A.4.2. Challenges in the Deployment of Healthcare Information Systems and Technology

In order to support its constituent enterprise in Latin America and the Caribbean and deliver appropriate solutions, IS/IT/IM face two broad challenges: the complex, dynamic nature of today's healthcare enterprise, and the generally unsophisticated, unprepared state of healthcare information systems development across the Region.

A.4.2.1. Dynamics of Technological Changes

A great deal of debating about current and future economic development and the reorganization of the health sector is centered on the implications of rapid technological change. In this context, information technology is seen as the means for catalyzing the radical transformations required.

Different from past forms of technology, which processed physical resources and economic commodities, information technology processes an abstract resource and one cannot assume that innovation in this area has necessarily the same characteristics as previous forms of technological progress. Indeed, the inputs, the scale of investment, the relationship between the scale of input and output, and even the time scale of information technology development place it outside the scope of mainstream thought on technology, which is still fixed to the physical resource processing paradigm.

Three reasons account for the significance of information technology innovation as a radically new or "revolutionary" as opposed to "evolutionary" phenomenon:

- Rate and extent of technological change that is unique in terms of the pace of development.
- Vast extent of applicability of this new technology, certainly the most general technology ever developed.
- The peculiar nature of the technology itself. Not only does it process abstract resources but also the technology is, in itself, partly information. Innovation in this technology occurs typically through the production of new information resources that include abstract machines, as software, rather than the development of new physical components.

A.4.2.2. Complexity and Changes in Healthcare Organizations

The nature of the healthcare enterprise, particularly as regards information, is markedly different from most other industries. For example, in the banking industry information is very well structured; the number of possible transactions is limited to a dozen or so; their vocabularies are also very limited; and there are well-established standards for data exchange among banks and their partners. Customer records contain a few, simple data types. Procedures in banks are easy enough that

nowadays most transactions can be performed by the customers themselves, with many benefits accruing to the banks.

Specialization and hierarchical considerations in a distributed healthcare system, departmentalization according to the technical qualifications of providers, and the stated goal of delivering integrated cost-efficient healthcare services to the whole population highlight the multiple challenges to be confronted by health managers and professionals when developing information systems.

In addition to the evolutionary nature of HIS in the Region as noted earlier, it should be plain that the various characteristics deemed to be important to healthcare activities require an extensive review for the majority of the HIS now in use. Most of these systems were conceived according to the prevailing philosophy of 15 to 20 years ago, which meant a different healthcare system focus. The vision then was generally healthcare institution-centered and focused on administrative and financial aspects, and the healthcare institution was considered as a collection of service-rendering units. These, from the point of view of the system as a whole, were required to access requirements for information for the purposes of following up on service orders, from the requisition of the needed inputs to the delivery of services and corresponding billing. In some instances, this collection of procedural functions was even more abbreviated, to the degree that it required not more than the recording of a given service (for example, the basic act of examination by a specialist), for the subsequent bill processing and collection. Most of the reports produced also pertained to *a posteriori* type of follow-up on the healthcare institution's earnings.

The purpose here is not to regard activities of this sort as invalid. On the contrary, institutions that control these processes can indeed improve their operational efficiency. Knowing what was performed, what was spent, and where such amounts were spent and, above all, the ability to collect timely reimbursement for services provided, are essential for the survival of most institutions.

A.4.2.3. The Healthcare Delivery Process

The organizational and operational processes of even a relatively uncomplicated healthcare institution, such as a long-term care facility or a home health agency, are many and complicated. Much thought and research have gone into the study and analysis of healthcare processes, resulting in a great deal of useful literature available to the industry professional. One view of the organizational structure of an enterprise seeks to align processes according to the needs of either the institution or the patient (Table 5).

Integration of the inherent variety of functions expected from information applications requires two operation environments: first, an environment characterized by a shared database of collective access and utilization; and second, an environment made up by subsystems of predominantly local or departmental use. At the technological level, two data processing environments are required in the development and implementation of the desired functional integration at systems level:

- An integrated common data environment not necessarily physically centralized, as data can be logically centralized in a distributed physical system, and

- A distributed environment in which each functional unit manages and processes data of local interest as well as systems of common use.

Vertical integration is achieved by defining data flows, reporting responsibilities, and integration of data generated and processed at each functional unit around an informational framework with three interacting areas for the generation and reporting of decision support oriented information: client-oriented managerial information, economic and administrative (utilization and production), and clinical and epidemiological.

Table 5. Organizational Structure and Processes of a Typical Healthcare Organization

Services Management	**Patient Management**
Resources Administration	***Logistics of Care Delivery***
Finances	Patient Identification
Personnel	Admissions/Discharges/Transfers
Materials and Support Services	Orders
Bed Management	Appointment Scheduling
Staffing and Benefits	Service Scheduling
Assets Management	
Facility Management	
Technical Equipment Maintenance	
Drugs and Medical Materials	
Evaluation and Planning	***Primary Clinical Data***
Activities	Automated Digital Instrumentation
Medical Care	Digital Images
Clinical Epidemiology	
Clinical Research	
Quality Assurance	
Information Management	***Medical Records Administration***
Data Files	Medical Records
Access to Data Bases	Insurance and Legal Documentation
HIS Architecture	Clinical Audit

A.4.2.4. The Variety and Detail of Healthcare Information

Healthcare institutions could not be more different from banks. For example, healthcare institutions automating their “customer records” first face the task of computerizing a daunting array of data types, as shown in Table 6.

The variety and requirements specification problems found in many healthcare data types is exacerbated by the size and complexity of the medical vocabulary, the codification of biomedical findings, and the classification of health conditions and interventions. Nomenclature issues include concepts such as procedures, diagnoses, anatomical topography, diseases, etiology, biological agents such as classification of microorganisms, drugs, causes for healthcare contact, symptoms and signs, and many others. Possible combinations and detailing represent a staggering number of possible identifying coding requirements.

Table 6. Typical Patient Health Record Data Types

Data Types	Typical Examples
Coded Data	Diagnosis, Procedures, Laboratory Results
Text	Radiology, Pathology Reports, Notes
Document Images	Optically Scanned Medical Records
Biological Signal Records	ECGs, EEGs, Spirograms
Voice Objects	Dictated Reports
Still Images	X-rays, MRIs, CATs, Mammograms, Photos
Full-motion Video	Cardiac Catheterization, Sonograms

Apart from difficulties with vocabularies, the very nature and structure of clinical documents such as prescriptions and medical records are not standardized for automated data processing. Attempts have been made to define a structured format for such documents. The Problem-Oriented Medical record is an example of an early attempt to deal with the standardization required for data processing. Many models have been defined since then but as yet there is no universally accepted paradigm.

Current approaches for recording medical data fall into two broad categories: free text and controlled vocabularies. In free text doctors and other professionals simply write what they want, using their own words. Usually these documents are later coded manually by other professionals, who use standard vocabularies to describe the most important parts of the document, such as primary diagnosis and procedures. Several approaches to automatically extracting information from free-text records, using the relatively new method called Natural Language Processing, have only partially solved the many problems associated with codification. The second basic method for recording medical data involves the use of controlled vocabularies. In this approach health professionals must use words and concepts that have been previously determined to be the standard, or “canonical” terms for the health enterprise. Certainly, this method achieves uniformity at the expense of professional freedom and is extremely difficult to implement. Even purely administrative applications — patient billing, accounts receivable, general accounting, personnel, materials management, fixed assets, etc. — all have their

own databases with their particular data elements and rules for processing and for information generation.

A.4.2.5. Different Perspectives in Provider- and Procedure-Oriented Sources

Specific provider and procedure-oriented information systems have a different scope as they are, as a rule, concerned with the utilization and the financial aspects of health delivery. They are generally imposed from the top administrative level and, in most cases, are directed to the reimbursement for services provided and financial control. They utilize standardized data sets that typically record patient identification, reimbursement category, length of hospital stay, diagnostic data and the utilization of special services. One criticism regarding most provider- and procedure-oriented systems is related to the fact that they have given little attention to the lower echelons of the healthcare structure in terms of supporting service operation and improvement.

Most databases are highly aggregated and have minimal value to clinical decision-makers, at individual or community level, or as a source of support information for individual patient care, surveillance, and monitoring. The aggregation or averaging of data over large groups may hide variations and can conceal important information, such as those related to the poor quality of primary data and failures or inadequacies of specific health program components. Many health information systems of this type produce only highly aggregated data directed to centralized bureaucratic control and supervision.

There is a growing trend in developing event-based patient-oriented systems, as the basis for unit, organizational, or regional information systems. Such systems demand the extensive training and continuous collaboration of physicians, nurses, and other direct care providers. A large amount of information is produced and needed where people live and make contact with the health services. Focusing on local information and local decision making and action involves finding answers that cannot be provided by information systems directed to central planning and supervision, typically based on highly aggregated data.

Patient-oriented systems consider clients as the central observational unit and reference of the information system. They can provide production, utilization, diagnostic, and epidemiological information of great importance to managers and direct care professionals. The major problems in designing such systems are related to:

- Definition of the data set to be processed
- Integration of unobtrusive data capture instruments into routine health practice
- Data procedures that are acceptable to direct healthcare professionals
- Common specifications, data dictionaries, and the agreement upon a minimum data set to be utilized by all healthcare professionals in any care unit

A.4.2.6. The Need for National Policies and Strategies

Technology developers and suppliers, users, and decision-makers must be aware of national policies and strategies that may affect their judgment regarding the acquisition, development, deployment, and operation of health information systems. Policy establishes the rules that an organization must follow in carrying out its work. Establishing an information management and technology (IM&T) for the health sector ensures that the development and use of systems will proceed in a coordinated manner. The policy must, necessarily, be in consonance with any overall informatics policies in force in a country as well as with its overall health sector policies. The national health IM&T policy, in turn, sets limits to any policies that may be established lower in the hierarchy, at regional or local levels. Once formulated, a policy must be implemented in a coordinated manner. It is highly recommended that a formal organizational entity be established to organize the strategy for the implementation of the national policies. A health IM&T policy may require legislation, operational regulations, and guidelines. As part of a national informatics policy, it should support established priorities and should also define linkages, common standards, and procedures for sharing information with other sectors.

The goal of establishing national strategies for IM&T is to provide a coherent national arrangement directed to facilitating projects, infrastructure development, maximizing the benefits for invested financial resources, and enabling people to function more effectively. The success of the strategy depends largely on people in all functions and levels. They must be computer-literate and have good awareness of the principles of information systems management. Success depends critically on the existence of an information systems staff with the right mix of skills.

Elements incorporated in a national set of policies consider the definitions regarding the following information system components:

- Identification of benefits,
- Technological standards (hardware and software),
- Common data sets and dictionaries based on a fixed structure of registries and forms — in particular a thesaurus of coded clinical terms,
- Procedures, data flow, and communication standards between sites and equipment,
- Measures and standards for ensuring reliability, privacy, and security of data,
- Policies for human resources development, allocation, and utilization,
- Financial requirements, and
- Plans for training and developing staff.

Since it is natural that strategies will differ from one country to another, and possibly between different

health authorities or institutions within the same country, each implementation must be carefully evaluated under the following strategy-related aspects:

- Systems specifications and architecture,
- Shared and local applications,
- Distribution of responsibilities and resources,
- Skills required, and
- Standards of compatibility.

The strategy must outline the architecture of the systems in terms of hardware, software, and method to be used for application development and communication protocols. Applications must be defined in terms of priorities and the time frame in which they are to be developed. Lines of responsibility and the allocation of human, financial, and material resources must be clearly defined and understood.

Health services, unlike most other social and human endeavors, have an additional complicating factor because of the potential clashes between those with responsibility for individuals (e.g., direct patient care) and those with responsibility to the organization and the community at large (managers). Human resources development through awareness programs, education of health staff, continuous training, and career opportunities must be institutionalized from the inception of the developmental effort. The obvious rationale for standards is to facilitate the exchange of programs and data. Technical standards relate to data definition and format, security, media utilized, systems and applications software, and equipment and training.

National, regional, and institutional health information systems committees have an essential role in the definition and enforcement of policies and strategies. Ideally they should have a rotating membership and be formed by users and producers of health information at all levels. Membership should be as broad as possible and, when possible, include: health statisticians from operating agencies and universities, epidemiologists, demographers, economists, sociologists, administrators, planners, community representatives, information specialists, representatives of industry, physicians, and nurses.

The committee should recommend policies and guidelines for overall development of the system. In many settings the committee will be, at the highest level, advisory to the Ministry of Health, and in some settings there will be an analogous internal standing committee to deal with practical problems of implementation at the institutional level. Practical activities of the national committee and analogous committees can include the use of working parties and external technical consultant panels, such as international organizations and agencies, to deal with a wide variety of special problems. The committee should publish a periodical, possibly annual, report commenting on health information systems issues and proposing changes, additions, and, especially, deletion of useless data and procedures.