

A Base Plan for Tomorrow's Patient Care Information Systems

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Abstract—The article is proposing a base plan for the future Patient Care Information Systems in a changing health care environment where it is necessary to assure quality patient care services and reducing cost and where new technology trends give the opportunities to develop clinical applications and services patient focused according to new business objectives.

Keywords—Health care management, planning patient care information system.

I. INTRODUCTION

THE synchronous changing world of health care is facing new trends and business realities that are increasing the necessity of bringing modern computer based information tools to give the possibility of continuing correlation of the variables and stable parameters of the health care system. New technological challenges are also appearing for assembling and managing the information and communications infrastructure.

One way of defining the ultimate patient care information system (PCIS) is to examine the prerequisites that affect to the process and management of health care delivery as well as on the structure of the health care organization best suited to deliver care according to the new environment. With critical process and roles identified, an appropriate organizational alignment and strategic plan established and technology issues understood and well implemented, we are proposing a “meta-base” plan for defining the evolution steps from today's information system to the future patient information reality.

II. IMPLEMENTATION OF A PATIENT CARE INFORMATION SYSTEM

It is known that a successful implementation of a PCIS promotes and supports the institution's ability to execute its business plans and meets its business goals. It also improves the overall performance of the institution. The system must be recognized as a strategic tool and corporate asset that can represent an investment in an organization's viability [1].

Nowadays, health care providers need to redefine business goals with competitive advantages and priorities according to their strategy and align information systems investments with the same goals. Critical processes, procedures and personnel roles must be evaluated, reengineered, created or eliminated

according to the objectives. Furthermore, it is necessary to ensure the efficient and effective management of resources organizational and technological, in flexible and appropriate manner in order to reduce the health care cost [2].

The pace of change in the health care environment is forcing health care institutions to improve customer service access, quality and efficiency through strategic alliances. In order to do this, the roles and responsibilities of health care professionals and managerial personnel within the health care institutions are broadening. The focus on improving the processes of providing care demands the involvement of cross-functional, multidisciplinary teams guided by the basic principles of total quality management (TQM) tools and theories [3].

At the same time the technology change has developed multiple applications for health care organizations in several interoperability levels and network solutions like telemedicine services so it is not longer viable to approach PCIS with a departmental or organizational view as some years before. The focus must be on how work is performed rather than on how work is organized [4]. In this way, organizations can develop business strategies and information systems plans that guide the implementation approach in a way that provides support to critical areas affecting the health care organization's core business-providing patient care.

III. FACING THE FUTURE PCIS

As health care organizations provide more services under fixed prices or capitation the business becomes increasingly accountable for delivering quality care at competitive cost [5]. Accomplishing this requires the following prerequisites:

- 1) Managing patient health care, providing the appropriate services
- 2) Eliminating the barriers to providing care efficiently and the most cost effective setting
- 3) Managing the cost and quality performance of all care processes and outcomes

Table I is showing the initiatives for planning new PCIS in three dimensions: Health care imperatives, organizations and information management.

In order to manage more effectively and efficiently patient health, capitation puts the health care provider financially at risk for each patient's utilization of resources. This results on focusing mostly on preventive medicine and manage wellness. Case management patient centered, guidelines and clinical pathways are tools for more than two decades to maximize patient management [6]. The underlying principle remains to maximize performance and quality of services, while

minimizing delays and resource utilization through identifying sequential plans and timing of activities for a given process and actively managing each step of procedures under these expectations. In place of the traditional structure of hospitals and independent physician practices, new integrated services were emerged with the use of Information Technology such as telemedicine and home care electronic patient records to provide comprehensive services when needed by specialized physicians without distance barriers [7]. It seems worldwide, even today, that these services have problems to overcome (social, political, economical) according to implementation environment.

TABLE I
 INITIATIVES FOR PLANNING NEW PCIS

Health Care Imperatives	Organizations	Information Management
<i>Capitation/ Insurance policies</i>	Integration through mergers and acquisitions	Enable the organization through interoperability of applications appropriate databases and big data analysis techniques
<i>Clinical Quidelines</i>	Telemedicine networks	Security issues
<i>Clinical Pathways</i>	Machine-learning techniques	Improvement through Information Technology (IT)
<i>Business Intelligence Measurements</i>	New roles for health care professionals	Supporting the health care role environment

The increasing quantity of next-generation PCIS data, which is expected to occur, alongside with a similar increase in the complexity of the data comprising these records, needs innovative business intelligence measurements through big data analysis techniques in order to facilitate meaningful use of patients data in daily clinical practice. The content of big data includes the PCIS data, along with a broader set of information derived from Personal Health Records (PHRs) such as: (a) health information from medical devices connected to patient from assistive telecare systems, (b) social care information retrieved on request from social care organizations, and (c) genomics information such as genotype and sequence data extracted from biobanks and genetic databanks. This can introduce a new era facilitating cohort-wide investigations and knowledge discovery, thus leading to more effective prevention, diagnosis and treatment of diseases by using machine learning techniques. Machine-learning techniques are data-driven approaches not only algorithmic but managerial and clinical also that are designed to discover statistical patterns in high-dimensional, multivariate data sets, such as those that are frequently found in PCIS and PHR systems.

Under these perspectives health care professionals will assume to manage the health of the population within the new integrated health care delivery system. It is important especially for the clinicians to establish a level to what the PCIS contains and how it will affect their clinical practice. Despite the foreseen potential of machine-learning to discover

useful knowledge from next-generation PCISs, the multi-owner and multi-user nature of the later raises unique challenges for the privacy and the clinical decision making process of the patients whose data are being processed. Each part of the patient's health information may be governed by different institutional or personal policies and practices with respect to confidentiality, security and reliability of information. However, health and social care organizations must comply with commonly approved rule's requirements and standards for the privacy of protected health data [8].

In order to simplify the process of pricing, control and appropriate compensation of hospitals, governmental organizations have to define diagnostic categories according the clinical pathways. Most countries in Europe, the United States of America and Australia have periodically introduced the prospective payment system called Diagnosis Related Groups (DRG's) and DRG-based hospital payment systems with the aims of increasing transparency, improving efficiency and assuring quality in hospitals. DRG's is a generalised price list of hospitalisations, which determines a cost and an average length of stay for each category of hospitalisation [9]. It is known that the type of patient demand for several cases determines the amount of services that need improvement or modifications in order to reduce the cost. Implementation of DRGs requires the existence of new integrated patient care information systems, simultaneously with appropriate training of health care personnel.

IV. PASSING TO A BASE PLAN FOR TOMORROW'S PCIS

The PCIS plan should take the organizational personality into account and balance the theoretical and practical aspects of implementing and supporting applications. A base plan can be a strategic tool for defining the evolution from today's information systems to future PCIS. An effective strategy should identify all necessary changes, including organizational improvements, payment methods and technical solutions. The need to improve information support depending on functional and technical matters, establish changes according to business objectives and critical roles. That means, health managers is required to have multilevel knowledge of new generation's information management. There is always a crucial need to support and bridge the business, clinical and technology sides of the health care organization. A series of key actions are necessary for achieving this target:

- Develop a strategic vision everyone understands
- Redesign outdated processes
- Manage the culture through change
- Invest in a technology infrastructure [10]

Our plan is focusing on the following changes:

- Definition of the parameters of the current PCIS applications that need to be continually upgraded, or maintained.
- Systematic approach of new patient's demands for improvement or modification of services or distance communication that needs to be added to the future PCIS.
- Definition and evaluation of the new role teams of the

managerial and health care professionals in order to implement and develop new procedures and clinical pathways in appropriate diagnostic categories according to patient's demands.

- Implementation and development of new databases and big data techniques with network and infrastructure enhancements where it is possible to provide interoperability and connectivity in secure and trustful platforms.
- Definition of end-user's roles and their interface to the continually upgraded information system and the organization processing
- Evaluation of the system's acceptance by the end-users

and patient's satisfaction in each phase of health care delivery.

- Resource management by using integrated business intelligence systems according to PCIS and PHR measurements data.

All these changes must be accepted by the clinical and managerial staff and promoted by the top level management. Table II shows the phases from today's information systems to tomorrow's PCIS. This base plan should be continually revisited and updated as business objectives change, IT solutions improve and user's acceptance for the system is provided.

TABLE II
 A BASE PLAN FOR THE FUTURE PCIS

PCIS	Phase I	Phase II	Phase III	Phase IV
Applications, Interfaces and Services	Primary Care	Acute Care	Continuum Care	Resource Management
Roles	Decision support Outcome management Preventive guidelines	Clinical pathways Guidelines, Diagnostic categories, Information Management Tele-consultation	Decision support, Quality Audit	Cost management, Operating records
Integrated Patient Records Tools	Tele-medicine networks	Tele-surgery Machine based data techniques	Telecare Big-data techniques	Integrated Business Intelligence Systems
Evaluation	Patient's satisfaction End-user's acceptance	Patient's satisfaction End-user's acceptance	Patient's satisfaction End-user's acceptance	Technology Acceptance Models

Specifically:

New database tools, faster portable computers, mobile technology, graphical interfaces, automated instruments and medical devices promise impressive benefits to patient care and practice management. No matter how many advances a PCIS offers, it still represents a change in the way work is done in clinical practice. The effect of change is positive as the system manages more patient information and physicians and nurses spend more interactive time with the system evaluating its applications more easily and effective than before [11]. In order to accomplish a stable level of positive periodically system's evaluation it is necessary to define all the parameters of the current PCIS applications that need to be continually upgraded, or maintained during that period.

The implications of system reliability and how these translate into technical requirements depend upon the target patient care situation and the extent to which the patient care system has replaced traditional based processes. For example, when PCIS is supporting ambulatory care, system reliability increases in importance as the range of information available in the system database grows by using appropriate Telemedicine networks. Once the system replaces the paper medical record as the preferred information source, paper records are no longer routinely pulled. Then the physicians may find it unacceptable to proceed with the clinic session when the system data upon which they rely are unavailable.

The practice of medicine is becoming more managed, the measurement of medical practice is an essential part of business intelligence measurements and the role of management in clinical practice is increasing according to

business objectives even if the cultural items are different between various health care environments. To play this role successfully, the Physician will need:

- Current information on patient status and all necessary patient's data available by the system (laboratory, imaging, medications, treatments, alerts from past medical records, personal characteristics etc) that can support the decision making process.
- Appropriate matching of patient's clinical information with protocol or clinical pathway to develop a plan of care best suited to patient's condition.
- Coordinated planning of treatment services
- Follow up services and assistance with appropriate quality management until the underlying illness or problem is resolved.
- The Physician should have when needed, system's assistance in transferring patient's data to other levels of health care delivery in case that patient needs to be hospitalized or require surgery or other kind of treatment.

It is not efficient to describe more detailed the roles of every health professional in each phase of health care delivery. These roles are likely to be shared by personnel, some of them located in patient care areas and some others in separate departments with specialized equipment and facilities. A major goal in providing these clinical/technical services will be coordinated delivery of services "just in time" based on the management plan for each patient in quality and cost effective means by obtaining appropriate information from and providing results in a secure environment to the providers of patient's care delivery and the patient who is the owner and the manager of his/her data.

Health care organizations need to adopt the new PCIS strategy plan and reorganize their processes in order to accomplish the new health reality. Studies in the USA have reported that exploration of Information Technology for the facilitation of PCIS systems can save in the medical costs up to eighty eight billion dollars (\$88) over ten (10) years [12]. The development of specific Quality Control Groups in each phase of the plan will support the implementation and evaluation of the plan [3]. Managers with the technology tools of the new PCIS are going to be able to take the pulse of the business at any point of time, using a broad range of internal and external standards and benchmarks to monitor performance and identify areas for improvement. This will be obtained by accessing to detailed clinical resources, financial and cost information concerning services delivered anywhere in the integrated health care system for patients, insurances and data owners. This latter form of semantic interoperability tackles the challenge of developing user understandable, computable and extensible knowledge representation schemes for capturing concepts and health information [13]. Success will require that each health player has flexible access to complete, secure, accurate, up to date information about both the clinical and financial aspects of the business.

The payment method of the "Diagnosis Related Groups" is operating through Health Care Units' information systems. As such, user acceptance of the PCIS is considered an important prerequisite for the DRGs acceptance also. The proposed cost per DRG procedure prescribes the total hospital expenses in as well as the forecasted average length of stay for each medical procedure. The coexistence of other diseases or complications and their severity is taken into consideration in gradation of the cost. In essence, users may be not disagreeing with the concept and benefits of DRGs but with the way they have been implemented in the specific IT infrastructure, which is also known that negatively affects the managerial effectiveness. Thus, the continuously evaluation of the quality of DRGs deliverables are essential for the improvement of the relevant IT infrastructure which in turn will positively affect DRGs' effectiveness [14].

In this point, sociotechnical approach sheds new light on the potential roles of IT applications in health care practices [15]. Optimal utilization of IT applications depends on the interrelation of the system's functioning with the skilled and pragmatically oriented work of health care professionals. That means that effective continuing education of health care professionals is crucial for the success of our planning.

V. CONCLUSION

The continuing IT improvement and the new managerial tasks give the opportunity to plan better solutions for PCIS applications. Our base plan suggests specific changes for a new PCIS that need evaluation on practice. The complexity of health care environment shows the need of further multilevel research of PCIS implementations in terms of social acceptance for the support of health care delivery in different environments.

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