Informatics: the key to efficiency

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In India a computer-based national health management information system is being implemented by linking more than 450 districts on a network. This and other actions in the field of informatics technology could significantly raise the efficiency of the country's health sector by making decisions more logical, speeding them up and monitoring their impact, and could help to improve the utilization of scarce resources.

It is clearly important to optimize the utilization of the scarce resources available for health care, particularly in developing countries. Decisions should be taken quickly on the basis of accurate, comprehensive information, their implementation should be rapid, and monitoring should be adequate. Informatics, the interfacing of computerized information with communication devices, offers the possibility of meeting these requirements. The present article examines this prospect in the case of India's health sector, where, although major developments are under way, the rate of progress is unsatisfactory.

Information systems

Because conditions vary widely in India, detailed information is necessary on small geographical units and the different segments of the population. At present the country's health information system mostly generates data at the state level on sociodemographic matters. There are no useful data on the incidence of many diseases and disabilities. Long delays occur in the processing of data, sometimes because manual methods are still employed.

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If a computer network were established to cover the country's community health centres it would be possible for information to be communicated nationwide much more speedily than at present. At the national, state and district levels, data could be processed so that valuable epidemiological information would be immediately available. It would be easy to discover gaps in immunization coverage, to check suspect data obtained from the community health centres, and to convert simple data into, for example, age-specific and area-specific figures. Such a network would also facilitate the identification of problems requiring research, their referral to agencies capable of conducting it, and the prompt reporting of results. An integrated system would help to achieve data standards, so important for comparative purposes.

The National Informatics Centre (NIC) has introduced a satellite-based computer network (NICNET) to provide a national health management information system linking over 450 districts. In the health field it is planned to collect limited information monthly in villages, hospitals, nursing homes and health camps on family welfare, tuberculosis, malaria, blindness, disabilities, maternal and child mortality and other matters, and to compile it manually in primary care centres and at district level. Data collected in villages

during the 1991 census are available on the network. The transmission of selected data between the district and national levels will take place on the computer network. There is a feedback system, the Health Management Information System (HMIS), but it does not cover the community health centres. Under NICNET each district headquarters has been provided with a computer, giving considerable scope for converting data into useful information. The possibility exists of computing some fertility and mortality rates and of obtaining useful indicators on immunization, contraception and the incidence and prevalence of tuberculosis and malaria.

The information acquired under HMIS is not exhaustive, and the collection of detailed data by various agencies therefore continues to be necessary. Furthermore, it is important to realize that special attention needs to be paid to the efficient utilization of facilities. It is intended that data from the primary care level should reach national headquarters within a week after the end of each month, and that aggregated tables should go back to the districts by the tenth day of the month *(1)*. HMIS does not go beyond the aggregation of data and there is no provision for further analysis within the system.

HMIS can only provide gross data in a limited range of fields. Information on important conditions, among them typhoid, AIDS and liver diseases, is not available, and it would probably be unwise to include them for fear of overloading the system. Furthermore, there would not be sufficient expertise and manpower at the periphery to gather the additional information. Other agencies currently collecting data, for instance the Sample Registration System, which gathers valuable information on mortality and fertility, should therefore be given access to NICNET. Any remaining gaps could be filled from the literature.

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Reports of small epidemiological studies should be brought together, taking account of differing methodologies, in order to arrive at estimates of incidence and prevalence rates of diseases and problems not covered by HMIS in various segments of the population, and to obtain external validation for those that are so covered. Once a database has been constructed and statistical procedures have been developed so as to arrive at population-specific estimates, these could be put on the network.

The methodology and computer programmes for this purpose should be developed at one centre and distributed on the network to institutions concerned with specific problems. Databases and estimates should be updated as new information becomes available. The network linkage should be used as a means of sharing information between the institutions so that the interactions of various health problems with one another can be studied.

With a view to generating comprehensive data on adequate population samples, annual health interview surveys should be conducted *(2)*; health examinations would not be appropriate because of the scarcity of resources. Subsequently, the literature on the statistical distributions of physiological and biochemical variables in different population segments should be assembled in order to establish local norms.

There is a need to strengthen and expand health databases. Discrepant values should be reconciled and additional indicators for which past data are available should be incorporated,

relating, for instance, to immunization coverage and the availability of paramedical workers. Once HMIS is fully operational, databases on some further indicators, such as the incidence of low birth weight, can be expected to accrue automatically, but information on age-specific fertility and many other parameters will continue to come from outside the system.

In contrast to the situation in HMIS, where the data comprise complete counts, statistical analyses are required for most indicators in the health database and for estimates derived from literature synthesis. These analyses, which should be available on the network, might deal with relative risks and their significance, the dependence of health problems on background correlates, or causality. No more expertise than that appropriate for running the software packages would be required in the institutions using them.

It should be borne in mind that many cases do not appear on computer records because they either go directly to private practitioners or are not seen by any physician. This means that incidence and prevalence rates based on HMIS are likely to be underestimates, and underlines the necessity of using epidemiological surveys reported in the literature.

Once a sound information base has been established, systems analysis should be undertaken, for instance to determine an optimal combination of strategies for combating cardiovascular diseases in specific population groups at a given cost. The Bioinformatics Information System of the Ministry of Science and Technology has established information centres in some prestigious biotechnological institutions, and there are links with international resources, e.g., databanks on genetic material. The computer network for this system is provided by NIC.

A computer-based hospital information system would improve management efficiency by making it easier to monitor the utilization of manpower and materials. In a given hospital, information would be readily accessible on:

- individual wards, concerning the number of cases admitted, bed occupancy, duration of stay and the types of cases staying for relatively long periods;
- individual laboratories, concerning the numbers of investigations of various types performed, the persons requesting the investigations, and the numbers and types of cases with negative results;
- the pharmacy, concerning the quantities of drugs given to different types of cases and the persons ordering the drugs;
- the store, concerning inventory control.

Computerized records would also contribute to hospital-based research by simplifying follow-up and making information on patients easy to obtain. Processing for linkages and interdependence would be much easier than under manual systems, leading to improved detection and diagnosis of problems in the management of patients and hospitals and to the prompt taking of rational remedial action.

The 1500-bed hospital of the All India Institute of Medical Sciences in Delhi is comprehensively computerizing its activities, using local area network technology. Some smaller hospitals have computerized their operations but there is no plan for linkage except by manually compiling certain categories of data at district level.

There is no question but that informatics technology should be increasingly employed to improve the functioning of India's hospitals. Separate modules can be developed for each department in a hospital, and linkage

between departments can be accomplished subsequently. Once computerization has been introduced, linkage between hospitals for referral or consultation is easy to achieve.

Databases and bibliographies

A computer network makes it easy to store, update and retrieve information on the wide range of indicators used to measure health levels. Indicators can be analysed simultaneously to identify confounding factors and investigate the dependence of one indicator on others. The availability of such data at a single centre is highly advantageous, since they can be distributed in a unifom format and there is none of the confusion that can arise when discrepant sets of data exist. For teachers and researchers lacking access to the network the information can be readily provided on diskettes.

The Centre for Biomedical Information (CBI), established in 1986 by the Indian Council for Medical Research (ICMR) and the NIC, provides bibliographic information on biomedical subjects to the country's scientific community and organizes training and user-awareness programmes. The CBI has access to the computer-based Medical Literature Analysis and Retrieval System (MEDLARS) bases and their monthly updates and has MEDLINE tapes from 1986 onwards; access has also been obtained to AIDSLINE, AIDSTRIALS and AIDSDRUGS. Through NICNET all district headquarters can interactively search the citations on world literature containing specified terms or specific medical subject headings. Many institutions now have an on-site node.

The CBI has the capability to search a range of international bases, including MEDLINE before 1985. The postal service is used to deliver search requests and the printouts produced in response. Searches are also performed by users with access to terminals. Since 1991 the CBI has been able to supply laser printouts of full-length articles from over 360 key biomedical journals to users anywhere in the country on payment of a fee, through the Article Delivery on Network Information System. The CBI is also preparing a Union Catalogue of Biomedical Serials, which is expected to be available on NICNET and to cover at least 140 medical libraries in the country.

As yet the only beneficiaries of this development are research institutions; professionals at the periphery are excluded. It should also be noted that a large part of the Indian medical literature is not cited in international indexes, despite the fact that India produces almost half the developing world's publications in this field. Efforts are being made by various national bodies to remedy this situation, but progress is slow. WHO's South-East Asia Regional Office publishes an index medicus whose coverage includes India.

Library networks are also being set up. Electronic medical books published in certain developed countries are commercially available in India. A detailed account of medical literature, indexing and other bases available in computerized form has been published *(3)*. User awareness programmes should be intensified in order that the bibliographic facilities already accessible in India be used more fully by health professionals.

In Indian conditions it is important that not only orthodox Western medicine but also the traditional Ayurvedic, Siddha and Unani systems, together with yoga, naturopathy and homoeopathy, be covered when literature bases are being developed: alternative medicine is generally affordable to the poor and has practitioners in villages and small towns. This task should be assigned to the research councils dedicated to the alternative systems.

A comprehensive database on over 30 health-related indicators is being built up for the whole country at the University College of Medical Sciences in Delhi, using material from 1980 onwards. All the indicators of mortality and fertility, and some sociodemographic indicators, are estimates based on sample surveys, whereas the remaining ones are based on complete counts. Once accuracy has been ensured the database and the menu-driven programme for making searches should be available for use. The possibilities of putting the database on NICNET or another network are being explored. It is already being used to investigate whether there is a time lag between changes in fertility and mortality levels on the one hand and literacy on the other *(4)*, and to conduct studies on health cartography *(5, 6)*.

The Department of Family Welfare, the Central Bureau of Health Intelligence, the Universal Immunization Programme, the Rural Health Division and other government bodies have computerized their operations concerned with the dissemination of data on health matters. In general, however, only current data are available in computerized form. These agencies are more interested in publishing yearbooks than in building up data banks for, say, distribution on a network.

Data and graphics analysis

Powerful biostatistical and epidemiological analysis allows the easy identification of even obscure factors that are accelerating or retarding a health process. It also helps to delineate the roles of competing factors: for instance, in the case of infant mortality, those of diarrhoea, maternal undernutrition, and poor availability of health facilities. The factors can be compared in quantitative terms, and strategies for dealing with them can accordingly be devised. Packages can be developed for use at the state, district and community health centre levels and can be located on the central computer. The nodes at the various levels of the network can use appropriate packages for analysing local data. If a manager at the district or state level requires a special analysis not available in the packages it is possible to programme a local computer to produce the desired output. This would be difficult in community health centres because of the limited computer literacy of the staff.

The limited availability of experts in India makes it desirable for their computers to be connected to those of doctors so that instant consultation becomes possible.

Computers are invaluable in systems analysis, for example the quantitative and qualitative analysis of health systems with a view to arriving at optimal combinations of strategies. Ways of reducing India's high birth rate could, for instance, be investigated by looking at overall economic development, female literacy, audiovisual promotion, domiciliary contacts, incentives and disincentives. What combination of actions in these fields might bring about the greatest possible change in the shortest possible time would depend on levels of development, health conditions, cultural background and political will. Such variables can be seen as forming an intricate web in which confounding is likely to occur.

Simple graphs are an important tool in the explanation of matters that might be very difficult to explain verbally. The skills needed for the creation of graphs manually at field level are seldom available. Computer graphics, however, can overcome this obstacle, since programmes can be provided via the network to districts and community health centres and instruction can be given on procedures for

producing graphs of local data. The primary health centres and community health centres are expected to display graphs depicting their activities in such a way that the mass of people in the rural areas can understand them. For this purpose it should be possible for field workers to draw enlarged copies of graphs provided by computers.

Many institutions in India have facilities for advanced biostatistical and epidemiological analysis but few use their full potential. The application of computer graphics is becoming widespread in these institutions but not at the district, community health centre and primary care levels, where much could be done to communicate complex ideas to the largely illiterate public by this means.

Updates on new developments

In India, doctors and others can spare little time for updating their knowledge of developments in medical science. There is a need for the provision, close to their workplaces, of information on these matters taken from the world literature.

MEDLARS is an extremely useful source of such information, its bases of citations on the international literature being updated every month. Computer programmes search through the citations in seconds and pick up

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those containing specified terms or relating to specific subjects. Any relevant citations can be downloaded on a disk or printer. An abstract is often included, and this may prove adequate for the enquirer; if it is not, the full document has to be located. The availability of MEDLARS on the computer network, with nodes in each district and in health-related institutions and other organizations, would undoubtedly be of immense value to professionals. The installation of the system on a central computer would suffice to make vital information accessible in the most remote areas of the country, thanks to satellite technology. Such a step could be expected to save lives, reduce suffering, and provide considerable support in the spheres of research and teaching.

Health staff could also benefit from computer-assisted instruction. Standardized modules in the form of a shell can be distributed to all sites, where local data or examples can be incorporated and marginal modification effected. Self-assessment can be provided for, and the modules can be updated at short intervals. It is, of course, necessary to field-test the initial modules for their efficacy as learning tools. Furthermore, the many languages spoken and written in India should be catered for.

The cost of providing computers for those training institutions that do not already have them would not be prohibitive. The modules can be centrally developed using existing expertise, which only needs to be harnessed and guided. Expertise is also available for making changes to the modules so as to take local conditions into account. These institutions do not need to be linked as the modules can be distributed on diskette.

Expert systems and consultation networks

As yet, no serious attempt has been made in India to develop expert systems in medical informatics technology. Some software firms are marketing packages intended to help in diagnosis, but proper evaluation should be performed before they are used.

The pooling of experts' knowledge with a view to programming decision-making in medical care could prove useful in the long term. Such expert systems *(7)* diminish reliance on memory, augment expertise, save time and provide help in diagnosis and treatment. Physicians consider computer evidence together with other information and remain the sole decision-makers on the management of patients. However, given the high cost of developing expert systems and the doubts that exist as to whether they would be widely adopted by doctors, they should not be accorded high priority in India.

The limited availability of experts in India makes it desirable for their computers to be connected to those of doctors so that instant consultation becomes possible. Signs and symptoms, laboratory results and even images and sonographs can be transmitted to experts whose advice can thus be obtained without delay. Data, graphs and maps relating to community-based health management can be dealt with in similar fashion. Many medical instruments are computerized and can be directly linked to a network.

It is likely that most experts in India will soon have access to computers. Linkage among experts and between them and other users is not difficult, thanks to the many networks that have sprung up, in both the public and private sectors. Access to the wider world is available through an international gateway. Unfortunately, comparatively few medical and health institutions have availed themselves of the linkage facilities, probably due to ignorance. The cost of linkage is high, although there are government subsidies for organizations in the public sector.

A major obstacle in the way of consultation networks becoming an effective tool in India seems likely to be the weakness of the computer culture. It is to be expected that some considerable time will elapse before this situation changes and computers become widely accepted in everyday work. Another serious difficulty is the relatively high cost of computers with large capacities, such as are necessary for storing images.

Informatics technology holds great promise for the Indian health sector and has been embraced by the government and its agencies. Educational institutions, particularly medical colleges, have lagged behind, and it is now highly desirable to involve them and use their expertise in health informatics activities. Indeed, these institutions should take the lead in demonstrating their own value and that of the technology in national endeavours to improve health care. The incorporation of informatics technology into the undergraduate medical curriculum would help to create awareness of the subject, as would articles dealing with it in suitable journals. ■

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