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DEVELOPMENT OF RAPID EPIDEMIOLOGIC
ASSESSMENT METHODS TO EVALUATE HEALTH
STATUS AND DELIVERY OF HEALTH SERVICES
Development of Rapid Epidemiologic Assessment Methods to Evaluate Health Status and Delivery of Health Services

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This paper describes the evolution of the concept of rapid epidemiologic assessment (REA) from a series of ideas to a defined area of epidemiologic research. Five broad areas of research are defined: small area survey and sampling methods, surveillance methods, screening and individual risk assessment, community indicators of risk or health status, and case control methods for evaluation. REA techniques can provide health information more rapidly, simply and at less cost than the standard data collection methods and yet still yield reliable results. The use of these methods is described with examples from both a research programme designed to stimulate the development of REA methods and from other studies in the literature. The further development of REA techniques can lead to better decisions regarding the delivery and allocation of health services in both developing and industrialized countries.

BACKGROUND

Developing countries often have scant resources for health programmes and are critically in need of good information systems that will allow them to allocate those resources wisely. In addition, these countries usually have few people skilled in data collection and analysis and frequently lack an established system of data collection.

Those health statistics systems that exist are often a legacy left behind by colonial administrators, and may not necessarily reflect the needs or priorities of the population. These systems usually rely on the use of long, complicated reporting forms from such sources as hospitals, health centres, and clinics. Data are rarely analysed. At best, they are tabulated and published in a statistical summary several years after collection. Too late to be of use in health planning and decision-making. Further, data collected and tabulated at a central location are of little use at the local level.

Similar problems of lack of data may exist at the local level in many industrialized countries. Often reasonably reliable data on health problems and health status are available at the national level through computerized records such as mortality and hospital discharge data files, and through various surveys such as the United States National Health Interview Survey or the National Health and Examination Surveys. However, even in the US for example, little information is available for use in planning or evaluating health programmes by city or county health departments.

The science of epidemiology should play a major role in the planning and delivery of health care services. Epidemiology provides basic information for identification of new or existing problem areas and risk factors for disease. It may be used to guide the establishment of priorities and to suggest the most appropriate ways to use available resources. In recognition of this role, the Pan American Health Organization (PAHO), for example, has redirected its technical operation activities to increase the use of epidemiologic techniques in the region it serves, and has recently published a volume of important papers in epidemiology in an effort to make classic epidemiologic information more available to public health workers.

The epidemiologic techniques used in industrialized countries may not always be appropriate in developing countries. Often these methods are designed for longitudinal studies of chronic diseases or rely on expensive
population-based disease registries. They may not be appropriate for studying the types of diseases found in developing countries, and even for a single disease, different techniques may be needed depending on the situation. The mass vaccination approach for smallpox had successfully eliminated the disease in many countries but failed in West Africa. It was only when more efficient and creative epidemiologic methods, such as improved sampling techniques and surveillance, were integrated into the disease control efforts that smallpox transmission was successfully eliminated. Financial, logistic, and managerial constraints and lack of sufficient trained staff prevented the use of standard statistical methods such as random sample surveys to assess vaccination coverage. This led to the development of a simple method of sampling to obtain information quickly and cheaply. Thus, the adaptation of standard epidemiologic techniques used in the US and elsewhere was one of the major factors responsible for the worldwide eradication of smallpox. Experience with the smallpox programme suggested that similar strategies could be successful in reducing the burden of other diseases in developing countries.

DEVELOPMENT OF REA RESEARCH
In 1981, the US National Academy of Sciences Advisory Committee on Health, Biomedical Research, and Development (ACHBRD), a joint committee established by the Board of Science and Technology for International Development (BOSTID), and the Institute of Medicine, met to identify areas of research that could contribute to improved health in developing countries and that currently were not being adequately investigated by other groups. One area identified by ACHBRD's initial chairman, Dr D A Henderson, was the need for further work with some of the new epidemiologic sampling techniques and methods used in the expanded programme of immunization. Novel epidemiologic sampling and surveillance methods developed during the smallpox eradication programme and World Health Organization (WHO) Expanded Programme on Immunization (EPI) provided models for the use of innovative techniques for gathering health information which improved health. However, while they were gaining widespread use, these new methods had not been subjected to rigorous scientific evaluation.

The term 'Rapid Epidemiologic Assessment' (REA) was coined by the Committee for this new area of applied methodological research. REA was conceived as a means of providing health information more rapidly, simply and at less cost than the standard data collection methods, and yet still yielding reliable results. REA began as an amalgam of concepts and techniques borrowed from the fields of health services research and operations research, as well as traditional epidemiology. It was largely inspired by the 'quick and dirty' methods of epidemiology utilized for acute disease outbreaks. The ACHBRD sought to develop REA into a coherent field of legitimate research that would provide skills and techniques to local programme managers for use in monitoring and improving health status and performance of health programmes.

Following the recommendations from the ACHBRD, the BOSTID Committee on Research Grants included REA as one of its areas for funding of research in developing countries. Funds were provided by the US Agency for International Development (USAID).

An REA grants programme was officially announced in late 1982 and proposals for research on the topic were solicited from institutions in developing countries. This paper reviews the evolution of REA to become a defined area within epidemiology through an analysis of research conducted by BOSTID grantees and that by other researchers. As the concept of REA has developed, five broad subdivisions of the area have emerged:

1. Small area survey and sampling methods
2. Surveillance methods
3. Screening and individual risk assessment
4. Community indicators of risk or health status
5. Case-control methods for evaluation

This paper will relate the development of research in each of the five areas and relate it to the BOSTID REA programme's efforts. These studies conducted under the BOSTID REA project will be identified as either BOSTID funded or simply REA projects. The paper will also discuss what further work needs to be done in each of the five areas of research.

1. SMALL AREA SURVEY AND SAMPLING METHODS
Health surveys seek to provide data on the relative contributions of selected diseases to the total burden of illness of a population and its health status. The standard procedure is to first select areas that are representative of the entire population being studied, and then to survey a sample of these areas. Standard techniques for choosing the sample to survey include: simple random sampling, stratified random sampling, and cluster sampling. Subjects are interviewed or examined and estimates of the prevalence of disease or conditions of interest are then calculated. Adherence to such sampling methods often results in surveys that are prohibitively expensive and may be difficult to achieve with the resources available in developing countries.


Table 1  REA grants funded, BOSTED programme 1981-1986, by area of research

<table>
<thead>
<tr>
<th>Title</th>
<th>Country</th>
<th>Principal investigator</th>
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<tr>
<td>Small area survey and sampling methods</td>
<td>Peru</td>
<td>Lanza</td>
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<tr>
<td>Development of survey methodology to assess childhood health status and service utilization</td>
<td>Costa Rica</td>
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<td>Surveillance methods</td>
<td>Mexico</td>
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<td>Risk factors associated with urban lesions and cysticercosis</td>
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<tr>
<td>Screening and individual risk assessment</td>
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<tr>
<td>a. A malnutrition risk assessment instrument for infants</td>
<td>Chile</td>
<td>Marsotu</td>
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<td>b. Prediction of malnutrition risk in infants</td>
<td>Egypt</td>
<td>Gidal</td>
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<td>Risk Assessment: identification and monitoring of fetal malnutrition</td>
<td>Guatemala</td>
<td>Koesler</td>
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<tr>
<td>Risk Assessment: development of an instrument to detect pregnant women at high risk of delivery of low-birthweight infants</td>
<td>India</td>
<td>Venkatarammopy</td>
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<td>Assessment of rapid survey techniques for ophthalmic health planning and monitoring</td>
<td>Philippines</td>
<td>Domingo de la Torre</td>
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<td>Standardization of simple method for identifying infants at risk of becoming Hepatitis B carriers</td>
<td>Bangladesh</td>
<td>Zaman</td>
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<td>Rapid Epidemiologic Assessment of childhood disability using community health workers</td>
<td>Pakistan</td>
<td>Hasan</td>
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<td>Rapid Epidemiologic Assessment of childhood disability using racial workers</td>
<td>Jamaica</td>
<td>Thoibrum</td>
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<td>Community indicators of risk or health status</td>
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<td>Positive predictive value of haemoglobin measures for programme to control iron-deficiency anaemia</td>
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<td>Determination of the value of school children’s height measurement as a tool for nutritional surveillance</td>
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<td>Potential of liver retinal reserves measured at autopsy as indicator of vitamin A deficiency in populations</td>
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<td>Case-control methods evaluation</td>
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<td>Water, sanitation, and diarrhoea: comparing case-control and prospective methodologies</td>
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<td>A case-control study of vaccine efficacy in the field: Antityphoid and vaccine</td>
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<td>Rapid Assessment of health status of non-users of services in population-based systems</td>
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<td>Case-control study of late diagnosis of breast cancer: Hospital visitors as controls</td>
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* One project funded in two phases.

There is a need for methods of sampling and surveying that can be tailored to the resources available in developing countries. Further, there is also a need for reliable and current survey information that is locally applicable. Local programme managers often totally lack data upon which to assess or evaluate the health problems in their area. It is usually not possible to interpolate the results of large general population surveys, even if available, to achieve local, small area, estimates. In the US techniques have been developed to create state-based estimates from national surveys such as the National Health Interview Survey, but these estimates are usually unreliable.

Alternative Sampling Methods

Several survey sampling techniques, applicable in developed and developing countries, have been developed to provide survey data at the local level. One such method is the cluster sampling technique of the WHO Expanded Program on Immunization (EPI), that was first proposed to assess smallpox vaccination coverage. It has been widely used since then by WHO to assess both immunization coverage and disease incidence in local communities. A variant of this technique has also been used for the rapid assessment of acute undernutrition. The EPI cluster sample survey method involves selecting at random thirty groups or clusters of children from the area to be studied, with seven children in each group. The seven children within the cluster are not selected randomly, but there is a single random starting point and the rest of the cluster of seven are collected from the next closest houses. This method has the advantage of saving interviewer time and producing relatively inexpensive estimates of immunization coverage quickly. A computer simulation model of this method suggests that for all thirty clusters combined the estimates are reliable, and even in areas where the distribution of immunization coverage is not uniform in the population, the bias is minor. However, when attempts are made to disaggregate the data into information for smaller areas (for which the method was not designed) considerable biases may appear in the estimates. Any clustering of disease or immunization coverage such as around a
road, stream, or in areas close to a health centre will result in larger variances and consequently larger confidence intervals in the estimates of immunization coverage or disease prevalence.

Several projects funded under the BOSTID REA programme are developing and testing the use of Lot Quality Assurance Sampling (LOAS) in the health sector. This method was developed for industrial quality control to assess the acceptability of lots of manufactured parts coming off a production line.\(^{12}\) Recently, this technique has been adapted to assess immunization coverage.\(^{12}\) A BOSTID sponsored study in Peru is using the method to identify localities with unacceptable low rates of immunization.\(^{23}\) The LOAS method determines if the coverage is adequate or inadequate based on a series of predetermined criteria. An early trial of the method detected an area of unexpectedly low coverage for measles vaccination of at-risk children in several health districts despite a recent and supposedly successful mass vaccination programme. Subsequent follow-up to health centres in the affected area revealed that only 20% of vaccine doses were given to children under one year of age. As a result of vaccinating older children there were shortages of vaccine and needles in some areas which had gone unreported, and thus unrecognized by the ministry of health.

Another REA study in Costa Rica seeks to apply LOAS for assessing the quality of care and adequacy of health services provided by local primary health care units.\(^{12}\) "This study evaluates the utility of sampling medical records to monitor health care delivery. The aim is to determine quickly, if an entire lot of records from a health centre is acceptable or unacceptable, rather than to arrive at precise estimates of the proportion of records that are acceptable. The aim is to use it as a screening tool for health centre visits to determine if the care is adequate or requires further investigation. However, a factor that may limit its applicability in many situations is the need for good records that adequately reflect the quality of care given."

**Rapid Ethnographic Assessment**

A newly developed survey technique that can provide useful anthropological data on factors which influence health seeking behaviour and other cultural factors in disease is rapid ethnographic assessment.\(^{24}\) This method seeks to provide more rapid anthropological data for use in health research than standard techniques which are both time consuming and require extensive field investigations. As part of a BOSTID sponsored study in Haiti, rapid ethnographic assessment was used to identify maternal factors which influence the use of preventive health services.\(^{25}\) It provided valuable information for planning a subsequent case-control study to look at factors relating to non-use of available health services.

**Use of Microcomputers**

The increasing availability of low cost portable microcomputers is likely to change considerably the way surveys and other epidemiological studies are conducted. In fact, their advent may even dramatically alter the types of studies that will be possible even at a local level in developing countries. Computer-assisted telephone interviewing already is being used in the US. This results in considerable cost-savings for data entry with only minimal (14%) increase in interview length.\(^{26}\) One of the REA projects in Peru made extensive use of data entry by vehicle drivers in the field with computers connected to automobile batteries.\(^{27}\) It used an interactive data entry program that was able to identify data inconsistencies while the team was still in the field, and thus suspect variables could be easily verified.

Recent studies by Birken using 'lap-top' computers for personal interviews in the US found them to be well accepted by interviewer and respondents, but to have a slightly higher error rate and result in up to a 25% increase in interview length when compared with the use of hard copy interview forms. In addition, 5% of the interviews required backup hard copy interview forms due to either language problems or computer failure (only about 1%). Projects has demonstrated that similar 'lap-top' computers can be successfully used for health surveys in Burana and Thailand.\(^{28}\) He has developed a Rapid Survey Methodology (RSM) that utilizes the full potential of microcomputers to provide health survey data at a local level. Portable lap-top computers are used to develop data collection forms, survey sampling procedures, and for data entry, analysis, and final report writing. Interviews are conducted using hard copy paper questionnaires because of the fear that entering data directly onto the computer would be too disruptive for the interviewer and respondent. Using RSM, one survey team collected data on immunization coverage for 3.5 days in the field, completed analysis in another half day, and on the fifth day presented the results (including computer-generated tables and graphs) to local health officials.\(^{29}\) Methods such as these have the potential to greatly improve the quality of data available for health planning and evaluation at the local level.

2. SURVEILLANCE METHODS

The modern concept of surveillance was defined by Dr. A. Langmuir\(^ {30}\) as 'the continued watchfulness over the
distribution and trends of incidence (of disease) through the systematic collection, consolidation, and evaluation of morbidity and mortality reports and other data. Even when data are incomplete the systematic collection of information over time can detect changes in disease, assuming that methods of case ascertainment have remained constant. Surveillance is not an alternative to properly conducted surveys but rather is a tool for continuous monitoring of changes in health status. The success of the smallpox eradication programme was heavily dependent on the creation of a surveillance system to provide data on cases and to monitor the effectiveness of the vaccination programme. Surveillance data revealed that despite high overall vaccination rates the programme was not achieving its goal of eradicating the disease. It was only when health care personnel changed their strategy from one of mass vaccination to disease containment and control, directing their vaccination efforts to the elimination of smallpox foci around each identified case, that they were able to completely eradicate smallpox transmission throughout West and Central Africa. On the strengths of this experience, the development of better surveillance methods was one of the initial ideas behind the BOSTID RUA programme.

In the US, the Centers for Disease Control has done extensive work on disease surveillance systems, which has led to a number of successful disease control programmes. Many developing countries have similar systems but often their results are inaccurate and results are not available for a long time. Often little attention is given to the quality or consistency of data reported, no feedback is given to those reporting the data, and no one is taught how to utilize the results of the surveillance. One aim of improving surveillance systems is to provide a warning to clinical and public health professionals of the emergence or re-emergence of clinical problems amenable to intervention. An example in Finland suggests that an increase in the proportion of reported cases (either by hospital reports or surveillance of laboratory reports) of meningococcal disease occurring in older ages may be a useful warning of an impending outbreak. This knowledge would lead to appropriate public action (vaccination of susceptibles) and thus prevent or reduce the impact of an impending outbreak. The applicability of this method for use in developing countries such as sub-Saharan Africa requires evaluation. In Nepal, however, the surveillance of trends in laboratory reports of purulent meningitis did lead to the early detection of the reoccurrence of an outbreak of meningococcal meningitis, and its subsequent control.

The value of surveillance for rapidly assessing the health status of a large population of refugees was demonstrated in Thailand by Glass et al. The rapid collection of basic health data allowed for a coordinated health plan to be established, directed at eliminating preventable causes of death and severe illness. Despite the scarce resources available in the emergency situation, the programme resulted in a decline in mortality from an initial high of 9.1/10000 population/day to 0.7/10000 population/day by the fifth week. The use of a health surveillance system has also been shown to improve routine delivery of health services. On the basis of surveillance information, a highly targeted health delivery system was directed at those preventable causes of death identified by the system. Mortality rates fell over a five-year period to levels one-quarter of the national estimates for comparable populations.

Only one BOSTID project has been funded in the area of surveillance. A recently begun study in Mexico seeks to develop a surveillance system for cysticercosis and taeniasis that can be used to direct, and later to monitor, a national control programme. Human cysticercosis is an officially reportable disease in Mexico. However, current passive reporting systems (the weekly Mexican Disease Surveillance system) only reported 73 cases in 1984. Clinical and other epidemiologic data suggest that this is a gross underestimate. A variety of different approaches are being investigated, including surveillance of diagnosed cases of human cysticercosis, methods to identify carriers, intestinal parasite surveys, serologic surveys, and surveys of swine slaughterhouses. Initial data from the system will be used to plan for control efforts, including the possibility of mass or targeted chemotherapy directed at eliminating tapeworm carriers.

**Sentinel Surveillance**

Since the quantity of data needed for routine surveillance systems can overburden a health system, it has been proposed that, rather than collect surveillance data on all hospitals or clinics, surveillance systems might target only a sample of facilities. These data would then serve as indicators of overall trends in the area. This system would allow better quality data to be collected and considerably ease the burden of data collection and analysis. An example of this approach is the sentinel cities programme which identifies impending influenza epidemics in the US. All pneumonia or influenza deaths from these cities are reported weekly. When the number of deaths exceeds a threshold that has been set based on a long-term average from previous years' experience, it indicates the start
of the influenza season or an outbreak. The method has also been advocated for the surveillance of immunizable diseases in developing countries.  

Stoudt et al., have developed a network of sentinel general practitioners in Belgium that has proven to be a successful and cost-efficient means of surveillance for measles when no routine morbidity statistics are available. Similar systems were developed in several parts of the US. Other examples of sentinel surveillance are the use of sentinel horses or chickens to detect impending outbreaks of arbovirus disease or the use of cancers in pets as an indicator of environmentally induced cancer risk to humans.

Sentinel surveillance appears to offer considerable potential both in developed and developing countries as an efficient alternative to routine surveillance. Several of the examples given could serve as models for the development of similar programmes in developing countries. However, no projects using this methodology were funded under the USAID programme.

An essential component to the implementation of these proposed surveillance systems is their evaluation. There is a need to determine the biases introduced by the design of the system. Sentinel sites may have different characteristics from those not participating, and the sites may not have even geographical distribution. The fact that participation in such systems is usually voluntary (which is essential to cooperation and success) may also introduce selection bias as to the type of individuals who volunteer to participate. A method to validate a sentinel surveillance system has been proposed by Lobet et al. There is a need for the extension of these methods to developing countries.

Mortality Reporting

Vital statistics systems collect mortality data and while not classically called surveillance systems they can provide important data for health surveillance. Cause-specific mortality data are essential in order to target interventions to solve the major health problems in a community. However, most developing countries have poor quality data on causes of death and many do not even have a way of measuring mortality. Often, there are no data at all; if death certificates exist, they are usually completed only for those who die in hospitals. Community studies frequently find that the causes of death for the small proportion of people who die in hospitals differ greatly from those who die in the community. To be of maximum use for health planning, vital statistics must be population-based. However, if collected systematically incomplete data may provide useful information on disease trends.

If mortality reporting exists, it may be incomplete or have inaccurate reporting of cause of death. The need for independent evaluations of these systems is demonstrated by a study in Egypt which evaluated the accuracy of the routine death reporting system for women of reproductive age. Earlier studies had found that vital statistics systems based on death certificates to be more than 90% complete for non-infant deaths. However, independent verification of cause of death found that vital statistics over-classified cardiovascular diseases, and only correctly identified about 30% of all the deaths from maternal causes. Trauma deaths were found to be well reported by both systems and to have high reliability with regard to classification of cause of death. While underreporting of maternal deaths (from 20 to 30%) has also been found in the USA the vast underreporting of maternal deaths by official reporting systems in Egypt had important implications for planning maternal and child health programmes. The utility of routinely reported data can be enhanced by the use of simple one-time validation surveys such as that described above. The results provide the necessary data with which to understand the limitations and to adjust the routinely reported data.

In many areas no vital registration at all exists. Consequently, a variety of demographic survey techniques must be used to determine mortality rates in the community. The estimation of early childhood mortality is an essential component of evaluating the effectiveness of health interventions. A more simplified method for estimating early childhood mortality was developed as a means of evaluating a PENTA supported study in Haiti. A problem with many demographic surveys, however, is their inability to provide data on the specific causes of death.

In an attempt to develop valid cause of death data, a number of studies, such as the field studies of mortality in Matlab, Bangladesh, have developed methods to determine cause of death by a "verbal autopsy." This method relies on a history from relatives about the symptoms or events leading to death to determine conditions or symptoms associated with death and is used as a proxy for cause of death. Usually a system is established to report deaths to a central registry on a continuing basis. Interviewers then go out and administer standardized questionnaires to relatives of the closest person who can provide data. Symptom complexes are used to determine cause of death. For example, fever, cough and shortness of breath of relatively short duration, and death from this condition, may be called pneumonia. While such systems can provide essential data both to determine cause of death and evaluate interventions, there is a need for more detailed studies to determine sensitivity and specificity of the method to determine causes of death.
Surveillance Needs

The development of novel techniques for surveillance data collection, and methods to make more effective use of available data from current surveillance systems already in existence, are areas of REA that remain largely unexplored. This is despite the fact that surveillance methodology was one of the aims of initiating the REA concept. A number of reasons may be responsible for this lack of research. The first is that researchers are often removed from the practical world of day to day health department activities. Thus they fail to see the need for the development of new techniques. Those who have the need for these techniques either may not have the time for new research projects or the necessary skills to conceive and develop research proposals to submit to funding agencies. The development of closer links between universities and local health departments should be encouraged. This association would help to encourage development of research in this area. More work is also needed to critically evaluate the usefulness of already existing surveillance systems. If they are found not to provide useful data, then serious consideration should be given to using available resources in other ways, such as the development of sentinel sites or periodic surveys.

3. SCREENING AND INDIVIDUAL RISK ASSESSMENT

This area of REA seeks to develop alternative means of identifying high-risk individuals who could benefit from programme intervention. The WHO has developed a number of techniques to identify high-risk people, or to identify those in need of special care. This approach has been particularly attractive to physicians who are accustomed to the assessment of individual patient risk. Examples include obstetrical screening programmes and individual screening for cervical or breast cancer. Another approach to identifying high-risk individuals include the health risk appraisal (HRA) instruments which assess an individual’s risk of cardiovascular disease and other diseases or injuries. However, the major limitations of these screening tests relate to the sensitivity (ability to correctly detect cases) and specificity (ability to correctly detect non-cases) of the tests used to screen for risk factors, and the ability of survey instruments to predict outcome. A number of BOSTID projects dealt with issues of screening, case identification, or developing simple assessment tools. The largest number of proposals were in the area of nutritional assessment. Nutritional assessment has been developed as a way to identify children either with clinical malnutrition or those at risk of subsequently developing malnutrition. Traditional indicators of malnutrition require measurement of weight for height or weight for age, both of which are often difficult to determine under field conditions. The use of simple arm circumference is an easier, more rapid, and less expensive means for non-health workers to monitor nutritional status. Upper arm circumference has compared well in sensitivity and specificity to standard methods for identifying malnourished children. One study found that circumference detected a younger and more severely malnourished group of children than screening with weight for height. In addition, the technique is easily learned by minimally trained health workers.

Two BOSTID supported studies in Egypt and Guatemala have designed instruments to detect mothers at high risk of delivering low birthweight infants. The study in Egypt tests the ability of illiterate midwives to weigh newborns and to follow them as infants with a simple scale, identifying those who are becoming malnourished. Most births occur at home and are attended by these traditional birth attendants. A simple low cost spring balance with coloured marks has been developed to indicate whether birthweight is acceptable or low. In Guatemala, an REA study assessed the ability of the regular staff of clinics to identify mothers at high risk of low birthweight infants and compared it to assessment by the special research team. Considerable problems were experienced in routine measurements, and the study emphasized the need to develop standardized procedures for a few simple variables that are most effective in identifying mothers in need of appropriate prenatal interventions.

Another REA study in Chile identified a few salient risk factors by which infants at risk of developing subsequent malnutrition by the age of one year could be identified in priori. A variety of techniques (simple relative risk, logistic regression, and classification and regression trees [CART]) were used to develop a reliable scoring system based on a certain critical cutoff point (eg weight for age at 90 days), or incremental scores for each percentage point below a certain criteria (eg weight for age less than 120%). These scores were then used to develop a simple scoring instrument.

A three-country collaborative REA project in Bangladesh, Pakistan, and Jamaica has developed and is evaluating different approaches to the use of a simple ten-question screening instrument for the detection of childhood disability. Earlier studies found the ten questions to have a high sensitivity but to have a low predictive value because of excessive false positives.
A series of probes have been added in an effort to improve the instrument's specificity. These studies are currently evaluating the sensitivity and specificity of the improved instruments to identify children in need of community-based rehabilitation programmes, and to identify the extent of disability in a community.

Hepatitis B is a major health problem in many parts of the world. Effective vaccines have recently been introduced but their cost is a major barrier to widespread use for preventing hepatitis B transmission to newborn infants. Infants of mothers who are positive for hepatitis B antigen (HBcAg) are at higher risk of being infected perinatally and becoming subsequent chronic hepatitis carriers for life. One approach investigated by Lumsang et al. in the Philippines was to develop a simple test to identify infants at risk of becoming hepatitis carriers. It involved developing a low-cost, easy-to-administer test for a surrogate antigen which was a less expensive means of indicating infectivity of the mother. The development of this test led to the development of a much more cost-effective approach to planning immunization programmes directed only at high-risk infants.

An REA study in India tested the ability of trained village workers to perform health evaluations. It seeks to develop low-cost effective screening techniques to detect cataracts and ensure that those who need surgery are referred. Earlier work found that patients with operable cataracts were not being identified, and an efficient programme to treat cataracts was being underutilized. The results of screening by trained paraprofessionals were compared to those of screening conducted by specialist ophthalmologists. This study is important in terms of both its ability to identify cataracts and for its more general assessment of the effectiveness of paraprofessionals in conducting village-based screening for conditions that are amenable to treatment. Other potential uses of such a programme could include screening for other correctable visual disturbances and possibly for tuberculosis and leprosy, particularly in children and young adults.

4. COMMUNITY INDICATORS OF RISK OR HEALTH STATUS

Programmes that use community risk indicators, unlike those using screening and individual risk assessment, seek to develop improved ways of identifying at-risk populations towards whom both public health efforts and health services should be directed, or to identify groups rather than individuals who need specialized care. Assessment of community risk indicators provides a means of targeting scarce resources towards those population groups in most need or most likely to benefit.

One approach is to assess health status in the community through the use of techniques such as proxy or surrogate measures of health status, disease flags, or other methods that can be used to indicate a particular health problem. The use of proxy measures to indicate disease prevalence was evaluated in Nigeria where the simple identification of 'leopard skin', a characteristic skin pigmentation, was found to be a much simpler and more rapid means of assessing the endemcity of onchocerciasis in a community than other expensive, time-consuming, and invasive methods.

A program being conducted in Guatemala uses schoolchildren's height and weight as an indicator of community malnutrition. School children represent a captive population that is easy to identify and measure. The BOSTID funded study found that the nutritional status of the school children was a reliable and inexpensive means of detecting communities at particular risk for malnutrition. Further, the study showed that school teachers were capable of performing the necessary measurements with precision. Fortunately, in this area school attendance rates are high. In areas of low school attendance the method may be less reliable.

Night blindness, the characteristic symptom of vitamin A deficiency, has been found to be a useful surrogate for vitamin A deficiency. Sumner showed that it was much easier to measure and diagnose a history of night blindness than to measure vitamin A deficiency. Detection of night blindness correctly identified 84% of children with clinical evidence of vitamin A deficiency (xerophthalmia), and mean serum levels of vitamin A were significantly lower in those children with night blindness. A BOSTID study in Brazil has been developing improved methods for assessment of community vitamin A status. Part of the study makes use of the fact that all deaths in Brazil are subject to autopsy, mostly by trained technicians. These investigators are taking liver biopsy specimens and analysing them for vitamin A. They will determine if testing the liver stores of vitamin A can be used as an indicator of community vitamin A deficiency, and if areas of the country can be identified that are likely to be vitamin A deficient.

A simplified methodology to permit local health services administrators to evaluate the need/impact of breastfeeding and family planning programmes in a community was developed by WHO. Based on an evaluation of questions and methods used in the World Fertility Survey a simplified 'minimal data' set of questions was developed, and through the use of current status methodology and life table analysis, it was possible to conduct and analyze a study of 900 women in Mexico in four days.
A BOSTID sponsored study in Quito, Ecuador sought to determine the accuracy of simple haemoglobin measurements in pregnant highland women as an indicator of the prevalence of a true iron-deficiency anaemia. For the purposes of screening, the sensitivity and specificity can be varied by changing the haemoglobin level cutoff point depending on programme needs.

The tracer method which is used to assess quality of ambulatory medical care in the US\(^6\) has been proposed by Stillman\(^7\) as a simple and relatively inexpensive method of assessing the quality of primary care provided in developing countries. It selects one or more 'tracer' conditions, such as diarrhoea, and monitors its diagnosis and treatment against a set of predetermined standards of care. However, its usefulness may be limited by its dependence on the availability of adequate records to evaluate. The use of tracer diseases that are easily diagnosed may be an efficient way to evaluate health programmes. Diarrhoea (or guineaworm disease) is much easier to diagnose than other water-related infections. Since it does not require laboratory testing, it may be a useful indicator disease with which to evaluate water and sanitation programmes. Another approach developed by Kullberg et al.\(^8\) uses sentinel diseases that are fatal but preventable as an indicator of the quality of health services in a community. A recent study by Ho et al.\(^9\) suggests that diarrhoeal deaths among US children may serve as such an indicator. Similar indicators have been suggested for diabetes.\(^8\)

5. CASE-CONTROL METHODS FOR EVALUATION

The case-control method was developed in the study of chronic diseases as a more efficient means than cohort studies to investigate the association of risk factors with disease. Rather than following large populations over time which is expensive and involves a considerable wait for results, the case-control method compares factors related to a disease in those with the disease (cases) and those free from disease (controls). The case-control approach has been proposed as a rapid and efficient means to evaluate health programmes, products, procedures such as screening programmes and diagnostic tests, and the evaluation of the quality of medical care services.\(^10\) One of the earliest uses of the case-comparison or case-control method to evaluate health programmes in developing countries was a study by Schwebel\(^11\) who compared use versus non-use of health services as outcome variables in evaluating child health services in Colombia. Most studies of health services do not include the non-users of the service. This group is important to study since if health services are to improve health status, it is necessary to know the characteristics of non-users. Traditionally, health services utilization studies were large population surveys that were expensive and time consuming. The case-comparison method proved to be efficient and provided valuable information on non-users of the system which could be used to target improved health services for the area. A recently funded REA study in Haiti is examining differences between users and non-users of available health services in an effort to better target scarce resources and improve health care delivery.\(^12\) The results of this study are still pending.

An REA study has been conducted in the Philippines on the effectiveness of a water and sanitation programme in reducing diarrhoea.\(^13\) The cases were children attending the clinic for diarrhoea. Controls were chosen from those patients presenting to the clinic with a disease not known to be related to water and sanitation, in this case respiratory disease. The exposure variable used was whether the person came from the intervention area or not. Future plans include a comparison of data collected from a traditional, long-term and expensive prospective study of diarrhoea with the data from the case-control study. Another REA study, also in the Philippines evaluated the validity of using hospital visitor-companions compared to using standard neighbourhood controls for a case-control study of factors responsible for late diagnosis of breast cancer.\(^14\) Results from these studies suggest that the case-control method provides significantly increased efficiency, greatly reduces the cost involved in doing such studies, and can provide important information to improve the delivery of health services.

The case-control method has also been proposed as a more efficient means to evaluate vaccine efficacy.\(^15\) A group of cases with disease and a group of controls free from disease are compared with respect to vaccination history. The odds ratio calculated from the case-control study, because it approximates the relative risk, can be used to measure vaccine efficacy. One of the first published uses of this method was a proposed evaluation of the effectiveness of BCG in protecting against tuberculosis.\(^16\) Other uses include the evaluation of meningococcal vaccine efficacy in Mali\(^17\) and an evaluation of its duration of clinical protection.\(^18\) A comparison of vaccine efficacy calculated by
case-control studies has been found to be similar to that from classical cohort studies.¹⁰¹

A recently funded BOSTID study in Chile uses the case-control method as a means of evaluating the efficacy of typhoid fever vaccines under situations where a normal double-blind trial is not possible.¹⁰² The vaccine was administered through a routine government immunization programme where the allocation of a randomly selected control group who was not immunized would have been unethical. Cases were defined as those people diagnosed with typhoid and two control groups were chosen; one consisted of children from the same area of residence and the other of children attending clinic for conditions other than typhoid. The exposure of interest was whether a person was vaccinated or not. The case-control methodology provides the programme manager with a means of evaluating the efficacy of the vaccine in the field, without the expense of following subjects for several years to accumulate enough cases to achieve statistically useful information.

An interesting and potentially useful method that may be of value in developing countries is the idea of nesting small case-control studies within large population-based surveys. The US National Health Interview Survey now has the capability for call-back surveys of particular cases identified in their survey, eg all cases of diabetes interviewed (O. Thorndeberry, National Center for Health Statistics, personal communication). These people can be followed up by a separate interview team who can then select appropriate controls from those found in the survey to be without disease. Large population-based surveys such as the World Fertility Survey are frequently conducted in developing countries and have been suggested as a useful means to evaluate health programmes.¹⁰³ The addition of small case-control studies are also potentially very useful for answering particular health data questions, and may offer a way to make better use of the data from these costly surveys.

6. CONCLUSIONS

Central to the achievement of the WHO goals of health for all by the year 2000 is the need to focus priorities on the most appropriate interventions for the world's most common health problems and to direct these health care services at the communities which most need them.¹⁰⁴ However, it is increasingly recognized that it is not just necessary to provide these health services, but that it is also essential to have effective and rational administration of healthcare systems. The development of methods of rapid epidemiologic assessment such as those outlined in this paper can provide programme managers with the tools necessary for priority setting, appropriate allocation of resources to those with particular or urgent needs, and the evaluation of the impact of services. Central to the concept of REA is the belief that improved information will lead to improved decision making, which in turn leads to better distribution of scarce health resources to those problems most likely to result in health gains. More and more health care researchers and practitioners, both in the US and abroad, are indicating an interest in the concept of REA. REA techniques are capable of assessing not only infectious diseases but the chronic diseases which are becoming an increasing burden in developing as well as developed countries. The application of REA techniques is likely to be of benefit not only to developing countries but also to state and local health departments in industrialized countries for assessing and evaluating their programmes.

The BOSTID REA programme received over 90 grant applications—an indicator of the great need for and interest in REA techniques. Eighteen different projects were funded. From them have come nearly 100 publications to date, along with a number of manuscripts in preparation and many presentations at scientific meetings to both local and international audiences. Thus, not only has dissemination of REA methods been greatly aided through BOSTID, but the programme has increased the awareness of the research community that developing countries are themselves capable of designing and employing new and innovative techniques of epidemiologic assessment.

A number of problems have been identified in the development of improved techniques of REA. A major constraint has been the lack of trained epidemiologists and biostatisticians in developing countries. Because of this, there were relatively few good quality proposals addressing the issues raised by the programme despite the availability of funds to support them. A worldwide effort to promote the programme included advertisements, active promotion by BOSTID staff and consultants conducting site visits, and appeals to faculty from public health schools to identify potential grantees. This lack of qualified epidemiologists in developing countries has also been identified as a major barrier to the evaluation of interventions against tropical diseases.¹⁰⁵ Similarly, the lack of trained epidemiologists inhibits the development of improved REA techniques in those areas where they are most needed. The restriction of the BOSTID grant awards to institutions in developing countries¹⁰⁶ has severely

¹⁰¹The restrictions were imposed under the conditions of the award by AID to BOSTID.
limited the input of epidemiologists from developed countries. In fact, some projects did involve such collaboration and seemed to benefit greatly from it. Collaboration between researchers from various countries should be encouraged in future efforts to stimulate research in this area.

At least two of the projects evolved from proposals developed while the researchers were receiving epidemiology training in the US. The other groups of researchers with formal epidemiology training were the researchers from the three projects in the Philippines. One is on the faculty at the public health school and the other two researchers were trained through the Rockefeller Foundation funded clinical epidemiology (INCLEN) programme which has established clinical epidemiology research units in various developing countries worldwide. Another researcher in Mexico is a graduate of the Centers for Disease Control Global EIS field training programme in epidemiology.

The majority of the other researchers in the BOSTID programme were scientists from other disciplines who applied their work to the concept of REA. The REA programme was moderately successful in providing them with an opportunity to apply some of their research to epidemiological problems. Ideally, there should be mechanisms to stimulate further the epidemiologic interests of other scientists without training in epidemiology, particularly in view of the very few formally trained epidemiologists in developing countries.

The concept of REA is still new, with more work still to be done in order to develop its full potential. More work is needed on the most appropriate uses of surveillance systems. In the past many epidemiologic surveillance systems have outlined their usefulness, generating data which are no longer useful, given changes in populations, health systems, and economic conditions. In some situations, sentinel surveillance or ad hoc data collection ultimately may be a better use of resources than routine surveillance which may be difficult to manage efficiently. The increasing availability of microcomputers will also greatly affect the types of studies it is possible to conduct, particularly at the local level. The development of applications for case-control methods has shown considerable promise as a simplified, more rapid way to evaluate programmes and interventions. However, to date few studies have employed it. It must be used in a wider variety of situations before the full range of its efficacy and efficiency can be ascertained.

In summary, REA has proved to be a collection of epidemiologic methods that can greatly improve knowledge about health problems and the effectiveness of their solutions by providing high-quality data within shorter periods of time. Better, information obtained more rapidly is not enough, however. Central to the notion of REA is that better information will lead to improved decision-making regarding the provision of appropriate and adequate health services. Only through appropriate allocation of increasingly scarce resources will the goal of 'Health for All' ever be realized. It is hoped that the concept of REA will stimulate more responsive and responsible policies to achieve this goal. This will be the true measure of the success of the BOSTID REA Program in the future.

Unfortunately, as part of the overall restructuring of priorities with USAID, new funding for the BOSTID Research Grants Program, including REA, has been withdrawn. Consequently there is a need for other groups to take up the challenge and to enlist new researchers to continue the momentum gained by the BOSTID REA Program. I hope that publication of this supplement to the International Journal of Epidemiology, devoted to the use of REA, will help sustain this momentum.

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