been defined as a parasite-positive blood smear. More recently, other definitions have included signs and symptoms, for example fever and anemia, rather than parasitemia. What definition is accepted affects the concept of control and how results are evaluated. Further, microscopy, because it is often unavailable, expensive, and yields inaccurate diagnosis when used by poorly trained technicians, may be replaced by improved serological tests and/or clinical diagnoses, which currently are major research priorities.

Evaluation. Clinical and entomological data must be evaluated in the ecological, environmental, and sociocultural context of each community. The choice of preventive strategies must reflect this context to ensure effective implementation. Whether evaluations are conducted manually or by mapping methods such as geographic information systems (GIS), an understanding of the complexity of malaria epidemiology and how it varies by site (forest, savannah, urban, etc.) is essential.

Stratification. The stratification of malaria data, based on topography, average rainfall, vectors, average annual parasite incidence over five-year periods, and the availability of health services, is necessary to understand epidemic potentials and vulnerability. With stratification, an appropriate mix of packaged preventive interventions can be designed to deliver the most cost-effective measures for the largest number of people. Such a model has been applied to the state of Karnataka, India, which was divided into five strata in order of increasing endemicity, each with its own malaria control objectives (Singh et al. 1990).

Monitoring. It is important to monitor antimalaria drug and insecticide resistance and the seasonality of transmission. Many countries have set up sentinel sites for this purpose.

5.1.4 Personal Protection

Insecticide-impregnated Bednets and Curtains. Studies in several African countries have demonstrated that bednets and bed curtains impregnated with safe pyrethroid insecticides offer greater protection against mosquito bites and malaria than conventional bednets (D'Alessandro et al. 1995). These studies have also shown the need for further investigation of a community's demand for bednets, their acceptance and proper use, the behavioral changes that may be necessary, families' ability to pay for

Bednets impregnated with safe pyrethroid insecticides offer greater protection than conventional bednets.

bednets, and the technical aspects of net material and insecticide treatment including continued use of the nets (Aikins et al. 1994). Bednets have proven to be more practical than insecticide-impregnated curtains, but promoting their use remains a challenge.

Repellents. Various botanical preparations have been used for centuries to repel hematophagous insects. Synthetic repellents were first introduced in the early 1900s, and DEET (N,N-diethyl -1-1,3 methylbenzamide), the most important of these, introduced in 1954, has supplanted all others in tropical regions and is the most widely used today. It is formulated as a lotion, cream, soap, aerosol, or towelette. In recent years, permethrin (primarily used as an insecticide) has replaced it for use on clothing and other fabrics. About 50 to 100 million persons use DEET each year, with few reports of adverse reactions. Reactions to permethrin (a repellent pyrethroid insecticide) are even less frequent. Gupta and Rutledge (1994) estimate that a U.S. military slow-release formulation of DEET, used three times a day, would cost \$0.51 per person per day, a price that would be unaffordable in areas where malaria is endemic.

In developing countries, coils, smoke, and other traditional products are widely used, but reliable data on their impact on reducing vector-borne diseases are not available. Data going back to World War II report reduction of sand fly fever (Egypt) and scrub typhus (New Guinea) from use of these methods. Although repellents alone are not recommended as a control measure, applied research on traditional products, especially derivatives of the Indian neem tree, may yield promising control options in the future.

Studies of community and personal expenditures for methods of vector control, including repellents, conducted by Ettlting et al. (1994) in Kenya and Malawi show that large (20%) proportions of disposable household income are spent on protective measures. Both traditional and commercial products are included.

Avoidance of Vectors. Parasite inoculation rates can be reduced if vector-human contact can be decreased through developing good anti-malarial habits in households and communities. These include the sustained use of mosquito repellents (such as coils and smokes or topical repellents) and the continuous use of IMNs and window and door screens.

5.1.5 Larvicides

Larviciding (killing mosquito larvae) for malaria control has value in certain, but not all, environmental conditions. It is often overlooked because the breeding sites of major vectors such as *An. gambiae* (Africa), *An. culicifacies* (Asia), and *An. albimanus* (Latin America) are so extensive. Larviciding on a grand scale would be inappropriate and costly but could be effective in and around communities where breeding sites are limited, remembering that most anopheline vectors do not fly more than one kilometer from where they emerge.

Studies in Kenya and Malawi show that large proportions of disposable household income are spent on protective measures against mosquitoes.

Larviciding could be effective in and around communities where mosquito breeding sites are limited.

Raising larvivorous fish is one of the oldest forms of community participation in malaria control.

Malaria case management at the household level goes hand-in-hand with clinic care.

With good design, development projects and land use planning can reduce the vector-breeding opportunities of such investments.

Larviciding is especially suitable in desert areas, where breeding is limited and small quantities of larvicides applied at the appropriate season can have long-lasting effects. Similarly, plantations and well-organized irrigation systems are suited to this treatment, especially if the excess water can be collected in convenient ditches where small quantities of chemicals can treat large quantities of water.

For environmentally conscious planners, it should be noted that *all* biological control agents (bacteria such as *Bacillus thuringiensis israelensis* or BTI, and juvenile hormone mimics/growth-regulating compounds) are applied as larvicides against mosquito vectors. This is also true of larvivorous fish, copepods, and other predators of mosquito larvae. (Raising larvivorous fish is one of the oldest forms of community participation in malaria control.) The problem is that not all vector breeding sites are suitable for efficient larviciding.

5.1.6 Appropriate Use of Antimalarial Drugs and the Health System

Individual and household practices regarding malaria case management and prophylaxis can complement malaria prevention. These include the proper use of recommended and available antimalarial drugs and an understanding of when to seek the services of a clinic. However, changes in behavior cannot be promoted unless current beliefs, perceptions, and practices are understood and a careful, concerted, and sustained health education program is put in place.

5.1.7 Training and Malaria Health Education

Reoriented approaches to malaria prevention, particularly in Africa, use new strategies in vector control and case management. For these to be implemented, malaria control staff must be retrained, and community awareness of malaria prevention must be raised, especially at the household level where inadequate knowledge has interfered with the correct application of preventive measures. Appropriate interdisciplinary curricula are available for both health worker training and community education. Malaria prevention has also been incorporated in formal education, particularly in primary schools. Education in malaria prevention is most successful when delivered through community participation similar to that employed by integrated pest management programs (Lacey and Lacey 1990).

5.2 Evidence of Effectiveness

5.2.1 Land Planning and Management

Where improper land use is responsible for increased vector breeding, preventive measures can significantly reduce the risk of malaria. Many examples show that health improvement practices in development projects have led to a decline of 50% in parasitemia and 18% in spleen infection rates for malaria (Bang 1988; Lu 1984). Many of these were the result of vertical disease control programs. It is also feasible to introduce appropriate preventive safeguards into the design phase of projects and to

recommend land management practices for agriculture and forestry that reduce the risk of malaria for the population (Birley 1989). At the micro level, such practices include increasing community awareness of the benefits of improved land use and of personal protection measures such as bednets and antimalarial drug prophylaxis.

5.2.2 *Residual Spraying*

In estimating the reduction in malaria brought about by residual spraying, all the components of the prevention package must be taken into account. In most programs, residual spraying is only one element in a combined program of vector control, surveillance, treatment, and larviciding. In well-run programs, like many in Latin America, malaria has been reduced despite growing populations. For instance, in El Salvador under a program supported by USAID, malaria has been reduced by over 95% (from 96,000 cases in 1981 to fewer than 4,000 in 1994) by such a combined program (PAHO 1992; Sauerbrey, personal communication). Excluding Brazil, where the Amazon situation is grave, all the countries in Latin America combined report fewer than one million cases of malaria (mostly vivax malaria) per year. Most of their malaria control programs have a strong residual spraying component.

Vector resistance to insecticides began to develop a few years after large-scale residual spraying was initiated in the 1950s and was exacerbated by use of the same insecticides in agriculture. Today, long-term reliance on spraying is costly, as newer insecticides are more expensive, greater quantities must be used, and concerns for environmental safety make donor agencies less willing to provide them as commodities.

Control programs heavily dependent on insecticides have poor prospects for sustainability unless they are linked to more efficient methods of application, protection of specific populations, and similar safeguards. Most of the malaria eradication programs based on spraying that failed, as in Sri Lanka, India, and parts of Latin America, were abandoned at the peak of their effectiveness because of a false sense of security that the vectors had been virtually eliminated. Furthermore, these programs were not funded to maintain success, and the long-term operating costs of control were never considered.

5.2.3 *Surveillance/Screening*

Prompt diagnosis and treatment are responsible for recovery in 80-90% of individual cases, but there are no available data to provide population-based figures. Nor is there precise information to substantiate the impact of prompt diagnosis and treatment on transmission of the disease in the community. Furthermore, the independent contribution of surveillance and targeted preventive approaches on malaria incidence has not been well measured.

Residual spraying is effective, yet costly. Long-term sustainability is not assured, in an era of shrinking donor resources.

More surveillance is needed to substantiate the impact of early treatment on malaria transmission.

5.2.4 Personal Protection: Bednets

Several studies in Africa (e.g., Aikins et al. 1994) have shown that malaria parasitemia can be reduced by up to 50% through use of insecticide-impregnated bednets, which also have reduced overall mortality by 63% in one-to-four-year-old children in The Gambia (Alonso et al. 1991). But, as indicated, more local research is needed to confirm the effectiveness of this approach in specific geographic areas.

5.2.5 Larviciding

The efficacy of larviciding can easily run to over 95% in controlled trials in limited areas. One recent study in Goa, India, reported lower slide positivity rates in experimental areas using weekly applications of the biolarvicide *Bacillus sphaericus* in *Anopheles stephensi* larval habitats, compared with control areas not using the larvicide—slide positivity rates of 2-8% versus 14-26% (Kumar et al. 1994). Since larvicidal treatment cannot be sustained over large areas, it should be confined to selected targets. Like other methods of vector control, larviciding is most effective as part of a control package.

5.2.6 Drainage Programs

Training of health care workers and community health education can significantly reduce malaria incidence. In Nepal, in one year, community participation in clearing vegetation from ponds, draining and filling in land depressions, and cleaning and repairing irrigation canals resulted in a one-third reduction of malaria cases from the baseline and a 50% reduction compared with controls that had no such program (Shretha 1986).

Community efforts in Nepal to reduce breeding sites made a significant reduction in cases.

ACUTE RESPIRATORY INFECTION

6

6.1 Air Pollution and ARI

Both indoor and outdoor air pollution have been associated with increased childhood morbidity and mortality. While the precise physiological mechanism is unclear, exposure to airborne particulate matter has been found to be especially significant. Epidemiologic studies have associated particulates with reductions in lung function, exacerbation of pre-existing asthma, emergency room visits, hospitalization, acute bronchitis, and non-specific mortality. In addition, mortality from childhood pneumonia appears to be related to particulate exposure.

Outdoor sources of particulates include motor vehicle exhaust, industrial activities, power generation, open burning of solid waste, construction and related activities, and resuspension of deposited dusts. Indoor exposures to particulates are often of even greater concern than those outdoors, both because concentrations are often much higher and because of the greater time spent indoors by vulnerable population subgroups, including young children.

Acute respiratory infection (ARI), which includes upper respiratory infections, such as colds and sore throats, and lower respiratory infections such as pneumonia and bronchiolitis, is the most important single cause of mortality in developing countries. Among children less than five years old in developing countries, 28% of the deaths are associated with ARI, and the presence of ARI can increase mortality from measles, malaria, and other diseases.

According to the WHO International Study Group on Indoor Air Pollution and Childhood Pneumonia, there are six potential intervention areas for reducing morbidity and mortality from ARI among children under five years of age: (1) case management and chemoprophylaxis (e.g., of severely malnourished children or high-risk neonates), (2) immunization (e.g., new vaccines for pneumococcus), (3) improving nutrition (e.g., encouraging breastfeeding), (4) reducing transmission of pathogens (e.g., reducing crowding), (5) improving childcare practices (e.g., promoting effective care-seeking behavior), and (6) reducing environmental pollution of the indoor and ambient air (Kirkwood et al. 1995). This last intervention is within the purview of environmental health.

Using a methodology described in Kirkwood et al. (1995) WHO has calculated the potential impacts on mortality from ARI from these interventions (see Bruce 1996). According to these calculations, a 20% reduction of indoor air pollution from biomass combustion could reduce mortality from ARI by 4.3% to 7.8%; a 60% reduction could yield decreases in mortality ranging from 13.0% to 19.5%. These estimates compare

Indoor exposures to particulates are often of even greater concern than those outdoors, both because concentrations are often much higher and because of the greater time spent indoors by vulnerable population subgroups, including young children.

Among children less than five years old in developing countries, 28% of the deaths are associated with ARI, and the presence of ARI can increase mortality from measles, malaria, and other diseases.

favorably with the expected impact of other types of interventions, such as reducing the incidence of low-birth-weight babies by 20% (expected reduction in mortality = 2.6% to 6.7%); or achieving a rate of 60/55/50 in the three-dose vaccination for pneumococcus (expected reduction in mortality = 7%).

Additional research on indoor air pollution and ARI looks at links between this risk factor and the cause of childhood morbidity and mortality. See studies carried out in a number of developing countries—South Africa (Kossove 1982), Nepal (Pandey et al. 1989), Gambia (Campbell et al. 1989; Armstrong et al. 1991), Nigeria (Johnson and Aderole 1992) and Zimbabwe (Collings et al. 1990).

6.2 Indoor Air Pollution Reduction Interventions

Half of the world's households use biomass fuels for cooking and space heating, according to estimates from Smith (1990). Incomplete combustion of these fuels (principally wood, crop residues, and dried animal manure) in inefficient stoves or open fires releases significant indoor air pollutants, especially suspended particulates and carbon monoxide. The hazards from these emissions are compounded by poor ventilation in kitchens, where women combine the tasks of cooking and child care.

Designing appropriate interventions to reduce indoor air pollution from cooking and heating stoves calls for an understanding of the fuels used, the use to which they are put, the combustion conditions, housing patterns, temporal and spatial behavior of the population, socioeconomic conditions, and physiological status of the population. Intervention options include the following:

- Use cleaner fuels—move up the energy ladder
- Lower emissions—use more fuel-efficient stoves
- Lower household concentrations—improve ventilation
- Lower exposure—improve kitchen design, change behavior

Of these, improved stoves, improved ventilation, and behavior change are the most feasible for the household and community level.

6.2.1 Improved Stoves and Ventilation

A large number of improved stoves are available. However, most are designed with fuel-efficiency, rather than improved health, as a goal. No studies have been carried out regarding the health impact of an improved stove. WHO is coordinating such a study in Guatemala, but it is still in the planning stages.

Improving ventilation is another option. However, generally speaking, it is not possible to increase ventilation enough to make an appreciable difference in the concentrations of particulate matter indoors.

Incomplete combustion of biomass fuels in inefficient stoves or open fires releases significant indoor air pollutants, especially suspended particulates and carbon monoxide. The hazards from these emissions are compounded by poor ventilation in kitchens, where women combine the tasks of cooking and child care.

6.2.2 Behavior Change

Behavioral change interventions to reduce indoor air pollution from stoves have not been adequately explored as to their feasibility and cultural appropriateness. Possible interventions include keeping children away from cooking areas, moving the cooking stove outside, changing kitchen design, and sharing cooking and child care so that children are kept out of smoky areas. Educational programs that convey an understanding of the connection between exposure and disease will likely be a part of the package. Field tests are needed in this area.

6.3 Ambient Air Pollution Reduction Interventions

Reducing exposure to particulate matter in ambient air depends heavily on technological, institutional, and policy interventions, such as control of stationary sources of emissions, conversion to cleaner fuels, improvements in vehicle fleets, the use of catalytic converters, and discontinuing the use of diesel-fueled buses. Nevertheless, some community- and household-level interventions are feasible. These include banning open burning of solid wastes and agricultural refuse, street sweeping, and keeping children from being too active on high-pollution days. The latter depends upon the presence of an air quality monitoring and health advisory system—something that most developing countries do not yet have.

Behavioral change interventions to reduce indoor air pollution from stoves have not been adequately explored as to their feasibility and cultural appropriateness.

INTEGRATION AND IMPLEMENTATION

7

7.1 Shifting to a Wellness Paradigm

7.1.1 *Current Trends Favor Promoting the Wellness Paradigm*

Perhaps the strongest argument in favor of a shift in paradigms is found in an examination of current trends. The health care sector is already overburdened and barely able to provide the staff and drugs for case management. The pressure of population growth and new health problems resulting from unplanned urbanization and industrialization is not lessening; added to that are issues of drug resistance, ecological shifts, and emerging diseases. Clearly, curative services cannot be abandoned, and more effective cost-recovery and financing systems must be put into place. Nevertheless, modest investments made now in maintaining wellness through prevention is a rational strategy that would begin to ease the case management burden and improve overall results in Child Survival.

The health sector should not see the construction of physical infrastructure (e.g., building water supply and sewage systems) as a primary preventive intervention. Promoting hygiene behaviors that yield more effective utilization of infrastructure, however, are part of primary prevention. Strategies that improve household food handling and preparation, designs to maximize latrine utilization by all household members, and simple handwashing campaigns are well within the purview of the health care system.

7.1.2 *Cost Implications*

The monetary cost to the health sector of primary prevention need not be high if the interventions are focused on gaining health improvements from better utilization of existing or planned physical infrastructure. Money spent on water and sanitation infrastructure is not usually part of the health sector budget. Traditional methods of computing the cost-effectiveness of water and sanitation have mistakenly assumed that the costs would be borne by the health sector. In the new prevention paradigm, public health costs are incurred to induce behavioral changes which promise substantial health impacts at a relatively low per-capita expenditure from the health budget.

7.1.3 *Adding Prevention to the Health Care Provider Lexicon*

Health promotion messages delivered by health care providers commonly focus on case management, as demonstrated by the Sick Child algorithm. Messages about how patients can prevent illness should be included. Due to their tremendous work load and poor staffing, health care workers normally spend 3-5 minutes per patient. Hence health messages frequently are communicated by ancillary staff. Yet, messages

Population growth, increased urbanization, industrialization, drug resistance, ecological changes, and emerging diseases all add to the pressures on an overburdened health sector.

Investing in prevention (via personal and household behavior) can lead to better use of existing or planned infrastructure.

The treatment plan for a sick child includes case management and prevention at home by parents. Health care workers are important voices in this matter.

Many sectors have a role to play in children's well-being.

coming from health care providers are often seen as more credible. Providers must understand that prevention is part of the treatment strategy, just as home management of illness is. Bringing this conceptual shift into the provider lexicon can be accomplished by adding prevention to training curricula and maintaining health provider behavior change through quality assurance monitoring schemes.

7.1.4 The Importance of Intersectoral Partnerships

The key to incorporating environmental health in primary health care and Child Survival is to develop partnerships with non-health sectors. The first step is to determine what other players are operating within the community and how their activities might be related to environmental health. The next step is to find the means to link their activities with health sector activities through collaborative programming. Linkage can involve developing common goals, designing mutually beneficial activities, defining joint program indicators, and, finally, devising collaborative monitoring and evaluation efforts.

While intersectoral partnerships cannot be carried out without national support, the activities operate at the municipal, district, and community level. Figure 3 gives some examples of how the activities of other sectors can be linked with the health sector to address the three major childhood diseases.

Figure 3: Intersectoral Partnerships

Sectors	Diarrheal Disease	Malaria	ARI
Health	Treatment: ORS Immunization Breastfeeding Nutrition Hygiene education	Treatment Chemoprophylaxis of pregnant women Surveillance Education in personal protection	Treatment Vitamin A supplementation Education in early recognition
Agriculture	Food supply Crop diversification Food safety	Source reduction: drainage & filling Land management Larvicides	Fuel substitutes
Education	Food hygiene Water hygiene Excreta hygiene Personal hygiene Helminth treatment	Personal protection measures	
Public Works & Housing	Water supply Protection of water sources Excreta disposal Excreta treatment	Screens Drainage strategies	Ventilation
Private Sector	ORS Soap Ban feeding bottles & formulas Water containers Food handling practices	Bednets Repellents Anti-malarials	Fuel-efficient stoves Non-biomass fuels

7.2 Adding Primary Prevention to Child Survival

7.2.1 *The Essence of the Strategy*

The current generation of USAID-funded facility-based Child Survival projects generally do not include the type of prevention activities discussed in this paper, but it would not be difficult to add a prevention component to existing projects in selected sites. This component could be a package of preventive interventions that are consistent with the goals of the existing project. If such a component were to be implemented through a centrally funded project, the cost would range from \$100,000 to \$200,000 per year, depending on the scope of the activity and costs in the country. The activity should be for at least a two-year period to allow sufficient time to show results. At the end of the period, the results could be compared to sites where preventive activities were not taking place. This approach would test out the validity of a preventive approach to improved care without radically changing the current direction of USAID-funded Child Survival projects.

Below are some examples of the way environmental interventions could be “packaged” in a fairly typical district-level Child Survival program. In this hypothetical program,

- diarrheal diseases are being targeted;
- health services are currently using ORS;
- health staff are being trained in diarrheal case management and are educating caretakers about home fluids, therapeutic feeding, and danger signs of diarrhea (when to bring the child to the clinic); and
- health services also offer immunizations, micronutrient supplementation, growth monitoring, promotion of exclusive breastfeeding, and weaning food education.

Five environmental health links with Child Survival are listed below with sample activities.

Water Hygiene Links with Child Survival

- *Water source protection.* Form a partnership with the sector and/or community body responsible for maintaining water supply sources. Share monitoring data on diarrheal disease incidence and water quality. Jointly assess with the sector or community group the potential contamination opportunities at the water source. Share decisions with the sector and community on means, financing, and resources to prevent source contamination (e.g., drainage designs, washing areas, aprons, fencing).
- *Household water storage.* Identify businesses that manufacture water storage containers. Link these businesses with enterprises that design low-cost contamination-proof containers. Design marketing strategies that are mutually beneficial for the consumer and producers in promoting safe drinking water delivery containers.
- *Household water handling.* Link the local water quality testing unit to school science programs. Through the school system, conduct training on clean water

A package of prevention activities could be added to an existing project, to test out the validity of this approach.

Water use practices can link together school, household, and community interests. Everyone uses water; there are many "entry points" for interventions involving water protection and use.

Social, cultural, and economic factors have a bearing on household and individual excreta practices.

Handwashing is a front-line assault on disease transmission.

handling procedures followed by student experiments in their own homes on household water quality using standard or proxy water testing technologies.

Excreta Hygiene Links with Child Survival

- *Latrine design.* Link technical staff with community members to insure culturally appropriate latrine designs to encourage full utilization. Carry out community trials with child-friendly strategies and/or designs (e.g., special holes, latrines without walls, pictures on walls), with a self-monitoring system for households and reporting of results/impressions.
- *Awareness of the dangers of children's feces.* Conduct experiments with women's groups and school-age children on fecal cultures (or an appropriate proxy), adult versus infant, led by a local doctor or microbiologist. Include animal feces and/or saliva to encourage corralling of animals and safe containment of their feces.

Personal Hygiene Links with Child Survival

- *Soap marketing.* Make soap manufacturers aware of hygiene education programs and messages. Encourage soap marketing as a means to protect health and prevent diarrheal diseases, i.e., a campaign that is mutually beneficial to the producers' profits and consumers' hygiene. Consult community on pricing, size, color, fragrance, costs.
- *Awareness of the importance of handwashing.* Conduct experiments with women's groups and school-age children using hand cultures (or an appropriate proxy, such as the two-glass method observing the difference in the dirtiness of wastewater from handwashing with and without soap). Consult with women in the community on type and location of handwashing facilities. Follow with self-assessments of impacts when handwashing is performed.

Domestic Hygiene Links with Child Survival

- *Fly control.* Using fly traps, assess breeding sites in the community. Develop community strategies to reduce breeding sites (e.g., organic waste recycling, protected storage points for community animal waste).

Community-Based Private Sector Initiatives

- *Local product advertising and endorsements.* Identify local businesses that supply products associated with the control of communicable diseases (e.g., liter containers to prepare ORS, soap, contamination-proof drinking water containers). Assist them in designing advertising angles and provide them with health center endorsements. The Grameen Bank uses an imaginative way to provide health messages to the poor at low cost to the health budget; to address treatment of diarrhea, the Bank prints a "saline poem" describing the correct procedures for oral rehydration therapy on the inside cover of its savings passbooks.
- *Local entrepreneurs as health promoters.* Identify food vendors, suppliers, or butchers with either best practices or a community service interest. Assist them

in conducting training-of-trainers programs or demonstrations in safe handling practices (endorsed and/or provided through the health center). The merchants could also provide food hygiene and/or weaning food preparation demonstrations for women and/or schoolchildren as a means to promote their businesses and improve feeding practices.

- *Commodities supply.* Use the transport systems of local businesses to bring health-related supplies to the community.

These measures focus on modifying hygiene behaviors and are best imparted not by standard didactic educational methods, but rather through a participatory, self-experimentation process. They can be implemented through existing systems (e.g., the private sector or school systems) to offer more sustainable low-cost approaches. These strategies also offer opportunities to develop partnerships between communities, local entrepreneurs, health services, and health-related professionals and technicians.

7.2.2 A Step-By-Step Plan of Action

The previous section outlined the overall strategy for incorporating environmental health in primary health care within USAID. This section provides more detail on the four phases of implementing the strategy: selecting the sites, identifying the health problems to be addressed, designing interventions, and evaluating results.

Phase I. Site Selection and Introduction of the Concept

- **Step One: Identify Implementing Partners and Intervention Areas**

The first step for incorporating environmental health in Child Survival is to identify with whom and where the initiative will be implemented. Potential partners may range from a USAID-assisted Ministry of Health project (e.g., the Community and Child Health Project in Bolivia or the Zambian Child Health Project) to an NGO (e.g., ProSalud, CARE, or Save the Children Federation). Multiple meetings will be necessary to introduce the concept with this and other documents as background information.

Implementers may wish to set data- or resource-dependent criteria in choosing areas of the country in which to work. Under-served areas at highest risk could be determined by income, ethnicity, mortality, food supply, etc. Whatever the criteria, they should be clearly defined at the onset of discussions within an appropriate forum. To gain support at upper levels, implementers may wish to involve other potentially concerned sectors at the onset (e.g., education, agriculture, private sector interests). Implementers may also wish to adapt the framework to address local health conditions. For example, they may wish to add other endemic diseases such as Chagas's disease, or other child health problems such as injury might be included.

There are various ways to develop partnerships between communities, local entrepreneurs, health services, and health-related professionals and technicians.

Partners in a packaged approach might include national ministries and NGOs currently collaborating on the health and welfare of children.

Community support is key to any prevention package.

■ Step Two: District Staff Orientation and Community Selection

The next step is to introduce the concept at the appropriate local level, be it district or municipal. Individuals to champion the initiative must be identified at this level. The framework is introduced and adapted to include the menu of local health conditions. A means to recruit interested communities with their associated catchment area health center staff must be developed. Communities with functioning community organizations may appear to be good choices, but they may be likewise more empowered and thus more resource-rich. Therefore, the district may want to base site selection on high-risk criteria, allowing communities the opportunity to form an organization around health issues.

Phase II. Health Problem Identification

■ Step Three: Health Center Statistical Profile

Once the sites are identified, health center staff must be oriented to the concept and learn about the steps necessary for implementation and their role in carrying them out. The first step in this phase is for health center staff to prepare their own health center statistical profile, with some technical assistance when needed. If possible, a year of morbidity and mortality data based on clinic visits should be compiled and graphically displayed (using the most simple, culturally appropriate means: pie charts, bar graphs, or locally understood icons) for presentation to the community. Clinic personnel may also wish to graph and display the data in their facility by month on major illnesses. (Such data might show seasonal trends, but it might also merely reflect trends in clinic utilization, which in turn may be a function of drug supplies and other aspects of clinic operations.)

■ Step Four: Community Consultation: Presentation of Health Data to Community

The next step is for the health center staff to present the data to the community for their consideration as a means of forging a community-health staff partnership. For the community, this is the beginning of a process of deciding what they view as their priority health problems. The clinic-based health data may not reflect the true community health profile because these data do not take into account under-utilization of health facilities and/or self-treatment. Therefore, at this stage the community is encouraged to conduct their own assisted survey as a means to verify the reliability of the health center's profile.

■ Step Five: Community Self-Assessment of Priority Health Problems

To complete the health problem identification phase, the community is asked to develop a list of common health problems they wish to investigate, based on the findings of the health center data and on other conditions of which they are aware. These may include lay folk illnesses that later will need to be classified. A simple data-collection instrument, pictorial or written depending on literacy, can be used by households or a lay data-collection team consisting of a group of interested and available community members (a school class, fathers and mothers, or retired elders). Health staff should assist with the initial data collection. The data can be gathered either retrospectively (e.g., two week history of illnesses) or prospectively (e.g., a four-week tally of health problems encountered). Data on both chronic or acute

Health clinic staff can provide a profile of clinic use, which will point the path toward disease prevention needs.

*The health staff's partnership with the community requires **the community** to decide what it views as priority health problems.*

Data-gathering activities strengthen the partnership between the community and the health center.

illnesses can be collected. The data-gathering activities strengthen the partnership between the community and the health center.

At the end of the data collection process the community is brought together a second time to tally up the results visually. The community survey can be compared to the health center profile and consensus can be developed on what the priorities should be.

Phase III. Intervention

■ Step Six: Identifying Possible Environmental/Behavioral Hazards Causing the Priority Health Problems

The next step is to identify the environmental and behavioral conditions that are contributing to the causes of the priority health problems. This process can be initiated by developing with the community a list of causes they know about based on traditional beliefs and then adding causes based on Western science, which may be unknown to the community. Because the community may have little information on the extent to which hazardous conditions and or behaviors exist among them, the next stage is to gather focused information on household and community environmental conditions and behaviors.

■ Step Seven: Community Self-Assessment of Potential Environmental Hazards

The next step is to assist the community in assessing the conditions that give rise to their priority health problems. Items to be assessed could be selected from the menu presented in Figure 4. Community members can design the best means to gather the information (i.e., how best to observe or report the information and who should gather it, an appointed team or selected random households). Households could gather some of the data on their own (distance or time spent in gathering water) but would need technical assistance to gather other data (such as total suspended particles or water quality, and/or vector breeding sites.) It is critical that household members be involved even in technically assisted data collection and that the results are explained to them and retained by them. Behavioral data of a personal nature (e.g., handwashing practices, latrines users) may have to be observed by a family member (e.g., school-age child) and could be reported anonymously. Even if there is biased under-self-reporting, the process will increase awareness of the hazardous behavior and may impart change.

■ Step Eight: Community Decisions on Interventions

After collecting the above information, the community gathers again to tally the household data and map the community data. During this process, the community identifies key critical environmental hazards or behaviors and examines the reasons for them. With facilitated technical assistance, the community discusses options for diminishing the hazards and changing the behaviors and what resources are available—human, material, or capital. Topics to be considered include methods to involve the private sector and other health or non-health government sectors, the use of credit schemes to cover capital costs, and personnel needed to assist technically or managerially. The final result of this step should be agreement on a list of possible interventions.

Community identification of conditions and causes of priority health problems opens the way for understanding local beliefs about disease.

Community members are data-gatherers and program designers, in this prevention approach.

Midterm revisions are common in local interventions. Check-points are important in the implementation process.

■ Step Nine: Community/Household Trials, Adaptation, and Implementation

Once the interventions have been chosen, a period of time is allocated for household or community trial-and-error testing. If one of the interventions is a new household technology (e.g., a water purification device), a few volunteer families may wish to use the technology and report back to the community. A community-wide initiative (e.g., breeding site reduction schemes) may need to be tried out for a month. After the trial period, the community meets again to assess the success and/or failure of the interventions. In some cases, the interventions are adapted or set aside in favor of more promising interventions. Adaptations or new strategies are designed and implemented.

After the interventions have been selected, the community must decide on the methods, frequency, personnel, and feedback mechanisms to monitor the interventions. The monitoring process will refine the intervention and keep it accountable to the community.

Phase IV. Evaluation and Replication

■ Step Ten: Community/Health Center Evaluation

After the intervention has been applied for at least a year, the community and health center should collect data like that collected in Phase I to evaluate their initiative. Health center and community data on the priority health problems should be assessed as well as the critical environmental and/or behavioral hazards. Outsiders may wish to conduct their own evaluation but this should not replace the community and health center activity.

■ Step Eleven: Community-to-Community Replication

Dissemination of the results of the community initiative should involve the community members and participating health or other sector staff. Other communities may be invited to observe the program to initiate the same process elsewhere. Likewise, participating community members can assist other communities with the specific steps (e.g., health survey or household/community health hazard appraisal).

7.3 Opportunities for a Greater Child Survival Impact

The strategies for integration and implementation described in this chapter are meant to be as flexible as possible. One size does not fit all; therefore, any plan to make primary prevention an integral part of a Child Survival program must be adapted to the particular circumstances of the locale. Further, the ideas put forward in this paper need to be tested through a country application.

The goal of this paper will be achieved if mission personnel are persuaded that primary prevention presents an opportunity for USAID to make a larger impact on the serious, and in some regions, growing, health problems of children in developing countries. In no way does this new approach repudiate what has been done in the past; it builds on and is based on the lessons of the past. For USAID personnel it should open up new horizons for imaginative, cutting-edge programming.

The community and health center gather data to evaluate their initiative.

The goal is to strengthen USAID's Child Survival efforts by adding primary prevention activities, building in incremental changes aimed to keep more children healthier.

Figure 4
Environmental Health Appraisals

A. HOUSEHOLD HEALTH HAZARD APPRAISAL

1. Food
 - a. Feeding Practices
 - Weaning: age, types of foods, feeding frequency
 - Breastfeeding: exclusive, additives, duration
 - b. Food Hygiene
 - Source of food items
 - Preparation: cleaning, cutting, mixing
 - Cooking: time/temp
 - Storage: time/temp
 - Serving: common vs individual utensils
 - Utensils and kitchen hygiene
2. Water
 - Source: distance, quality, use
 - Amount: per capita per day
 - Storage: type, quality
 - Handling: contamination opportunities
3. Sanitation
 - Excreta disposal: where, type, users, anal cleansing, children
 - Personal: handwashing procedure/when, bathing, laundry
 - Domestic: animals, solid waste, wastewater
4. Air
 - Fuel/stoves
 - Ventilation/TSP
 - Time in cooking area: who, hours/day
 - Smoking
5. Vectors
 - Housing construction
 - Vector resting/biting
 - Sleeping arrangements
 - Personal protection measures
 - Breeding sites/Drainage: gardens, wastewater, solid waste
6. Injury
 - Location/access to poisons
 - Fires/Electric outlets, wiring
 - Bodies of water
 - Fall potentials

B. COMMUNITY HEALTH HAZARD APPRAISAL

1. Food Supply
 - Source: slaughter procedures, night soil, pesticides
 - Quantity and variety
 - Market safety: time/temp. perishables, cleanliness
 - Food vendor safety: source, preparation, time/temp, hygiene
2. Water Supply
 - Amount available
 - Quality: protection from contamination and vector breeding
 - Distance to households
 - Institutional access: health centers, markets, vendors
3. Community Sanitation
 - Public excreta disposal
 - Solid waste
 - Drainage
 - Livestock
4. Commodities Supply
 - Transportation
 - Fuel, stoves
 - Vector personal protection devices
 - Feeding bottles, milk substitutes
 - Soap, water containers
 - Drugs, vaccines, family planning supplies, condoms, etc....
5. Institutions
 - Health services: access, hygiene
 - School: water/sanitation/environmental hygiene/health education
 - Workplace: health hazards (injuries, vectors, chemicals)
 - Recreational: injury/vector/hygiene hazards

A shift in paradigm such as this does not happen all at once but is a gradual process of incremental changes and openness to new ideas. All in USAID are invited to give EHP the benefit of their experience as the project explores how to tip the balance towards interventions to keep children healthy. Creating healthy environments and promoting healthy behaviors can be the basis of a major contribution to Child Survival.

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