

Chapter 17

Malaria Control and the Future of International Public Health

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Malaria control depends on the presence of certain essential public health functions. Health services systems in tropical malarious countries, following health models of the industrialized world, have not developed a public health capacity adequate for malaria control. To control malaria under current conditions requires an international response, one that builds national public health capacities capable of fully supporting local initiatives. In this chapter, my purpose is to explore the history of malaria control and public health in the twentieth century to bring to light certain critical features of the current situation that must be recognized and attended to before any agenda for the future can be placed on a solid foundation.

In a general sense, the fight against malaria has always been and will no doubt always be an instance of “public health.” However, there has never been a consensus concerning just exactly what is meant by “control.” In the early part of the twentieth century, control was generally taken to mean a reduction, if not elimination, of malaria transmission. This position helps explain why the League of Nations Conference in 1937, when it addressed malaria, pointed out that “the distribution of anti-malaria drugs ... is not so much malaria control as an alleviation of acute disease with reduction of mortality” (League of Nations 1937). Today, the reduction of mortality is seen as a legitimate goal for control programs to pursue. Nevertheless, the sentiment remains that control involves more than the diagnosis and treatment of malaria; in particular, it also should include the detection and containment of epidemics and the prevention of transmission where likelihood is strong that such action will reduce the incidence of disease and mortality (WHO 1993).

Where and when malaria was “king of the diseases,” it was the most important public health problem present. Midway through the twentieth century, many looked to malaria control as an essential building block for the control of other diseases of public health importance. Instead, the eradication of malaria was attempted by an independent, vertical approach that kept malaria outside the mainstream of public health development. Once the great burden of malaria was dramatically reduced, it lost its priority. Today, it is seen by many as but one disease among others.

When malaria came back to the fold, so to speak, in the 1970s, most health systems where malaria was present were in a state of crisis that since has deepened. Instead of

confronting the fact that public health infrastructures are lacking in most countries of the world where malaria is a major problem, malaria control has remained hostage to the idea that such infrastructures will be developed. Consequently, the reality today is that malaria control may be even less possible than it was 30 years ago. Confounding the problem even further is the fact the model health services system advocated by World Health Organization (WHO) initially grew out of the experiences of the industrialized countries and, later, from those of nontropical ones. These models largely ignored the special needs of malaria control under tropical conditions and consequently may be totally unsuitable for meeting such needs.

To justify these conclusions, I review the development of both malaria control and public health throughout the whole of the twentieth century. Because malaria control and public health have largely evolved along independent lines, I present the topics separately. Next, I review the past relationship between malaria control and public health. Most of this discussion is conceptual in nature, because little current practice exemplifies malaria control in the context of a national public health service. From this historical and functional review, several major deficiencies are identified, from which strategies for the future are suggested. A brief conclusion follows.

Malaria Control during the Twentieth Century

The global malaria eradication campaign was officially launched in 1955 and came to an unofficial end in 1969. Thus, the twentieth century can be seen as consisting of three periods: before, during, and after global eradication. None of these periods were homogenous in experience. Nevertheless, the global campaign was quite unlike what had preceded it, and the posteradication period, in which we still find ourselves, was radically altered by the earlier assumptions of the possibility of eradication.

Preeradication Era: 1900–1954

Prior to Ronald Ross' discoveries in 1898, the only sure method available to reduce the burden of malaria was the use of quinine, although the association of malaria with certain nefarious ground and wind conditions had led some towns and areas in Europe to attempt to control malaria by various environmental means, with occasional satisfactory results (Najera 1994). Ross' work opened up two new points of attack: reduction of mosquito numbers through larval and adult destruction, and reduction or elimination of contacts between man and the *Anopheles* mosquito (Bynum and Overy 1998). Although Ross was inclined toward a direct attack on the mosquito, Italian malariologists led by Giovanni Grassi and Angelo Celli explored all three possibilities during the early decades of the twentieth century, with varying degrees of success (Fantini 1998).

Ross was supremely confident that his work had opened the way for malaria to be controlled, if not fully eliminated. Before leaving India in February 1899, he wrote to Patrick Manson, "It is evident that the study of malaria has now entered on the third and last phase—prevention." He distinguished five classes of measures: public, isolated communities, medical men, travelers, and general private. He divided public measures into towns, rural areas, and general. With the exception of malaria cases that were to be "isolated in nets (with) treatment to be continued sufficiently long after the fever has ceased," all measures were directed against the mosquito. He also recognized that "little can be done in rural areas" (Bynum and Overy 1998).

Others soon joined Ross and the Italians in the battle against malaria, notably, William Gorgas, Sir Malcolm Watson, and Nicolaas Swellengrebel (Litsios 1996). Gorgas “conquered” malaria in the Panama Canal Zone; Watson achieved outstanding results in very specific plantation and mining conditions; Swellengrebel demonstrated the possibility of species sanitation, that is, altering the natural environment in such a way as to destroy the breeding of malaria-carrying anophelines (Takken et al. 1990; Bradley 1994). Nevertheless, whatever dream Ross and other early malariologists may have had that antivector work would eradicate malaria proved to be of very short duration, if it ever really existed at all. Even Gorgas and Watson, who achieved remarkable results in economically important areas and whose budgets were orders of magnitude greater than what could be expected to be available under “normal” circumstances, never eliminated malaria.

There was no escaping the fact that resources available for malaria control in typical rural areas of the tropics were totally insufficient. Furthermore, malaria was so intertwined with poverty that many malariologists concluded that its control depended on overall social and economic development (Litsios 1996). Paul Russell, commenting in 1936 on the situation in India, noted, “the ordinary rural community in India could not be expected to spend more than two and a half cents per capita per annum for malaria prophylaxis, yet malaria has never been controlled in such areas for less than twenty cents per capita per year and seldom for so little” (Russell 1936). What to do under such circumstances was one of the major questions discussed during a conference on rural hygiene organized by the League of Nations in Bandoeng, Indonesia, in 1937 (League of Nations 1937). Russell chaired the malaria technical working group.

To reduce costs for rural communities the conference recommended that “every effort be made (a) to extend the free distribution of cinchona products, (b) to enlist the aid of the people themselves in minor control methods, and (c) to explore cheaper methods of control which use time more than money.” Of particular note is the conclusion that “persistence rather than perfection in control is required for rural areas.” The so-called naturalistic methods were highlighted. Research was needed to obtain “a much more definite understanding of the relationship between malaria, malnutrition, famine, and poverty ... as well as further elucidation of the factors concerned in malarial immunity.” Also needed was “a good deal more investigation ... to develop practical mosquito-nets for rural areas in the tropics” (League of Nations 1937).

Representative of this pre-DDT era were the conclusions reached by John Grant concerning malaria in rural India. A longtime (1917–1962) staff member of the International Health Division of the Rockefeller Foundation, Grant was “lent out” to be director of the All-India Institute of Hygiene and Public Health in Calcutta from 1939 to 1945. During that period, he played an important part in shaping the Bhoire Committee recommendations concerning India’s medical education and health-care systems. He judged in 1941 that malaria control could not be undertaken “solely through cash purchase,” as it had been in Panama. But “considerable protection [could] be secured in Bengal provided there were education, organization, and methodology developed whereby citizens provided themselves with protection through local voluntary effort” (Grant 1963b).

With the arrival of DDT, as noted by the first WHO Expert Committee on Malaria in 1947, there was “at last a method of controlling malaria in many areas at costs within the economic means of the people” (WHO 1947). Expert committees are convened by WHO to give advice on technical and scientific matters. In the early years of the organi-

zation, the decision to convene a committee to address a particular subject reflected the priority being given to that subject by the WHO governing bodies.

In its first program statement concerning malaria, the WHO secretariat indicated that “the ultimate aim for WHO can, and should be, the eradication of malaria from the world” (WHO 1949a). Immediate aims, however, were confined to promotion, demonstration, and showing “the indirect benefits derived from malaria control, both with regard to public health in general and to increased agricultural or man-labour production.” Methods to achieve these aims included, among others, “an attack on the problem of African malaria with a view to opening up the continent to large-scale development” and “the planning and carrying out, in collaboration with the U.N. Food and Agriculture Organization (FAO), of broad-scale programs of malaria control, of public-health improvements and of overall rural rehabilitation in large areas.” These two points no doubt reflected the real sentiment, which stems from the conclusions of the Bandoeng conference, that the economic feasibility of malaria control was dependent on its socioeconomic importance.

The “economic importance of malaria in Africa” was one of the subjects discussed at the November 1950 Malaria Conference in Equatorial Africa (WHO 1951b). There, it was noted that “information relating to the economic importance of malaria in Africa is small and not always reliable.” This was considered “the main cause of the lack of a unanimous consensus of opinion with regard to the appraisal of the effect of this most prevalent African disease on the distribution of population, on population movements, on demographic trends, on agriculture, industry, and transportation, education, and social welfare.” The report highlighted in summary form the relationship seen to be present between malaria and these socioeconomic factors.

Although a joint effort on food production and malaria control had started between FAO and WHO in 1948, by 1953 it was no longer being pursued (Litsios 1997a). It collapsed for a combination of reasons. Suffice it to say, the cold war was probably enough to have killed it, although evidence suggests that the FAO secretariat would have dragged out the relationship long enough to have caused it to fail as well. Also, the fact that malaria control clearly stimulated rapid population growth placed in jeopardy the calculus of the malaria–economic development hypothesis. These factors contributed to the decision soon taken to drop intermediate objectives and to seek the aim of global eradication.

Eradication Era: 1955–1969

One aspect of the eradication era is worth noting for the purposes of this chapter. It relates to the generally accepted role of the health services to maintain eradication wherever it had been achieved. In 1960, WHO proposed the idea of preeradication projects, that is, building up the health services to the point where they could take over eradication in its final stages (Najera 1989). This proposal was driven in part by the large number of newly created African states that pressured WHO to extend the global eradication program to include the African continent.

Some eradicationists saw no role for the health services. Fred L. Soper—seen by many as almost single-handedly having forced WHO to undertake an eradication campaign—led this group (Litsios 2000). His position was rather simple: Eradication depended on the area where it was achieved increasing steadily until the area covered the whole globe, or major regions of the globe. WHO, however, stressed the role of the

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health services in safeguarding whatever degree of eradication had been achieved, even if it were only confined to a national or subnational level. Soper argued that this approach doomed the campaign, because there were not enough resources to simultaneously pursue global eradication and develop health services capable of carrying out the epidemiological surveillance required to maintain eradication on a limited basis.

Soper's position was never expressed clearly in any public setting, as far as I am aware. Only in his diary notes did he express himself in unambiguous terms, as in this entry of May 4, 1964:

I refuse to be pessimistic regarding the future ... the measures which are building up will eventually force the World Health Organization to abandon the Alvarado, Gonzales proposal for rural health infrastructures and will lead to the development of more highly specialized malaria eradication efforts with adequate technical and administrative support for efficient and honest services. (Soper 1964)

(Alvarado was director of WHO's Division of Malaria Eradication, having taken over that responsibility in November 1958 on Pampana's retirement, and Gonzales was the senior consultant who prepared the 1964 study group report concerning the integration of mass campaigns.)

Soper couched his public criticism in such vague terms as to make one doubt if even those sympathetic with his position were fully aware as to how strongly he was opposed to the manner in which WHO was engaging the eradication campaign. This possibly accounts for the fact that the debates that took place in the 1960s concerning the feasibility of eradication make no reference to his position.

Had such debates taken place, public health generalists would have learned not only that there was a major division in the eradication camp but also that the role of the health services in malaria control was a difficult, even controversial, subject of major importance. They would have learned, for example, that Arnaldo Gabaldón, who was responsible for the establishment of the first WHO Expert Committee on Malaria in 1946 and who had participated in almost all of its first 15 sessions, approached the question of malaria eradication in a manner that antagonized both Soper and WHO (Litsios 1998)! He neither sought total eradication throughout all of Venezuela, nor did he rely at all on the general health services to maintain what the eradication program had achieved. Instead, he concentrated on controlling transmission using antivector methods. He went so far as to consider spraying as "natural" a public health measure as periodic vaccination.

Such a debate might have caused the eradication campaign to come to an end earlier. In any case, it would have led to discussions as to what role the health services, as such, had in malaria control. Lacking such a debate, the prevailing view well into the 1970s concerning the role of the health services was to see them solely in terms of protecting what had been obtained by the earlier eradication campaign. Those who favored the basic health services (BHS) were willing to accept this responsibility as the price that had to be paid to gain the upper hand over vertical campaigns. But the price paid was an unfortunate one, because the need to safeguard the gains of the eradication campaign placed the yet-to-exist services in a no-win situation. Instead of building services with the capacity to control disease outbreaks, attention was given to case detection by active and passive means, that is, the means advocated by the campaign for maintaining eradication gains. When malaria eradication campaigns were "integrated" with such services, outbreaks inevitably occurred that forced the return to specialized transmission control efforts.

Posteradication: 1969–Present

The transition from eradication to control did not occur quickly. Strictly speaking, the 1969 World Health Assembly (WHA) had not recommended the stoppage of eradication campaigns. On the contrary, it urged governments “to ensure the successful implementation of the [eradication] programmes” (WHO 1973b). Only in the 1975 and 1976 executive board and WHA resolutions can one clearly see the shift; for example, the 57th executive board meeting in January 1976 requested the director general “to assist countries to develop more realistic and flexible approaches in antimalaria programmes adapted to the different epidemiological and socioeconomic conditions” (WHO 1985a). Similarly, it was the last of the three Expert Committees that met in the 1970s—that is, the 17th Expert Committee in 1979—that was the first committee in which eradication, *per se*, was not discussed; control was its exclusive preoccupation (WHO 1979).

Around the time of the 1979 Expert Committee meeting, two of its participants, Mohyeddin Farid (an expert) and Leonard Bruce-Chwatt (a consultant), wrote revealing papers on the subject. Farid’s (1980) was entitled “The malaria programme: From euphoria to anarchy,” and Bruce-Chwatt’s (1978) was entitled “The challenge of malaria: Crossroads or impasse?” Farid, a retired WHO malariologist who had worked with Soper in the 1940s, believed that the “goal of global malaria eradication—in its revised form—must be maintained” (a position that Russell totally agreed with in his comments on Farid’s paper). Bruce-Chwatt, also a retired WHO malariologist, was less inclined to revert to the past. Nevertheless, he characterized the 1969 WHA decision as “the great leap sideways” and pointed out several critical issues associated with the newly accepted goal of control:

1. What degree of malaria, in terms of morbidity and mortality, is “acceptable”?
2. How can it be delineated where control should concentrate, especially in light of the fact that “beyond a certain degree of endemicity the adverse clinical and socioeconomic effects of malaria are directed not at the whole indigenous community but primarily at its youngest age-groups”?
3. How could a “great deal of steady devotion to a very distant goal” be obtained?
4. Should malaria control remain a “vertical target-oriented mass campaign,” or should its responsibility be “transferred to the basic health services”?
5. How will the shortage of technically competent international and national staff be overcome?
6. Of greatest importance, would the technical and financial assistance that had so characterized the eradication era continue?

Much of WHO’s activities in the years that followed can be seen as responding to these questions, particularly points 2 and 5. A major international training program was initiated in the early 1980s that has organized courses at national, regional, and international levels in all aspects of malaria control. With respect to point 2, considerable efforts have been undertaken to refine epidemiological information and evaluation systems that can be used to delineate where and what kind of malaria control should be undertaken. This has helped clarify issues related to point 1.

Point 6 has been addressed by the development of a global strategy for malaria control, which led to the adoption of the Amsterdam World Declaration on the Control of Malaria in 1992 (WHO 1993) and the more recent Roll Back Malaria initiative (Roll Back Malaria Partnership 1999). Point 4 has been addressed by all of the last five Expert Committee on Malarias that have convened since 1980. Point 3, however, has received far

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less attention. It is this point that has plagued many campaign efforts that are organized and carried out under the prevailing system of national health services. I will return to this important point later.

Public Health during the Twentieth Century

To facilitate an understanding of the parallel histories of malaria control and public health, this section covers the whole of the twentieth century, divided into approximately the same three time periods as above.

1900–1954

At the end of the nineteenth century, two different views existed concerning the control of epidemic disease, one old and one new (Litsios 2001a). The old view dated back to the Hippocratic ideas of “miasmas” and “epidemic constitution” in which disease was seen as intimately linked with the quality of the natural environment (i.e., air, water, and soil). The sanitary movement, which had taken place earlier in the century, largely was based on this view of disease causation. The new view grew out of the Pasteurian revolution, that all epidemic diseases were understood to have a microbial origin.

During the initial part of this period, the United States rapidly oriented its budding public health systems to incorporate the latest microbial developments, which were mostly emanating from European laboratories, particularly those in France and Germany. These same countries were slower than the United States to use antimicrobial methods, such as regular immunization against diphtheria (Newsholme 1932). Instead, Europe favored sanitary measures, improved diet, and the development of specialized hospitals for the different infectious diseases, such as fever hospitals.

Stimulated by the financing of private foundations, the United States took the lead in the development and promotion of public health during and immediately following World War I. This lead regressed as the private medical sector in the United States squelched further developments, particularly those related to developing a nationalized, compulsory health insurance system. Meanwhile, public health reestablished itself in Europe after the war and continued to develop along progressive lines. A common feature across the entire industrialized world was the rapidly growing importance given to the control of chronic illness and disability, a shift that relegated the infectious diseases to a much lower priority than they held earlier. In so doing, the center of gravity of public health efforts moved from community-based action toward individual care, especially preventive medical care. This brief, nutshell summary is expanded upon below.

Social reformers led the nineteenth-century sanitary movement in Europe. Differing somewhat from country to country, these reformers shared the desire to bring about broad economic and social change in order to break the link between poverty and disease. In England, for example, epidemic diseases were believed to be caused by environmental filth. Prevention was pursued by the provision of clean water supplies as well as effective sewerage and drainage; the removal of nuisances, such as refuse from all streets and roads; the control of industrial effluents; and the establishment of new standards of environmental and personal cleanliness (Fee and Porter 1991).

The United States was slow to take up the sanitary movement but quick to make practical use of the latest antimicrobial methods emerging from Europe’s laboratories. William T. Sedgwick, a biologist with the Massachusetts State Board of Health, noted, “Before 1880 we knew nothing; after 1890, we knew it all; it was a glorious ten years” (Fee 1987). The

period 1890 to 1910 marked “the start of an era that brought greater changes in medicine and medical practice than at any other time in (American) history” (Duffy 1990).

Stimulated by the promise and early accomplishments of the microbial revolution, Charles V. Chapin, chief medical officer for Providence, Rhode Island, argued in 1911 that health departments need no longer be responsible for social, economic, and environmental measures, because a clean environment “will make no demonstrable difference in a city’s mortality.” More important is to “learn the nature and mode of transmission of each infection [to] discover its most vulnerable point of attack” (Chapin 1934). Chapin used this philosophy to launch what became known then as “the new public health” (Rosenkrantz 1972). He brought together the new knowledge concerning infectious diseases in his book, *Sources and Modes of Infection*. In 1925, Carlos Chagas said that this book “still remains the most complete and most impartial documentary statement of our knowledge concerning the life and virulence of pathogenic microbes in the external world” (Winslow 1943).

The new knowledge concerning infectious diseases led the Rockefeller family to enter the field of medicine in 1901, when the Rockefeller Institute for Medical Research was established (Fosdick 1952). It was followed in 1907 with the creation of the Rockefeller Sanitary Commission, which launched a hookworm eradication campaign in the southern United States from 1909 to 1914 (Ettling 1981). This initiative brought to light the lack of suitably trained health workers to lead state and county health services. Public health schools were required to meet this need. The nucleus of such schools was seen to be an institute of hygiene, which should be autonomous but closely affiliated with a university and its medical school (Fosdick 1952). The first such school was the School of Hygiene and Public Health at Johns Hopkins University. It was built and endowed by the Rockefeller Foundation, and it opened in 1918.

The Rockefeller Foundation envisioned that the school would be used primarily for the training of low-level public health workers—those needed to fill positions in state health departments. William H. Welch thought otherwise. He successfully obtained the financial support of the foundation while establishing a school whose prime strength lay in research and the provision of “high-level education for an elite corps of public health professionals” (Fee 1987). Other medical schools that sought but did not receive support from the Rockefeller Foundation, including Columbia and Harvard, were more interested in the practical sides of public health, including social and economic reform. However, they were judged to have medical schools so oriented to private practice as to jeopardize the long-term survival of an independent school dedicated to the promotion of public health aims. So strong was the Harvard Medical School that it effectively blocked the creation of what would have been the first independent school of tropical medicine in the United States (Curran 1970). Johns Hopkins was different; there, the full-time medical professors were committed to research and teaching rather than to private practice. As a point of contrast, it is interesting to note that the London and Liverpool Schools of Tropical Medicine, which opened in 1898, had no formal affiliation with any medical school or university (Wiebe 1967).

With the establishment of new and largely independent institutions committed to the cause of public health, the vision of public health expanded much beyond its early sanitary orientation. Charles-E.A. Winslow defined public health in the following broad and sweeping manner:

Public health is the science and art of preventing disease, prolonging life, and promoting physical health and efficiency through organized community

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efforts for the sanitation of the environment, the control of communicable infections, the education of the individual in personal hygiene, the organization of medical and nursing services for the early diagnosis and preventive treatment of disease, and the development of social machinery to ensure to every individual a standard of living adequate for the maintenance of health, so organizing these benefits as to enable every citizen to realize his birthright of health and longevity. (Winslow 1923)

In practice, public health differed from county to county. Numerous projects were undertaken with the support of different foundations to help establish model county programs, especially in the rural areas. The Milbank Memorial Fund sponsored one such project in Cattaraugus County of New York State, with a population of around 75,000. This project, which met with Winslow's full approval, incorporated a county health unit, a school health service, a nursing program, tuberculosis control, a consultation service, a laboratory service, nutrition studies, the care of crippled children, and statistical studies. Whereas the unofficial national "standard" county health team had one nurse along with a full-time health officer, a sanitary inspector, and a clerk, that of Cattaraugus grew to have 27 nurses before the end of the project. The nursing service, which was responsible for home visits, bedside care, and school and sanitary inspections, cost more than 40% of the total budget. Winslow judged it to be a model that was "entirely sound and points the way along which other counties should seek to develop" (Winslow 1931).

Whatever vision that might have existed during the early decades of the twentieth century concerning a U.S. public health system along these lines had to give way to the prevailing political (and economic) reality. Most U.S. physicians favored sanitary measures, regulation of food and drugs, collection of vital statistics, and other public health measures. But by moving from the confines of sanitary engineering and taking on the battle against specific diseases, public health "entered the territory of medicine" (Fee 1987). By the 1920s, in fact, the American Medical Association's attitude toward preventive and public medicine was "actively hostile" (Cassedy 1991), as witnessed by the local County Medical Society's attack on the Rural Health Demonstration in Cattaraugus County (Winslow 1931). This negative attitude was fueled by increasing commercial prosperity (Hirshfield 1970) and by the social unrest following World War I, which led to a general distrust of any ideas that smacked of socialism (Wiebe 1967).

Preventive and public medicine fared far better in parts of Europe, where different models were explored in different countries. Under the leadership of Ludwig W. Rajchman, the League of Nations Health Organization (LNHO) blended the Rockefeller Foundation with Yugoslavian, German, and Soviet initiatives into a new program for rural health (Weindling 1995). Although the United States did not join the LNHO and Rajchman was considered too radical by many, the Rockefeller Foundation contributed importantly to these developments (Dubin 1995). The foundation not only financed much of the work of LNHO, it also invested \$25 million in the renovation and building of public health institutions and developed a system of fellowships for graduate training along with refresher courses for those already trained as public health officers and teachers (Fosdick 1952). Through this system, an informal international network of public health institutions grew that in time provided the international public health leaders for the post-World War II period. This network brought together public health schools in the United States with those in Ankara, Athens, Belgrade, Bucharest, Budapest, Calcutta, Cluj, Copenhagen, London, Madrid, Manila, Oslo, Prague, Rome, São Paulo, Sofia, Stockholm, Tokyo, Toronto, Warsaw, and Zagreb.

The hope that creating independent public health schools would suffice to establish a cadre of public health workers who would lead the way to develop national public health systems around the world proved overly optimistic. Grant, for example, who became a faculty member of the Peking Union Medical College in 1921, came to realize that the college was totally irrelevant to the real needs of China (Farley 1980). Modeled after Johns Hopkins, it did not address the diseases, poverty, and problems of “the sick man of Asia.” Nevertheless, the network of schools contributed to the spread of innovative ideas, many of which did lead to important developments in the field of public health.

One important development was the emergence of a model for regionalized health services, one that was largely based on the work of Andrija Stampar, inspector general for health in Yugoslavia (Grmek 1966). The Central Institute of Hygiene in Belgrade served as the technical and methodological center for a network of hygiene institutes. Each regional institute technically and administratively supervised health centers that were responsible for hygienic and epidemiological services in one or more districts. Services included environmental sanitation, drinking water supply, public health education, as well as the administration of antimalaria stations, venereal dispensaries, antitrypanosomiasis centers, and other specific disease services where conditions required them. The 1931 congress on rural hygiene recommended that such health centers should be the basis of all new health-care systems (Dubin 1995).

This model was closely linked with *social medicine*, a way of conceptualizing health that had its roots in nineteenth-century social reforms (Rosen 1948). Stampar fought for the introduction of social medicine into the regular curriculum of medical schools (Grmek 1966). A special Institute of Social Medicine was founded at the Zagreb Medical School under his influence. As formulated earlier in the century by the German physician Alfred Grotjahn, social medicine recognized that the etiology of disease is biological and social. Social conditions may create or favor a predisposition for a disease, cause disease directly, transmit the causes of disease, or influence the course of a disease (Rosen 1948).

Social medicine “places the emphasis on man” (Ryle 1948). When confronted by an ailing individual, the physician would move beyond attempting to determine “what’s he got and what’s good for it” and seek to determine “the overall performance of the individual according to his position in life; that is, in the light of his age, educational, vocational, social, and other prerogatives and obligations” (Galdston 1954). According to John A. Ryle, who in the 1940s was professor of social medicine at Oxford University, social medicine derives its experience from the field of clinical experience and thus finds its place in hospital practice in the form of “social diagnosis and social therapeutics—the investigation of conditions, the organization of after-care, and the readjustment of the lives of individuals and families disturbed or broken by illness” (Ryle 1948).

The growing (theoretical) importance given to social medicine was largely due to the dramatic reduction of certain infectious diseases and the parallel growth in importance of many chronic conditions. As early as 1919, Sir George Newman, chief medical officer of the Ministry of Health of the United Kingdom, declared, “there is a relatively light burden of epidemic and infectious disease, which, with certain exceptions, is steadily decreasing in incidence and mortality” (Newman 1919). In 1926, Winslow noted that “communicable diseases and environmental diseases have been so substantially reduced that the problems of the future are heart disease, the acute respiratory diseases and cancer” (Winslow 1926).

Social medicine probably peaked in importance just when WHO was being founded. Its biases and assumptions were commonly accepted by many of the founders

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of WHO, particularly Stampar (known as the “father of WHO”). It provided the key ideological base on which WHO’s early conception of a national health system was built. This conception took the form of a hierarchical set of health units, which dealt with both preventive and clinical work. Such a system looked to the practice of preventive medicine, *per se*, to control infectious diseases. Traditionally, this “involves some action which in many instances can be compelled by law, and in which the individual is acted on by some one authorized to perform the action” (Galdston 1954).

Strongly conditioning the above history was the industrial world’s limited experience with the tropical diseases particularly related to environmental factors, such as malaria, plague, and yellow fever. Yellow fever and plague were much too short-lived and too marginal in the U.S. twentieth-century experience to allow the natural environment to remain as important in disease etiology as microbes. The “environment” that social medicine explored was a social and economic one; there was little, if any, place for a consideration of vector biology and ecology, human-made malaria, and a host of other issues of importance in the control of malaria and other diseases mostly found in the tropics.

Also of importance in this history is the fact that tropical medicine, as such, developed along lines that “diverged from contemporary European public health policies.” This divergence was most pronounced in England, where Ross’ discoveries served to help stake out new “professional territory.” Malaria control took central place in the “new” profession of tropical medicine, a profession that focused on the parasite, the vector, and transmission, “at the expense of immunity, educational programmes and self-help” (Worboys 1996).

One unfortunate consequence of these earlier developments was the neglect of an independent consideration of the health needs of the tropics at the time of WHO’s establishment. The tropical medicine model for malaria control was a vertical one, which was out of tune with the horizontal tendencies of public health in the temperate countries. Leading public health voices were from the north; tropical medicine was relatively “marginal ... in world medicine” (Worboys 1996).

Further undermining the development of an independent approach to public health in the tropics was the earlier shift in the field of infectious disease epidemiology, from operational field investigations to laboratory research studies. When the Rockefeller Foundation carried out its hookworm program earlier in the century, the purpose was not to control hookworm, *per se*, but “to make demonstrations which will lead ultimately to the enlistment of local agencies in the work” (Ettling 1981). In effect, each demonstration was an applied research project where innovative solutions to the different scientific and operational problems encountered were developed in the field. There was no separating out of any work that might on its own qualify as scientific. Particularly important was the supporting role of public health laboratories, which were used for education and training as well as public health investigations initiated in response to the appearance of “serious gaps in the knowledge essential to successful control” (Farley 1995).

This policy remained in force until Frederick Russell, appointed director of the International Health Division (IHD) of the Rockefeller Foundation in 1928, pushed for the creation of a central laboratory in New York that could carry out more fundamental research, especially in the field of yellow fever. Most reaction from IHD staff was negative. Winslow and Victor Heiser were adamantly opposed, the latter arguing “there is still a tremendous amount of needless suffering and death because existing scientific knowledge has not found its way into the lives of the people.” Heiser was an interna-

tional public health specialist who began his career with the U.S. Public Health Service before joining the Rockefeller Foundation in the Far East. Wade Hampton Frost, professor of epidemiology at Johns Hopkins University School of Hygiene and Public Health, warned that a central laboratory would be acceptable if it were directly geared to the problems in the field, but workers in such laboratories have a tendency to initiate studies from “the standpoint of their attractiveness as intramural laboratory investigations” (Farley 1995).

As greater attention was given to laboratory research, central or otherwise, some began to worry that the whole nature of public health was being undermined. Louis W. Hackett, one of the leading malariologists at the time, interpreted Russell’s “field research” as “lab research in the field rather than ... public health and statistical investigation” (Farley 1995). More foreboding was his observation that the IHD began to offer more support to the “advanced, cultured, and prosperous nations” of the north than to the “poorer, ignorant, and backward countries” of the south. When the IHD closed down its experimental malaria stations in Italy, Hackett pointed out that the absence seemed to have changed the entire character of malaria work in Italy. Field stations, he believed, were “the life of a malaria laboratory.” Without them, laboratories would study bird and monkey malaria to the exclusion of the practical and applied.

All these trends were present when WHO was established in 1948. However, the WHO constitution, adopted in 1946, did not attempt to conceptualize a model health system according to the thinking of advocates of social medicine or other variants that were current then. Instead, it listed various functions related to the health system, such as health services; administrative and technical services, including epidemiological and statistical services; work to eradicate epidemic, endemic, and other diseases; improvement of nutrition, housing, sanitation, recreation, economic or working conditions, and other aspects of environmental hygiene; maternal and child health and welfare; mental health; research in the field of health; and an informed public opinion among all peoples on matters of health.

The WHO Expert Committee on Environmental Sanitation was the first WHO-affiliated body to present a systems view of public health, one based on the premise that the “sanitation of the environment is literally the foundation on which a sound public-health structure must be built” (WHO 1950a). This committee held three sessions, in 1949, 1951, and 1953 (WHO 1950a, 1951a, 1953). The first report was judged by the executive board to have placed “undue emphasis on the engineering aspect of the problem rather than on the sanitation viewpoint” (WHO 1950b). While approving the publication of this report, the executive board requested that the director general, when developing proposals for the future, bear in mind “the advantages of activities in the nature of self-help, education, and stimulation of local interest in favor of general improvement of environmental conditions.” The third report confined its attention to rural sanitation and, in doing so, avoided the question as to what kind of organization is needed to administer rural sanitation programs.

The Expert Committee on Environmental Sanitation did not meet again to consider the totality of environmental health services until 1969 (Litsios 1998). Instead, environmental health services were incorporated in what came to be known as the BHS model, developed by the Expert Committee on Public-Health Administration during its second session in 1953 (WHO 1954). This committee continued in the direction established by the first (WHO 1952), which had met in 1951 and had adopted Winslow’s 1920 definition of public health (amended to include mental as well as physical health). It defined the BHS model in terms of maternal and child health, control of communicable diseases,

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environmental sanitation, maintenance of records for statistical purposes, health education of the public, public-health nursing, and medical care (to an extent varying with the needs of the area and the accessibility of larger hospital centers). Although the functions of a public health service remained more or less the same as those identified earlier by the first committee, staff requirements were greatly enlarged by the second committee. A team consisting of only a physician, a nurse, a sanitarian, and auxiliary workers was judged to be "uneconomical." Rural health units, to provide the greatest efficiency, should have, in addition to a physician in charge, "some five to ten nurses, several sanitarians, and a substantial number of auxiliary workers (including clerical staff)."

This is more or less where matters stood, conceptually, concerning the international view of public health, when the global malaria eradication campaign was launched in 1955.

1955–1974

This period is difficult to characterize. The Expert Committee on Public-Health Administration had defined a model for the health services system that, with hindsight, appears totally unrealistic. The world was caught up in a cold war that made rational discussion of the pros and cons of alternative approaches to social and economic development, including health, almost impossible. It certainly did not help that the U.S. system of health had moved even farther away from providing a model that was in line with the more progressive social health developments of Europe. Not only was the U.S. health system largely dominated by curative medicine, its public health officers were reluctant to take any initiative with respect to public health research or new health problems (Duffy 1990).

In light of the evidence that basic health services were not evolving as it had been hoped they would, it became apparent that studies were needed in individual countries to determine what specific mix of programs and services best suited each situation. The third report of the Expert Committee on Public-Health Administration, in 1959, called for the execution of pilot studies on local health services (WHO 1960). The report outlined how such studies might be carried out and encouraged all countries to make such studies "a routine procedure in health administration." Grant pointed out how important it was that such studies (demonstration projects) conform to "an already existing political unit of the administration of the country in question" under the responsibility of an authority "in the central government for the technical services in question" (Grant 1963c). He viewed such studies as a form of "operations research aimed at developing methods and procedures to secure a greater return on the health care dollar"; particularly important for "developing areas" was the "development of a research arm to facilitate innovation and experimentation with alternative ways of meeting the people's health and social needs" (Grant 1963d).

As the malaria eradication campaign began to falter in the early 1960s, calls for the integration of such campaigns into the general health services intensified. A study group was convened by WHO in 1964 to address this subject (WHO 1965). Study groups differ from expert committees in that they address problems of a highly uncertain character, such as one where expert consensus may not be possible. The 1964 study group reviewed the role of mass campaigns in the evolution and development of health services, assessed the comparative advantages of the two approaches, and reviewed the factors influencing the process of integration. Aware that there was inadequate experience to demonstrate the series of steps involved in developing the general health services in a

manner acceptable to the continuing execution of mass campaigns, the study group concluded that “this is a challenging opportunity for WHO to stimulate and sponsor useful operational research.” The subjects for study identified were “the acquisition and analysis of data on the staffing needs of mass campaigns and general health services in terms of both general and specialized personnel, the financing and organization of campaigns, the methodology of training, and the evaluation of results in terms of economics and of benefits to the health of the people” (WHO 1965).

WHO’s Division of Research in Epidemiology and Communications Sciences (RECS), established in 1967, undertook several operational research studies related to the organization of health services. Most were attached to public health schools supported by the Rockefeller Foundation, particularly those in Cali, Colombia, and Teheran, Iran, where strong professional and personal links existed between Kenneth Newell, the director of the division, and leading faculty members of each school. The idea behind these studies was to demonstrate the utility of population-based epidemiology to the planning of local and regional health services. Also foreseen was the involvement of several North American schools of public health.

Although this effort led to an important health services project in Iran (King 1982), it did not lead to the creation of a network of public health schools as Newell had hoped. None of the North American public health schools that were approached accepted the condition of being involved in a study where someone else would choose their study subject. Nor did most staff in RECS, many of whom were already involved in unrelated studies in Colombia. Instead, these and other public health schools became part of an international clinical epidemiology network established around 1970 by the Rockefeller Foundation. Although in theory the network was designed to sensitize clinicians to community health, the program “focused entirely on hospitals and medical schools” to such a degree that it fueled “perceptions that the Rockefeller Foundation had ‘abandoned’ public health altogether” (Chen 1997). A more critical interpretation of this movement is that it was trying “to stop the development of prevention and public health” as part of a “retrogressive movement ... [where] the medical profession is trying to recoup its fortunes” (Milton Terris, quoted in PAHO 1988). This history provides further evidence of the failure of developing countries to escape the dominating trends of the industrialized world.

RECS, which was disestablished in 1972, did cooperate with the WHO malaria program in the development and carrying out of the Garki Project (Molineaux and Gramiccia 1980). However, whereas RECS staff members were working from the premise that malaria could not be eradicated, the participating staff members from the malaria program were hoping that Garki would demonstrate that eradication was feasible even in the savanna of West Africa (personal communication from L. Molineaux, Sept. 10, 1982). How far apart RECS views were from those of the eradicationists can be judged by contrasting the views of René Dubos (whose works were essential reading for RECS staff) and those of Soper (Litsios 1997b). Soper used his successful attack on *Anopheles gambiae* in Brazil in the 1930s and Egypt in the 1940s to argue in favor of attempting the global eradication of malaria, whereas Dubos argued that what worked in one area might not work in another, owing to the fact that malaria is “a huge congeries of disease, occupying a large number of ecological provinces each with its particular conditions ... (where) the climate, the topography, the plant and animal populations are different, to say nothing of the habits of the human populations” (Dubos 1965).

Although WHO efforts in the field of operational research had faltered, the WHO secretariat continued to promote the idea that each country had to work out its own

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approach to the development of health systems. In a major report presented to the executive board in January 1973, it was found “improbable” that any international model for health services would be developed. Each country “will have to possess the national ability to consider its own position (problems and resources), assess the alternatives available to it, decide on its resource allocation and priorities, and implement its own decisions” (WHO 1973a). This same report announced the failure of the BHS approach, a failure that Halfdan Mahler, WHO director general from 1973 to 1988, characterized as “the most signal failure of WHO as well as the Member States ...” (Mahler 1974).

The resolution adopted by WHA in May 1973 (WHO 1985b) in response to a paper presented to the executive board recommended, among other things, that the organization

- concentrate on specific programs that would assist countries in developing their health-care systems for their entire populations, with special emphasis on meeting the needs of those populations that have clearly insufficient health services;
- improve its capability for assisting national administrations to analyze their health delivery systems through organized research projects, with the goal of increasing their efficiency and effectiveness;
- design its programs so as to encourage member states to develop a strong national will to undertake intensive action to deal with their long-term health-care problems as well as their immediate requirements in a form designed for the orderly development of health services; and
- further develop management methods suited to health service needs and assist countries in developing a national capability of applying these methods.

The executive board also requested that the director general report “on a comprehensive long-term research programme with systems of health care organization on local and country-wide levels” Such a program was never presented to the board. Instead, in January 1975, the secretariat presented a paper on a conceptual approach called *primary health care* (PHC), its principles and assumptions, and a list of ongoing activities that could be considered part of the proposed program, such as technical material for the training of PHC workers and the preparation of technical packages that detail the functioning of select types of PHC services (WHO 1975). Concerning research, the report indicated that “the objectives of each country’s programme should be the prime determinant of the research (health service, epidemiological, operations research, managerial) to be sponsored and conducted.” WHO could be expected to contribute to the evaluation of such research, an activity that it considered should be pursued both nationally and internationally.

From 1967 to 1975, the socialist bloc countries, led by the Soviet Union, pushed for WHO to recognize their centrally planned and administered health services system as a model suitable for other countries to follow. WHO countered, at first, with the call for greater self-reliance on the part of individual countries to develop their own health services system model, and then with a conceptual approach (PHC) that opposed the Soviet model. Whereas the Soviet model was heavily oriented to centrally determined norms and standards, PHC was to evolve from and to be shaped “around the life patterns of the community” (WHO 1975). Furthermore, instead of consisting of a hierarchical series of independent health units, PHC was to be “fully integrated with the services of the other sectors involved in community development.” Although the Soviets failed to have their model officially sanctioned by WHO, they did succeed in forcing the organization to hold an international conference in 1978, in Alma-Ata, then-capital of the Kazakh Soviet Socialist Republic (Litsios forthcoming).

Marcolino Candau, WHO director general from 1953 to 1973, in his 1972 review of WHO's first 25 years, commented that "much of the developing world has had imposed upon it a manpower pattern that is foreign to it and that is unlikely to function properly in the conditions obtaining there" (Candau 1972). Surprisingly, this observation did not seem to attract any attention at the time. Possibly, those who agreed with him believed that the ongoing review of the BHS would make more explicit his concern, which it did not. My guess is that Candau, who started out his career as a malariologist in Brazil, came to this conclusion under the influence of Gabaldón and Soper, both very close to him.

Gabaldón was of the opinion that "the health risks in tropical countries are not only quantitatively different from those of temperate countries, but also qualitatively different." Despite these differences, however, "Latin America continues to imitate the temperate zone health schemes as intensely as possible" (Gabaldón 1969). Soper, who is rumored to have been responsible for Candau being elected WHO director general in 1953, believed that disease campaigns were a necessary prelude to the building of general health service. Lack of enthusiasm (for mass campaigns), he believed, could be attributed "in great part to the previous predominance of schools of public health in the United States as international centers for the training of public health administrators" (Soper 1963). From his review of the past, Soper concluded that the first generation of international health workers—that is, Americans and those trained in the United States involved in the earlier hookworm campaigns—had "moved too fast in [their] attempts to transform the campaigns for the prevention of a specific disease into a general health service." He particularly criticized the attention given to maternal and child health, noting that such services depended on public health nurses who, although available in the industrialized countries, particularly America, were "nonexistent or scarce" in undeveloped countries. Furthermore, they were not needed for any mass campaign.

How far apart the industrialized world was from the developing world during this immediate postwar period can be judged by Grant's observation concerning public health nurses. Whereas Soper noted that none existed in the developing countries, Grant, when examining trends in health care in social welfare in the United Kingdom in 1949, noted that "an outstanding administrative problem with respect to the practice of social medicine in the community ... is the relationship of the public health nurse and the social worker" (Grant 1963a). In other words, even as early as 1949, industrialized countries were facing the problem of redundancy and conflict involving different categories of health workers, a luxury that the developing countries were not yet in a position to afford.

A look at the names of the leading public health specialists who took part in the meetings that led to the creation of WHO and the establishment of its public health program shows that almost all were from nontropical countries. Gabaldón was an exception, but he confined his attention, in Geneva at least, only to malaria, although as I note below, his interests were far broader. Those concerned with the development of the BHS were from temperate countries. They had no practical experience concerning the development of such services or the control of common diseases under tropical conditions.

1975–2000

Mahler (1976) called for a "social revolution in public health." Noting that "social evolutions and revolutions have taken place because the social structures were crumbling," he saw signs that the "scientific and technical structures of public health are also crumbling, because they cannot cope with social needs at a price that most societies can

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afford to pay.” Conditions “appear to be ripe for a truly critical reevaluation in social terms of the means for attaining health.” Mahler believed that four key factors were necessary to bring about the “adoption of an approach to the solution of community health problems that is completely new.” It is necessary for any society

- to determine what social health goals it wishes to attain;
- to identify the health technologies that serve those social health goals;
- to select those health technologies that are not merely sound but that it can afford; and
- to manifest the political will to determine health policies and to create the necessary mechanisms for formulating health programs and developing appropriate health-care systems to implement them.

Social health goals should be shaped by a social justice whereby individual care would be provided beyond what can be afforded for the population as a whole “only when the total population has been provided with a level of care that society considers essential and is able and ready to pay for, even to the extent of making sacrifices in other areas” (Mahler 1976).

As noted earlier, it was during this period that the PHC concept emerged. Another important development was the decision in 1977 that the principal social target in health of member states and WHO was “the attainment by all the citizens of the world by the year 2000 of a level of health that will permit them to lead socially and economically productive lives.” In 1978, the Alma-Ata Declaration identified PHC as the key for achieving “health for all by the year 2000,” known as HFA 2000. The clearest distinction between BHS and PHC was the latter’s call for the use of “appropriate technology” and “community health workers,” the latter to include “traditional medical practitioners and birth attendants.”

Even before the ink was dry at Alma-Ata, the conservative medical community in many industrial countries attacked PHC. They believed that WHO had been overly influenced by the example of the Chinese barefoot doctor and that attention to appropriate technology, as exemplified by the concept of “essential drugs,” would lead to second-rate care. Within WHO, both PHC and HFA 2000 were derided. Those leading the development of PHC did not appreciate that although a “far cry from the definition of the WHO constitution, (but) at least [HFA] is nearer to reality” (Howard-Jones 1981). Instead of exploring how a society might define the contribution of health to social and economic productivity, the impossibility of achieving anything so grandiose by a fixed date was ridiculed.

Even the friends of PHC were undermining its development. Development agencies, in their rush to help countries implement PHC, imposed their particular versions of appropriate technology, setting out timetables for implementation that were totally unrealistic. It was not unusual to find countries where regions were being assisted by different aid agencies and where no single national health system pattern was being followed. Thus, community health workers in different regions were trained differently and for different tasks and responsibilities. Governments were hard pressed to use assistance, and assisting agencies judged their success not by any real progress but by the mere spending of money.

All of these developments led Mahler to denounce the “development crisis,” which he characterized as “too many countries, too many bilateral and multilateral agencies, too many influential individuals [having] become too disillusioned with the prospects for genuine human development to be ready to continue the struggle for it” (Mahler 1985).

The replacement of a universal model such as BHS with a set of principles and general objectives proved particularly unsatisfactory for those who wished specificity concerning exactly what the peripheral health services would be delivering. A counterrevolution set in, which Newell claims already had started at Alma-Ata, where PHC was identified in terms of a list of health problems—adequate food supplies, maternal and child health care, immunization, and so forth—that needed to be dealt with (Newell 1988). The counterrevolution took a sharper form in the notion of “selective primary health care” (Walsh and Warren 1979). Selective PHC purported to place the choice of what to do in terms of the cost and effectiveness of available interventions (Warren 1988). Selective PHC and any other form of priority listing deprive people of their ultimate responsibility to decide what problems their health system should address. The responsibility of the health sciences should be “to describe possible interventions and their implications and costs, but not to choose”; no “collective or world list of health service actions should exist” (Newell 1988).

The counterrevolution gained further ground with the development of indicators such as the disability-adjusted life year (DALY) and the quality-adjusted life year (QALY). These indicators have been and are being used to estimate the total global burden of disease from which alternative interventions in terms of DALY/QALY gained per dollar invested are ranked and national and international health research priorities are established. The use of DALYs suit those in the international community who lobby for the achievement of specific global targets through well-defined interventions, as witness their importance in guiding “efforts in prioritization at all levels of government” and “the direction of investment in international health programs” (NAS 1995). But such prioritization undermines any long-term investment in the improvement of public health systems that meet the criteria called for by Newell and Mahler, that is, building a system that promotes human dignity through an informed and active public role in decisionmaking, a decreasing gap between the haves and the have-nots, preferential allocations to the social periphery, and achievement of a level of health that contributes to socially and economically productive lives. That DALYs divert attention from these goals can be seen most simply by the fact that the total disability attributed to a local disease outbreak that affects the working population is the same whether that population group happens to be employees in secure jobs covered by health insurance or poor farmers who lose their crops and are pushed into a state of destitution.

Concerning malaria, the use of DALYs would not have captured any of the economic benefits achieved during past control and eradication campaigns, such as increased agricultural productivity and the opening up of new lands. DALYs might even not be useful in portraying the importance of epidemic detection and containment. This is reflected in the latest WHO publication concerning health systems, where only “case management (early assessment and prompt treatment) and selected preventive measures (e.g., impregnated bed nets)” are rated as “interventions with a large potential impact on health outcomes” (WHO 2000). Consciously or unconsciously, the use of DALYs and DALY-related indicators favors a magic bullet approach to preventive medicine.

Even if DALYs were accepted as a proper basis for portraying disease burden, the fact that estimates are based on an entire population, national and global, means that the nature of the disease burden among the poor is not properly appreciated. Thus, for example, communicable diseases, which account for 63.8% of DALY loss among the global poor, account for only 10.9% of DALY loss among the global rich (Gwatkin and Guillot 1999). The shift from estimating the impact of disease on the poor in developing

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countries to estimating global burden has led to a lowering of the priority given to communicable as opposed to noncommunicable diseases.

These criticisms aside, the use of DALYs provided the World Bank with a quantitative justification for a new agenda for action, one that called for increased investment in “basic public health services and essential clinical care” (World Bank 1993). Health reform is required that eliminates spending on “discretionary clinical services” so that governments can concentrate on ensuring cost-effective clinical care for the poor. An “essential public health package” would be expected to include immunization and micronutrient supplementation; school health programs to treat worm infections and micronutrient deficiencies and to provide health education; programs to increase public knowledge about family planning and nutrition, self-cure or indications for seeking care, and vector control and disease surveillance activities; programs to reduce consumption of tobacco, alcohol, and other drugs; and AIDS [acquired immune deficiency syndrome] prevention programs with a strong component for sexually transmitted diseases. However, it should be noted that this public health package is largely if not uniquely dominated by interventions whose success depends on their acceptance by individuals, as opposed to the earlier nineteenth-century approach to public health, which called for governments to do “for the health of the individual [that] which the individual cannot do for himself” (Galdston 1954).

The weak state of public health was the subject of several global meetings in the first half of the 1990s. For a while, WHO flirted with the idea of a “new public health” to focus attention on the crisis situation that was seen to exist almost worldwide (WHO 1995). Instead, “new challenges” were recognized, and the call for reforms and change was incorporated in the policy introduced as Health for All in the 21st Century (WHO 1997). The new challenges include globalization, ecology and environment, public–private interaction, governance, social change, community action, and political advocacy. More relevant for this discussion is the introduction of “essential public health functions” that include, among other things, preventing and controlling disease and protecting health; developing health information systems and ensuring active surveillance; and securing adequate and sustainable financing. These functions are discussed next as they apply to malaria control.

Malaria Control and Essential Public Health Functions

In the posteradication period, a situation has emerged in which malaria control has made and continues to make increasing demands on public health systems whose capacity, for all intents and purposes, does not exist. It is precisely the lack of such a capacity that led to the resurrection of the notion of “essential public health functions.” Furthermore, malaria has received very little attention in the general public health literature over the past 30 years or so. Even the fact that malaria is one of the major obstacles to socioeconomic development has only recently returned to the central stage of global thinking. This neglect seems to have been a sort of punishment aimed at those responsible for malaria control for having attempted eradication. Not appreciated by diehard proponents of PHC and HFA was the fact that the shift from infection control to disease control, which was led by the Expert Committees on Malaria in the 1980s, represented a major policy shift for the malaria community. Instead, disease control has been derided because it “does not inevitably lead to health or to what people necessarily want” (Newell 1988). By indicating that health is “not merely the absence of disease,”

the WHO constitution had possibly set the tone for later criticism of efforts that “merely” sought to control or eradicate disease.

Also, from the counterrevolution point of view, the control of a specific disease still has connotations of having been selected by a committee meeting in Geneva; this extreme view condemns disease control programs for being “ideologically similar to the malaria eradication disaster and ... a regression to the very qualities of imposed systems” (Newell 1988). However, instead of imposing a model to be followed by all countries, the global malaria control strategy, which has evolved over the past 20 years, emphasizes the integration of malaria into the national health services system. The idea of integration is not new, but it did get sidetracked during the eradication era.

What follows is a review of certain aspects of malaria control that relate to three essential public health functions. In this review, the function of preventing and controlling disease and of protecting health is considered from an infrastructure point of view—in other words, the kind of organizational arrangements envisioned that include malaria control. Most of this section reflects conceptual positions that have been taken at one time or another by the international community concerned with the malaria problem.

Malaria Control as Part of a Wider Public Health Infrastructure

Most of the early twentieth-century efforts to control malaria were undertaken independently of any other public health problem; they were carried out either as demonstration projects or where control was deemed economically necessary. No doubt there are instances where other public health problems were addressed at the same time (for example, Gorgas’ control of yellow fever at the Panama Canal), but they were exceptions and did not follow any preconceived model.

Only in the 1920s and 1930s, when malaria control in rural areas of tropical countries was under study, was malaria’s relationship with the rest of the health system addressed. The Bandoeng report, for example, indicated that where “malaria is an outstanding social and health problem, the resources of the health administration, specially augmented where necessary, should be directed chiefly towards malaria control, even if this should entail the restriction of other public health activities, until malaria is no longer of major importance.” The responsibility for malaria control “should rest squarely on the minister or other officer in charge of the public health policy of a country and not on the technical expert.” Furthermore, “since malaria is a focal disease ... absent in some rural areas, lightly prevalent in others, and moderately or heavily endemic elsewhere, the structure of, and programme for, rural health organization, including health units and health centers, should not be stereotyped, but flexible” (League of Nations 1937).

This model applied to rural tropical countries. Nontropical industrialized countries were able to control malaria (more or less) using independent means. For example, in the United States, the Malaria Control in War Areas program was established in 1942 to control malaria in the southern United States, where malaria threatened the health of soldiers stationed at the many military facilities located there (Mullan 1989). In 1946, this program evolved into the Communicable Disease Center, which had the responsibility of controlling all communicable diseases. This is a rare if not unique example of a malaria control effort, admittedly relatively short-lived but intense and costly, evolving into a specialized national communicable disease control program. However, malaria

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was, already on the way out; its eradication may not even have required any application of DDT. Had malaria been more extensive and more difficult to control, the separation of disease control from other related public health concerns in the United States, particularly environmental sanitation and housing, might have been less acceptable.

Those who outlined the concept of BHS in the early 1950s, although allowing that malaria campaigns might precede the development of more general health services, preferred to approach campaigns with the belief that the local health services would be intimately involved with campaign implementation. Thus, health services staff “will lay the groundwork for these major campaigns, by education of the people and in other ways” (WHO 1954). They would obtain special training so that they could “undertake contact-tracing, follow-up of cases, and ‘mopping-up’ operations when the intensive campaign is over, as well as participate in the evaluation of results.” Contrary to the conclusion reached by the Bandoeng meeting, specially trained teams of experts would direct the campaign itself. Why this difference existed needs additional historical exploration.

Although PHC replaced BHS in the mid-1970s, the relationship between malaria control and the health services has been described in terms similar to those above. Where a strong health infrastructure exists guided by “strong leadership oriented toward primary health care and preventive services,” most routine antimalaria activities, including some vector control ones, “could be undertaken as an integral part of primary health care” (WHO 1986). Where the infrastructure is less developed, “a specialized unit” may be required for some “vector control operations,” but where malaria “is a high priority problem” and where PHC is weakly developed, “a special project may be the only effective means of implementing antimalaria action.”

Although most attention has been given to placing malaria control in a well-structured and hierarchical health services system, other structural contexts have been suggested that are worth examining, even if only briefly. Mention has already been made of the link between malaria control and agricultural development. Historically, that link goes back many centuries to early efforts to drain swamps and adopt irrigation methods to control mosquito breeding (Najera 1994). Just before the arrival of DDT, the so-called naturalistic measures to control breeding were investigated and their use promoted, “especially such methods as primarily will improve agricultural yields of the land” (Russell 1936). With DDT, a more proactive malaria-agriculture policy engaged the international community for a while.

Malaria control has also been linked with the control of other vector-borne diseases. In 1949, for example, the Italian delegate to WHA proposed that the Expert Committee on Malaria be transformed into one that dealt with malaria and other vector-borne diseases. He described how house disinfection was a common response to several diseases, concluding that it would be “highly desirable that personnel should be trained in the whole field of insect control as a measure of public health” (WHO 1949b). The issue was referred to the executive board, where it was voted down, eight votes to three.

Instead, the control of other insect-borne diseases was addressed in the context of environmental sanitation. The first session of the Expert Committee on Environmental Sanitation took place in 1949. The committee singled out the projected FAO/WHO scheme for combined agricultural development and malaria control to be of particular importance for the development of environmental services. In later sessions (1951 and 1953), the committee strengthened the link between environmental sanitation and general community development, particularly with agricultural progress. This line of thinking ceased rather quickly when eradication became the leitmotif of the program. Still,

some malariologists, including George Macdonald, who chaired the third Expert Committee on Environmental Sanitation, foresaw that the malaria effort would form the backbone of a very large and important international organization (Macdonald, 1954). At the least, when a malaria organization was established in 1954, it was expected that

the development of malaria control would lead to more progress in the control of other tropical diseases.

Not only was malaria control expected to lead to more progress in the control of other tropical diseases, but also

development of malaria control was expected to lead to more progress in the control of other tropical diseases, and also to more progress in the control of other tropical diseases.

through the development of malaria control, it was expected that progress would be made in the control of other tropical diseases.

standards for the control of malaria, and also for the control of other tropical diseases.

health issues related to malaria, and also to the control of other tropical diseases.

were conducted in order to determine the extent of malaria, and also to determine the extent of other tropical diseases.

scenarios for the control of malaria, and also for the control of other tropical diseases.

upon the development of malaria control, it was expected that progress would be made in the control of other tropical diseases.

where no formal organization existed for the control of malaria, and also for the control of other tropical diseases.

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straightforward control tools are used, but such situations are few, and their number will decrease even more as different types of malaria spread around the world.

The nineteenth Expert Committee on Malaria specifically addressed the question of “development of epidemiological skills in the health services” and arrived at this position:

The areas where malaria is most prevalent are also those where personnel trained epidemiologically to evaluate the information obtained by community health workers are in shortest supply. These epidemiological workers are usually stationed at the district health facility (the second referral level), and should have a qualification in biology equivalent to the B.Sc. They require in-service training in stratification, in planning and implementing the programme as it applies to their assigned area, in consolidating and analyzing epidemiological data, and in evaluating the progress of the campaign. They should be trained to identify vectors and changes in vector habits and patterns, ecological changes, vector resistance to insecticides and parasite resistance to drugs, human migration both into and out of their districts, and (to the extent possible, using previous seasonal records and current climatic and parasitological data) to forecast epidemics. These epidemiologists may have to undertake a range of duties, and deal with other vector-borne and communicable diseases which may have epidemiological characteristics in common with malaria. It is particularly important to appreciate that existing personnel already trained only in malaria, or those trained only for other diseases, will require reorientation. (WHO 1992)

Some concerns identified, such as drug resistance, human migration, and climate changes, go far beyond concerns of the district level. For example, the lack of a regional perspective on the spread of multiple-drug-resistant falciparum malaria, the epicenter of which is in southeast Asia, impedes the development of a system of information that would form the backbone of any resistance-containment policy (Kidson, Indaratna, and Looareesuwan 2000). The challenge is more than a simple harmonization of information; the countries involved have conflicting, largely vertical strategies regarding malaria. And the relationship between these vertical programs and PHC is so weak that it “needs to be urgently addressed. There is a great deal of ferment about health sector reform: malaria control is on the sideline in that great debate, it must be brought into the main game” (Kidson, Indaratna, and Looareesuwan 2000).

Molecular-level factors need to be added to this list as well:

The most pressing intellectual challenge, requiring collaboration between researchers and operational workers ... will be to take the rapidly growing body of detailed epidemiological understanding at the micro level and the unfolding work on molecular mechanisms of pathogenesis and so of risk, and to incorporate them, together with socioeconomic considerations, into a macro-epidemiological understanding that can be the basis of operational control programmes. (Bradley 1991)

A personal anecdote shows the size of the gap between malaria specialists and public health generalists concerning how information might be processed at the periphery of PHC. As a faculty member in an international malaria training course, it was my task (as the generalist) to lead a discussion on the relationship between malaria control and PHC. Having just joined the Malaria Action Programme in 1981 after having been chief of Primary Health Care and Rural Development in the Strengthening of Health Services Division of WHO, I had a deep professional interest in developing the issue to the max-

imum extent possible. In one exercise, I distributed a detailed map of a cluster of villages in Turkey and asked the students to develop a control strategy appropriate to each village situation. They did so, but during the discussion one student, who in fact was head of a major national (vertical) malaria control program, rejected the whole exercise. In his mind, it was impossible for any health service system to be so knowledgeable and sensitive to each local situation.

At the time, I took his position to reflect the thinking of a nonrepentant eradicationist and hoped that others with a more open mind would think differently. Now I realize that I had presumed a certain epidemiological capacity on the part of the general health services that normally might not be present. In fact, nowhere in the report to Alma-Ata on PHC can the role of epidemiology be found! Reference is made to multidisciplinary planning teams that include only the disciplines of economics, political science, and other social sciences. In addition, the brief discussion on information is technically nondescriptive. Mention is made of the importance of identifying relevant information, the need for two-way exchange between levels, and the need for information gathering and analysis to be an integral part of PHC activities.

Others had noted that PHC was not incorporating epidemiology in the logic of its functioning, or as one editorial put it, PHC “seems to be bypassing the epidemiological intelligence on which it should be based” (*International Journal of Epidemiology* 1976). But in reality, according to a follow-up editorial, the problem lay in the rank-and-file epidemiologists who questioned their own utility in “health policy” work (*International Journal of Epidemiology* 1977). “Real” epidemiology was a research activity; epidemiology within the health services had been reduced to a routine one that was preoccupied with the analysis of data to develop norms. Furthermore, the editorial continues, epidemiologists were “deliberately relieved of responsibility for program operations and field activities.” PHC programs were being implemented in the Americas “without the essential components of epidemiological surveillance and disease prevention and control” (*International Journal of Epidemiology* 1978). Ironically, the past existence of vertical programs such as malaria eradication was cited as one reason for epidemiology being isolated from program operations.

PHC has not led to the resurgence of interest in surveillance and monitoring over the past quarter-century. Instead, the combined threat of a deteriorating global environment and the emergence of new infectious diseases has mobilized countless new initiatives, many of which offer the potential of radically altering the availability of information at the grassroots level, that is, at the individual malaria foci in the world.

Although it is beyond the scope of this chapter to summarize the current status of developments in this field, some indication of how information for decisionmaking is being approached is relevant for the future direction outlined below. This subject was explicitly addressed at the U.N. Conference on Environment and Development held in Rio de Janeiro, Brazil, in 1992. Chapter 40 of Agenda 21 outlines the commitment taken at that time. One of the major objectives identified is to “strengthen local, provincial, national, and international capacity to collect and use multisectoral information in decision-making processes and to enhance capacities to collect and analyze data and information for decision-making, particularly in developing countries” (United Nations 1992). Indicators for sustainable development are required. Governments are expected to establish “comprehensive information frameworks,” and the international organizations are expected to help create such frameworks along with “supporting mechanisms to provide local communities and resource users with the information and know-how they need to manage their environment and resources sustainably.”

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Various global information networks that address different aspects of Agenda 21 are being established. Similar developments are beginning to occur to in the field of emerging diseases. For example, the U.S. Centers for Disease Control and Prevention (CDC) has developed a strategy for preventing emerging infectious diseases in the twenty-first century in which four interdependent goals are identified: surveillance and response, applied research, infrastructure and training, and prevention and control (CDC 1999). The program of WHO, "the CDC for the world," calls for global monitoring, global information access, strong national surveillance and control, and international preparedness. WHO's Division of Emerging and Other Communicable Diseases was created following the international turmoil caused by plague in India and the Ebola outbreak in Zaire. The division brought together expertise in disease surveillance and viral, bacterial, and zoonotic diseases (diseases of animals potentially transmissible to humans) to address the problem of emerging and reemerging communicable diseases that could become international threats to public health.

Financing Malaria Control

Malaria control, like any other organized affair, requires secure financing if it is to thrive and perform well. Watson was able to find the funds to control malaria in Malaya's rubber plantations and Zaire's copper mines because the relationship between a healthy work force and profits was understood and was immediate (Watson 1953). Gorgas, on the other hand, only managed to obtain a free hand to control yellow fever and malaria while the Panama Canal was being constructed because he had the full backing of the president of the United States (Gorgas and Hendrick 1924; Litsios 2001b). Without that backing, the engineers in charge of the project would never have agreed to allocate the funds needed for his efforts.

When Winslow spoke to the 1952 WHA, he urged that careful records be kept of the cost of health programs and of the actual results attained, including economic ones, so a "sum equal to one half such economic gains be appropriated for the further expansion of the public-health programme" (Winslow 1952). Myrdal, who spoke on the same occasion, argued that the demographic explosion that no doubt would follow any major investment in health would overwhelm resulting economic gains (Myrdal 1952). Myrdal's view cast a deep shadow across the whole rationale for malaria control; as Russell put it, "the satisfaction of malariologists has thus been disturbed" (Russell 1955).

In any case, even if economic productivity could be assured, there was no obvious method for ensuring that a reasonable percentage of health-driven economic gains would be invested in public health. Early efforts in the twentieth century offer no useful example. All major malaria control programs associated with economic projects, for example, never contributed to the building of a public health infrastructure.

When the malaria eradication program was being pressured by WHA in the late 1960s to revise its strategy, it attempted to argue that the economic gains that had been achieved where malaria had been significantly reduced justified maintaining a high priority for malaria eradication and control. Most of that argument fell on deaf ears. Malaria had had its turn; international funding shifted to other global priorities, particularly that of family planning (Gramiccia and Beales 1988).

The threat of epidemics has always been used to mobilize political and economic support for some form of preventive action. Soper did not hesitate in 1938 to superimpose a map of the region in Brazil where *An. gambiae* had invaded on a map of the state of New York to suggest that the whole of the United States was threatened by this inva-

sion. Some “millions of dollars and many years of constant effort” might be needed, but “the problem is such a serious one that such an expenditure might well be justified” (Packard and Gagdelha 1994). Similarly, when the funding of state mosquito control boards is threatened, a mass propaganda campaign is launched to remind the public of past epidemics and the need to remain vigilant. Even better is the appearance of a new mosquito-borne disease, as witness the emergence of the West Nile virus in the United States, which has led many states to reinvest in their antimosquito programs, which had been severely cut back over the past few decades.

The use of threats can go only so far; it is certainly no way to build a permanent public health capacity anywhere. Stable financing is required. Today, the financing of public health work is threatened more than ever by the increasing privatization of the health services. It is not obvious what economic arguments can be used to reverse these trends. Even when improved health can be demonstrated to have positive economic benefits, of the kind Winslow identified 50 years ago, the means for investing some part of those benefits into building and strengthening essential public health functions are still lacking.

Where malaria and poverty contribute significantly to environmental degradation, there is the possibility of justifying malaria control and the alleviation of poverty to preserve ecological wealth. In the past decade or so, a new economics has arisen that attempts to develop realistic arguments that, once accepted, would dramatically alter the way prices are determined and investments are valued. Such an economics, for example, would “impose worldwide prices that reflect approximate real costs (including environmental externalities, worker health, and livable wages)” (Meadows 2000). Where environmental externalities involve saving malarious tropical forests, worker health and livable wages would apply to the whole population living in such areas. (For an example of current thinking on the subject, see the South African New Economic Foundation website at <http://www.sane.org.za/>).

It is important to remember at this point that many of the malaria control programs attempted in the immediate pre-DDT era were built on the premise that malaria could be controlled only if the measures undertaken were intimately related to rural development. Equally important was how the mere presence of DDT led to a dramatic cutback in funds available for such control and development efforts. For example, John McArthur, who proposed experimental villages in Borneo where agricultural practices would suppress mosquito breeding, was denied such funding (McArthur 1947). Today, there is as much risk as then that malaria control will follow the path of the magic bullet, when the long-awaited vaccines for malaria are finally developed and that history will repeat itself.

Malaria and Public Health in the Twenty-First Century

This chapter’s highly selective review of the twentieth-century history of public health and malaria control has brought to light several trends that continue and that greatly undermine the future prospects for health development in malarious countries.

- The policies of western industrialized countries have influenced international public health concepts and priorities. These policies have favored the control of infectious and noninfectious diseases by means of medical treatment. Consequently, the control of vector-borne infectious diseases, especially those that strike in epidemic form, has been increasingly problematic, especially in tropical countries, where

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resources are very scarce but still largely consumed by the provision of curative services.

- Public health is in a state of crisis. As Berlinguer (1999) put it, “The model of primary health care as fundamental to the prevention and treatment of diseases has almost been abandoned. The trend is now toward dismantling the machinery of public health. Even in countries with minimal resources, priority is given to costly technologies, to the exclusive benefit of the happy few. Community services are increasingly replaced by private insurance This is, in brief, a step back to nineteenth-century Europe.”
- Largely opposed to curative services, the discipline of public health exists today in a heavily fragmented manner, where it exists at all, a far cry from its comprehensive, early twentieth-century roots. Dominating decisionmaking methodologies in public health, as evidenced in the use of DALYs, further favor fragmentation.
- Epidemiology, instead of becoming the scientific arm of public health, has become a sophisticated research-oriented practice, more and more remote from the needs of communities. Furthermore, epidemiological research is no longer oriented to the solution of problems encountered in the field, such as those met in the course of efforts to control diseases.
- Malaria control over the past 20 years or so has been pursued under the false assumption that essential public health functions either are present or in the process of being developed. As I demonstrate above, these developments are not taking place. Many malariologists have concluded that the control of malaria in the future must be pursued as an independent, vertical approach, as exemplified by the eradication campaigns of the 1950s and 1960s. Yet it is doubtful, under prevailing political realities, that an independent effort would be allowed to materialize.

Currently, malaria is receiving priority attention on many fronts, with WHO’s Roll Back Malaria initiative—calling to halve the malaria burden by 2010—leading the way. A group of senior health economists has restudied the economic costs of malaria in Africa and concluded that they are many times higher than previously thought. Presented at a malaria summit held in Abuja, Nigeria, in April 2000, this evidence suggests that malaria has impeded development in Africa and that its control is essential if Africa’s poor economic performance is to be reversed. After the call for funding, several multilateral and bilateral donor agencies came forward in Abuja with pledges totaling about \$750 million for malaria. How this funding will be managed remains to be worked out.

One must hope that these initiatives will be successful and reduce the burden of malaria in such a way that what is achieved can be sustained for periods well beyond the initial target date of 2010. Yet many disturbing signs suggest the contrary. What seems to be emerging is an initiative driven by a vertical mentality, so that interventions will not be a consequence of a strengthened local health infrastructure but rather special efforts largely driven by external assistance, technically and financially. History suggests that such initiatives may achieve short-term gains (at high cost) but will not survive far beyond the day external inputs are no longer present. Donors want quick results for their investments, and few malarious countries are in a position to absorb such inputs effectively or efficiently. In other words, many millions of dollars may be spent, but the results will not be as hoped.

If the current push against malaria fails to achieve significant results, the international community could very well abandon the pursuit of malaria control and await newer technologies, particularly vaccines, before reengaging the battle against malaria.

This risk could be greatly reduced if, instead of combating malaria head-on, so to speak, malaria control became part of a much longer-term commitment to build local public health capacities to the level necessary to control all major infectious diseases. Something different is needed, something analogous to the early twentieth-century efforts of the Rockefeller Foundation to strengthen local health units in the southern United States. That program envisaged, but never achieved, the creation of a network of supporting services, including laboratories, that would be on call to serve the needs of the local level.

Each local project needs to demonstrate a local capacity to control malaria. It clearly involves bringing to bear the most up-to-date technical understanding of malaria. It also involves demonstrating the socioeconomic feasibility of maintaining whatever results are achieved. In this regard, one of the key questions to be addressed is to what degree malaria control contributes to economic gains that can justify increased investment in the strengthening of related public health functions. But perhaps the greatest problem facing such a program is the question raised by Bruce-Chwatt, namely, how to obtain a great deal of steady devotion to a very distant goal? It is perhaps here where one can hope to achieve results that have not been possible to date, owing to the growth in recent decades of extraordinarily powerful means of communication. These means allow individuals and communities to be in constant communication with others. Properly organized, such communication should provide a continuous source of encouragement, both psychologically as well as technically. This is a power that opens up new possibilities for developing public health capacities from the ground level up with the active involvement of communities and the active support from all higher levels. Although still largely confined to the industrialized world, modern communication is rapidly coming to the fore in many developing countries, as well. The Madras-based M.S. Swaminathan Foundation (<http://www.mssrf.org>), for example, provides villages with free technology and information in exchange for the villages' promise to house the computers and staff of their operation. Although primarily oriented to sustainable agriculture and rural development, many of the project specifics concern community health issues as well.

How such grassroots efforts will materialize is for national and international public health leaders to determine. Nevertheless, some elements can be gleaned from history, in addition to points already made above, that should be taken into account in such a development. They are addressed below.

Strengthening Local Managerial Capacities

Community development projects have probably been the most successful in their approach to strengthening local managerial capacities. These projects have used various methods; for example, the Montana Study, funded by the Rockefeller Foundation in the 1940s, used a group study guide as a form of community self-analysis with the aim of discussing "in an objective way the economic, social, and cultural problems" present, to find "ways of stabilizing and improving the local economy, and to help people make life in their own town more enjoyable and more secure" (Posten 1950). Another approach, which stems from late nineteenth-century Scandinavian tradition, is the use of adult education to stimulate communities to address major problems they were facing (Adams 1975).

From these studies and empowerment efforts, a wide range of methods have arisen to help local leaders organize their efforts to help the community better address their priority concerns. Today, these methods can readily be found on the Internet; see, for

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example, <http://nrm.massey.ac.nz/changelinks/>, which is dedicated to “improving community participation in the environment and development.”

Where malaria is a concern, local studies might take several, nonmutually exclusive, forms, for example,

- historical accounting of past malaria outbreaks and control efforts,
- understanding the impact of malaria,
- building an epidemiological model of malaria, or
- developing an adaptive management approach to malaria control.

Adaptive management has its roots in more analytic and quantitative efforts from the 1960s to address specific environmental problems (Holling 1978). Whereas the traditional community involvement efforts are largely qualitative in form, adaptive management seeks to develop quantitative models of the problem being addressed. Such models invariably involve extensive field investigations to gather data, interspersed with highly structured workshops that focus on the key question “what would I do with the information if I had it?” This area, too, has extensively grown over the past few decades. A website entitled The Adaptive Management Forum (<http://www.mnr.gov.on.ca/MNR/arm98/amfinfo5.html>) provides URLs of “the various groups, agencies, and universities which are currently at the forefront of the development of adaptive management approaches and their links.”

The local development of quantitative models is clearly benefiting from the increased ability to obtain needed information concerning malaria and other public health problems from external sources, when needed (Fraser and McGrath 2000). Particularly important in this connection is the development and use of geographic information systems (Omumbo et al. 1998).

Active Involvement of Communities, Especially Schoolchildren, in Public Health Projects

Community involvement has been seen primarily as a means of getting local communities to adopt approaches developed at higher levels of government. However, efforts have been made, admittedly on a much more limited scale, to approach involvement as a means of empowering the local level. Although found mostly in community development projects of one kind or another, it was proposed by health development specialists as part of the 1970s PHC movement (Banerji 1978).

The involvement of communities in public health work is nothing new. The special role of schoolchildren has been demonstrated over and over again, but rarely has the power of children been developed and sustained over any length of time. For example, when head of the U.S. Public Health Service in the Philippines in the early 1900s, Heiser (1936) made a point of involving children in educational campaigns undertaken to improve personal hygiene of adults. These campaigns were developed with the Bureau of Education and the active cooperation of churches. One subject was taken at a time—beriberi, cholera, tuberculosis, or “whatever was important at the time.” Similarly, the Rockefeller Foundation hookworm campaigns underscored the community education role that children could play. They were the ones who attended lectures concerning health in full force and who carried “the message home to the older ones” (Ettling 1981).

Malaria history also offers some outstanding instances of children’s involvement. In 1916, when Wilhelm Schüffner attempted to control malaria by destroying adult anophelines, he taught schoolchildren to identify *Anopheles sudaicus*, *Anopheles hyrc-*

nus, *Anopheles annularis*, *Anopheles aconitus*, and *Anopheles vagus*. When he visited villages, as the first ceremony, the schoolmaster, with some of his senior students, would carry bamboo tubes containing freshly caught specimens of each species. They were able to reduce “a pile of hundreds of mosquitoes to five or six smaller heaps of one species each, even without the use of a hand lens—and they never made a mistake” (Swellengrebel 1950).

Education played an important role in the control of the 1930s malaria epidemic in Natal and Zululand (Park Ross 1936). Native schoolmasters were taught how to treat the disease and complications, take blood slides, conduct spleen examinations, and search for *Anopheles* larvae and adults. They addressed meetings and led village discussions to promote the methods being used to control the epidemic. A weekly nature study on mosquitoes was made compulsory for all children from Standard IV upwards.

In one district in India, a health assistant, on his own, developed a system whereby the schoolchildren of one particular year became responsible for educating their parents concerning malaria as well as the students of the lower grade who would take over that responsibility from them the following year (personal communication from D. Clyde, Jan. 20, 1976).

Use of Graduate Students to Support Local Efforts

College-level students are traditionally involved in community activities, as exemplified by the Montana Study. In that study, students from the University of Montana were actively involved to “find ways to enrich the quality of living in Montana” (Posten 1950). This approach also has been used for health development; for example, the Narangwal Studies in India included a rural internship study to prepare doctors for rural service and to develop a rural orientation as part of their medical training (Taylor et al. 1967). Many countries have made compulsory service in rural areas part of the program for obtaining a medical degree, but under the prevailing conditions of isolation, lack of immediate support, and total lack of preparedness for the task, this approach has filled a resource need but little more.

With modern communication methods, it is tempting to suggest that attractive and productive ways of making community service for health development compulsory exist. Medical and public health students could be trained to lead certain school health activities, such as field investigations, microscopic analyses, computer simulations of local epidemic possibilities, and video preparation.

Local schools also should be involved, with their curriculum redesigned to incorporate malaria-related topics. Courses in geography, mathematics, computers, history, and so forth have relevance to disease control efforts and, with the use of modern multimedia approaches, courses often thought dull and a waste of time could be made interesting and—why not?—even exciting while meeting vital needs in the community.

Additional problem-solving programs organized at the community level could also benefit from the input of graduate students who have been fully trained in the use of one or more of the methods indicated above. In countries where participatory management disciplines are taught at colleges and graduate schools, student involvement in local public health projects could be sought.

Making Local Information Available to the Community

Much knowledge concerning malaria and all of its determinants has been accumulated over the past century. But almost all of it rests in institutions far removed from where

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that knowledge has been obtained. Even within countries, certain facts gathered in the course of major campaign efforts have not been made public. For example, many countries did not make publicly available maps that were being used by the eradication campaign, fearing that the maps could be used for military purposes by unfriendly nations.

The communication and information revolution that is in the process of taking place, in theory, should increase the free and easy access to information. It is encouraging many institutions to code their information into electronically readable forms and to provide easier access to these sources. Individuals with strong personal interests (professional or otherwise) are taking the time to create websites concerning very specific subjects.

All needed information is not to be found on the Internet, however, despite claims to the contrary. Malaria history, for example, is still largely an archival affair, with historians delving into diaries, books, and records, mostly covered with dust and not easily found. Bringing local but old historical information back to the communities may require the active involvement of malaria historians. One could imagine a network of historians willing to be involved in historical work in local communities engaging the malaria problem, where, of course, there was sufficient indication that such delving into the past would resurrect points of view as well as actual results of direct relevance to the current situation.

International Role

The international health community has a major role to play in ensuring that the skills needed for the strengthening of local and national public health systems, including non-governmental initiatives, form part of the information revolution. Malaria should be one of the leading priorities in the future, because 60% of malaria deaths occur among the poorest 20% of the total global population (Gwatkin and Guillot 1999). This percentage is higher than any other disease condition, including respiratory infections, diarrheal diseases, and tuberculosis. Clearly, the percentage would be near 100% if, instead of including all countries of the world, only malaria-endemic countries were included.

Health economists are also looking at malaria more carefully to better understand how costly this disease is in direct as well as indirect economic terms. Preliminary conclusions indicate that “despite important local differences ... the burden of malaria is great” (Hamoudi forthcoming). These results support the call for a sustained and integrated global effort against malaria. The recognition that the goals of malaria interventions should be place-specific and should be adapted to particular local ecological, epidemiological, economic, and social conditions suggests that such a global effort must adopt strategies that are designed to build capacities to control malaria in each specific place, that is, in each malarious community.

The strategic elements outlined above suggest the following tasks for international organizations:

- Carry out demonstration projects aimed at enhancing local capacity to control malaria.
- Develop prototype approaches for local capacity building using adaptive management workshop protocols.
- Integrate such projects within wider efforts to strengthen national public health functions.
- Extrapolate the information needed concerning malaria to other situations of the world and make that information readily and easily available on the Internet.

- Encourage national governments to adopt information policies that are supportive of local public health initiatives.
- Encourage and support, technically and financially, national governments in their efforts to reform their educational systems to provide needed support to local public health initiatives.
- Invite the global applied research community, including historians, to be on-call when specific skills are in short supply, locally and nationally.
- Ensure that a representative sample of local initiatives are well evaluated.

Such an agenda is not a quick fix to the problem of malaria. The history of the twentieth century suggests, however, that no such quick fix exists. If the twenty-first century is not to follow the same mistakes that have been made during the past 60 years, then the problem of malaria must be taken seriously; it can only come about when site-specific efforts to control malaria become the common approach, as it was during the pre-DDT period of the twentieth century.

Conclusion

Malaria remains special. Its specialness lies less in the absolute burden of illness and death that malaria imposes than in the fact that its control demands a response from public health systems that few, if any, are in a strong enough position to provide. Malaria exemplifies a problem worthy of a different approach to public health than has been used thus far. It calls for an educated response; no brute force, top-down method will solve it. If active community collaboration is not obtained, available control methods will fail. Malaria is technically as complex as any problem that humankind has had to face up until now and thus should attract the attention of the entire scientific community.

Acknowledgements

Thanks to Andrew A. Arata, Robert Bos, Randall M. Packard, V.P. Sharma, and Burton Singer for constructive comments. Remaining faults and omissions are those of the author, and no one else.

Disclaimer

Opinions expressed in this chapter are the author's only and do not necessarily reflect the policies and views of the World Health Organization.

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