A CONCEPTUAL MODEL FOR HEALTH CARE INFORMATION SYSTEMS

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Summary

The health care delivery system both needs and generates information in the course of providing service to its beneficiaries. The heightened interest of groups peripheral to the patient-provider relationship has resulted in ever increasing requests for information and serve to focus attention on the need for uniform data.

This paper describes initial efforts to identify and define a core grouping of health-care-related information which is expected to be of maximum use both to members of the health care team and external oversight agencies. To explore the concept of maximum utility, a model of the health care information system was postulated, and functional information categories identified. Application of other criteria resulted in identification of discrete items of information. Definitions and codes, where appropriate, are being developed. The potential usefulness of the concepts to the health care community at large are also discussed.

Background

The past ten years have seen quantum increases in the application of automation to support the institutional health care delivery process. In many cases, system development has followed the same course as the manual information system which it was meant to supplant, in that the system is designed to meet a specific reporting requirement or the needs of a specific group of users. The lack of information interchange has created redundancy in gathering information, often with differing definitions. Efforts to stimulate information interchange have demonstrated success within specific organizations using specific systems,^{1,2,3} but interchange between systems is costly and difficult, if not impossible, due to lack of uniform definitions and data representations.⁴

The ever increasing requirements for information brought about by changes in both health care practice and public policy serve to focus attention on the need for uniform data.^{5,6} Widespread concern with the rising cost of health care mandates the introduction of automated information systems that are as cost effective as possible and that promote, not impede, the delivery of health care.

The Military Health Services System (MHSS), in common with all health care delivery systems, both uses and generates information in the course of providing service to its beneficiaries. Increasingly, faced with limited resources and growing demands for health care, the armed forces medical departments are turning toward automated medical information systems to permit provider personnel to concentrate on patient-care activities. To increase the comparability of data used in MHSS data systems, the Assistant Secretary of Defense, Health Affairs, directed that a work group, composed of representatives from the military medical services, be formed to develop standards for health care data.

Introduction

The health care delivery system both needs and generates information in the course of providing service to its beneficiaries. Much of the information used is redundant in nature - for example, a patient's identification number may be used for retrieval of historical records, patient billing and reporting of laboratory findings, while patients' age and sex may be used for developing population stratifications or determining bed assignments. Attention has been focused on specific aspects of the health care delivery process such as quality assurance and cost containment, and the establishment of related reporting requirements. The lack of clear-cut uniform definitions results in duplicate data collection. Resulting differences in interpretation can provide widely disparate views of the system.

To provide a frame of reference for analyzing the information requirements of members of the health care team and external oversight agencies, a conceptual model of the information flow within the health care system was postulated.

Health Care Information System Model

System Description

At a macro level, the objective of a health care delivery system is to provide health care services to eligible beneficiaries in order to influence the health status of the population. Delivery of health care can be viewed in general systems terms; that is, input, process, output (figure 1) and can be described in the following manner:

a. Input - People who are eligible to utilize the services of the health care delivery system represent a population grouping from which potential input to the system can occur.

b. Process - Members of this beneficiary population will, on occasion, perceive a need for health services and seek entry to the system. Members of this population may also be selected for entry based on certain characteristics, as a result of some public health initiative. During their encounter with the system, various components are brought to bear on the condition presented.

c. Output - The outcome of the encounter(s) is a change in individual health status, which results in a change in the characteristics of the beneficiary population. Conceptually, this model is a generic representation of health care delivery, be it a physician's practice, public health clinic, hospital, or the entire U.S. health care delivery system. To facilitate structuring the analysis of information needs, the model was expanded. From an information standpoint, the model (figure 2) depicts the major components and activities of the health care system and the links to the external environment. Each block represents a module of the system and can be examined in terms of input/output relationships. It allows one to determine where in the overall process that information is initially generated or obtained and to identify its reutilization at subsequent stages. Each module can be further broken down, providing successive levels of detail to support the particular analysis being undertaken. The multidimensionality of a health care matrix makes meaningful graphic representation nearly impossible. One must rather visualize the criss-crossing independencies, interdependencies, and dependencies which define relationships among its elements. And never to be forgotten is the inescapable time dimension. Any dynamic matrix of system activities is uniformly constrained by the time factor, something which is neglected at one's peril, even though satisfactory graphic representation is not achievable. The model is a two dimensional representation of an N-dimensional process, in an attempt to demonstrate the existence of a common path through intersecting processes involving a multiplicity of related disciplines. This is illustrated through the following example involving three of the many health care subsystems. The ambulatory care subsystem (e.g. physician's office) and inpatient care subsystem (e.g. hospital) collect and originate information on patient encounters; while the analysis/planning subsystem (e.g. a health systems agency) requires certain patient encounter information. A physician may be, at different times, an integral part of all three subsystems and information on his characteristics (specialty, privileges, etc.) may be utilized by one or more subsystems.

Figure 3 qualitatively depicts the overlapping nature of these particular subsystems information requirements. The area (number 1) where all three intersect represents information common to all three. The analogy can be extended by the superimposition of other subsystems with the end result

being an area common to a majority of subsystems which represents a core group of information. The traditional system-by-system approach stresses the satisfaction of individual user needs with little regard for external considerations. The numbered areas in Figure 3 suggest that the priorities be reversed so that information requirements common to all members of the user community (number 1) be defined first and unique user requirements last.

Development of Information Categories

Using the model, the following major information groups were identified:

Beneficiary Population

Patient Population

Health Care Delivery System Parameters

Health Care Delivery System Indicators

For analytical purposes, a hierarchy of categories and sub-categories was developed for each group as follows:

Beneficiary Population

Sponsor

Personal Characteristics

Demographic Characteristics

Dependent

Personal Characteristics

Demographic Characteristics

Patient Population

Ambulatory Care

Personal Characteristics

Demographic Characteristics

Encounter Data

Inpatient Care

Personal Characteristics

Demographic Characteristics

Encounter Data

Health Care Delivery System Parameters

Facility Characteristics

Personnel

Materiel

Procedures

Health Care Delivery System Indicators

Health Status Indicators

System Performance Indicators

Identification of Core Information Requirements

Based on a review of other efforts in defining information data sets^{7,8} and Department of Defense (DoD) standardization criteria,⁹ the following guidelines for identifying core information items for each category were formulated:

a. Utility - Items are useful to the majority

of potential users on a routine, recurring basis.

b. Feasibility - Items can be readily collected with reasonable accuracy.

c. Uniqueness - Items can be uniformly defined to facilitate common understanding and use.

d. Scope - Items are applicable to more than one data system or organization.

Sources examined for information items included current and proposed DoD and service reporting systems, other government agencies, and civilian data systems. This phase resulted in the identification of 136 items of information which form a basic core of health care information requirements.

Data Element Standardization

Considerations

As previously mentioned, the introduction of automation has highlighted a number of problems associated with independently developed manual systems. One such problem is the vocabulary used to express the meaning of data and the inherent ambiguity of the English language. One can readily call to mind examples of different English expressions which mean the same thing. In face to face communication, the nuances can be explained, but the man-machine interface for entry or retrieval of information does not possess this flexibility: it is unforgivingly unambiguous.

In order to effectively use the capabilities of computers and associated communication equipment, the words and terms (data elements) used in data systems must be uniformly understood to enhance the human aspects of data system communication. The related data representations (data codes) must be standardized to control the machine usage of the data elements and allow interchange of information between systems without costly conversions.

Terminology

The following terms and definitions are used in the DoD Standardization Program.¹⁰

a. Data Element - A basic unit of information having a unique meaning with sub-categories (data items) of distinct units or values; examples of data elements are sex, states of the United States and types of laboratory procedures.

b. Data Item - A sub-unit of descriptive information or value classified under a data element. For example, the data element "States of the United States" contains data items such as Alabama, Illinois, and Wyoming.

c. Data Code - A number, letter, character, or any combination thereof used to represent a data element or data item. For example, the data codes "AL," "IL" and "WY" might be used to represent the examples of data items given above.

d. Data Use Identifier - The name given to the use of a data element in a data system. For example, the data element "States of the United States" when used in a system may be assigned a data use identifier "State of Birth" or "State of Residence."

e. Data Chain - A name or title given to the use of a combination of two or more logically related standard data elements, data use identifiers, or other data chains. For example, the data chain "Complete Calendar Date" is made from the combination of the four data elements "Century," "Year," "Month" and "Day."

Analysis

The core information items were examined to determine the number of potential data elements which they represented. Each item was screened, using a DoD catalog of data elements,¹⁰ to determine if a suitable DoD standard already existed. If not, a proposed course of action was identified. The analysis indicated that eight approved DoD standard data elements existed, for example, sex, ethnic group, which could be utilized in health care systems and seven other approved data elements could be utilized through the development and addition of at least seventeen health related data use identifiers. Research and development of at least forty new health related data elements with associated data items, codes and data use identifiers would be required.

Progress

Preparation of a standardization request involves developing a concise and exact definition of the data element, identification of the related data items, specification of field size and characteristics, development of data codes, data use identifiers and explanations and abbreviations for data system use. Thirty-three requests for standardization have been completed and are in various stages of coordination with some twenty-two agencies within the Department of Defense. After approval as a DoD standard by the Assistant Secretary of Defense (Comptroller), the data elements will be published in the DoD catalog of data elements. The new data elements will thus be available for incorporation during the design of new health care data systems. For current data systems, implementation will be scheduled at a time when other periodic changes are made, when major systems revision or redesign are required, or when they will provide substantial immediate benefits.

Other Health Sector Aspects

Although this paper has described the use of the model in the military medical environment, the concepts are applicable to the civilian sector. The ever expanding demand for information has led to a sharp increase in requirements for information storage and retrieval.

Information must be classified as a major corporate resource, along with personnel, facilities and equipment, and managed as such. This approach

would formalize such considerations as cost/value of obtaining new information, time sensitivity, frequency of collection, and potential reutilization of information already available. Reutilization, in a cost effective manner, is dependent on the existence of uniform definitions and data representations. The model at its current stage of development implies an order of precedence for developing uniform definitions and representations. For example, certain characteristics of the beneficiary population (sex, date of birth, etc.), once defined, could be used not only, say, in stratification studies, but also in various stages (admitting, test ordering) of the health care delivery process. A further priority ordering can be established by considering such factors as the requirement for interchange of information between systems, and the number of potential users of the information.

Conclusions

The development of a comprehensive catalog of data elements containing definitions or data representations, which initially represents a core grouping of health-care-related information, can be of inestimable value to members of the health care team, external oversight agencies and system developers. The use of uniform definitions can reduce or eliminate semantic confusion. Adoption of uniform data representations is a valuable contribution from the human factors viewpoint, in that the same sets of codes can be used to represent the same information whether the user is served by one or more systems.

Health care delivery is a highly dynamic system which demands that changes be quickly assessed and skillfully managed. When a common basis for communication and understanding is established by the development of codified uniform data representations, users will be equipped with a powerful tool for the management of change.

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HEALTH CARE SYSTEM MODEL

Figure 1

HEALTH CARE INFORMATION FLOW MODEL

Figure 2

SUBSYSTEM INFORMATION REQUIREMENTS

Figure 3