PN-ABT-315

The ACSI-CCCD Experience with Routine Epidemiologic Surveillance:

A review based on implementation experience with 13 African countries
Burundi, CAR, Congo, Cote d'Ivoire, Guinea
Lesotho, Liberia, Malawi, Nigeria
Rwanda, Swaziland, Togo, Zaire

Compiled from ACSI-CCCD Project Records
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This work was supported and made possible by the Africa Bureau, Office of Operation and New Initiatives (ONI) and the Office of Analysis, Research and Technical Support (ARTS), United States Agency for International Development (A.I.D.) through the Africa Child Survival Initiative - Combatting Childhood Communicable Diseases (ACSI CCCD) Project, Africa Regional Project (698-0421) Washington, D.C.

This document was prepared by (staff of the ACSI CCCD project) and does not represent the views or opinions of CDC or of the United States Agency for International Development. The views expressed are solely those of the author.

This document draws upon and reflects the work of the authors' colleagues in thirteen nations of Sub Saharan Africa. These colleagues continue to earn our admiration. Thanks are due also to the many USAID Mission and Washington staff members who supported the CCCD project throughout its 13 years, and who particularly supported and stimulated the development of health information activities by their continued interest in and demand for epidemiologic data relevant to the monitoring of project activities and the evaluation of project impact.

The principal assembler of this document wishes to thank particularly Dr. Stanley Foster for his continued inspiration, and to thank colleagues from Zaire - Dr. Okwo Bele, Dr. Mutombo wa Mutombo, and Dr. Paluku Mbudi - for sharing so generously with him their time, skills, and energy. In addition, Jennifer Bryce, Kelly Bussell, Richard Spiegel, Bradley Hersh, George Stroh, Michael Deming, Marguerite Pappaioanou, Michael Toole, and Ronald Waldman all contributed to the activities described here.

Much of the material reflected here was discussed during a Workshop on Health Information Systems held in Dakar, Senegal, in March 1993 in association with the USAID and CCCD sponsored Forum on Public Health Professionals on Africa's Progress in Child Survival; participating in that workshop were representatives of Burundi, Cameroon, CDC/Atlanta, staff of the Demographic and Health Surveys, MSF/Epicentre, Namibia, Niger, Nigeria, Togo, USAID (Washington and selected field missions), and Zimbabwe. Mr. David Boyd of USAID/Washington provided a superb summary of that meeting.

Parts of the materials included here have been presented previously, notably at a seminar on "Measurement of Maternal and Child Mortality, Morbidity and Health Care" of the International Union for the Scientific Study of Population, held in Cairo, Egypt in November 1991, and at a meeting on "New Findings and Developments in the Measurement of Mortality Levels, Patterns and Trends in Less Developed Countries" of the Committee on Population, National Research Council, in Washington in February 1991.

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Africa Child Survival Initiative (ACSI)
Combatting Childhood Communicable Diseases (CCCD)

in collaboration with
World Health Organization (WHO)
United Nations Children's Fund (UNICEF)
Rotary International

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT
Africa Regional Project (698-0421)
Participating Agency Service Agreement (PASA) No. 0421 PHC 2233

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control
and Prevention
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A

"Disease surveillance was the single, critical factor which transformed previously inadequate control activities into successful eradication programs."

Dr. Donald A. Henderson

"The government is very keen on amassing statistics. They collect them, add them, raise them to the nth power, take the cube root and prepare wonderful diagrams. But what you must never forget is that every one of those figures comes in the first instance from the village watchman, who just puts down what he damn pleases."

Sir Josiah Stamp

"In the long run, I must depend on my wits and on Divine Providence, but in the short run I can now depend on public health surveillance."

Secretary Antonio O. Periquet

"Imagine the newspaper headline, 'New Surveillance System Developed, Valid Representative Data Available.' I doubt it!"

Dr. Ronald Waldman

"If you don't know where you are going, any road will get you there."

Lewis Carroll

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Centers for Disease Control
and Prevention (CDC)
Atlanta GA 30333

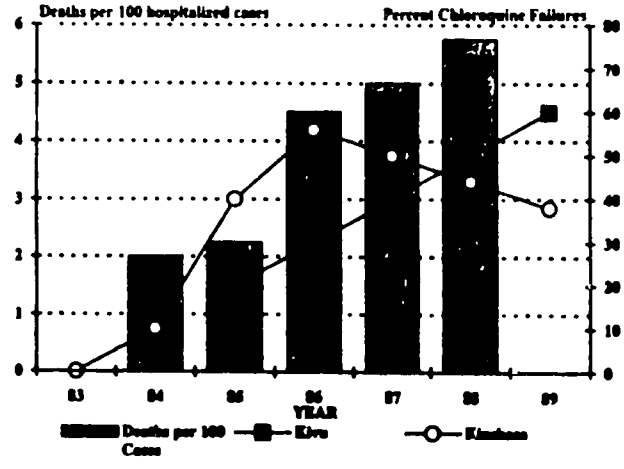
December 1994

Dear Colleague:

We are pleased to share with you two new publications resulting from the USAID-supported Africa Child Survival Initiative-Combatting Childhood Communicable Diseases (ACSI-CCCD) Project.

The first of these documents is entitled "The ACSI-CCCD Experience with Routine Epidemiologic Surveillance." It includes a review based on implementation experience in 13 African countries. This review provides nine lessons for the future (see page 1) and is perhaps one of the most valuable documents of the ACSI-CCCD series of publications. Please note that figure 7 on page 29 was inadvertently omitted. That figure is provided below.

TABLE 7.
Deaths per 100 Hospitalized Cases of Malaria and Clinical Chloroquine Failure Rates Zaire, 1983-1989



The second document is entitled "Malaria Control in Africa: Guidelines for the Evaluation of National Programs." This document presents the efforts of African countries, WHO, and CDC to address the most serious public health problem in Africa, malaria.

We are including a third document "Building on the ACSI-CCCD Experience for the Future," which you received earlier. Please share this additional copy with colleagues.

Sincerely yours,

Jean A. Roy
ACSI-CCCD Technical Coordinator

Enclosures

Executive Summary

This document reviews the experience of the CCCD project with routine epidemiologic surveillance in 13 Sub-Saharan African countries, from 1981 until 1993. Historical aspects of epidemiologic surveillance in Sub-Saharan Africa are briefly reviewed. Key attributes and issues confronting surveillance systems are discussed. The three types of facility-based reporting systems (single site [SS], sentinel [S], and universal [U]) are described. The structure of the CCCD approach to surveillance within the context of development of overall health information systems is presented.

Examples are cited from the CCCD experience to illustrate surveillance efforts in all three types of facility-based reporting systems. These include:

-malaria surveillance in central hospitals in Lome and Kinshasa [SS]
-poliomyelitis surveillance in Kinshasa [SS]
-mortality surveillance in the central morgue in Kinshasa [SS]
-surveillance of diarrhea case management in Zaire, Malawi, and Swaziland [S]
-national sentinel surveillance in Zaire [S]
-sentinel surveillance of measles in Kinshasa [S]
-sentinel hospital surveillance in Liberia [S]
-antimalarial sensitivity surveillance in Guinea, Nigeria, Togo, and Zaire [S]
-preceding birth technique mortality surveillance in large maternities [S]
-universal ambulatory and hospital reporting in Togo [U]
-experience with multiple interlocking systems in Nigeria and Burundi [U]

Nine lessons for the future derive from this review:

First, routine epidemiologic surveillance provides an important segment of information needed to support targeted public health and child survival programs.

Second, routine epidemiologic surveillance systems must be supplemented by or extended to include management and health service delivery information, special surveys, applied research activities, outbreak investigations, and program monitoring and evaluation activities. They serve their purposes best when integrated with other elements of the health information system which contribute to overall knowledge of the health situation.

Third, surveillance systems require investment and support — equipment, supplies, personnel, training, supervision — if they are to function successfully. Such support may be best assured when the Ministry of Health creates a budget line item and allocates resources specific to the maintenance of surveillance systems.

Fourth, surveillance systems are likely to be sustained only where they provide data that are useful in the planning and management of programs ("data for decision making"). As a matter of efficiency, surveillance efforts should be focused upon those programs and problems which can demonstrate that the cost of data gathering is justified by the utility of the data gathered.

Fifth, efforts are needed to assure the quality of data which are collected, reported, analyzed and communicated, and which serve as the basis for decisions. Pertinent concerns include the development and use of standardized case definitions, the simplification of the process of data collection, and development of supervisory systems to ensure timely and complete reporting. In addition, the development of public health laboratory capacity and appropriate methods for laboratory quality control are additional measures to ensure the quality of reported surveillance data.

Sixth, there is a clear need for increased use of data at the local (district or facility) level. This implies both increased capacity development and increased authority for decision-making at this level.

Seventh, training in areas relevant to surveillance will be increasingly needed by staff in African Ministries of Health. Personnel with skills in epidemiology, data management, training and communication will be needed.

Eighth, newer applications of epidemiologic surveillance (eg. surveillance of behavioral risk factors) and use of newer methods will be increasingly important in the coming years.

Ninth, systems of vital registration and mortality surveillance will require increased attention in the next decade. Particularly evident is the need for inexpensive methods which can provide data over extended periods, allowing improved assessment of trends in infant and child mortality.

CCCD Experience in Epidemiologic Surveillance

I. Introduction

II. Historical aspects

III. Attributes of epidemiologic surveillance systems

IV. Key issues
- A. Reasons for surveillance
- B. Types of health information needed
- C. Classification and quantification
- D. Information management and the PC revolution
- E. Active versus passive systems
- F. Training, supervision, and feedback
- G. Inpatient versus outpatient reporting

V. Types of facility-based surveillance systems
- A. Universal
- B. Sentinel
- C. Single site/Facility

VI. Routine epidemiologic surveillance within the CCCD-supported health information system

VII. Key examples from the CCCD Experience
- A. Single site surveillance
  - 1. The central hospital and malaria surveillance:
    - a. University Hospital Center, Lome/Togo
    - b. Mama Yemo Hospital, Kinshasa/Zaire
  - 2. The Kinshasa CRHP and poliomyelitis surveillance
  - 3. The central morgue and mortality surveillance: Mama Yemo Hospital, Kinshasa
  - 4. Surveillance of diarrhea case management in specialized units: Kinshasa, Lilongwe, Swaziland
- B. Sentinel surveillance
  - 1. The Zaire experience:
    - a. National sentinel surveillance
    - b. Measles in Kinshasa
  - 2. The Liberia experience with sentinel hospital surveillance
  - 3. Antimalarial sensitivity surveillance in Guinea, Nigeria, Togo, Zaire
  - 4. Preceding birth in large maternities
- C. Universal ambulatory and hospital reporting in Togo
- D. Multiple interlocking systems of surveillance
  - 1. The Nigeria experience
  - 2. The Burundi experience

VIII. Some Key Obstacles

IX. Role of WHO, UNICEF, and other agencies

X. Lessons for the Future

I. Introduction

A. Introduction to CCCD.

From 1981 through 1993, the US Agency for International Development and the US Centers for Disease Control and Prevention collaborated with thirteen Sub-Saharan African countries in a project called the African Child Survival Initiative/Combatting Childhood Communicable Diseases (ACSI/CCCD). This project was a collaborative effort to apply the principles of selective primary health care,[1] through programs designed to control vaccine-preventable diseases, diarrheal disease, and malaria. Table 1 lists the 13 countries in which the project was active, and the years during which activity occurred.

Table 1: CCCD Countries and Years of Activity

COUNTRY	PERIOD OF ACTIVITY	YEARS OF ACTIVITY
1. Togo	1983-1993	11
2. Zaire	1982-1991	10
3. Central African Republic	1984-1992	9
4. Burundi	1985-1993	9
5. Liberia	1983-1990	8
6. Lesotho	1984-1991	8
7. Swaziland	1984-1991	8
8. Cote d'Ivoire	1985-1992	8
9. Guinea	1985-1991	7
10. Nigeria	1987-1993	7
11. Malawi	1984-1988	5
12. Rwanda	1984-1988	5
13. Republic of the Congo	1985-1987	3

The original project purpose as stated in 1981 was to:

> "strengthen the Africans' ability to control six communicable diseases (measles, polio, tuberculosis, diphtheria, pertussis (whooping cough), and tetanus) through the Expanded Programme on Immunization (EPI); control diseases of local importance such as yellow fever, and yaws, and possibly malaria at some time in the future; and provide simple treatment for the Control of Diarrheal Diseases (CDD)."[2]

The original project objective was to reduce under-five mortality by 25%, through vaccination and improvements in case management. More specific targets — revised to reflect acquired information and experience — were described in 1987[3]:

• mortality:	
under-five	decrease by 25%
neonatal tetanus	decrease by 50%
inpatient diarrhea and malaria	decrease by 50% each
• morbidity:	
measles and poliomyelitis cases	decrease by 50% each
• immunization coverage:	
at age 1 year	increase to 80%
at term with tetanus toxoid	increase to 60%
• effective case management of diarrhea and and malaria in health facilities:	increase to 90% each
• effective case management of diarrhea and malaria in the community	increase to 50% each

In order to achieve these goals, three interventions and four support strategies were originally planned. The three interventions were vaccination (to prevent measles, poliomyelitis, neonatal tetanus, tuberculosis, diphtheria, and pertussis), oral rehydration therapy (to prevent death from diarrhea-associated dehydration), and improved case management of febrile illness (to prevent death from malaria). The four support strategies were training and supervision, health education, operational research, and health information systems (HIS). In choosing the term "HIS," the project planners included and expanded CDC's traditional use of epidemiologic surveillance in the design, implementation and evaluation of health programs. Epidemiologic surveillance had been defined by Alexander Langmuir in 1963 as:

> "the collection, collation, and analysis of health data, with dissemination to those who need to know".[4]

This definition of surveillance has more recently been refined to:

> "the ongoing and systematic collection, analysis and interpretation of health data in the process of describing and monitoring a health event. This information is used for planning, implementing and evaluating public health interventions and programs. Surveillance data are used both to determine the need for public health action and to assess the effectiveness of programs".[5]

The reason that the term "HIS" was selected rather than "surveillance" was precisely because the project planners envisioned that the project would collect information in areas outside the traditional domain of morbidity and mortality, and because considerable effort would be devoted to the collection of process information as a means of monitoring progress in program implementation.

B. Relation of surveillance to health and management information systems.

Health information systems include many activities and sources of information in addition to the routine collection of disease incidence data, which is usually called epidemiologic surveillance. In CCCD participating countries, principal additional activities and sources included national and local censuses, national and local special surveys (particularly including vaccination coverage surveys,[6] surveys of home child care practices such as diarrhea and fever case management,[7] health facility surveys,[8] and child mortality surveys[9]), special studies and operational research, information related to program execution ("process measures" such as reports of vaccinations administered or numbers of personnel trained), and management information (such as quantities of equipment and supplies distributed). There is a complex and overlapping relationship among these several activities which various authors refer to as program evaluation, operational or applied research, and surveillance.[10] Similarly overlapping is the relationship between outbreak investigation and surveillance; while outbreak investigation was not a strategic focus for CCCD, several noteworthy investigations were undertaken.[11] Management information systems (MIS) are subsumed within the HIS rubric, and focus on collection of information on process measures, budgets and finances, personnel, supplies and equipment, logistics, and other data critical to program management.

C. Focus of this document.

This document describes primarily those aspects of HIS related to routine epidemiologic surveillance, by which is meant ongoing surveillance of morbidity and mortality through activities which are desired to continue indefinitely (although the activities may be continuous or periodic in execution). In CCCD countries, this surveillance was primarily performed through health facilities. Some parameters in addition to morbidity and mortality, such as drug resistance characteristics of malaria parasites, are included for illustrative purposes. Examples are also included of one-time analysis of data collected on an ongoing basis, such as the analysis of data from specific hospitals. This document does not seek to describe and illustrate all other sorts of health information activities (e.g. the cited types of surveys). However, the author and the CCCD programs recognize the critical importance of other segments of HIS in assuring the successful function of public health programs, and refers the interested reader to the sources noted earlier.

II. Historical aspects

A. Surveillance and smallpox in Sub-Saharan Africa.

Epidemiologic surveillance for health purposes began under many colonial governments during the 20th century in Africa, but was often limited to the reporting of numbers of cases seen in governmental health facilities. Limited, if any, collation and analysis of data was undertaken at central or peripheral levels. Surveillance in Sub-Saharan Africa was stimulated by major disease control efforts in the post-World War II era. Efforts to eradicate or control malaria,[12] yaws,[13] and smallpox[14] demanded that reliable data be available for the guidance of activities and the allocation of resources.

It was in the context of the smallpox eradication campaign that epidemiologic surveillance first achieved prominence in Sub-Saharan Africa. In the early years of the eradication effort, energies were focused upon the elevation of vaccination coverage. In this context, the role of disease surveillance was limited, because surveillance data did not specifically precipitate action. However, in the late 1960's, the campaign strategy was shifted to disease containment.[15] In this context, disease surveillance became critical, as vaccinations were focused around cases. The prompt and accurate reporting of cases became the specific data upon which program activities were based. Dr. Donald Henderson, the architect of the global smallpox eradication campaign, later stated that:

> "disease surveillance was the single, critical factor which transformed previously inadequate control activities into successful eradication programs."[16]

In addition to eliminating smallpox as a cause of morbidity and mortality, the success of the smallpox eradication campaign in Africa had many additional important impacts upon regional health systems,[17] and several are relevant to CCCD surveillance activities:

1. it provided a first demonstration in many African nations that their Ministries of Health were capable of significant and beneficial actions, and thus that decisions made by Ministries of Health were important
2. it established vaccination as a highly effective and safe prevention technology in the eyes of much of the population of Sub-Saharan Africa;
3. it demonstrated the importance of epidemiologic surveillance in efforts to control endemic and epidemic disease.

Thus, the success of the Smallpox Eradication Program set the stage for the inclusion of epidemiologic surveillance in public health programs in Sub-Saharan Africa in the 1980's.

B. State of Surveillance systems at start of CCCD, including state of vital registration systems.

At the outset of the CCCD project, and despite the lessons of the smallpox program, epidemiologic surveillance systems remained nascent in most Sub-Saharan nations. Their situation was exemplified by that encountered in 1979 by a consultant team seeking data on yaws: in response to a request to review the available national data, team members were ushered into the office of a

mid-level manager in the Ministry of Health, where tall stacks of provincial health reports from the preceding years awaited attention.

There were few epidemiologists, minimal data management capability, little demand for current health data, and few programs for which such data were considered to be important (initial efforts to address these issues were made by the Strengthening Health Delivery Systems (SHDS) project of USAID in Cote d'Ivoire, the Gambia, Cameroon, and Burkina Faso from 1976 to 1982). Few countries in Sub-Saharan Africa possessed functioning vital registration systems anywhere, even in their capitals. Reliable information on births and deaths was only available through national censuses, and these occurred rarely in many nations (for example, Nigeria went for 28 years after 1963 until its next national census).[18] Child and infant mortality rates in most nations in the region were available only through infrequently conducted retrospective surveys.[19] Finally, education was available to the majority of the population on only a limited scale,[20] and literacy and quantitative skills among adults remained limited.

Three potential resources for surveillance did exist:

- first, many individual institutions had established documentation services, and some of these already — in 1980 — had accumulated a decade or more of useful health data;[21]
- second, in many countries a colonial legacy of careful attention to documentation remained throughout the health systems; this was particularly true in francophone Africa, where routine submission of lengthy report forms remained a norm; and,
- third, the smallpox program left a positive legacy concerning the utility of surveillance.

Thus, the situation confronting the CCCD project at its inception was one of limited health information infrastructure, on a background of focal points of considerable strength and the recent success of the Smallpox Eradication Program's surveillance activities.

III. Attributes of epidemiologic surveillance systems

It is helpful as background to consider briefly the various attributes of surveillance systems. Seven attributes of surveillance systems were formally described by epidemiologists at the Centers for Disease Control in 1986: simplicity, flexibility, acceptability, sensitivity, predictive value positive, representativeness, and timeliness.[22] These are listed and described in Table 2.

Table 2: Attributes of Surveillance Systems

ATTRIBUTE	DEFINITION OR COMMENT
Usefulness	Capacity to contribute to the prevention and control of adverse health events, including an improved understanding of the public health implications
Simplicity	Refers to both structure and ease of operation; considers flow of information and lines of response
Flexibility	Ability to adapt to changing information needs or operating conditions with little additional cost, time, staff
Acceptability	Reflects willingness of individuals and institutions to participate
Sensitivity	Proportion of cases detected, and ability to detect epidemics
Predictive Value Positive	Proportion of persons identified as cases who actually do have the condition under surveillance
Representativeness	Ability to accurately describe the occurrence of a health event over time and its distribution in the population, and thus of the ability to generalize findings from surveillance data
Timeliness	Reflects the speed or delay between steps in a surveillance system

Each of these attributes are considered in the evaluation of surveillance systems, which involves the step-by-step detailing of what activities are expected at each level of the system (that is, as observations of individual persons and events are recorded, as these data flow from the clinic to the central levels, as the data are collated and analyzed, as feedback is provided to the reporting sites, and as actions are taken predicated upon the information received). These attributes have been considered in the descriptions of individual CCCD surveillance experiences provided in this report.

Additional pertinent features of surveillance systems are:

- Coverage refers to the proportion of the population of interest which is actually under surveillance by the surveillance system; it is related to, but distinct from, representativeness.

- Completeness of reporting refers to the proportion of all reporting sites that do in fact submit reports at the expected time; it is generally estimated by dividing the number of reports received by the number of reports expected.

- Feedback refers to the provision of information derived from data analysis to the reporting sources, enabling them to take action in response. The functioning of surveillance systems depends on the extent to which information flows in BOTH directions; the components in the system need feedback to fulfill their functions successfully.

- Case definitions are the means by which standardization of surveillance reporting is achieved. Standardized definitions assure that reported cases meet minimum standards for diagnosis. They should be easily understood and applied by all reporters. Appropriately chosen case definitions facilitate the achievement of acceptable levels of sensitivity and positive predictive value.

In addition, surveillance systems share basic managerial realities common to organizations. They rely upon the availability of basic materials and equipment, from paper and pencil up to (sometimes) computers and appropriate software for data collation, data analysis, and report production. They are associated with costs, for the personal and financial resources expended in collecting, processing, analyzing and disseminating the surveillance data. These include the costs of training and supervision of personnel, of provision of feedback, and of equipment such as computers. And surveillance systems have explicit requirements for personnel with specific skills and training, and the responsibilities of those persons must be clearly delineated.

Each of these features was relevant to the CCCD surveillance experience, and most will be further considered below.

IV. Key issues

General conceptual and operational issues in epidemiologic surveillance are thoroughly discussed in recent texts.[23] Only a few of these issues are discussed below.

A. Reasons for Surveillance.

The purpose of surveillance is to gather information which will stimulate specific public health actions.[24] Thacker and Berkelman[25] list the uses of surveillance as including:

> "detecting new health problems..., detecting epidemics, documenting the spread of disease, providing quantitative estimates of the magnitude of morbidity and mortality, describing the clinical course of disease, identifying potential factors involved in disease occurrence, facilitating epidemiologic research, targeting resources for program intervention, and assessing control and prevention activities."

CCCD surveillance efforts were directed towards each disease or condition whose prevention was the specific target of the project. The uses of surveillance data in the CCCD project included all of those listed above, but particular use was in the areas of policy development (e.g. targeting of vaccination strategies; e.g. selection of recommended antimalarial therapy) and program monitoring and evaluation (e.g. assessment of program effect upon epidemiology of target diseases). More recent attention has been focused on the potential use of surveillance information in district level management,[26] but actual application at this level was not formally systematized and evaluated under the CCCD project.

B. Types of health information needed.

In relation to CCCD objectives and targets, a variety of sources and means of gathering data were obvious objects for surveillance activities. The use of traditional facility-based morbidity and mortality data were readily engaged by project staff and consultants. More challenging were the needs to monitor the quality of care provided in facilities as well as the overall child mortality. The information needs in these two domains were generally met by special surveys, rather than by routine epidemiologic surveillance. Strategies to obtain quality-of-care data on a routine basis were successfully implemented briefly in Rwanda, as part of a national health-worker supervision project. The issue of quality of care remains challenging even in the setting of developed nations. To respond to the need for data on the quality of case management and prevention services in the CCCD project, one particular methodology — the facility-based assessment — was added to those already in place.[27] To date, this has been a special survey activity rather than a part of "routine" surveillance; efforts are underway to standardize many aspects of the method and to promulgate its use in support of several specific World Health Organization programs, such as those addressing diarrheal and respiratory diseases (CDR) and AIDS (GPA).

The need for reliable mortality data in Sub-Saharan Africa remains a challenge for the decade of the 1990's. Few, if any, countries of Sub-Saharan Africa were able to establish valid and reliable systems of vital registration during the 1980's.[28] The paucity of reliable information on levels of infant and child mortality in Sub-Saharan Africa will continue to pose difficulties for programs in child survival.

One item of service delivery (or "process") information was gathered by all CCCD countries with as much or greater care than was given to the gathering of routine surveillance data — records of numbers of vaccinations administered. Administrative data on vaccinations administered was adopted in most, but not all, CCCD countries as the standard basis for estimation of vaccination coverage; a few countries continued to rely upon special coverage surveys for this purpose. Extensive discussion of coverage measurement is provided by another document in this series, and it is thus not considered in detail here.[29] However, the link between vaccination coverage data and EPI morbidity data was more than theoretical: in many CCCD countries, childhood vaccines were available only through the CCCD project, and often the vaccine depots required receipt of vaccination and surveillance reports before the next lot of vaccines was released to district officers.

Finally, the challenge of behavioral surveillance was engaged by CCCD with only limited success. Selected maternal behaviors, such as diarrhea and fever case management practices, were addressed by questions added to vaccination coverage surveys or by special program-specific surveys.[30] In general, however, CCCD was not notably successful in introducing and utilizing standardized methods for the collection of data on behavioral risk factors, which could be easily used for tracking trends over time and assessing program progress. Efforts were underway near the close of the CCCD project to develop locally sustainable methods for behavioral surveillance in Nigeria, using as a model the Behavioral Risk Factor Surveillance System of the United States.[31]

C. Classification and Quantification .

Surveillance systems confront issues in both classification and quantification. Classification issues are those related to correct diagnosis of each case (or non-case). Quantification issues are those related to the difference between the actual numbers of persons or events occurring in the population, and the number of persons or events counted or estimated by the system. Problems in either area affect the usefulness of data derived from the system.

1. Classification. Several types of classification issues are pertinent to surveillance in the developing world, and three are discussed below. First, all surveillance systems should address the definition of a case.[32] Some systems leave the determination of what constitutes a case to the reporting source, usually a physician or laboratory; others prescribe specific case definitions to be used by those reporting.[33] In most developing nations this issue is complicated by the general lack of laboratory support, resulting in the necessity of diagnosis on clinical criteria alone. Standardized clinical case definitions for many of the major pediatric health problems in the developing world (selected vaccine preventable and diarrheal diseases, malaria, acute lower respiratory infection and disease due to infection with the human immunodeficiency virus) have been proposed by the World Health Organization.[34] The sensitivity and predictive value positive of these clinical definitions vary; they appear high for measles and poliomyelitis, moderate for dysentery and ALRI, and low for malaria, pertussis, and HIV disease.[35] Although a substantial base of information for the development of standardized case definitions exists, few CCCD nations have yet adopted or widely disseminated standardized case definitions (in fact, the United States did not propose such standards until 1990).[36]

A second classification issue involves the use of laboratory tests in assisting diagnosis of disease. All nations have been eager to acquire and utilize laboratory technology, but the ability of most CCCD nations to support this technology over long periods has been limited. In particular, adequate attention is irregularly given to the important problem of quality control. Two issues are involved: the technology for making certain laboratory diagnoses may not exist at all (e.g. the capacity to perform blood cultures for the diagnosis of septicemia), and good quality control (i.e. to ensure that the results of laboratory tests are reliable where they are available) may be lacking. This latter issue can be quite important, as is shown by the example of Kinshasa's Mama Yemo Hospital below.

Third, a problem which is not unique to CCCD or developing nations generally, but which must be resolved, is the issue of primary cause of death. Even in circumstances where the clinical and

laboratory data are of adequate quantity and validity, it is often difficult to determine what should be defined as the primary versus secondary causes of death. For example, what is the primary cause of death for a malnourished child of an impoverished illiterate mother who dies of pneumonia complicating measles; or, what is the primary cause of death for a similar child who dies of a febrile illness with severe anemia and dehydration? This is a classic problem.[37] It has received substantial attention in the developed world, where detailed procedures exist to guide vital registration personnel in their determinations of underlying cause of death.[38] Few such guidelines exist that are appropriate for developing countries,[39] and the need for such guidelines is apparent.

2. *Quantification*. Many of the quantification issues can be exemplified by considering the case of hospital-based surveillance systems. Under CCCD, hospitals were one of the major sites at which epidemiologic surveillance was carried out. Hospital-based surveillance systems (HBSS) are by definition limited in coverage, since in most developing countries, only a part of the total population utilize hospitals. A large portion of the non-using population does not reside near enough to hospitals to seek care in the event of acute illness. Use varies according to several factors, including the number of hospitals and their distribution in the country, adequacy of transportation infrastructure, patterns of population density, the perceived efficacy and cost of care, and the severity of the illness. One consequence of differential use is that hospital-based data do not represent (or represent inaccurately) that segment of the population lacking full access to hospital care. The degree of misrepresentation also varies for particular causes of death. The most often cited example of this problem is that of neonatal tetanus (NNT). NNT is known to be a serious problem for rural and poorly educated populations with limited access to health and hospital care. As a consequence, cases of NNT have a reduced probability of being detected by hospital-based surveillance, in comparison to many other diseases. This assertion is supported by recent estimates: of the 160,000 cases of NNT estimated to occur annually in the Africa region of the World Health Organization (46 countries), only 3% are reported officially.[40] Thus, health problems of the poorest and most distant segments of the population are likely to be under-represented in hospital-based surveillance in resource-poor nations. Some hospital-based surveillance systems have recruited only the better-managed and more technically able hospitals. Such systems are often dominated by one, or a few, central facilities, and fail to represent the nation's hospitals as a whole.

A second quantification issue concerns completeness of reporting. Several aspects are relevant. First, all facilities must report in a timely manner if tabulation is to be meaningful. At the beginning of CCCD, few countries in Africa regularly published data on completeness of reporting; throughout the project, efforts were made to monitor the proportion of facilities reporting in many CCCD countries.[41] Second, reporting from individual facilities should include all cases. However, especially in the large urban hospitals which often dominated CCCD-country surveillance data, cases and deaths occurred in multiple sites within the facility, but were not always counted at all sites. For example, in many hospitals in CCCD countries, either there was no central site for registration of all deaths, or that site was distant from the pediatric ward and its register did not allow ready extraction of pediatric deaths. Child deaths occurred in the emergency room, in the delivery suite, in the nursery, in the pediatrics ward, in the neonatal intensive care unit, in the pediatric intensive care unit, in the operating suite, or in other specialized units such as ORT units. Reporting from the pediatric ward alone sometimes missed deaths occurring in these other areas, and thus underestimated pediatric mortality. If all deaths are to be included in a surveillance system, then

considerable time, personnel effort, and internal reorganization may be required to assure that reporting to a central registry is timely and complete, or that each site is visited in each reporting period to register all deaths.[42]

A last example of quantification problems concerns denominators for population rates. Cases or deaths in hospital are numerators only. One reasonable denominator might be the number of persons at risk for being hospitalized in that facility; however, most health facilities have difficulty in estimating their catchment populations. A second approach to this issue assumes that reported cases represent a minimal estimate of the number of cases occurring; population data are used as denominators to calculate a minimal population rate. As noted above, however, the frequent absence of valid and current census data — especially data appropriate to the regional, district, or city/town level — renders difficult the estimation of such disease rates. A second approach expresses the cases or deaths as a proportion of total admissions or of total deaths that occur over the same period of time. This approach seeks to address the concern that rises or falls in cases or deaths might be due to changes in rates of admission to the hospital for the cause of interest. It is not a fully satisfactory solution, however, since extraneous factors may alter this proportion (e.g. increases or decreases in admissions for diseases other than the one of interest, due to changes in disease patterns or to changes in the availability of care).

D. Information management and the PC revolution.

The 1980's witnessed the wide dissemination of the personal computer for all types of information management. Prior to the 1980's, the surveillance systems in most CCCD countries were pencil and paper systems, with very little automated data management and analysis. The first CCCD epidemiologists went to the field with early models of Kaypro® portable computers, and the precursor softwares to the first version of CDC's surveillance and epidemiologic analysis software, Epi Info.[43] By the end of the CCCD project, Epi Info had undergone 4 major revisions, and personal computing in surveillance offices of some CCCD countries (eg. Zaire, Nigeria) had advanced to include computers based on the 486 chip, with Bernoulli boxes for storage of large data sets, the advanced data analysis capacities of Epi Info's version 5.01b and the surveillance data mapping capability of Epi Map software.[44] In addition, diverse softwares for data management, word processing, graphics production, and desk-top publishing of reports were in routine use. In the majority of countries, however, surveillance data were handled through computer systems relying either on Epi Info or upon simple spreadsheets and database softwares.

The revolution in the way in which surveillance data were handled had both positive and negative effects. The major positive impact was upon the extent and speed with which information derived from surveillance data became available to program managers and decision makers. Annual reports filled with surveillance and administratively-derived project data were available within 4-8 months of the end of the year, and data were available for planning purposes even sooner. However, these machines and softwares sometimes increased the "distance" between the data sources (health workers and health facilities, generally) and those responsible for collating, analyzing and disseminating these data (the central office personnel), by focusing attention on softwares, analysis strategies, and graphics rather than upon field visits, verification of findings,

and direct communication with field workers. This particularly posed a problem in those CCCD countries whose communication and transportation infrastructures were quite limited.

E. Active versus passive systems.

Surveillance systems are called "active" if staff receiving surveillance reports take actions to assure the receipt of surveillance reports, such as soliciting reports and following-up sites which have failed to report. In contrast, systems are called "passive" if staff depend on the peripheral levels for timely and complete submission of reports, and take no specific measures to insure the timeliness or completeness of reporting. In general, active surveillance provides more complete and more timely information; however, passive surveillance is usually less costly and demands fewer personnel. Typically, "as programs mature and cases become more uncommon, surveillance tends to move from the simple passive collection of limited data on cases to more sophisticated [and active] individual case investigations...."[45] Throughout the course of CCCD, most country surveillance systems were a mixture of passive and active components (i.e. reports were awaited passively, but often requested if not received in a timely manner). However, individual projects were also undertaken which involved active surveillance efforts.

F. Training, supervision, and feedback.

Training and supervision of personnel involved in surveillance activities generally receive inadequate attention. In the United States, for example, public health surveillance has begun only recently to appear in the curriculum of schools of public health (Harvard 1989; Emory University 1992), and it remains the subject of perfunctory attention in most U.S. schools of medicine. In CCCD countries, training in surveillance concepts and skills was not separately organized. The project did not promulgate a rigidly standardized approach to surveillance, but sought to adapt surveillance methods and structures to each individual country situation. To the author's knowledge, public health surveillance did not receive substantial attention in pre-service health care worker training in CCCD countries. Surveillance was included in the CCCD Training Modules developed by CDC for in-service and introductory training of program personnel. The World Health Organization's programmes included the subject of surveillance in many of their training activities, and some of the training materials developed in this respect are excellent.[46] These materials were most successful when they were used or included in the training of district managers, linked to specific program implementation activities and responsibilities. Several CCCD countries adapted these materials to their local settings, and used them in the training of a generation of district health officers.[47] The School of Public Health at the University of Kinshasa in Zaire, in collaboration with Tulane University and with funding support from USAID-Kinshasa, offered summer courses in the use of computers in data management, and one module of that course involved exercises in nutritional surveillance.[48]

In most countries, supervision of surveillance activities performed by health workers was not rigidly formalized. At the central level, it relied upon frequent interaction between the CCCD technical officers and epidemiologists, and the national program staff. At regional and peripheral levels, supervision of surveillance activities was included in the overall program of supervision, which was variably successful. However, attention to consistency and frequency of reporting was

included in every supervisory effort and program evaluation undertaken by the CCCD project. Surveillance was a continuous project concern.

One important means by which some supervisory functions were accomplished was the provision of feedback to reporting sources; this was achieved in two manners. First, the annual CCCD reports became, throughout the life of the project, increasingly more extensive and more data-based. This was true for individual country reports as well as for the overall project reports prepared in Atlanta. Second, most CCCD country projects produced within-country a feedback bulletin as well as an annual report. The regularity and longevity of these publications varied by country, and some were highly dependent upon the presence of expatriate expertise and external funding. Notable successes in the production of feedback bulletins were achieved in Zaire (Sauvons Nos Enfants), Nigeria (Nigeria Epidemiology Bulletin), and Burundi (Bulletin Epidemiologique du Burundi), and in each country was the result of collaboration between CCCD project national staff and CDC field staff.

G. Inpatient versus outpatient reporting.

Facility-based reporting systems in CCCD countries drew upon both outpatient and inpatient sources. Inpatient reporting is biased towards more severe cases, since only the more seriously ill cases require hospital admission. However, only inpatient sources are likely to offer mortality data, since deaths are not likely to be reported from the outpatient setting. Either type of source will include the bias of using information generalizable only to those persons who have access to health facilities. The importance of this bias is likely to be greater for conditions afflicting the rural poor and for conditions likely to be rapidly lethal (e.g. neonatal tetanus). Also, the use of both inpatient and outpatient sources in the same system creates the opportunity for duplicate reporting (for example, cases of measles seen as outpatients may be reported a second time, when they become inpatients). In many CCCD countries such duplicate reporting occurs; its magnitude is uncertain though likely small.

V. Types of facility-based surveillance systems

A. Universal.

The term "universal" (or "global") refers to surveillance systems which seek to obtain reporting from all possible facilities or sites. Such systems are operative in many developed and developing nations. It is a common circumstance, however, that such systems are characterized by subgroups of reporting sites which report very well or very poorly. In such circumstances, the system may provide substantially less than "universal" representation. This was the case for reporting systems in many CCCD nations at the outset of the project: universal reporting was formally required, but in practice completeness of reporting was low and the amount of information being requested was excessive in relation to its utility (e.g. in some countries, regular reporting of several hundred conditions was required). Several different approaches have been proposed to address these issues:

- the small and highly centralized government of Togo sought to establish nation-wide hospital based reporting, relying upon standardization of procedures and computerization;

- strengthened surveillance activities in Burundi included an effort to reduce the number of conditions for which routine surveillance is required;

- in Nigeria, the largest of CCCD countries, multiple overlapping surveillance systems were developed, some of which (e.g. the system for reporting of notifiable diseases) remain universal in scope.

B. Sentinel.

In the CCCD context, sentinel surveillance refers to routinely conducted epidemiologic surveillance limited to a small number of surveillance sites or populations. An example of sentinel surveillance is the collection of information on cases of measles admitted to specific hospitals. Sentinel systems present several advantages and disadvantages relative to universal systems of surveillance. The advantages are impressive from the perspective of developing nations. Sentinel systems are simpler than universal systems, because fewer sites are involved. In addition, the sentinel sites may be health facilities with a special interest in participating in the surveillance activity; specialized facilities with access to select populations, such as clinics for persons with sexually transmitted diseases or with physical handicaps; or facilities with particularly strong laboratory or diagnostic capabilities. The participating facilities usually have a high rate of correct and accurate reporting, and greater motivation to report promptly (greater timeliness). Reporting from a smaller number of more motivated participants is often more complete and less costly than reporting in a system attempting to cover all possible reporting sites. More detailed information on cases is often obtainable from sentinel systems. In addition, sentinel systems often involve "model" facilities, which can serve as training sites for the expansion of the surveillance effort to additional sites. Sentinel systems, like other types of surveillance systems, may be either active or passive in nature.

A major disadvantage of sentinel surveillance systems is that the population under surveillance may be less clear than is the case with universal systems; sentinel systems will certainly be less representative of the entire population. This degree of non-representativeness can vary according to the individual situation, as will the implications for decision making. For example, health facilities chosen as sentinel sites are less likely to be in remote or peripheral areas. Although sentinel systems can provide useful information concerning trends in the occurrence of health events they usually do not provide robust estimates of population-based rates. This is sometimes an important limitation.[49] Another disadvantage of sentinel systems is the risk that the population under surveillance may change, resulting in considerable distortion of trends estimated from the data. This risk is particularly important for facility-based systems and imposes a need to monitor the demographic characteristics of the population using the facility. For example, abruptly increased use of an urban sentinel hospital by poorer persons might cause an apparent, but false, increase in the rate of an income-associated disease. Proposed criteria for selection of sentinel surveillance sites have been published by WHO.[50]

C. Single site/Facility.

As noted earlier, many individual facilities in CCCD countries have maintained institution-specific health data (e.g. case counts for major diseases of interest) for many years. The advantages of such datasets are their inclusion of long periods of time (often several decades), the relative consistency of their procedures, and the existence of institutional memory concerning the data. The disadvantages inherent in such record systems include the lack of representativeness of the data, the difficulty some facilities have in defining precisely their catchment populations, and the susceptibility of such datasets to variation introduced by fluctuation in facility use (due, for example, to changes in economic conditions or to varying competition from other facilities in the same area). In general, such datasets have proven invaluable in many CCCD countries, and often are consistent with data from other sources. They have been most useful when derived from referral centers which encounter a very large proportion of incident cases (e.g. specialized rehabilitation facilities for poliomyelitis surveillance).

VI. Routine Epidemiologic Surveillance within the CCCD-supported Health Information System

Technical assistance for national health information systems under CCCD was intended to follow a logical sequence of:

1 - Planning and definition of objectives,
2 - Implementation of planned activities,
3 - Evaluation of system performance, and,
4 - Modification as needed and indicated.

An initial planning exercise included structural and functional assessments of the current system (both what was reported and how well the system operated with respect to data flow and timeliness, completeness of reporting, performance of data analysis, provision of feedback, and use of data). A plan to meet project data requirements was developed, which included assessment of requirements for computing hardware and software, and for personnel development. Needs for continuing epidemiologic support were noted, and funding support was planned as necessary (e.g., for purchase of computers and printing of bulletins).

Guidelines for identifying specific data needs of the individual programs (immunization, diarrheal disease control) usually followed global standards, and included a variety of elements and methods which are shown in Table 3.

While virtually all CCCD countries were able to satisfy these requirements at some level, there was considerable variation among countries in their capacity to respond to each of them with data of high quality. The methods for gathering some of these specific data evolved over the life of the project (e.g. health facility assessments;[51] e.g. in-vivo surveys[52]). Furthermore, repeated national-scale surveys were successfully executed either in small countries (e.g. Burundi, Central African Republic, and Lesotho) or in large countries (e.g. Nigeria) with specialized external assistance, such as that provided by USAID's Demographic and Health Surveys.[53] The representativeness of the available national data varied considerably by country, and CCCD sought to collaborate frequently in data gathering activities with other projects and international organizations, such as the World Health Organization and UNICEF. Also indicated (through shading) in Table 3 are both those types of surveillance which were considered routine, and the other surveillance activities which are illustrated in this paper.

Table 3

DOMAIN	DATA NEEDED	ROUTINELY COLLECTED ?	ARTS PAPER IN WHICH TOPIC IS DISCUSSED
Vaccine preventable disease	Vaccinations administered by antigen, dose, & age	YES	IMMUNIZABLE DISEASE (EPI)
	Outpatient morbidity	YES	ROUTINE EPID SURVEILLANCE IMMUNIZABLE DISEASE (EPI)
	Inpatient morbidity & mortality	YES	ROUTINE EPID. SURVEILLANCE, IMMUNIZABLE DISEASE (EPI)
	Coverage surveys	VARIABLE	IMMUNIZABLE DISEASE (EPI)
Diarrheal disease	Outpatient morbidity	YES	ROUTINE EPID. SURVEILLANCE
	Outpatient management	VARIABLE	ROUTINE EPID. SURVEILLANCE
	Inpatient morbidity & mortality	YES	ROUTINE EPID. SURVEILLANCE
	Surveys of home treatment	NO	----
Malaria	Outpatient morbidity	YES	ROUTINE EPID. SURVEILLANCE; MALARIA
	Outpatient management	VARIABLE	MALARIA
	Inpatient morbidity & mortality	YES	ROUTINE EPID. SURVEILLANCE; MALARIA
	Surveys of home treatment	NO	MALARIA
	Studies of antimalarial resistance	NO	ROUTINE EPID. SURVEILLANCE; MALARIA
Case Management in Facilities	Health facility surveys	NO	EVALUATION; MALARIA INITIATIVE
	Surveys of use of health services	NO	EVALUATION; MORTALITY AND USE OF HEALTH SERVICES PAPERS
Epidemics	Outbreak investigations	NO	IMMUNIZABLE DISEASE (EPI); ROUTINE EPID. SURVEILLANCE
Reference	Census data on pop and births	NO	----
	Large-scale mortality surveys	NO	MORTALITY AND USE OF HEALTH SERVICES PAPERS; MANGOCHI REPORT
	PBT mortality pilots	NO	ROUTINE EPID. SURVEILLANCE

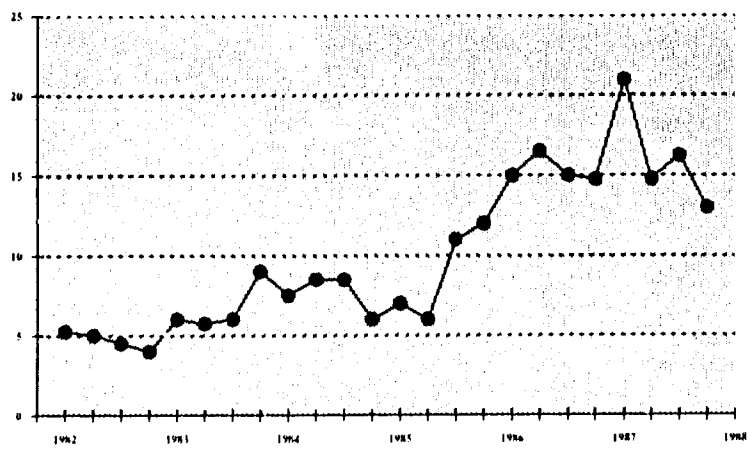
VII. Key examples from the CCCD Experience

A. Single site surveillance.

1. The central hospital and malaria surveillance. In several CCCD countries, a key hospital in the capital city was sometimes the best source of consistent surveillance data for preceding years. Two such facilities are the Mama Yemo Hospital in Kinshasa, Zaire, and the University Hospital Center (CHU) in Lome, Togo. Data from these two facilities have been important in documenting the increasing morbidity and mortality from malaria in Africa.

a. Kinshasa/Zaire Mama Yemo Hospital. At Mama Yemo Hospital, data from the pediatric inpatient services and the hospital morgue were reviewed by CCCD-supported epidemiologists to evaluate trends in malaria mortality. Such review involved tabulation and subsequent computerized analysis of data from hand-written registers, since computerization of data management at the hospital had not yet been feasible. These data indicated that a substantial increase in the proportion of deaths attributed to malaria occurred between 1984 and 1988, simultaneous with the appearance and spread of chloroquine-resistant falciparum malaria in Zaire (Figure 1).[54]

Figure 1.
Proportional Mortality Rate for Pediatric Malaria, by Quarter, Mama Yemo Hosp. Morgue, Kinshasa

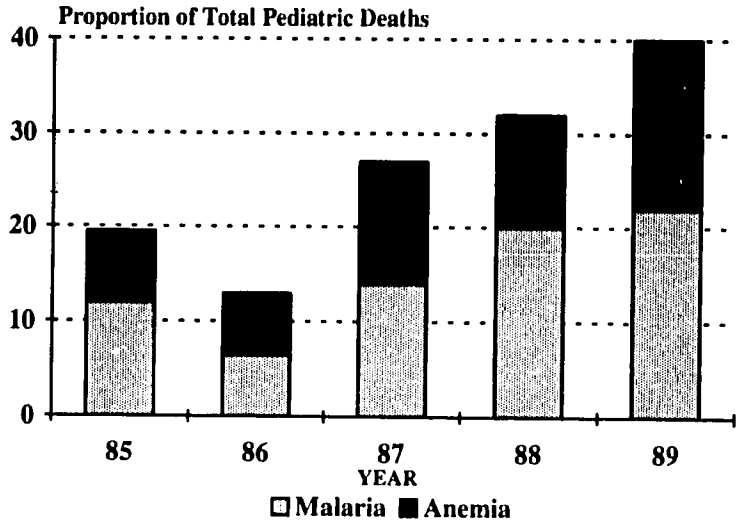


Source: Greenerg, 1989 and Mama Yemo Hosp. Morgue

These findings were supported by similar findings from a large variety of other sources. However, a later evaluation at the same hospital by a team from CDC's Malaria Branch brought to light a different problem with the hospital's surveillance data on malaria: smears taken from 55% of patients who had received a clinical diagnosis of malaria at the hospital were read as negative by an experienced malariologist.[55]

b. Lome/Togo CHU. Data from the CHU in Lome over approximately the same time period indicated a substantial increase in pediatric hospitalizations and deaths attributed to malaria and malaria-associated severe anemia (Figure 2).[56]

Figure 2.
Anemia and Malaria Deaths - Child Health Unit
Lome, Togo, 1985-1989



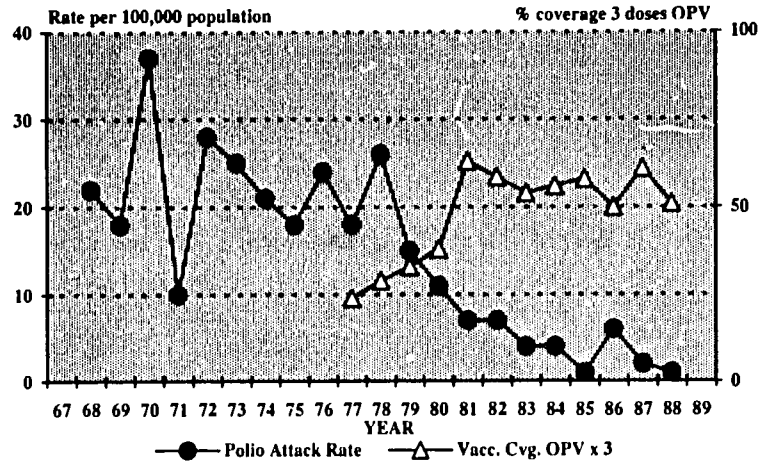
The Pediatrics Department of the CHU has maintained such data since 1984. While such sentinel data are subject to a variety of qualifications, including fluctuation in facility use rates and in diagnostic standards over time, they corroborate and are consistent with trends seen in data from other sources or for other diseases (e.g., the same sentinel sites report declines in polio and yaws and increases in HIV disease and tuberculosis).

2. The Kinshasa CRHP and poliomyelitis surveillance. Since paralytic disease typically motivates parents of affected children to seek specialized services, rehabilitation centers for handicapped children havebeen used as sites for the surveillance of paralytic poliomyelitis. Use of such facilities for surveillance has been reported in Pakistan, India, and Zaire.[57] In Kinshasa, the Center for the Rehabilitation of the Physically Handicapped (CRHP is the French acronym) has provided over 20 years of surveillance data from a single site since 1968. Figure 3 displays these data and indicates the city's level of vaccination coverage with three doses of oral polio vaccine.

In 1988-89, the Zaire EPI sought to evaluate the proportion of all Kinshasa polio cases which were reported from this single site. With funding support from Rotary International's PolioPlus program, an active reporting system was developed which obtained reports from 27 surveillance posts, including major pediatric hospitals, major rehabilitation services, and a city wide network of centers serving handicapped children. During the 12 months of evaluation, 132 cases of reported paralytic polio were epidemiologically confirmed. Slightly over half (53%) of these cases would have been reported by the CRHP alone. Characteristics of cases seen at the CRHP were similar to those seen at the other sites. These data suggested that surveillance at the CRHP would likely monitor trends in polio adequately. It was apparent, however, that when the city begins to undertake efforts directed

toward the eradication of poliomyelitis by the year 2000 (a goal of the World Health Organization, UNICEF, and the World Summit for Children[58]), surveillance will have to be extended to all sites in order to detect cases not identified by the CRHP.

Figure 3.
Attach Rate of Paralytic Polio & Vaccination Coverage, 3 Doses OPV - Kinshasa 1968-1988



S

Sources: Cluster surveys (VC)
Numerator = Data from CRHP/Gombé
Denominator = Census projections

3. The central morgue and mortality surveillance: Mama Yemo Hospital, Kinshasa. In many CCCD countries, a variety of circumstances, including adverse economic conditions and cultural responses to vital events, have rendered difficult the establishment of a locally sustained mortality registration system. One approach to the acquisition of mortality information has involved review of mortality records in specific health facilities. Such an approach is inexpensive and rapid, but suffers often from important biases and lack of representativeness. Several special projects reviewed mortality data at Mama Yemo Hospital in Kinshasa in the 1980's. These included a study conducted by the national nutrition center,[59] a 1986 study of malaria morbidity and mortality conducted in collaboration with CDC,[60] and a study of diarrheal disease conducted by the hospital's Department of Pediatrics.[61] The major patterns which emerged were consistent in their indication of a worsening problem with malaria and a diminishing proportion of deaths due to diarrheal disease in children.

One approach to broadening mortality surveillance at Mama Yemo was taken by pathologists working on AIDS research at the hospital. They reviewed a systematic 10% sample of deaths from the 1987 Mama Yemo Hospital morgue registry.[62] Each year the morgue registers approximately 10,000 deaths from the hospital and 5,000 deaths from the surrounding community. Registration of deaths at the hospital morgue are encouraged by the civil requirement for a burial permit; permits are issued by the morgue. Few autopsies are performed. Cause of death is entered as declared by the surviving relatives, or as stated on referral documents from the hospital ward. The dataset for this analysis was limited in detail, but demonstrated some important findings. Mortality in children under age 5 is shown in Table 4.

Table 4: Proportional Mortality in 861 Deaths of Children Under Age 5, by Place of Death, Mama Yemo Hospital Morgue, 1987*

CAUSE	IN-HOSPITAL	OUT-OF-HOSPITAL
Meningitis	1.8%	0
Diarrheal disease	2.7%	0
Pneumonia/Pulm. dis.	6.5%	0
Malaria	18.5%	<1%
Measles	5.4%	0
Perinatal causes	48.0%	13%
Hematologic/anemia	6.0%	0
Other	7.1%	<1%
Unknown	4.0%	86%
TOTAL	100% (151)	100% (710)

* Data are a 10% sample of morgue registrations.

The relative magnitudes of major causes of death are similar to those seen in the data from Togo, although the Mama Yemo data lack the degree of detail seen in Togo's system. Table 5 summarizes the mortality for adults aged 15-44 years from the morgue register at Mama Yemo.

Table 5: Proportional Mortality in 209 Deaths of Adults Aged 15-44 Years, by Place of Death, Mama Yemo Hospital Morgue, 1987*

CAUSE	IN-HOSPITAL	OUT-OF-HOSPITAL
AIDS	22.7%	0
Diarrheal disease	2.3%	0
Pneumonia/Pulm. dis.	15.2%	0
Malaria	12.1%	0
Hepatitis	3.8%	0
GI/hepatic	3.0%	0
Other inf. dis.	6.8%	0
Malignancy	2.3%	0
Hematologic/anemia	4.5%	0
Obstetric/gynecologic	0.8%	0
Other	19.7%	0
Unknown	6.8%	100%
TOTAL	100% (132)	100% (77)

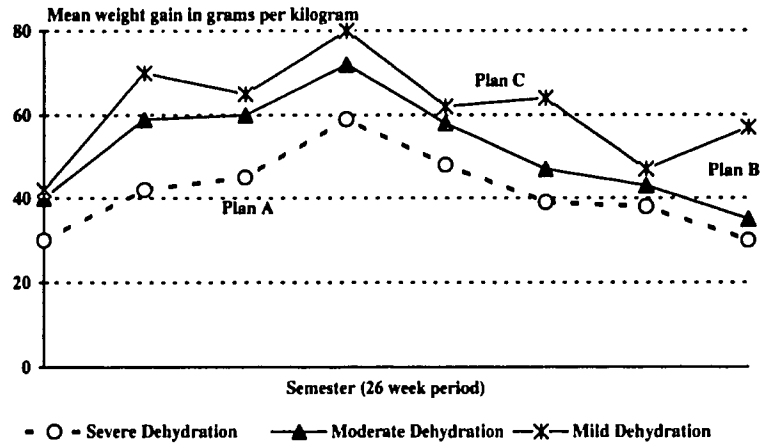
* Data are a 10% sample of morgue registrations.

Of note are the lack of pregnancy-related deaths, the importance of malaria deaths, the prominence of liver deaths (1 in 14), and the overwhelming impact of HIV disease (nearly a quarter of all in-hospital deaths). In fact, these data underestimate the impact of AIDS since some additional deaths due to chronic diarrhea, malignancy and other causes were also likely due to undocumented HIV disease. Thus, despite the limitations in this setting, the use of morgue data can be of substantial utility in select circumstances in developing nations. Such data would be more useful if greater effort were directed towards improving diagnostic capacity within hospitals, and towards the determination and registration of cause for out-of-hospital deaths.

4. Surveillance of Diarrhea Case Management in Specialized Units: Kinshasa, Lilongwe, Swaziland. Routine surveillance was applied in several ways to the issue of case management of diarrhea. As noted above, home case management was measured in many types of surveys, including vaccination coverage surveys and the Demographic and Health Surveys. Also, special facility-based assessment surveys were utilized at least once in almost all CCCD countries; these surveys included, but did not specifically target, facilities specializing in oral rehydration therapy (ORT) and diarrhea case management. The establishment of such units was encouraged by the World Health Organization, and many were established in hospitals in all CCCD countries.

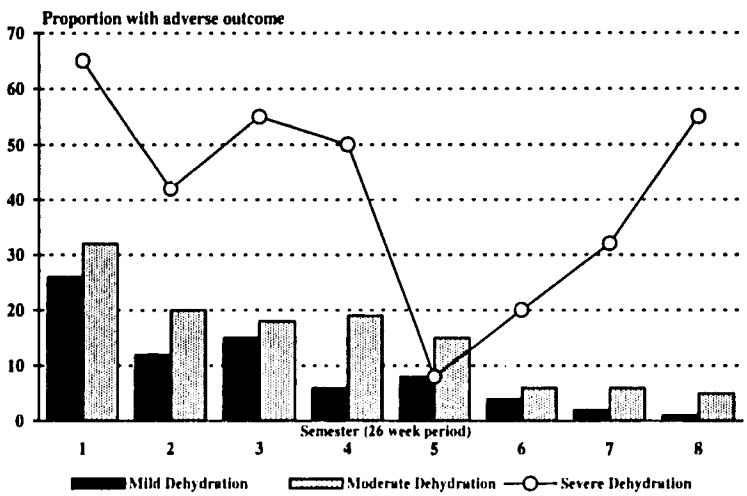
Surveillance of practices and case outcomes in such a reference unit was undertaken as a special study in Malawi.[63] Key referral hospitals in many countries established reference and training units for case management, such as the international training center established at Mama Yemo Hospital's ORT Unit in Kinshasa, Zaire.[64] In Kinshasa, a routine surveillance activity was established which continued over several years. This activity involved computerized entry of data from each patient record form completed in the Mama Yemo Hospital ORT Unit. Data from this unit were analyzed every 6-12 months, and feedback meetings were held with professional staff in the unit. Findings from these analyses were important not only locally, but also in their influence on other CCCD countries, many of whose key staff were trained in Kinshasa and others of whom learned of these findings at CCCD Consultative Meetings. A key contribution of these data was their demonstration of the utility of monitoring routinely and quantitatively the quality of care and the impact of care provided in the unit; for example, Figure 4 shows the trend over 4 years in the mean weight gain of children rehydrated in the unit, stratified by severity of initial dehydration, and Figure 5 shows that the proportion of cases with adverse outcomes declined over time.[65]

Figure 4.
Mean Weight Gain from Oral Rehydration Therapy for Diarrhea Cases at Mama Yemo ORT Center by Semester and Severity ("Plan")



Kinshasa, Zaire 1964-1988

Figure 5.
Proportion of Cases Hospitalized or Dead Mama Yemo Hospital ORT Center by Semester and Severity



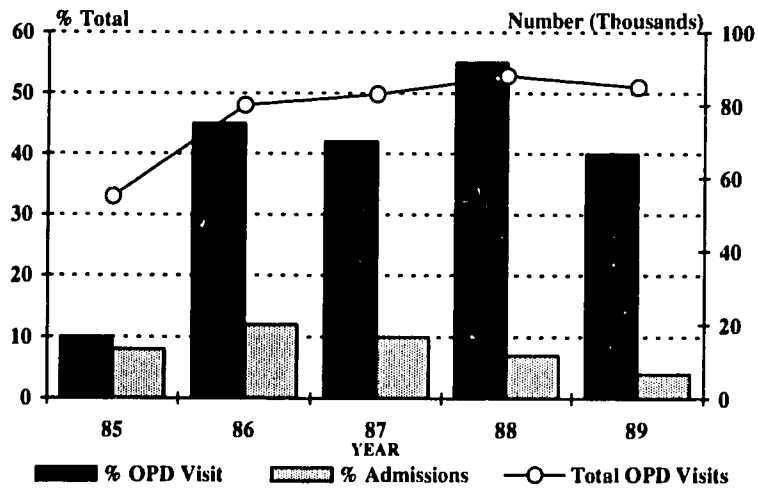
Kinshasa, Zaire 1984-87

B. Sentinel surveillance.

1. The Zaire experience.

a. National sentinel surveillance. In Zaire, as in many other nations of Sub-Saharan Africa, central authority is not highly evident outside the capital of Kinshasa. Furthermore, harsh economic conditions reduce the resources available for a surveillance system. The CCCD project in Zaire consequently opted, ten years ago, to develop a national sentinel surveillance system, relying upon the better health facilities with more motivated staff. Approximately 35 inpatient pediatric services and approximately 85 outpatient centers in the major urban centers throughout the country reported monthly on cases and deaths of CCCD target diseases (measles, tetanus, poliomyelitis, diarrheal disease, and malaria). The system relied upon regular visits by CCCD regional managers to the surveillance sites located in their cities. Data from the system have been useful in many respects. For example, they documented a decline in hospital admissions for childhood diarrheal disease, at a time that facility use was increasing or stable (Figure 6).[66]

Figure 6.
Diarrhea OPD Visits and Admissions
Sentinel Sites, Zaire, 1985-1989



As a second example, they have helped to document some aspects of the increasing severity of malaria, such as the increasing rate of death associated with hospital admission (Figure 7).[67]

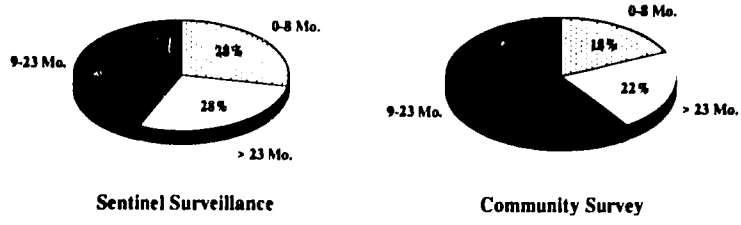
One problem with this system was the domination by facilities in the capital, which obscures regional variation; in 1987, for example, the capital region contributed 57% of the reported cases and deaths from malaria. Since 1989, the system has been threatened by both economic hardship and internal difficulties in the Ministry of Health.

b. Measles in Kinshasa. Zaire's Expanded Programme on Immunization (EPI) began in 1977-78. In the early 1980's, the program established a system of sentinel surveillance for target diseases, including measles, throughout Zaire. The system was active in the sense that data were demanded by regional supervisors at the time that vaccine supplies were replenished; however, missing data were not aggressively pursued. In Kinshasa, the system included 4 inpatient and 10 outpatient health facilities, which represented the large majority of health facilities in Kinshasa. No measles case definition was formally promulgated and reported cases were accepted on clinical diagnoses; however, the EPI did disseminate information describing the typical clinical characteristics of measles disease. Data from the sentinel system in Kinshasa were used in an evaluation of measles epidemiology in a typical urban African setting[68], and were highly useful in developing a new measles immunization policy and in monitoring the progress of a demonstration trial of the revised strategy for measles control.[69]

Determining the need to change the policy:

In 1983, Taylor et al. compared data derived from Kinshasa's EPI sentinel surveillance system with data obtained from other sources, particularly community surveys. The sentinel surveillance data showed the biennial occurrence of measles epidemics in Kinshasa (this is a characteristic of urban measles epidemiology worldwide, wherever coverage with measles vaccine is not high). The sentinel data indicated that an important proportion of cases (28%) and deaths from measles were occurring in children under 9 months of age, and thus were not preventable under the EPI strategy which specified that measles vaccination should not be given before the age of 9 months. However, this proportion was overestimated in the sentinel surveillance system data; a 1983 community-based survey, which provided data more representative of the total population of measles cases, estimated this proportion as 18% rather than 28%, as shown in Figure 8.

Figure 8.
Age Distribution of Measles Cases, Kinshasa, Zaire, 1983

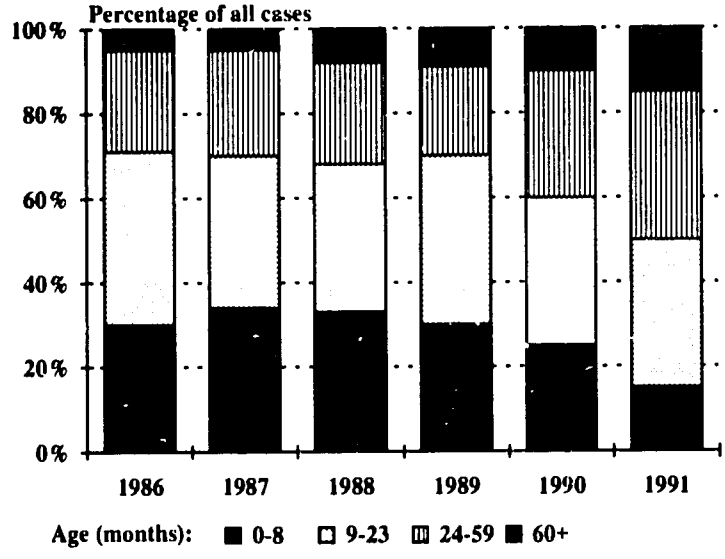


Source: Amer. J. Epid., 1988

Data from the sentinel system were complemented by data from other sources (for example, international research data on new measles vaccines and local data on presence of maternal antibody at young ages), and led to major program decisions.

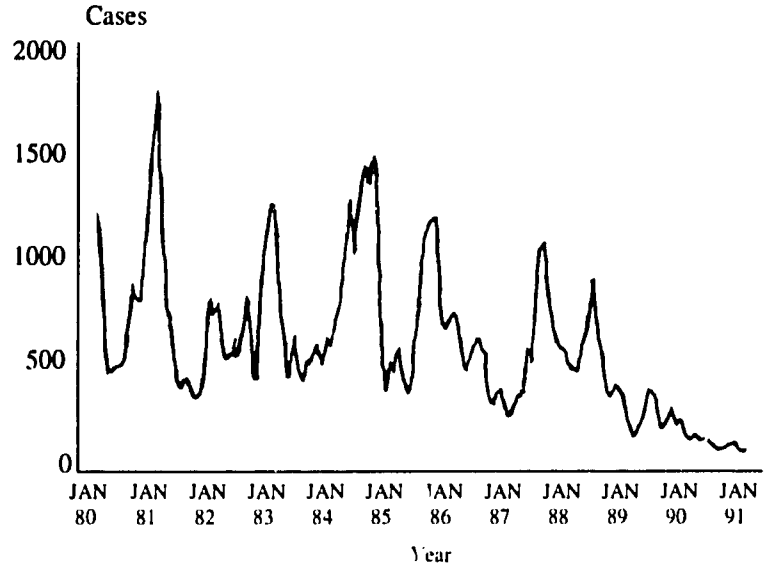
Monitoring the impact of the policy change. In 1988, the Kinshasa EPI undertook a substantial measles control project which included efforts to increase vaccination coverage as well as use of a new measles vaccine which could be administered at 6 months of age. The sentinel surveillance system played an important role in monitoring the impact of that effort. First, the system correctly demonstrated a shift in the age distribution of reported cases consistent with the expected increase of cases in older children (Figure 9).

Figure 9.
Age Distribution of Measles Cases
Kinshasa, 1986-1991



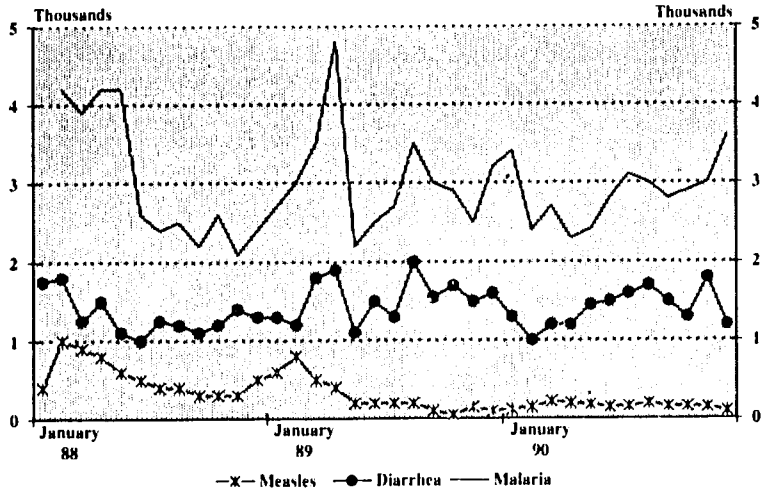
Second, the system demonstrated a substantial reduction in the total number of measles cases consistent with improved control (Figure 10).

Figure 10.
Reported Measles Cases, 1980-91
Sentinel Sites - Kinshasa, Zaire



The reported number of cases of diarrhea or fever diagnosed in these sentinel sites did not decline, suggesting that the reduction in measles cases was not due to a decline in facility utilization rates (Figure 11).

Figure 11.
Reported Cases of Measles, Diarrhea, and Malaria
Kinshasa, 1988-1990

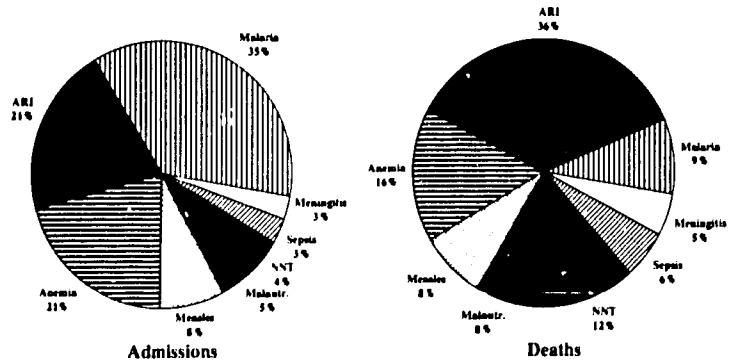


Source: PEV/CCCD
Sentinel Surveillance

Thus, the sentinel system in Kinshasa was able accurately to reflect trends over time and was sufficiently sensitive to be of use in monitoring a large-scale prevention program.

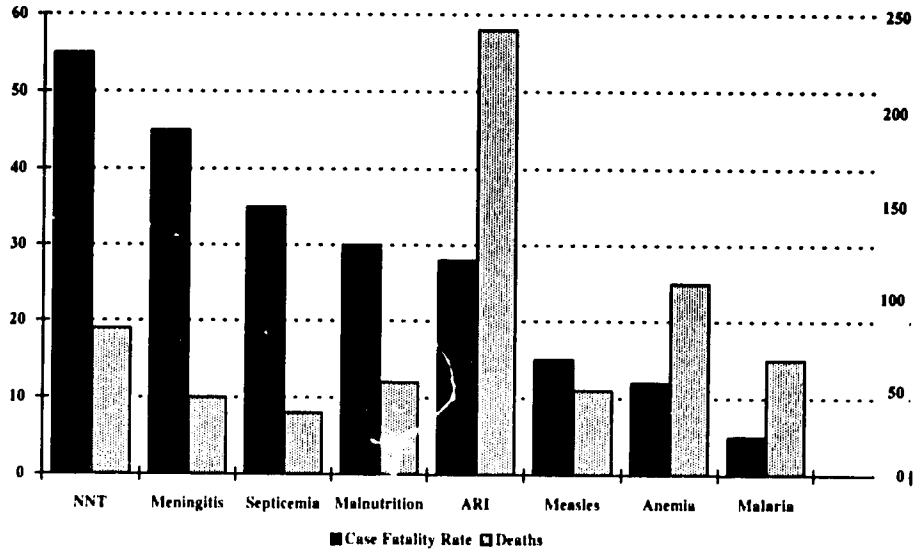
2. The Liberia experience with sentinel hospital surveillance. In 1988, CCCD/Liberia developed a pilot sentinel hospital surveillance system which used the CDC-developed software, Epi-Info. The system's data entry programs were menu-driven, and asked for additional information where indicated. Six hospitals initially participated in the sentinel system. In 1989, the system registered over 5600 pediatric admissions and over 22,000 total patient admissions (approximately one admission per 111 persons in Liberia). The system rapidly provided information useful to program and facility managers, and users were pleased with the software's ease of operation. Figure 12 presents the distribution of pediatric admissions and deaths by cause,

Figure 12.
Pediatric Admissions and Deaths
5 Sentinel Hospitals - Liberia



and Figure 13 shows total deaths and case fatality rates by cause.[70]

Figure 13.
Disease Specific Case Fatality Rates
5 Sentinel Hospitals - Liberia

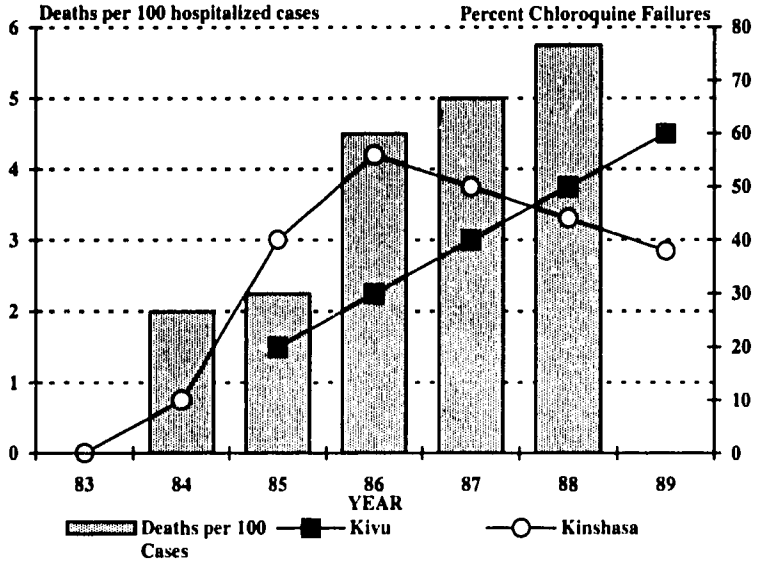


This system was largely destroyed in the civil war of 1990[71], but the experience gained in Liberia contributed to the development of the system in Togo, described below.[71]

3. Antimalarial sensitivity surveillance in Zaire, Togo, Guinea, Nigeria. Sentinel surveillance for malaria was conducted in two ways in the CCCD project countries. First, surveillance for morbidity and mortality attributed to malaria and malaria-associated severe anemia was conducted in selected major hospitals. Second, surveillance for resistance to antimalarial treatment was conducted at sentinel sites, using the response to therapy of small groups of parasitemic children as a sentinel indicator.

In most CCCD countries, a system of surveillance for resistance to antimalarial treatment was instituted as part of their national malaria control policy.[72] In each surveillance site, resistance was assessed by evaluating the response to antimalarial therapy of 30 to 50 consecutively enrolled parasitemic children under age 5; studies generally required several weeks to enroll and follow the required number of children.[73] In some countries, multiple studies were conducted; in others, only one or a few such studies were conducted. Children were administered a standard therapeutic dose of antimalarial and followed for 7 to 14 days to assess clinical and parasitologic responses. These studies provided sentinel data concerning the spread of chloroquine-resistant falciparum malaria. For example, in Zaire, studies in the eastern (Kivu) and western (Kinshasa) parts of the country demonstrated a gradual but consistent increase in resistance to chloroquine during the same years when hospital surveillance indicated an increase in morbidity from malaria (Figure 14).[74]

Figure 14.
Deaths per 100 Hospitalized Cases of Malaria and Clinical Chloroquine Failure Rates Zaire, 1983-1989

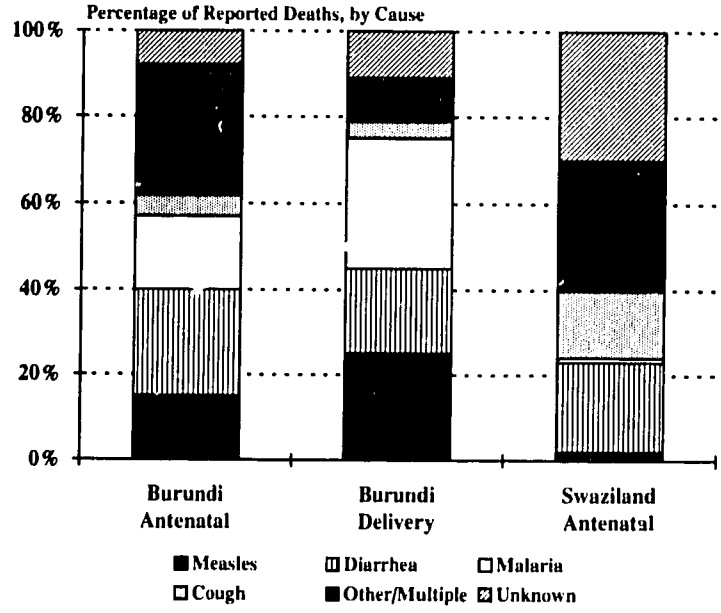


In Nigeria during the years 1987-90, an extensive network of sentinel sites demonstrated that chloroquine resistance was present but at lower levels than in central and eastern Africa.[75] Although in retrospect, few sites in any countries succeeded in making such surveillance a routine activity, this type of surveillance provided many countries with an initial experience in antimicrobial susceptibility surveillance. Such surveillance is likely to be of importance in the coming decades, as drug susceptibility issues confront developing world programs concerned with cholera, dysentery, acute respiratory infection, malaria, sexually transmitted diseases, and tuberculosis.

4. Preceding birth in large maternities. A variety of techniques for surveillance of child mortality in developing countries have been proposed, such as surveillance in pediatric hospitals, hospital morgues, burial sites, or as part of community surveys. The preceding birth technique (PBT), a method proposed originally as a simplified means of early childhood mortality estimation, has potential to become a useful surveillance tool.[76] PBT feasibility has been investigated in several sites in Sub-Saharan Africa through the CCCD project. The PBT can be used in antenatal clinics and maternities, where women at or near the time of delivery are asked about the survival of their last live-born child. In settings of high child mortality and unrestricted fertility, the proportion of preceding born children who have died (PBT quotient) crudely approximates the mortality of children under age 2 years (2q0). However the performance of PBT as a precise estimator of 2q0 is variable; in Haiti[77] and in The Gambia,[78] for example, the PBT estimate differed moderately from survey-based estimates of the same mortality quotient. Nonetheless, the PBT quotient may provide a useful index of early child mortality which could be estimated at regular intervals for the purpose of following trends. This type of frequent and regular repetition is not practical if the mortality measurement involves costly, large-scale field surveys. Furthermore, verbal autopsy techniques combined with the

PBT may provide useful information concerning causes of child mortality which would be otherwise unavailable or difficult to obtain.[79] The known limitations of the PBT may constrain its utility in this regard (e.g., sensitivity to fluctuations in fertility levels and facility use rates), but experience in three CCCD countries suggests that the technique may be useful. In Burundi, the PBT was employed in two sites: a maternity clinic and a large antenatal clinic in Bujumbura, the capital. The PBT estimate of 2q0 in both sites was similar and agreed with interpolations from other estimates of child mortality. An important proportion of the child deaths were reportedly associated with measles, consistent with other data indicating that measles was at that time (1989) still an important cause of early child death in Bujumbura. In Swaziland, when reports from mothers seen in several antenatal clinics were combined, measles was absent as a reported cause of death, consistent with other surveillance and administrative data indicating that measles was no longer a major cause of child mortality in Swaziland (Figure 15).

Figure 15.
Symptoms and Diseases Reported with Child Deaths



In the Central African Republic, the PBT was pilot tested in Bangui prior to planned initiation of city-wide PBT monitoring in maternities. Experience in Bangui suggests that PBT is sensitive to variations in facility use and access to health services.[80]

While these initial and time-limited efforts to use PBT in sentinel sites suggest that long-term mortality surveillance is feasible, they do not establish the validity of the method; to date, no CCCD country has acquired long-term experience with the PBT. It will be important to determine whether this simple method, over time, can identify trends similar to those documented in more expensive and less frequent large surveys. If so, the PBT may become a highly useful addition to the surveillance package in developing countries, because it is inexpensive, it responds to a need for mortality information which is not otherwise met, and it promises to capture a larger proportion of total child mortality than does reporting of hospital-based deaths alone.[81]

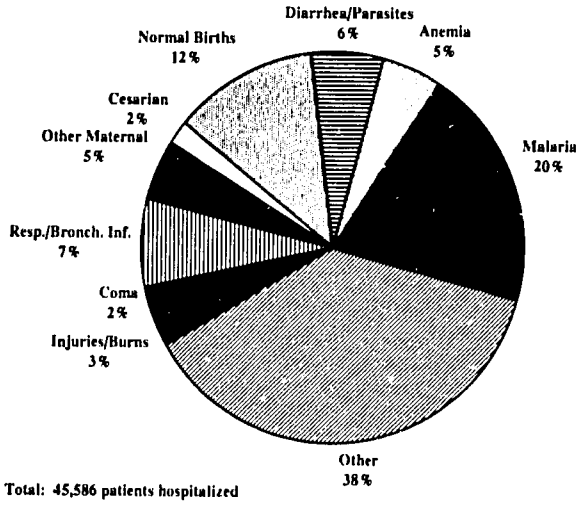
C. Universal ambulatory and hospital reporting in Togo.

In 1982, Togo's Annual Statistics Report had not been published in over 5 years, and was being hand-tabulated by a group of temporary Ministry of Health employees. The reportable disease list included over 400 diseases. The Report included primarily tables, with little analysis or discussion, and was of little use to health planners. In 1986 efforts began to strengthen training and supervisory activities for HIS in all 21 prefectures. Six national staff members received additional computer and surveillance training at the USAID- and Tulane University-assisted School of Public Health in Kinshasa, Zaire. Computer hardware and software were supplied to the National Epidemiology Division, which had been designated as the central site for data compilation. Simple programs were written for data entry and analysis. In 1988, a simplified outpatient reporting form was developed through a process of consensus among program managers, district health officers, and clinicians. The revised form was pilot tested for one year, and further modified in response to suggestions from clinic personnel. The modified form contained fewer than 40 conditions, classified by age and gender of patient. A system was developed for tracking incoming monthly reports, and tables were published in annual reports indicating the reporting record of each district. Subsequently the Director of the National Statistical Service made a national tour of health facilities and local health authorities. By 1990, 96% of expected monthly reports were received at the central level.

In 1988-89, the Ministry of Health (MOH) in Togo was assisted by the CCCD project in the development of a nationwide system of hospital-based morbidity and mortality surveillance (HBMMSS). The system covered 30 hospitals with 5307 beds, and served a population of 3,400,000 persons. In 1989 each hospital began reporting 8 items of information for every admission: age, sex, an identifier, date of admission, admitting service, date of discharge, discharge diagnosis, and condition on discharge. These data were transcribed from a central hospital registry at each site onto a simple recording form with duplicate copies; one copy was forwarded to a central MOH office for data entry. The system did not include data from the emergency rooms of the participating hospitals. Personnel from the central MOH offices went on supervisory visits to the hospitals, and verified a sample of reports periodically. Responsibility for the submission of data rested with the chief of each service, the hospital director, and the district health officer.

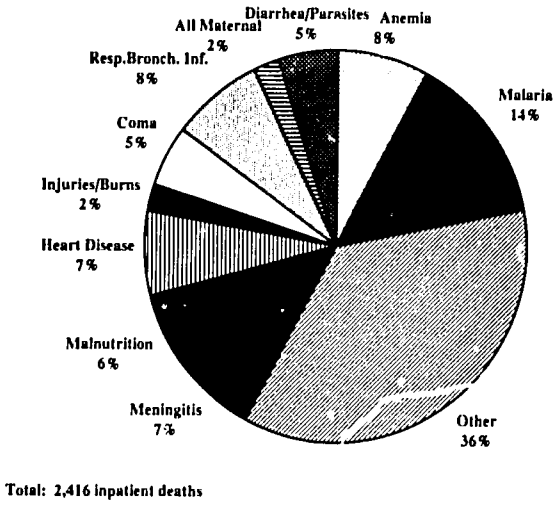
The 1989 report[82] included data from 26 hospitals (several private hospitals did not join the system until 1990), and reported on 2.1 million outpatient visits and 45,500 admissions. Three hospitals contributed 46% of all admissions in 1989. All admissions were classified into 1 of 109 conditions. Figures 16 and 17 present principal causes of hospitalization and of death in 1989.

Figure 16.
Principal Causes of Hospitalization
Togo, 1989



Source: Svc. Nat. Stat. Sanit.
Ministry of Health, Togo

Figure 17.
Principal Causes of Death in Hospital
Togo, 1989



Source: Svc. Nat. Stat. Sanit.
Ministry of Health, Togo

Readily apparent are the important roles of obstetric causes of hospitalization, and the major burden imposed by malaria and anemia as causes of death.

Table 6 shows the major causes reported for outpatient consultations, inpatient admissions, and inpatient deaths in children under age 5 years, for 1989.

Table 6: Number of Outpatient Consultations, Inpatient Admissions and Inpatient Deaths, In Children Under 5 Years, by cause, Togo, 1989

CAUSE	OUTPATIENT CONSULTATIONS	INPATIENT ADMISSIONS	INPATIENT DEATHS
ALRI	23469 (6%)	1224 (10%)	85 (9%)
Amebiasis	3896 (1%)	64 (<1%)	1 (<1%)
Anemia (not sickle)	2826 (<1%)	1481 (12%)	117 (13%)
Ankylostomiasis	1686	0	0
AURI	35214 (9%)		
CS Meningitis	161 (<1%)	272 (2%)	66 (7%)
Colic	2982 (<1%)		
Coma	0	563 (5%)	42 (5%)
Conjunctivitis	25206	0	0
Dental/oral dis.	10226 (3%)	0	0
Dermatoses	5002 (1%)	47	
Diarrheal disease	53430 (14%)	1040 (9%)	58 (6%)
Ear diseases, all	5509	0	0
FUO	3220 (<1%)	230 (2%)	19 (2%)
Gen-urin. dis.	1254		
Helminth infection	8605	0	0
Malaria	116622 (30%)	4045 (34%)	199 (22%)
Malnutrition	24929 (6%)	685 (6%)	113 (12%)
Measles	1091 (<1%)	269 (2%)	5 (<1%)
Mumps	360	1	0
Other dis.	17435 (5%)		
Pertussis	176	3	0
Rabies	0	1	1
Sickle cell anemia	430	195	3
Tetanus	26	32	20 (2%)
Trauma/Wounds	29291 (8%)	87 (<1%)	2 (<1%)
Tuberculosis, all	12 (<1%)	16 (<1%)	2 (<1%)
Varicella	505	14	0
Viral hepatitis	96 (<1%)	18 (2%)	
Yaws	416	1	0
TOTAL	383644 (100%)	11925 (100%)	912 (100%)

Major causes of outpatient consultation were generally similar to diagnoses associated with hospital admission and with inpatient death, with three exceptions: (1) cerebrospinal meningitis (meningococcal disease; primarily an inpatient diagnosis), (2) anemia other than sickle cell anemia, including malaria-induced acute and chronic anemia (primarily an inpatient diagnosis, possibly reflecting the absence of diagnostic skill or technology at the outpatient level), and (3) trauma/wounds (primarily an outpatient diagnosis).

Table 7 shows the major causes of death in-hospital in adults aged 15-44 years.

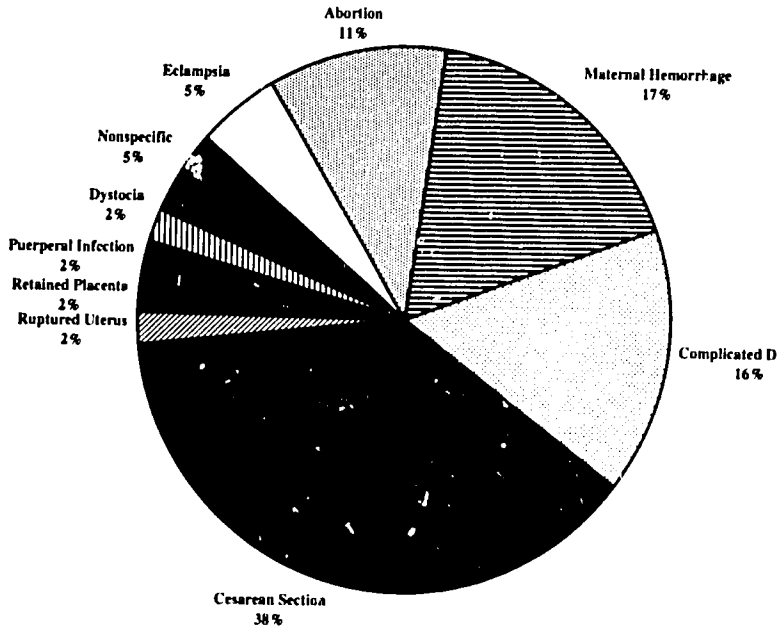
Findings apparent in Table 7 include:
-the high level of mortality in this young adult group due to complications of pregnancy and childbirth (maternal mortality);
-the possible importance of hepatitis B (cirrhosis, viral hepatitis, and hepatic cancer);
-the importance of several external causes of death, including snakebite, tetanus, burns, and road accidents and other trauma;
-the importance of malaria mortality;
-the surprisingly high mortality from meningococcal disease.

Table 7: Inpatient Deaths in Adults Aged 15-44 Years
by cause, Togo, 1989

CAUSE	NO. ADMISSIONS	NO. DEATHS
Abdominal pain	468 (2%)	30 (5%)
Allergic reactions	18 (<1%)	2
Anemia	363 (2%)	36 (6%)
Burns	53 (<1%)	2
Diarrheal disease	478 (2%)	30 (5%)
CS Meningitis	322 (1%)	44 (7%)
Cirrhosis	41 (<1%)	6
Coma	220 (1%)	25 (4%)
Heart disease	217 (1%)	29 (4%)
Hepatic cancer	20 (<1%)	3
Hepatitis, viral	202 (1%)	18 (3%)
Malaria	2811 (12%)	50 (8%)
Poisoning	319 (1%)	17 (3%)
Pregnancy-related causes	8819 (39%)	59 (9%)
Abortion	1024	7
Cesarean birth	1094	25
Dystocia	127	1
Eclampsia	14	3
Normal delivery	5378	8
Obst. hemorrhage	746	7
Other	347	6
Puerperal infection	14	1
Retained placenta	75	1
Respiratory disease	967 (4%)	39 (6%)
Sickle cell anemia	279 (1%)	13 (2%)
Snakebite	457 (2%)	14 (2%)
Tetanus	52 (<1%)	8 (1%)
Trauma	813 (4%)	18 (3%)
Tuberculosis	681 (3%)	26 (4%)
Unknown	473 (2%)	40 (6%)
Other	(22%)	(17%)
TOTAL	22821 (100%)	646 (100%)

Another example of the expanded utility of this surveillance system is provided by information related to obstetric and gynecologic mortality. Figure 18 shows the major causes of death in inpatient obstetric and gynecologic wards reported by the system in 1989.[83]

Figure 18
Main Causes of Dealth in All Hospital Obstetric and Gynecologic Wards Togo, 1989



Such information can be of great utility to public health personnel and researchers. For example, the three diagnoses of Caesarean section, complicated delivery, and maternal hemorrhage accounted for 71% of the reported maternal mortality, and thus suggest areas for urgent investigation.

Although this HBMMSS captured less than 10% of the total estimated annual deaths in Togo, its coverage was geographically extensive, and the data obtained were consistent with information derived from special studies in other sites. By 1990, the hospital reporting system had also achieved a completeness rate of greater than 90%. Critical in this initial success has been the high degree of central authority typifying Togo's Ministry of Health; efforts to pursue decentralization of this system will challenge it in the coming years. Such efforts are already underway, with the goal of providing timely and relevant data at the local level; two sites are already performing local data entry, and forwarding data by computer diskette to the central level.

The introduction of graphs and the shift from cross sectional to longitudinal analysis, has increased national interest in and use of data. The introduction of a new and more appropriate data entry and analysis system for outpatient clinic-based aggregate data[84] has also enhanced efficiency of the

D. Multiple interlocking systems of surveillance.

1. The Nigeria experience. The variety of Nigerian surveillance systems in which CCCD plays a role were reviewed by Marston[85] in 1991 and by Pappaioanou in 1992.[86] Table 8 presents a summary of the multiple surveillance systems in Nigeria.

Table 8: Health Information System of Nigeria

HIS Component	Admin. Unit	Data Users	Software
PHC M & E	PHC Agency, M&E Unit	Health Facilities, LGAs, SMOH, FMOH PHC Coordinators, Asst. PHC Coordinators, LGA Chairman, LGA Health Councilor, State Commissioners, Directors of PHC and Dis. Control	NiCare (Clipper 5.01) Lotus, Harvard Graphics, Epi Info
Routine Disease Notification	Department of Disease Control and PHC	SMOH and FMOH Epidemiology Divisions, Dir. of Dis. Control	EPID (Clipper 5.01), Lotus, Harvard Graphics, Epi info
Immediate Disease Notification	Department of Disease Control and PHC	SMOH and FMOH Epidemiology Divisions, Dir. of Dis. Control	Epi info
Sentinel PHC disease Surveillance (150 Sites)	Department of Disease Control and PHC	SMOH and FMOH, Depts. of Disease Control	EPID, Epi info
Hospital Inpatient (8 Sites) Routine Hosp.	CCCD During Development Planning Research and statistics	Hospital Directors; Clinicians; FMOH, SMOH International Partner Agencies Planning, Research and Statistics	Epi info; D-Base, Epi info
EPI Coverage Surveys Vaccines/Cold Chain	Department of Disease Control and PHC	EPI Coordinators, Dir's. Disease Control EPI Coordinators, Dir. Fed. Vaccine Cold Store	COSAS NiCare, (Planned Currency Manual)
CDD Community Surveys ORS Commodity Operational Research	Department of Disease Control and PHC		Epi info NiCare (Planned)
Malaria Antimalarial Drug Efficacy Operational Research	Department of Disease Control and PHC		
HIV/AIDS	Department of Disease Control and PHC	National AIDS Coordinators, Dir. Disease Control, MOH	Epi info, D-Base, Lotus
Guinea Worm	Department of Disease Control and PHC	NIGEP Director	EPI info, D-Base
Demographic Health Surveys		FMOH, All Depts., SMOH	ESA, SPSS

The major information systems which are pertinent to the CCCD project are the following:

a. Primary Health Care Monitoring and Evaluation (PHC M&E) system: collects routine statistics from the health facility and community level in local government areas (LGAs) throughout the nation. This system is just being initiated, and represents an enormous undertaking.

b. Notifiable Disease and Epidemic Reporting Systems of the Epidemiological Division, Department of Disease Control and International Health: this system was established following a workshop held in August-September 1988, stimulated by the 1986-87 yellow fever epidemic. It collects mandated reports of 40 notifiable diseases from all health facilities, as well as emergency reports on 9 of these 40 and on epidemics of any type. Reporting in the non-emergency arm of the system is dominated by a small number of states and sites.

c. 150-Site Sentinel PHC Disease Surveillance: plans to collect data on measles, polio, tetanus, pertussis, malaria, pneumonia, diarrhea, malnutrition, Guinea worm, onchocerciasis, and AIDS from up to 150 health facilities in all 30 states. This system was designed to supplement and perhaps supplant a non-functioning routine data collection system. An earlier (1985) effort to establish 43 EPI sentinel sites failed.

d. Sentinel Hospital Inpatient Surveillance: plans to collect data on all inpatient admissions from 8 major hospitals, and will eventually include all the teaching hospitals. This system uses ICD coding of diagnoses, and relies upon data entry by committed hospital staff on-site, using computers provided by CCCD. Because it relies upon motivated local personnel, and because it responds to clear needs on the part of facility managers for management-relevant data, this system promises to provide some of the best data available from the various systems.

e. Special Surveys: including Demographic and Health Surveys (DHS), immunization coverage surveys and diarrheal disease surveys conducted over the life of the CCCD project. While the DHS survey has provided data of high quality, the programmatic surveys have often been beset by problems in sampling procedures which have resulted in the provision of data of uncertain quality or representativeness.

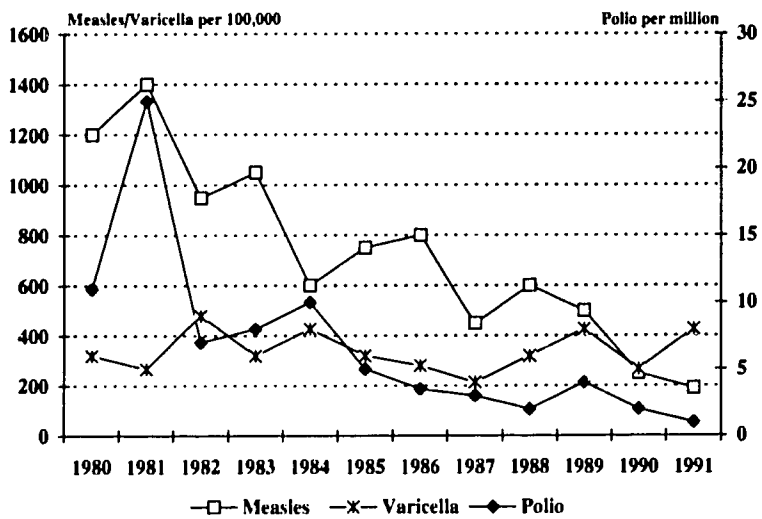
f. Antimalarial Drug Efficacy Surveillance Network: this system conducted periodic *in vivo* drug efficacy studies in over 20 sites throughout Nigeria, and provided high quality data while being assisted by the CCCD epidemiologist. Recently interest in this system has waned (in part due to the departure of a highly interested epidemiologist, and in part due to questions about the continuing priority of such data), and fewer data have been available.

CCCD-Nigeria has assisted in the design and implementation of these systems, as well as in the creation of softwares designed to support the computerization of data derived from them. CCCD-Nigeria has been particularly active recently in the design or innovative adaptation of softwares for the integrated management of data collected by these systems. Working with data management staff of the Ministry of Health and of the USAID-funded Family Health Services project, CCCD has helped to design an integrated system of softwares (including "NICARE" for PHC M&E and sentinel surveillance, "EPED" for notifiable diseases, and "CLM" for commodity and logistics management) capable of serving all of the systems described above. Major current challenges confronting CCCD in this domain are the assurance of data quality at the level of the reporting facility, and the maintaining of high levels of completeness and timeliness of reporting. To assist in meeting these challenges, CCCD has hired 4 national epidemiologists to work with the 9 states in which it is active. This ambitious surveillance effort

evolved in response to the existence of multiple surveillance systems operating in Nigeria, and sought to provide a rational structure within which all could operate. Whether it can be sustained (in whole or in part) remains uncertain at this time.

2. The Burundi experience. The Burundi CCCD project has supported surveillance efforts throughout its duration. The Ministry of Health in Burundi had long devoted attention to surveillance, and consequently possesses useful national datasets which extend over two decades — a long period by CCCD standards. Moreover, some virtually unique elements are present. For example, Burundi has required reporting on varicella for many years, and thus is now able to use the trends in reported varicella as a means of monitoring the stability of reporting. Figure 19 shows reported incidence of measles, polio and varicella over ten years; the stability of reported varicella, for which no intervention program exists, suggests that the declines in measles and polio are not due merely to declines in disease reporting.

Figure 19.
Measles, Polio, & Varicella Incidence, Burundi, 1980-1991



* Varicella serves as an indicator of completeness and constancy of surveillance

In the past two years the Burundi Ministry of Health has specifically focused on strengthening surveillance. Efforts to reinforce the system sought first to centralize many information functions in the Ministry of Health within a single office staffed by specialized personnel. This office implemented an approach to information management and surveillance which was earlier proposed for CCCD in Cote d'Ivoire,[87] and which is known as the "single gateway." Under this system, all data from reporting health facilities — pertinent to all programs and projects — pass first through this single office, where data entry and collation take place. Data are then passed to the interested project or program offices for further specialized analysis. The availability of a complete dataset at a single central office assures that the Ministry will have access to the totality of its data, and will be capable of performing analyses which were previously

impossible. Similarly, this specialized office for routine surveillance has begun to provide programs with services which were not previously feasible, such as enhanced analysis, reporting and even outbreak investigation.[88] Maintenance of such capacity remains a challenge.

VIII. Some Key Obstacles

In addition to its many successful uses in CCCD, routine epidemiologic surveillance encountered some key obstacles which were common to many countries. They were of three types: technical, structural, and conceptual.

A. Technical obstacles.

Technical obstacles were particularly evident with regard to case definitions and the lack of reliable clinical diagnostic algorithms for some target diseases. For example, the clinical diagnosis of pertussis is unsatisfactory, and useful data on pertussis were not available from CCCD countries. Similarly, the clinical distinction of pneumonia, milder forms of acute respiratory infection, and malaria poses problems for many countries.[89]

B. Structural obstacles.

Structural obstacles included the lack of basic laboratory services such as microscopy and chest radiography; such services could vastly improve the reliability of diagnoses for several CCCD target diseases. A second structural obstacle was the small number of professionals with skills and training relevant to epidemiologic surveillance. The CCCD project did occasionally achieve remarkable synergy in this regard in those countries where appropriate personnel received long-term training support, but a clear strategy for long-term training of disease surveillance personnel was lacking. A more important structural obstacle was the lack of equipment and personnel at local levels for the collection, analysis, and interpretation of locally relevant data.

C. Conceptual obstacles.

Conceptual obstacles were most notable with regard to surveillance of diarrheal disease. There was not logical coherence between the project's intervention (promotion of oral rehydration therapy) and the targets of surveillance in many countries (cases of diarrhea). The intervention sought to prevent deaths due to diarrhea-induced dehydration, not cases of diarrhea. As noted earlier, the measurement of total and cause-specific mortality remained problematic. Thus, the project was unable to define a satisfactory and feasible surveillance target which would have been appropriate to the intervention being applied. A few countries sought to perform surveillance of case management by reporting the proportion of cases in which ORT had been applied, but such reporting was beset by problems of lack of standards and continuing debate about whether national policies should promote sugar salt solution or other home fluids. The necessity for clear goals and standards is self-apparent. Most information of programmatic relevance for diarrheal disease control programs was thus acquired through special surveys and studies, and routine surveillance played a minor role in supporting this segment of project activities.

IX. Role of WHO and UNICEF

The World Health Organization serves as the global authority on epidemiologic surveillance relevant to the variety of domains in which it exerts technical leadership. This includes both the general issues in surveillance which are addressed by its Division of Epidemiological Surveillance in the Office of Health Situation and Trend Assessment, as well as surveillance matters specific to individual programs, such as the Expanded Programme on Immunization (EPI), the Diarrheal Disease and Acute Respiratory Infection Control Programmes, the Global Programme on AIDS, the Programme on Maternal and Child Health, and others. In recent years the EPI demonstrated particular strengths in this domain, as it encouraged CCCD and other child health programs to shift from vaccination coverage-based programs (with the goal of maximizing coverage measures) to surveillance-based programs (with a goal of measuring reduced morbidity and mortality from target diseases). A wealth of documentation, manuals, softwares, and other materials has been produced by these programs related to surveillance. Many are cited in this document; a related product in this series describes some of the available computer softwares.[90] The interested reader is referred to the specific offices, whose addresses are listed among the references.[91] In addition, many personnel who contribute directly and indirectly to surveillance activities acquired their skills in WHO-sponsored or WHO-implemented training activities. Manuals and background materials for these training activities are available from the appropriate programme offices at WHO.

The United Nations Children's Emergency Fund (UNICEF) was a critical partner in each country in which the CCCD project was active. UNICEF has traditionally focused on material support, training, and service delivery, and has relied upon W.H.O. as a sister United Nations agency to provide technical support in areas such as epidemiologic surveillance. In recent years, however, UNICEF has increasingly shared interest in and support for surveillance activities related to child health programs. In some countries, such as Nigeria, the local UNICEF office has been actively involved in efforts to develop and strengthen surveillance activities related to their programs.

X. Lessons for the Future

Nine principal lessons for the future with respect to epidemiologic surveillance systems in countries of Sub-Saharan Africa emerge from this review; these are summarized in Table 9.

First, routine epidemiologic surveillance provides information needed to support targeted public health and child survival programs. The examples provided above have illustrated the utility of information provided by such systems in directing public health actions. This link between surveillance and programs requires continued emphasis. At different stages of development, health programs require data for policy development, for monitoring and evaluation of program activities, and for assessment of program impact. Surveillance will continue to form an important support for targeted public health programs throughout the developing world.

Second, routine epidemiologic surveillance systems must be supplemented by or extended to include the collection of management and health service information, special surveys, applied research activities, outbreak investigations, and program monitoring and evaluation activities.

Table 9: Lessons for the Future	
I	Routine epidemiologic surveillance provides an important segment of information needed to support targeted public health and child survival programs.
II	Routine epidemiologic surveillance systems must be supplemented by or extended to include management and health service information, special surveys, applied research activities, outbreak investigations, and program monitoring and evaluation activities.
III	Health information systems generally, and surveillance systems specifically, require investment and support -- equipment, supplies, personnel, training, supervision -- if they are to function successfully.
IV	Surveillance systems are likely to be sustained only where they provide data that are useful in the planning and management of programs ("data for decision making").
V	Efforts are needed to assure the quality of data which are collected, reported, analyzed and communicated.
VI	There is a clear need for increased use of data at the local (district or facility) level. This implies both increased capacity development and increased authority for decision-making at this level
VII	Increasingly, training in rational data management (including attention to data quality and data preservation) will be needed by health personnel in African Ministries of Health.
VIII	Non-traditional applications of surveillance and use of non-traditional methods in surveillance will become increasingly important in the coming decade, as the challenges confronting programs shift from technical to behavioral.
IX	Systems of vital registration and mortality surveillance will require increased attention in the next decade. Particularly evident is the need for inexpensive methods which can provide data over extended periods, allowing improved assessment of trends.

Surveillance is best achieved when the variety of sources and means of gathering information are integrated to provide overall knowledge of the health situation. The effort to control measles in Kinshasa exemplifies this integrated use of data. Such integration may be best achieved in many settings by the establishment of a single site with responsibility and authority for health information management, such as that in Burundi described above. Whether this site actually receives all reports, and distributes data to interested offices, or whether interested offices manage their own data systems and provide a data copy to this site, will depend upon local needs. Integration, however, is likely to better serve the needs of health planners and decision makers by making information more readily available, and may help to foster collaborative efforts between programs.

Third, surveillance systems require investment and support — equipment, supplies, personnel, training, supervision — if they are to function successfully. This is illustrated by the experience of CCCD in Togo. Planning for personnel development, in-service training, supervision, and supplies and equipment, are required. Few countries in Sub-Saharan Africa have a distinct budget line item for such systems. Recently, the World Declaration on the Survival, Protection, and Development of Children, to which all CCCD countries except Liberia are signatories, called for each country to establish mechanisms for "the regular and timely collection, analysis, and publication of data required to monitor relevant social indicators relating to the well-being of children,"[92] including morbidity and mortality rates. Efforts are underway in multiple fora to develop means to assist countries in responding to this need. The inputs required include equipment and supplies, as well as training and supervision.

Fourth, surveillance systems are likely to be sustained only where they provide data that are useful in the planning and management of programs ("data for decision making"). As a matter of efficiency, surveillance efforts will be focused upon those programs and problems which can demonstrate that the cost of data gathering is justified by the utility of the data gathered. Efforts to strengthen the surveillance and health information infrastructures are likely to be successful only to the extent that they serve to strengthen the relationship between data collection and analysis, and use of data for planning and decision making.[93] This will be the case both at local and at higher levels. Surveillance data will increasingly form the basis for actions taken by program management. Part of this issue involves the communication of such data to those who are in a position to take action based upon them. The impact of surveillance data concerning chloroquine resistance in malaria exemplifies this point. Basing its decision upon both in-vivo and morbidity/mortality surveillance data, Malawi recently became the first country in Sub-Saharan Africa to designate a drug other than chloroquine (pyrimethamine-sulfadoxine) as its recommended choice for initial therapy of mild/moderate malaria in children.

Fifth, efforts are needed to assure the quality of data which are collected, reported, analyzed and communicated, and which serve as the basis for decisions. Pertinent concerns include the development and use of standardized case definitions, the simplification of the process of data collection, and development of supervisory systems to ensure timely and complete reporting, as well as the development of public health laboratory capacity and appropriate methods for laboratory quality control. The experience with the diagnosis of malaria at Mama Yemo Hospital in Kinshasa is illustrative of the issues that must be addressed.

Sixth, there is a clear need for increased use of data at the local (city, district or facility) level. This implies both increased capacity development and increased authority for decision-making at this level. The CCCD experience with measles surveillance in Kinshasa exemplifies this point. Data gathered at the local level were analyzed there, and decisions about vaccine policy were based upon information derived from them. Similarly, the national system in Togo now permits analysis of hospital-specific data, and will (in theory) allow local decisions to be made based upon local data.

Seventh, increasingly, training in areas relevant to surveillance will be needed by staff in African Ministries of Health. Personnel with skills in epidemiology, data management, training and communication will be needed. There is an urgent need for the development of explicit long-term training strategies in these domains. Relatively modest attention has yet been provided to development of standards for data management and analysis in the environments of Sub-Saharan African Ministries of Health, and assistance in this domain is likely to be needed in the coming decade. As the quantity of data increases, attention to data security will be more urgently needed. Softwares and other tools appropriate to the developing country environment are also needed; these may differ greatly or little from the best available tools used in the context of more developed nations' surveillance activities, depending upon the specific programs involved.

Eighth, newer applications of epidemiologic surveillance and use of newer methods will be increasingly important in the coming years. The AIDS pandemic has clearly established the need for behavioral surveillance in Sub-Saharan Africa. Similarly, the expense associated with special surveys of case management suggests that simpler, less costly means of surveillance of the quality of services will be needed. Qualitative methods employed by social and behavioral scientists, such as focus groups and key informant interviews, will be of increasing use to surveillance epidemiologists in the next decade, as key challenges become behavioral rather than technical.

Ninth, systems of vital registration and mortality surveillance will require increased attention in the next decade. Particularly evident is the need for inexpensive methods which can provide data over extended periods, allowing improved assessment of trends. Already the challenge of monitoring progress towards the Child Summit goals of infant and child mortality reduction has focused attention upon this issue.

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47. In Malawi, for example, a series of modules in epidemiology were developed within the context of the CCCD project. In Zaire, the CCCD training modules and the EPI Mid-Level Managers Course were adapted for training of district medical officers in the early years of the CCCD project.

48. Personal communication, Dr. Melinda Moore. Since 1991, the school's function has been severely compromised by the persistent political crisis in Zaire.

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91. Programmes at World Health Organization headquarters may be contacted by writing to:
Programme Title (eg. *Expanded Programme on Immunization*)
World Health Organization
1211 Geneva 27
Switzerland

Inquiries to W.H.O. headquarters offices can often be sent expeditiously by pouch through the office of each country's W.H.O. Representative.

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