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COMPUTERIZED EPI INFORMATION SYSTEMS (CEIS)

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Other technical reports in this series are available from REACH and include the following:
Urban EPI
Missed Opportunities for Immunization
Acceptability of Immunization
Neonatal Tetanus
Cost and Financing of EPI.

CONTENTS

ACRONYMS

A.I.D.	(United States) Agency for International Development
AFRO	African Regional Office of WHO
CEIS	Computerized EPI Information System
DOS	Disk Operating System
EPI	Expanded Program on Immunization
KEPI	Kenya Expanded Program on Immunization
OCCGE	Organisation pour Coopération et Coordination pour le Controlle des Grandes Endenmies
PAHO	Pan American Health Organization
REACH	Resources for Child Health
SEARO	South-East Asia Regional Office of WHO
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development, country mission
WHO	World Health Organization

EXECUTIVE SUMMARY

As one of a series of technical papers prepared as part of the internal assessment of the activities of the Resources for Child Health (REACH) Project, this paper documents REACH's contributions to the development and installation of computerized Expanded Program on Immunization (EPI) information systems (CEIS) worldwide from 1987 to 1990.

Computer programs to collate and analyze immunization-related data were first systematically developed by the South-East Asia Regional Office (SEARO) of the World Health Organization (WHO) in 1986. The increased access to reports and graphs summarizing important areas of EPI management made possible by computerization led the regional managers to recommend the development of similar software programs for installation at the national level. Regional WHO managers in Africa, South-East Asia and the Americas have also actively promoted the use of computers at the national level in collating and analyzing immunization data for program management.

REACH support for CEIS falls into several areas:

- REACH sponsored the installation and upgrading of CEIS in nine countries. A long-term advisor completed the work in four countries in Asia and independent consultants from other collaborating agencies completed activities in four countries in Africa and in Turkey.

- REACH supported the ongoing development and improvement of the software used to implement CEIS. The original software was limited in the variety of reports and graphic presentations it produced and required extensive reprogramming at each new installation. In contrast, the software developed by REACH and installed in Kenya in August 1990 required little reprogramming and permitted the national EPI to design its own reports in its own language and to produce graphs using Harvard Graphics software.

- REACH has continually evaluated CEIS as a management tool, including the completion of a thorough assessment of its CEIS-related activities.

- REACH co-sponsored one global conference on strategies to implement CEIS and sent participants to another. These meetings provided forums for REACH and other partners and users of CEIS to share experiences, recommend changes, and prioritize additional capabilities to be included in CEIS.

National managers in more than 40 countries are now using CEIS to provide information required to manage the EPI. The systems evaluated by REACH have been used mostly to collate and analyze data on the number of doses administered by the program and on the percent immunization coverage achieved. Users have not taken advantage of the system's capabilities to process other types of immunization data. The focus on coverage has in part resulted from the emphasis placed on coverage levels by UNICEF and other donors as 1990 approached and from the lack of existing manual systems to collect and analyze data in the other areas relevant to comprehensive program management.

In the future, technical assistance in CEIS should promote the development of software that is fully flexible and responsive to the needs of EPI managers and the establishment of comprehensive information systems that provide managers with the range of data they need to fully monitor and evaluate their programs. As a first priority, this should include improving strategies and manual systems to collect and analyze disease surveillance data, and designing the relevant computer software.

BACKGROUND

In 1986, the prototype for future country-level computerized Expanded Program on Immunization (EPI) information system (CEIS) was developed by the South-East Asia Regional Office (SEARO) of the World Health Organization (WHO). It was used to monitor and evaluate immunization-related data reported from countries within SEARO.

As originally designed, CEIS contained program modules that supported data entry and prepared reports summarizing six areas relevant to comprehensive EPI management: program activity (the number of doses of vaccine administered and the percent coverage achieved), the morbidity and mortality caused by the EPI target diseases, the results of immunization coverage surveys, program funding, training given to staff, and the target populations for vaccination. The system prepared graphs for the number of doses administered and the morbidity and mortality data.

As with other programs, data on program inputs and outputs are essential to adequately plan, monitor, and evaluate immunization activities. Within EPI, data on the percent of the target population receiving each antigen permit the manager to assess the access to immunization services, the acceptability of the services provided, and the effectiveness of health education efforts. Morbidity and mortality data permit the manager to evaluate the impact of immunization activities on target disease incidence, to identify areas where higher levels of coverage are necessary to interrupt disease transmission and to identify areas where the cold chain may not be functioning adequately. Finally, data on personnel and financial resources and training activities permit efficient planning to implement required program activities.

SEARO staff realized that the use of computers could greatly increase national EPI access to useful reports and graphs summarizing information for management, as they had in the regional office. For example, reports and graphs from the regional CEIS summarized the number of doses of antigens administered and the percent immunization coverage by country on an annual basis. The module on EPI target diseases produced reports and graphs summarizing the number of cases and deaths reported and the morbidity and mortality rate by country on an annual basis. Using computers, national managers could produce similar reports and graphs. Without computers, national managers had difficulty producing reports showing the number of doses administered by reporting unit by month, and coverage reports were rarely completed other than on an annual basis.

The regional CEIS was demonstrated to SEARO country EPI managers in June 1987. Much interest was generated for the development of a similar system that could be installed at the country level to assist national managers in monitoring their programs. There was also enthusiasm at the regional office in supporting the installation of CEIS at the country level to improve completeness of reporting to the regional office and to improve the capability of national managers to collect and analyze program data.

A consultant working for SEARO developed a prototype country-level system in September 1987, by modifying the existing regional system, and installed it in Jakarta, Indonesia. At the time, this prototype software was not completely functional and the graphics component was not developed. Following this activity, the SEARO director for EPI requested assistance from the

Resources for Child Health (REACH) Project to further the development and installation of CEIS in the region.

SUMMARY OF REACH ACTIVITIES IN CEIS

Installation of CEIS

A REACH consultant completed development of the Indonesia prototype country-level CEIS, including the graphics module, in January 1988. After Indonesia, the next fully functioning country-level system was installed in Nepal in March 1988. Following these activities, REACH agreed to SEARO's request to support an advisor for CEIS in the region for a one-year period. The long-term advisor provided technical assistance for the installation and maintenance of CEIS in Indonesia, Nepal, Bangladesh, India (the regional WHO office in New Delhi and the Polio Control Project in Vellore). REACH assistance also included the provision of a personal computer for Bangladesh, Indonesia and the regional office in New Delhi. The REACH Deputy Director and a REACH consultant installed CEIS at the national level in Turkey in May 1989. A summary of REACH technical assistance to SEARO countries appears in Appendix A.

The African Regional Office (AFRO) of WHO has also been very active in supporting the installation of CEIS. WHO/AFRO first approached REACH in October 1988 to provide technical and financial support for the installation of CEIS in member countries. REACH agreed to install CEIS in Kenya, where a REACH long-term intervention was already in place. The SEARO version of CEIS was installed in Kenya in April 1989. At the Bobo Dioulasso meeting in August 1989, REACH agreed to WHO/AFRO's request to work with the Organisation pour Coopération et Coordination pour le Controlle des Grandes Endenmies (OCCGE) to install and support CEIS in two to three of the eight OCCGE-member countries. A buy-in from the Africa Bureau of the U.S. Agency for International Development (A.I.D.) supported these activities, and CEIS was installed in Burkina Faso and Senegal. The buy-in funds also supported installation of CEIS in Madagascar, where REACH had also agreed with WHO/AFRO to support CEIS. A summary of REACH technical assistance to AFRO countries appears in Appendix B.

In the nine countries where REACH has supported CEIS, technical assistance included two or three visits by a CEIS consultant. Usually during the initial visit, the software was installed and modified so that data could be entered and reports and graphs generated for the level of reporting decided upon by national EPI managers. Staff were also trained in how to enter data into CEIS, produce reports and graphs, and make back-up copies of program and database files. During subsequent visits, problems identified by the users were corrected, reports were either modified or added to meet managers' needs and additional training in systems operation was provided.

REACH was not active in CEIS in Latin America primarily because the Pan American Health Organization (PAHO) focused on the development and installation of software to assist national managers in their efforts to eradicate polio (Polio Eradication Surveillance Software). PAHO requested no technical assistance for these efforts or support for the installation of software similar to CEIS.

Software development and strategy planning

In the process of supporting the installation of CEIS in South-East Asia and Africa, REACH

became increasingly aware of the limitations in the software originally used to implement CEIS. Foremost was the necessity to rewrite the source programs each time the system was installed in a new location and each time a modification was requested. This required that a computer programmer always be present during an installation or follow-up visit.

REACH responded to these limitations by making significant contributions to the improvement of the software used to implement CEIS worldwide. Under project sponsorship, a generic version of CEIS, capable of being installed without modifying the computer programs is nearly completed. Discussions on a generic CEIS started in February 1989, and a REACH consultant used CEIS assignments in Nepal and Turkey to develop the generic software which was demonstrated to WHO/Geneva in July 1990. The generic CEIS can be installed and made site-specific without modifying source programs. In addition, the specific content of reports can be selected by the user, as can the report titles and column identifiers. Data entry screens can be designed by the user to closely resemble the forms used for data entry. Finally, menus, report titles, and column identifiers can be translated into any language by the user.

REACH also sent participants to one meeting in Washington, DC, in April 1989 to discuss strategies to implement CEIS and supported a second global meeting in Geneva in July 1990. Both meetings provided an opportunity for users, programmers and technical experts in EPI management to share experiences in using CEIS, prioritize suggested modifications and plan for additional capabilities to include in the system.

Assessment

REACH has continually evaluated CEIS as a management tool, both informally and formally through its internal assessment from February to May 1990. REACH successfully prompted the software redesign mentioned above and has recommended that the opportunity to routinely assess CEIS be taken during all country visits. The standard CEIS assessment criteria developed by REACH for its internal evaluation have now been adopted by WHO/Geneva for routine use by all partners and donors active in CEIS. (See Appendix C.)

MAJOR CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE ACTIVITIES

- CEIS has increased national EPI managers' access to and use of immunization data for program planning and evaluation. In the past, emphasis has been placed on ensuring that national programs can collect meaningful data on program activity (the number of doses administered and the percent immunization coverage) and that the CEIS produces useful reports and graphs summarizing these data. In the future, EPI managers and groups providing technical assistance should begin similar activities to ensure that disease surveillance data can be collected and then collated and analyzed by CEIS. The installation of CEIS and subsequent lack of use of its morbidity and mortality module have highlighted the inability of many EPIs to collect disease data and measure program impact in a useful way.

- Software development was a new area for many technical experts in EPI. Much has been learned from the CEIS experience that should guide future activities and that should be useful to other national and global programs as they move to computerize

health information systems. Procedures established by commercial software developers may also be of interest and help. The following general guidelines should be followed in the future:

1) Initial software development should include extensive input by the intended users of the system.

2) A test version of the software should be produced and thoroughly evaluated by the users.

3) After users' suggestions have been incorporated, a working version should be distributed.

4) All software should be generic in design, meaning that one can install it and adapt it to the specifics of the installation site without modifying the computer programs that run the software.

- At the peripheral level, and to a lesser extent at the national level, skills in data collection and analysis are generally weak. Technical assistance to develop these skills should be provided as appropriate in conjunction with assistance in computerizing EPI information systems to ensure that peripheral managers can monitor their programs locally. Training for peripheral managers is particularly important, given the logistical and time constraints often involved in providing feedback from the national to the peripheral level from either a manual system or CEIS.

The following pages document the major lessons learned through REACH's work in CEIS in South-East Asia and Africa. Based on these lessons learned, REACH intends to modify its approach to the installation and maintenance of CEIS substantially. The changes will include installation and promotion of a fully generic CEIS that is capable of being easily adapted to different installation sites without requiring custom modification of source programs and extensive training at the central and peripheral levels in the analysis and use of data for decision making.

CEIS GENERAL LESSONS LEARNED

The installation of CEIS should be considered one important component in a strategy to improve EPI management information systems. Some kind of manual system to collect and analyze data on EPI activity, the incidence of EPI target diseases, financing of EPI, personnel and training should already exist prior to the installation of CEIS. Ideally, these data on program inputs and outcomes are reported directly to those in the EPI responsible for using them to make decisions. If not directly reported, the data should be easily available to EPI managers.

The installation of CEIS should be viewed as an important component of an overall package to improve a country's EPI information system. A plan should be developed prior to the start of CEIS installation that outlines the series of steps required to ensure that a comprehensive management information system that includes target disease surveillance exists.

Major work required to either complete or enhance a country's EPI information system should be completed prior to the installation of CEIS.

The plan may include the following steps. First, a thorough assessment of a country's management information needs and capabilities should be completed to determine if computerization is the most appropriate and necessary assistance required at the time. Although computerization is desirable and beneficial, recommendations for modifications and improvements to the manual system should be made first. Technical assistance should be provided as necessary to ensure that a manual information system exists that collects all data relevant for comprehensive program management and evaluation. At this point, computerizing the information system can be considered.

Of the six CEIS modules currently available, only the coverage module is well used in the countries evaluated by REACH. The remaining five are, for the most part, unused in all locations where installed. The cases and deaths module is poorly used primarily because, in general, information systems to collect disease surveillance data are less well established than systems to collect data on program activity. In Nepal and India (Vellore), the CEIS cases and deaths module is not used because there is no routine system by which target disease data are reported from the same administrative units reporting coverage data. The CEIS assumes that the reporting units that provide coverage and target disease data are the same. In addition, disease reporting through these systems is not complete. In Burkina Faso, Kenya and Bangladesh, systems do exist to collect disease surveillance data, but reporting is again incomplete, and the data that are reported are reported to another division within the ministry of health, and the EPI often has difficulty in obtaining this information.

Consequently, there is often a need to develop an appropriate disease surveillance system or enhance an existing system in countries where CEIS is to be installed. This may often be a sentinel surveillance system that collects data on tetanus, measles and polio. This development work should form part of the technical assistance.

Once computerization is appropriate, EPI managers and installers should discuss fully the capabilities of CEIS and the criteria for determining under what conditions an existing computerized information system should be replaced by CEIS. In Madagascar, a well developed computerized system was basically put aside for CEIS because an adequate assessment of its capabilities as compared to CEIS was not made prior to the consultant's visit to install CEIS. It is arguable that the time the consultant spent in installing and modifying CEIS there might have been better spent in providing assistance to the resident computer programmer to upgrade his skills and the existing information system.

The installation of computerized information systems can enhance a country's existing information system. The installation of CEIS has often prompted EPI managers to simplify and improve their existing manual system of collecting immunization related data, particularly when the installed CEIS can collect the data and produce the types of reports and graphs that are recommended for inclusion in manual systems. The improvements to the manual system which result from the installation should be considered a positive effect of CEIS that demonstrates the utility in modeling computer systems on "ideal" or recommended manual systems.

- In Kenya, the manual system that existed when CEIS was first installed was not functioning. Data flow from district to national level was not regular, and the form used to report the number of doses administered was not standardized. Furthermore, some districts reported to Kenya Expanded Program on Immunization (KEPI) and others reported to the health information system. The lack of use of CEIS following its initial installation highlighted the need to revise and standardize the form used to report the numbers of doses administered and ensure that all reports were sent to KEPI. The revised form and reporting procedures were presented to all district EPI managers during a nationwide workshop.

  The installation of CEIS also prompted managers to recognize the need to send all reports directly to those responsible for taking action based on the data. Consequently, all reports on immunization activity are now sent to KEPI.

- In Madagascar, the existing information system was overly complex. Data were being collected that could never be analyzed. Installation of CEIS provided the opportunity to review and simplify the existing system. For example, before the installation of CEIS, disease reporting was broken down by seven age groups. During the installation process, the number of age groups was reduced to three.

- In Bangladesh and Nepal, completeness in reporting of the number of doses administered increased following the installation of CEIS, because managers were more easily able to identify and contact districts that had not reported their most recent data.

  However, it would have been preferable if such enhancements to the country's EPI information system had been completed prior to the installation of CEIS, rather than during the installation or a follow-up visit. Improvements made during the installation visit took time away from training personnel to both use CEIS and interpret its outputs. Where improvements were made during a second visit following the initial installation, CEIS was either not used at all or only used partially in the interim. On these occasions, personnel had to be retrained and remotivated to use CEIS.

The demonstrated utility of easily accessible coverage data should be used to encourage collection and analysis of other immunization-related data. CEIS has increased national EPI managers' access to and analysis of immunization data, particularly on immunization coverage at the peripheral level. As a result of the increased availability of data, EPI managers are able to direct program activities better and have also developed innovative methods to analyze data about immunization coverage.

- In Nepal, prior to the installation of CEIS, no routine monthly analysis of district-level coverage data was possible. At most, a cursory review of the number of doses administered was completed. The potential to provide feedback through quickly produced district-specific reports and graphs summarizing immunization coverage has also been greatly increased by CEIS. Providing feedback in a timely and routine manner remains difficult, however, due to logistic and time constraints.

Additionally in Nepal, new methods of analyzing coverage data have been developed, including the use of monthly proportional denominators in calculating coverage figures and the determination of monthly coverage for the past 12 months.

- In Turkey, only limited analysis of immunization coverage among the 67 provinces was possible prior to the installation of CEIS due to a lack of personnel to generate tables and graphs manually for each province.

- In Bangladesh, CEIS outputs are used each month by EPI and the United Nations Children's Fund (UNICEF) to target the 50 upazilas (subdistricts) with the lowest cumulative coverage.

Efforts to improve the collection and analysis of other immunization-related data, most importantly disease surveillance data, have been limited in the past but should be strengthened in the future and guided by the achievements made with coverage data.

It should be recognized that interest in the CEIS coverage module at the country level is no doubt a reflection of the need for EPI managers to first achieve high coverage levels and of the global level interest in achieving universal childhood immunization by 1990. Until similar attention is focused on the impact of EPI and on the incidence of target diseases, it is unlikely that national EPI managers will begin to refine their information needs in this area.

Training in data collection and analysis and in local program planning and management is very important for peripheral-level EPI managers. At the peripheral level, skills in data collection and analysis often need strengthening. The expectation that a national-level CEIS can provide the feedback for decision making at the periphery is not realistic because logistic, time and system-design constraints often prevent the feedback from being timely or detailed enough to meet the needs of managers in the field. Furthermore, feedback from a national-level CEIS is better able to verify a peripheral manager's own assessment of performance, provide an analysis of the trend in immunization coverage or disease incidence at the peripheral level, and provide comparative data on the important indicators of program performance to peripheral managers.

As a result, an installation of CEIS at the national level has rarely resulted in an improved capacity to manage the EPI at the peripheral level. Peripheral managers should be completing a basic analysis of their own data for decision making at the same time they are compiling the data and sending them to the national level.

Peripheral-level training in data collection and analysis and local program planning and management should constitute an important component in the package of technical assistance aimed at improving an EPI's information system. Training may motivate peripheral managers to collect and analyze immunization-related data and to request feedback from the national-level CEIS to confirm the data they have reported. Training would also help managers better appreciate the increase in immunization-related data provided by CEIS, as in the past. groups providing technical assistance and national EPI managers have not always adequately demonstrated the utility of CEIS outputs to peripheral managers. Plans should be outlined for the development and improvement of supervisory systems to ensure that personnel who receive training in data collection and analysis are supported.

Training given to district EPI managers in Kenya in August 1989 was an important step in providing training to peripheral workers. The training focused on the interpretation of CEIS reports and graphs that were to be fed back to the district level, but did not include any training in the manual compilation and analysis of data. This information should have been included, given the fact that CEIS cannot realistically be the only source of data about program performance at the peripheral level.

- In Nepal, two reports summarizing immunization coverage are fed back to districts each month. Due to logistical constraints, however, the reports summarize program activity from four months previous. Feedback with this delay does not provide timely enough information for district managers to use in ongoing program management. Clearly, a national-level installation of CEIS has not translated into an improved capacity to plan and manage EPI at the district level, where critical implementation decisions must be made. UNICEF is working at the district level to train managers to analyze immunization data, respond to feedback from the national-level CEIS and to plan and manage their program activities better.

- In Madagascar, there is a two- to three-month delay in reporting data from the periphery to the central level on the number of doses of vaccine administered and the number of cases and deaths due to EPI target diseases. Feedback based on these reports cannot be timely enough to be useful to peripheral managers in program planning or in responding to disease outbreaks. Peripheral managers need to complete their own analysis.

- In Senegal and Burkina Faso, no system of routine feedback of CEIS reports and graphs has been established. Training needs of peripheral managers in data collection and analysis and in program planning should be assessed in conjunction with efforts to establish a system of routine feedback from the national-level CEIS.

Unless there are basic computer skills in the Ministry of Health and in the country, CEIS should not be installed. There should be a basic level of understanding about computers, Disk Operating System (DOS) and dBASE prior to the installation of CEIS so that minor technical difficulties can be corrected in-country should they occur. In Senegal, a lack of knowledge about simple DBASE procedures prevented the reinstallation of CEIS from a diskette after the system was deleted from the computer because of a hard disk problem. As a result, CEIS could not be used for almost one year.

A minimum level of computer experience should also be established for EPI staff who will be responsible for using CEIS in country. After the initial installation of CEIS, at least one follow-up visit should also be considered an essential component of the technical assistance provided. The visit should be scheduled for four to six months after the installation and after the users have had the chance to enter data and thoroughly test the system's capabilities.

Installers should maintain contact with the users between the installation and the first follow-up visit. In Senegal, a CEIS was installed in January 1989. After a problem with the hard disk, the system was removed and could not be reinstalled because of an easily rectifiable problem with the version of DOS being used. Had the installer maintained contact with Senegal, it is likely that the problem could have been corrected by phone, rather than having the system

go unused for more than a year until a second technical assistance visit could be arranged in April 1990. In the future, phone, fax and telephone numbers of key contact persons should be provided.

INSTALLATION ISSUES

An epidemiologist or an individual with experience in EPI management and a computer programmer are needed for the installation of CEIS if non-generic software is used. The participation of both a programmer and an epidemiologist during installation visits allows for a more thorough review of the existing information system and the development of recommendations to improve the system. Furthermore, the reports and graphs produced by the coverage and disease surveillance modules can be specified in more detail and estimates and assumptions regarding the target population for immunization can be refined and documented. User's manuals have also been much better developed by two-person teams, as programmers alone often do not have enough time or possess the appropriate skills to complete the manual. For example, the manuals for Burkina Faso and Senegal are much more detailed than those developed for the initial installations in SEARO countries.

Data should be entered into CEIS during the installation visit. At least one year of data should be entered into CEIS during the installation visit so that reports and graphs can be generated and reviewed with EPI managers and modified to meet their needs before the consultant(s) depart(s). When data are not entered, the utility of CEIS and its outputs are not immediately obvious, so personnel are less motivated to continue using CEIS following the installation. Data were not entered during three REACH-supported CEIS installation visits for the following reasons:

- The computers on which CEIS were installed in Burkina Faso and Kenya were not physically located close to where data were collected at central level. Staff responsible for data entry and analysis were also not located near CEIS. It was therefore difficult to maintain a regular schedule of data entry and report generation.

- The computer on which CEIS was installed did not function adequately. In Madagascar, the computer broke on the last day of the consultancy. Staff will not be able to continue data entry and analysis until the computer is either fixed or replaced.

Source code and system documentation must be left in country if CEIS source programs were customized during the installation. Source code and system documentation must be left in country at the time of the installation to serve as a learning tool for in-country programmers and to permit programmers to modify CEIS should the need arise. In Bangladesh, SEARO, Vellore, Indonesia and Kenya, neither system documentation nor source code was left after any installation or follow-up visit. A lack of system documentation caused major problems in Bangladesh when the system crashed after the first installation. The database index files were corrupted because there was insufficient hard disk space to re-index the files. When disk space was made available, there was no documentation that indicated the key field(s) on which to re-index the files. It should be noted that when the generic CEIS is available, there will be no need to leave source programs in country as it will not be necessary or desirable.

USERS OF CEIS

CEIS modules should be redesigned to conform better to EPI managers' information needs. All current CEIS modules, with the exception of the coverage and population modules, should be redesigned, because, as previously mentioned, they remain unused in all locations where installed. Only the coverage module has been sufficiently developed to meet the majority of needs expressed by EPI managers. The remaining CEIS modules are almost universally not used either because they have not been designed to address the information needs of managers, they do not process data being collected, or the data specified for collection by the modules are not available. CEIS modules found useful at SEARO were not relevant at the national level because the information needs of regional and global managers were quite different from those of national managers.

Clearly, EPI managers have not been consulted concerning their information needs in the program areas targeted by the modules, and no technical assistance has been provided to assist managers in meeting these needs. Had these activities been completed with reference to disease surveillance, it is likely that the difficulties experienced by many countries in collecting such data would have been identified in addition to the unusual CEIS surveillance module.

Technical assistance should be provided as necessary to implement systems to collect required disease surveillance data. EPI managers should be consulted on their information needs in the areas covered by the remaining CEIS modules and the modules should be redesigned to meet the expressed needs. Possible modifications may include the following:

- The disease surveillance module should permit entry of data from sentinel surveillance sites that do not correspond to sites reporting routine coverage data. The module should also permit users to track the incidence of as many diseases as they wish, in addition to the EPI target diseases. This is because in some countries like Turkey, EPI is under the communicable disease control program. In such countries, CEIS will be well used only if it can capture data on many diseases of interest to disease control managers. In African countries, EPIs often include yellow fever and meningitis, and managers will want the ability to track these diseases as well.

- The training and funding modules should produce relevant analyses that correlate financial and training inputs with program outputs and impact such as the number of doses administered and the incidence of target diseases.

- The coverage survey module should produce an analysis that compares coverage figures obtained from surveys with coverage figures obtained from routine reports on the number of doses administered. The algorithm used to make this analysis should be carefully designed to ensure that the appropriate cohorts of children are compared for the correct time periods.

The intended users of CEIS should be prioritized. A national-level CEIS can provide WHO regional offices with summaries of country-level immunization-related data and provide peripheral-level managers with feedback that is useful to them in managing their programs. However, providing national managers with information about program performance at the peripheral level and providing feedback to the periphery should be considered the priorities. The

design of CEIS and the focus of interventions which include CEIS should be based on these priorities.

SYSTEM DESIGN ISSUES

Computer software needs to be thoroughly evaluated by its intended users and modified to meet their requirements prior to its widespread distribution. At the time of its installation in Indonesia, the original SEARO version of CEIS had not been thoroughly reviewed by country EPI managers and then modified to meet their needs.

The original SEARO system underwent limited modifications when it was adapted to serve as a prototype country-level CEIS in Indonesia and then reviewed by EPI managers there. For example, the system's reports were modified so that the number of doses administered and the percent coverage appeared side by side on one report. However, this and other modifications were made based on input received from Indonesia's EPI managers (such as the introduction into reports of coverage ranking) not routinely extended to other installations. This is because CEIS would have required reprogramming for each modification at each installation site and apparently there was not always adequate time.

However, even if the CEIS software had been flexible enough to easily incorporate modifications, input from Indonesia's EPI managers alone was not sufficient to design a system that would be useful in the context of many different countries' EPI. More extensive field testing of the original SEARO CEIS in several countries was particularly important because the system was first designed to meet the needs of regional WHO staff and not national EPI managers. The field testing would have also given EPI managers the opportunity to better define their own information needs and to contribute to the development of CEIS prior to its widespread installation. Consequently information needs of national managers were not thoroughly considered in the initial design of CEIS.

The results of not adequately field testing the SEARO CEIS soon became obvious as EPI managers in all SEARO countries where CEIS was installed quickly noticed the same series of limitations such as the system's inability to generate summary reports for more than the one level of administration.

In the future, REACH will take an active role in reviewing newly developed software, including new modules, and in promoting the field testing of new software before it is widely distributed. REACH should follow procedures established by professional software developers in these activities.

A vaccine flow and inventory control module for CEIS should be developed. The report capabilities of the existing six CEIS modules do not meet all the information needs of EPI managers. A vaccine flow and inventory control module for CEIS should be developed as soon as possible. Managers in Nepal, Bangladesh, Madagascar and Senegal have all expressed a need for computer software to help them better manage their program in these respects. Additionally, CEIS should permit the aggregation of data and generation of reports based on several characteristics as defined by a country's EPI (delivery strategy, rural/urban split, geography).

CEIS installations should not require customizing source programs in each country. For installing CEIS, the approach in which source programs are customized and modified in each country is expensive and time-consuming and has resulted in countries becoming totally dependent on external consultants for system maintenance and upgrades. This approach was first followed in SEARO and is currently being followed in AFRO. Custom installations are time-consuming because in addition to the time required to write new programs, each new installation also requires the development of a new user's manual and technical documentation. It is the software equivalent of re-inventing the wheel each time. Furthermore, when countries request the same types of modifications or the inclusion of the same new reports and graphs, separate visits to each have to be made to custom modify the country's programs. The dependence on an external programmer resulted in unacceptable delays in providing additional assistance when requested.

Problems with this approach in SEARO were exacerbated by several technical difficulties which arose after installation. Also, the reports and graphs produced by CEIS were not as clear or useful as they should have been for feedback because not enough time had been devoted to their design and because they were initially generated using Lotus.

A fully generic CEIS should be developed and made available for installation. A fully generic CEIS should be completed and made available for future installation by groups providing technical assistance to improve EPI information systems. The generic CEIS can be configured to the specifics of an installation site without modifying source programs. Rather, the system is made country specific by entering country-specific data into database files. The user is assisted in entering the necessary country-specific information through a series of on-screen prompts and instructions.

A generic CEIS would reduce the cost and time associated with the installation, maintenance and upgrading of a CEIS by external consultants for the following reasons:

1) Users will be able to easily adapt the system to the specifics of their country needs by entering data into database files. A programmer will not be required to custom modify source programs. It is likely that one CEIS specialist would be able to work with representatives from multiple countries to install CEIS in a workshop setting.

2) New and innovative programs and reports can easily be transferred between countries that are using the same generic CEIS without custom modifying programs in each country. A lack of standardization prevented the easy sharing of the ranking reports developed for the West Java CEIS.

Furthermore, with a generic CEIS, the focus of technical assistance can shift from programming and custom modification of software to training in the collection and analysis of data for decision making and to the improvement of information systems.

REACH ASSISTANCE

It has been difficult for REACH to monitor its CEIS assistance. It has been difficult for REACH to adequately monitor CEIS activities in the field. Certain problems such as source

programs not being left in country and lack of adequate training being provided could have been avoided had REACH more closely supervised the consultants working on CEIS. The need for frequent supervision was more critical given the fact that CEIS was a new intervention in an area in which no one had much experience. Feedback from the field did not indicate that there were problems before the end of 1989, but in the future REACH may want to more actively solicit feedback in situations where the consultant or the intervention is new.

It has been difficult for REACH to coordinate CEIS activities with other donors involved in CEIS. It has proven difficult for REACH to coordinate activities with other donors involved in CEIS. REACH/A.I.D. procedures do not allow REACH to plan installations until the A.I.D. mission in a suggested country provides concurrence for the activity. However, organizations such as AFRO, charged with coordinating the installation of CEIS in many countries, require that specific details of resources and commitments be made by participating donors to adequately plan resources and activities. Consequently, there have been misunderstandings and an ongoing need to clarify A.I.D. policies and REACH's proposed CEIS activities with other partners.

Furthermore, additional difficulties arose when REACH contracted an employee of another organization such as EPICENTRE or OCCGE to perform the installation of CEIS. Although such arrangements promoted collaboration and the sharing of technical expertise and experience, they also resulted in an increase in the amount of time and costly communication required to complete the scope of work.

REACH can improve the effectiveness of its CEIS assistance. REACH can be a useful and flexible resource to promote the development and installation of CEIS worldwide. In the past, REACH's input into developing the technical content of CEIS has not been as great as it could have been. In the future, REACH should increase its emphasis on ensuring that the software used to implement CEIS is technically sound. Furthermore, REACH should ensure the country's entire EPI management information system functions adequately so that CEIS is installed under circumstances in which national and peripheral EPI managers can benefit from computerizing their information system.

APPENDIX A

SUMMARY OF REACH TECHNICAL ASSISTANCE TO SEARO COUNTRIES

COUNTRY	DATE	TRIP ACTIVITIES
Indonesia	January 1988	Installation of CEIS at national level
	April 1988	Installation of CEIS at provincial level (West Java)
	May 1988	Training of CEIS users at national level
Nepal	March 1988	Installation of CEIS at national level
	February 1989	Upgrading of CEIS software, first installation of generic CEIS
	April 1990	CEIS assessment
Bangladesh	June 1988	Installation of district CEIS at national level
	January 1989	Installation of upazila CEIS at national level
	August 1989	Additional training of CEIS users at national level
	May 1990	CEIS assessment
India	December 1987	Modification of regional CEIS at SEARO headquarters
	April 1988	Development of User's Guide for CEIS
	November 1988	Installation of CEIS at Christian Medical College, Vellore, for polio control project
Turkey*	May 1989	Installation of CEIS at national level

*WHO/EURO Region

APPENDIX B

SUMMARY OF REACH TECHNICAL ASSISTANCE TO AFRO COUNTRIES

COUNTRY	DATE	TRIP ACTIVITIES
Kenya	November 1988	Assessment of information system and readiness of national management for CEIS
	April 1989	Installation of CEIS at national level
	September 1989	Provision of additional training of CEIS users
	August 1990	Upgrading of CEIS software, training of new KEPI data manager
Burkina Faso	November 1989	Installation of CEIS at national level
	May 1990	Installation of graphics component of CEIS and provision of additional training
	May 1990	CEIS assessment
Senegal	April 1990	Installation of CEIS at national level
Madagascar	April 1990	Installation of CEIS at national level

APPENDIX C

CEIS ASSESSMENT CRITERIA

1. Data

   A. How many years' data were available for the following indicators at EPI office when CEIS was installed?:

      1. The target populations
      2. The number of doses of vaccine administered by the EPI
      3. The incidence of EPI target diseases and the mortality rate
      4. The results of EPI coverage surveys conducted nation-wide or at lower levels
      5. The content of and personnel who attended EPI training programs
      6. Sources of EPI funding and amounts provided

   B. Were the available data reported directly to EPI, or did EPI request it from another division/department? If so, what department?

   C. How many years' data were entered into CEIS during the installation visit? If the amount of data entered was less than the amount available, why?

   D. Did the forms used to report data on the number of doses administered and the incidence of target disease correspond to the CEIS data entry report formats? If not, were the reporting forms and procedures modified or was CEIS modified?

2. Hardware

   A. What is the make and model of the computer on which CEIS was installed? How much total memory was available on the computer? What type of printer was connected?

   B. In what location was the CEIS installed? Is the CEIS only used by the EPI unit, or is it shared among other programs?

   C. Does the CEIS function adequately on your hardware? If not, what problems have occurred?

3. Training and Personnel

   A. During the initial installation of CEIS:

      1. Who was trained to use CEIS (names, positions held within MOH/EPI and amount of previous computer experience)?
      2. What specific tasks were they trained to do?
      3. How long were they trained for?
      4. Are the persons who were originally trained to operate CEIS still working at EPI/MOH on CEIS?

   B. What additional training was provided during the follow-up visit(s)? Should any of this training have been conducted during the initial installation?

C. What training was given to EPI managers regarding the interpretation and analysis of outputs produced by CEIS?

D. Was there a local computer company or personnel available to assist in providing training to EPI personnel in general computer use (including training in DOS, DBASE and Lotus), data entry and system maintenance?

E. What training do EPI personnel consider essential to fully and correctly operate CEIS?

F. What additional training is still needed or should have been provided?

G. Have persons initially trained to operate CEIS or to interpret outputs of CEIS given training to their co-workers in CEIS?

4. Documentation

A. What technical documentation about the programs and data base files of CEIS were provided at the time of installation?

B. Was a user's guide for CEIS provided? If yes:

1. What language was it written in?
2. What are the contents? What additional information should have been included?
3. Did users use the guide, and if so, were they able to follow it?
4. Is a copy of the user's manual available?

C. What additional documentation or training materials were developed during follow-up visits? What should be developed in the future?

5. Programming/Capabilities

A. What software is used to run CEIS?

B. What are the specific capabilities of the CEIS? What modules and programs were installed? What is the exact function of each of the programs installed?

C. What specific modifications were made to tailor the CEIS to suit the needs of the national EPI?

D. What specific modifications or features were requested by EPI staff and included in the version installed?

E. What are the reports and graphs generated by the system? In what language are they produced?

F. What additional modifications are required?

6. Operation of CEIS

A. Who is responsible for data entry?

1. How often are data entered into CEIS and for what months/years have data been entered on:

a. the number of doses administered entered?
b. the incidence of EPI target diseases?
c. the mortality due to EPI target diseases?
d. the results of EPI coverage surveys?
e. the content of and personnel who have attended EPI training courses?
f. the sources of funding for EPI and amounts provided?

2. If data have not bee. entered routinely or if data entry is not up-to-date, why?

3. Are facilities/districts that do not report identified and actively followed up to obtain all reports?

4. Are the data that are entered verified? By whom?

B. Who is responsible for generating reports and graphs?

C. Which of the installed modules and programs are used on a regular basis? Which of the installed modules and programs are not used on a regular basis? What are the reasons for not using certain modules?

D. What on-going operational support is required for system maintenance and training?

1. Who is responsible for ongoing system maintenance?
2. Is there a local capacity for system maintenance, troubleshooting and customization? If not, is local expertise in DBASE, FOXBASE and Lotus available?
3. Are there other organizations in country willing and able to provide support (equipment, consultants)?
4. What additional support does REACH need to provide?

E. Have back-up and restore procedures for databases been established? Are data regularly backed up? How often? By whom?

7. Use of CEIS Reports and Graphs

A. Who is responsible for analyzing the reports and graph produced by CEIS? How often are reports and graphs analyzed?

B. What routine reports, graphs and summaries about EPI program performance were available to EPI managers prior to the installation of CEIS?

C. What reports, graphs and indicators of EPI performance are now analyzed by EPI managers using outputs from CEIS?

1. What additional indicators of EPI performance are managers able to monitor since the installation of CEIS?
2. Has the quality of the graphic presentations of program performance improved with CEIS as compared to graphics available before the installation?

D. What reports are prepared and fed back to EPI managers at the next lower level? How often are reports fed back to lower level managers?

E. What specific actions have managers taken based on reports/graphs from CEIS? Cite specific examples, including the following possibilities:

1. Do EPI manages use CEIS to determine completeness of reporting? Do EPI managers know which facilities/districts reported for a given time period?
2. Do EPI managers use CEIS to monitor progress of districts in meeting set coverage objectives?

8. What problems have been experienced in using CEIS in terms of data entry, report and graph generation, analysis and providing feedback to lower level managers?

A. What are the limitations of the current system in terms of data entry, report and graph generation, analysis and providing feedback to lower level managers?

9. Has the CEIS been expanded to state, provincial or district levels?

A. If yes, in what locations? Who completed the installation and provided training?

B. If no, are there any plans for expanding CEIS to other levels? Who will complete the installation and provide training?

10. What capabilities should be added to the CEIS next?

11. What are CEIS' most important contributions to EPI?

12. What are CEIS' greatest weaknesses?

APPENDIX D

REACH DOCUMENTS ON COMPUTERIZED EPI INFORMATION SYSTEMS

GENERAL

Anabase: Computerized Analysis of Immunization Coverage Surveys. A Review of 3 Programs
Didier Patte
February 1988

CEIS: Helping National EPI Managers
Outreach
Ann Yanoshik
Spring 1989

The Evolution of Computerized EPI Information Systems
Paper presented at the Computerized EPI Information Systems Meeting at PAHO
Robert Kim-Farley, Dinesh Gupta
April 24-26, 1989

Expanded Program on Immunization Information System - EPIIS
Assistance to: WHO/SEARO
Dinesh Gupta
November 29, 1987 - March 4, 1988; March 15 - June 30, 1988 (India, Indonesia, Thailand, Bangladesh); July 1-29, 1988 (India); August 20-31, 1988 (Philippines)

Expanded Program on Immunization Information System (EPIIS) Country Level Computerized EPIIS. User Manual for Version 2.10
Dinesh Gupta

REACH Technical Assessment Report: Computerized EPI Information Systems
David Boyd
August 1990

Strategy Document for REACH Long-Term Assistance in EPI Information System (EPIIS)

BANGLADESH

REACH Assessment Report: CEIS in Bangladesh
David Boyd, Mimi Church
September 1990

BURKINA FASO

REACH Assessment Report: CEIS in Burkina Faso
Edward Wilson
June 1990

Suivi du CEIS a la Direction de la Prevention par les Vaccinations Ministere de la Sante et de L'Action Sociale
Louis Pierre Regere, Brigitte Helynck
May 2-18, 1990

INDIA

Assessment of REACH Assistance in Computerized EPI Information Systems Vellore, Tamil Nadu, India
Nese Cakiroglu
September 1990

Assessment of REACH Assistance to WHO South-East Asia Regional Office (SEARO) in Regional Computerized EPI Information Systems (1987-1990)
Pierre Claquin
September 1990

INDONESIA

Report on Three-Day Visit to Jakarta, Indonesia
Pierre Claquin
October 16-18, 1989

KENYA

Computerized EPI Information System, Nairobi, Kenya
Dinesh Gupta
April 1989

Trip Report: Follow-up Visit to Kenya Expanded Programme on Immunization for Upgrade and Modification of CEIS
David Boyd, Mimi Church
September 1990

MADAGASCAR

Installation du CEIS a Madagascar
Giles Desve
April 3-8, 1990

MALI

Rapport sur L'Evaluation du PEV du Projet du Survie de L'Enfant de Plan/Banamba
Mary Harvey
April 3-28, 1989

NEPAL

CEIS: Nepal Version Technical Reference Manual
Mimi Church
April 1989

REACH Assessment Report: CEIS in Nepal
David Boyd, Mimi Church
September 1990

Revision of the Computerized EPI Information System in Nepal
Mimi Church
March 1989

PHILIPPINES

EPI Coverage Survey Results. Phase I, Philippines
Alasdair Wylie
September 1988 (plus monthly reports)

Trip Report: Review of Information Systems for Cold Chain Management in the Philippines
Mimi Church
March 5-9, 1990

TURKEY

Installation of a Computerized EPI Information System
Edward Wilson
May 1989

Results of a Vaccination Coverage Survey in Nine Provinces in the Republic of Turkey
Nilufer Unver, Mehmet Ali Biliker, Pierre Claquin
January - February 1988

Trip Report on CEIS Work in Turkey
Pierre Claquin