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HC+: Towards a Framework for Improving Processes in Health Organizations by Means of Security and Data Quality Management

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Abstract: There is currently a need to optimize the levels of perceived quality in most public services. Some of the most critical services are those related to Health, since health and welfare are fundamental to the population as a whole. Both public and private Health organizations are therefore interested in quantifying how good their services are, and to what extent the population is satisfied with their usage. These services can be classified into two main groups: health management and clinical. The performance of both kinds of processes is being assessed through the development of certain indicators. However, as these processes are intended to be supported by Health Management Information Systems (HMIS), some legal and technical concerns must be addressed when an HMIS is developed. These HMIS commonly manage personal data which is highly sensitive, and some mechanisms to ensure both security and data quality should therefore be also implemented. But the assurance of security and data quality goes beyond the HMIS, to the overall processes. This paper introduces a framework, HC+, whose objective is to assess and improve the level of perceived quality for services by paying special attention to the way in which the processes manage the levels of security and data quality. This will be achieved by studying the dependence of indicators that are able to describe the levels of perceived quality from the levels of security and data quality. HC+ is composed of three main components: a common *Information Model* with which to better represent the elements of the processes involved in the study, a set of selected *Indicators* to measure the levels of quality, and a *Methodology* to assess and improve the processes so that they can obtain better values for the chosen indicators. In addition, all the changes and decisions made should be consistent with the Quality Management System (e.g. ISO 9000) of the Organization.

Keywords: Health Management Information System (HMIS or HIS), Quality Health Information, Security Health Information, Software Engineering, Security, Quality, HIS, Personal Health Record (PHR), Electronic Health Record (EHR).
Categories: K.6.5, L.4

1 Introduction

Health and welfare are human beings' most fundamental rights. As Humanity has grown and matured, the requirement of ensuring sufficiently good means to maintain adequate levels of health care services for the population has become part of this fundamental right. This signifies that there is an ever-increasing need, with strong social pressure, to assess how well health organizations provide their services, specifically in terms of their performance and quality [Mainz 2003]. This assessment will allow managers to discover not only how health organizations are working, but also to predict the performance of future activities in order to better estimate and manage resource allocation [Michael Rigby, Jari Forsström et al. 2001]. In this context, evidence-based information and appropriate tools are needed to assist providers, managers, stakeholders, doctors, nurses and other health care organization users when confronting this challenge.

Furthermore, providing a Health care service involves the execution of several organizational processes related to health. These processes may be of one of two types: Managerial or Clinical [Littlejohns, Wyatt et al. 2003]. Health organizations, or at least those in First World Countries, typically benefit from the implantation of Quality Management Systems based on any of the existing standards, such as ISO 9001 [van der Heuvel, Konig et al. 2005], to implement certain characteristics such as patient and client orientation, process-oriented health care, continuous improvement, performance measurement and document system. Whatever these characteristics are, the intention is to better address the need to unify the organizational culture, the patient requirements and the vision of the health sector [Mäenpää, Suominen et al. 2009]. In order to better study the extent to which this integration is achieved, some indicators to assess the efficiency of Health services should be chosen [Freitas, Costa et al. 2011; IQIP 2011] and integrated into the Quality Management System [Smith, Mossialos et al. 2008]. Choosing the right indicators is paramount to better describing the service provision scenario which must be better managed.

As previously stated, health care services are provided by executing certain organizational processes, described by means of the most appropriate indicators (dashboards). These processes are usually interconnected through data which has to be shared. Better supporting the running of these interconnected processes makes organizations aware of the need to rely on customized Health Management Information Systems (HMIS or HIS) [Fernando and Dawson 2009; Bose-Brill and Pressler 2012]. When using this kind of HMIS to support processes in Health environments, it is necessary to take into account the interchange of data which is also required. It is therefore mandatory to pay particular attention to both security and data quality management, since they have been proven to be critical concerns owing to the sensitivity of the data interchanged [Smith and Eloff 1999]. This has been recognized over the years by several researchers [Michael Rigby, Jari Forsström et al. 2001; Fernando and Dawson 2009; Chiba, Oguttu et al. 2011; Winter, Haux et al. 2011],

although sufficient investigation has yet to be conducted to successfully address some of the related issues [Bose-Brill and Pressler 2012].

In spite of the awareness of the need to implement strong protection and data quality mechanisms for such data, they must be easily available and accessible, particularly when they might be required to be consistently accessed wherever and whenever the population needs them. As cities and regions have grown in different ways, the need for health care services has also grown in different ways, and over time different HMIS have consequently been created for each different area using different standards for health data and technologies. The authorities are aware of this need, and some organizations like the Commission of the European Communities have recently dictated the importance of sharing information between different healthcare organizations to improve the quality and security of patient care and to make improvements to public health [Reding 2008].

This has led to, among other issues, certain problems concerning the semantically interoperability between different HMIS when interchanging data [Garde, Knaup et al. 2007; Stroetmann VN, Kalra D et al. 2009], which in turn, results in major complications concerning the management of the security and quality of the data that these systems manage [Häyrinen, Saranto et al. 2008; Martínez Costa, Menárguez-Tortosa et al. 2011]. As an example of the kinds of complications that result from the lack of implementation of mechanisms to access personal data with adequate levels of security and quality, we could cite the special case of health organizations in Spain, where Health Care services are mostly publicly supported. Since the beginning of the period of Democracy, neighbouring regions have developed highly customized HMIS depending on the very specific economic situation and population-related-needs of the areas involved. In many cases, these HMIS are consequently unable to share patients' personal Electronic Health Record (EHR) leading to the need to repeat unnecessary - and sometimes over-invasive - clinical tests, which inevitably leads to delays in diagnosis, and subsequently to delays in the application of treatments: this latency finally has an impact on patients, who are those most affected. Comprehensive surveys exist which show that the implementation of independent and not sufficiently well connected HMIS has led to the apparition of many problems in information sharing, this being even worse when they are in different phases of their development and evolution [Campillo 2008].

In recent years, many researchers and practitioners have attempted to provide approaches by creating standards with which to perform the required interchange of data between HMIS. Examples of such contributions are HL7-4 [HL7-4 2012], openEHR [OpenEHR-Foundation 2007; OpenEHR-specification 2011], the ISO13606 [ISO13606-1 2008; ISO13606-2 2008; ISO13606-4 2009; ISO13606-3 2010; ISO13606-5 2010], ISO22220 [ISO/TS22220 2011], ISO14265 [ISO/TS14265 2011], ISO727953 [ISO/TS14265 2011] and many others. Unfortunately, most of these works do not totally cover data quality and security issues, because they go beyond HIS: their scope is the overall organization, and they need the context of organizational healthcare processes if they are to be correctly assessed. This finding led us to develop the following research questions:

- *RQ.1. How can we determine the adequate levels of data quality and security for data in healthcare processes?*

- *RQ.2. How easy is it and how much (in resources) might it cost to adapt healthcare processes to include security and data quality concerns?*
- *RQ.3. To what extent can organizational processes benefit from the implementation of such characteristics?*

This last question can be reformulated in another way: To what extent will performance indicators vary with the implementation of such characteristics? And this is precisely what has principally motivated us to continue with our research. Unfortunately, we discovered that there are no ways in which to systematically confront the problem. One strategy might consist of studying each of the scenarios present in a health care organization independently, with a special focus on the capabilities of the HIS to support the corresponding processes. Since this means of working is highly complex and time consuming, we decided to develop a strategy with which to better cope with a problem that currently requires solid approaches based on the need for an organizational focus to optimize the usage of resources.

Our approach, and the main contribution of this paper, is a framework denominated as HealthCare Plus, HC+, which introduces and addresses certain elements aimed at the commitment of the management team, at modelling the elements involved in healthcare processes and their dependences, at managing the assessment of healthcare processes by means of the most relevant performance indicators, and finally, as part of the improvement, at guiding the implementation of data quality and security artefacts in the healthcare processes as a strategy to enhance their performance. To do this, the elements that we have depicted are:

- *An Information Model (HC+.IM)*: a kind of ontology describing the components of the healthcare organizations and their processes, which additionally brings together the concept related to data quality and security.
- *A set of Indicators (HC+.I)*: a set of indicators which are internationally recognized as the best means to describe the behaviour (performance) of healthcare organizations and their processes.
- *An Assessment and Improvement Methodology (HC+.M)*: a Plan Do-Check-Act (PDCA)[Deming 1986]-based methodology whose main purpose is to identify common roots for defects as derived from the interpretation of the indicators measured, and taking as a basis the concepts of data quality and security, proposing changes to the processes in order to increase their performance.

As primary concerns, and in order to make HC+ as widely usable as possible, we identified the following requirements:

- Any solutions provided must take into account all the data and stakeholders involved in the execution of the processes in a comprehensive manner, in addition to the dependency between the various types or processes (management and clinical).
- The solutions provided must comply with international standards.
- HC+.M must be easily applicable without the need to invest too many organizational resources.

The remainder of the paper is structured as follows: Section 2 shows an analysis of the knowledge required to better manage concerns regarding data quality and security

concerns in Health Processes (particularly those identified in international standards). In Section 3, the HC+.IM (section 3.1), the set of Indicators HC+.I (section 3.1), and the HC+.M (section 3.2) are presented. Finally, in Section 4 some conclusions are shown.

2 Related Work

The goal of this section is to identify those works that will allow us to build a body of knowledge, based principally and as far as possible on international standards, since these standards already address the most important concepts to be used. The objective of the body of knowledge sought is to provide guidelines as to how to confront certain known problems and how to identify those that are unknown. Although the set of standards that we have identified for this work contains some standards that specifically address security and data quality concerns, these dimensions are not directly related to eHealth concepts.

Problems in health data may have an important negative effect on the quality of knowledge discovery results [Cruz-Correia, Rodrigues et al. 2009]. Expert knowledge regarding data collection, processing, and analysis should be considered when using and analyzing healthcare data. The process of healthcare delivery, and the consequent recording of data in electronic health records, should be adequately understood in order to correctly analyse data and avoid erroneous interpretations. Some existing ICT standards could help to provide guidelines as how to better implement concerns in order to somehow ensure adequate levels of security and appropriate levels of data quality. However, this work has yet to be carried out. Given the large number of existing or under-developed standards, we decided to group them into sets according to their nature. No description of them is provided here owing to restrictions on the length of the paper, but in a first approach we have identified the following sets (see Figure 1):

- A first set will include those standards which would be used to build the information model and IT architectures to support the Health Information Systems because they provide the most relevant concepts related to the eHealth environment. This represents 47% of the standards to be considered.
- The standards to be included in a second set are those that are focused on the security aspects of data and information systems. This represents 39% of the standards to be considered.
- A third set will include issues related to data management and data quality. This represents 8% of the standards to be considered.
- Finally, the aim of the fourth set of standards will be to address how to define measurements with regard to the performance of the HIS. This represents 5% of the standards to be considered.

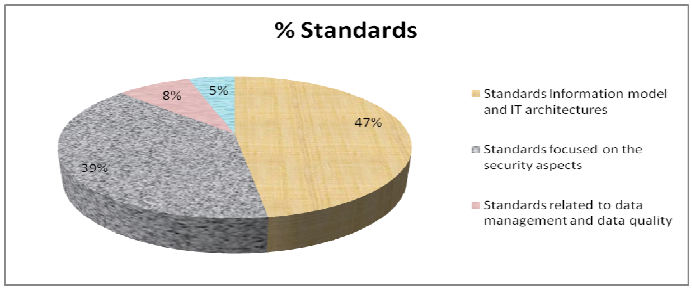

Figure 1: Set of standards considered in the development of HC+

These standards will be used to provide solutions to the most important technical and managerial problems. In order to tackle these problems, it is necessary to take into account that many different data sources, with different strengths and weaknesses, can store administrative data related to the execution of eHealth processes. It is necessary to extract administrative data from these data sources which are needed to calculate the measure performance indicators, including administrative data (e.g. billing data), electronic health record data, patient-derived data (questionnaires), reports and direct observations. The higher the level of quality the data have, the more real and reliable these performance indicators will consequently be. Administrative data is routinely collected, widely available, relatively inexpensive, comprehends large amounts of data, and is nationwide. However, with some data quality problems [Szeto, Coleman et al. 2002; Peabody, Luck et al. 2004; Freitas, Silva-Costa et al. 2010; Freitas, Gaspar et al. 2012] administrative data is a valuable source for measuring the quality of care. This data contains information from discharges, is used to bill and pay hospital services, has a standard format, and can be used for many other purposes, such as research or public reporting [Price, Estrada et al. 2003]. Administrative data is an important resource for hospital management and policy makers. It typically contains demographic data (e.g., age, gender), "administrative data" (length of stay, type of admission, payer, discharge status) and ICD-9-CM coding of clinical data (diagnostics, procedures, external causes) [Iezzoni 1997].

The following section briefly introduces the HC+ framework that we have developed to enhance eHealth processes by means of a continuously improving approach.

3 The HC+ Framework

As stated previously, the goal of our research is to develop a framework that will allow the performance of Health-related processes to be improved by means of security and data quality.

Some health organizations do not properly monitor their business processes, principally owing to the high amount of processes being run simultaneously.

Moreover, the data dependencies between different processes make it even more difficult to track some of the problems that occur.

In order to facilitate the assessment and improvement of health care processes (both managerial and clinical), we considered the need for an integrative framework that would address how to tackle the concerns regarding security and data quality.

The components of our framework will be introduced in the following subsections (see Figure 2).

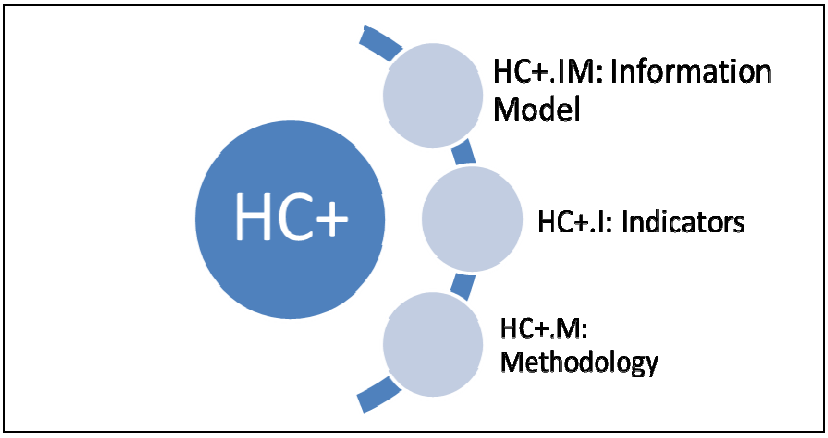

Figure 2: Components of the HC+ framework

3.1 HC+.IM: An information model to describe Health care processes

The first component of the framework that we propose in order to improve the levels of data quality and security in HealthCare processes is an Information Model that contains all the concepts related to the methodology to be developed.

This Information Model will be developed by bringing together concepts from the following domains: Healthcare, Security, Data Quality and Performance Indicators (see Figure 3):

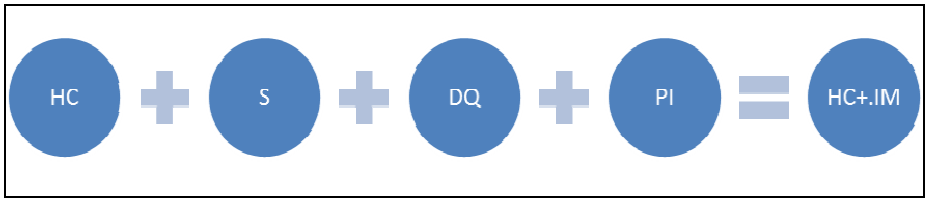

Figure 3: Foundations of the Information Model

The information model will be built by including and relating three main blocks of concepts:

- *Concepts from the Health domain (HC):* to generate an Information Model covering the widest spectrum possible. We shall begin by performing a

comprehensive systematic review of the related medical, managerial and computer science literature and we shall then add the existing knowledge from the related international standards previously presented (HL7, ICD-9-CM...).

- *Concepts from Security domain (S):* in order to be able to describe the concepts of security, it is necessary to add and appropriately adapt the concepts provided by the body of security knowledge to Health Environments [Mellado, Blanco et al. 2010]. This body of knowledge is mainly composed of certain international standards related to security management, such as those previously described in Section two (e.g. ISO 27000, ISO 27799 ...).
- *Concepts from Data and Information Quality domain (DQ):* as occurred with security, the concepts of data and information quality will be analogously redefined for their use in the Health environment. We shall also address the concepts which are being introduced in the new data quality standards that are under development. The Data Quality Measurement Information Model presented in [Caballero, Verbo et al. 2007] might be very useful when carrying out this task.
- *Concepts from Performance Indicators (PI):* Performance indicators, also called quality indicators or management indicators, are usually quantitative measures for a particular feature of an institution and can be used to screen, compare and evaluate the quality of a service [Donabedian 2005]. Indicators can be used to describe the pieces of structure (e.g., material resources, human resources, organizational structure), the capability of processes (e.g., proportion of patients treated according to clinical guidelines), or the outcome of health care (e.g., mortality, morbidity, quality of life) [Mainz 2003]. The establishment of a core set of indicators may therefore provide an answer to the demand for transparency and efficiency in healthcare management. This set of concepts will be completed by adding those related to them in order to describe performance and quality indicators, like those generated in the International Quality Indicator Project (IQIP) [IQIP 2011].

The set that will result from analyzing these domains in a common field such as health, will lead to the information model required to describe the corresponding scenarios in which processes that need to be improved are running.

3.2 HC+.I: The set of usable performance and quality indicators

The second component of the framework is a set of performance and quality indicators. Performance indicators should be identified by considering interviews (with stakeholders and healthcare providers) and by reviewing the relevant literature [(AHRQ) 2001]. They should then be classified and selected according to the availability of data and ease of implementation, among other criteria (validity, reliability, sensitivity, specificity, simplicity, and applicability).

The resulting set of performance indicators will be tabulated to permit the selection of the most suitable indicators to satisfy specific information needs. The objective of the set is not only to identify the indicators per se, but also to delimit the ranges of values that might be acceptable for each indicator in similar situations. This would allow different health organizations to establish comparisons amongst them. It is important to realize that the bounds of the acceptable values are fixed in terms of

the assumed risk that a specific kind of organization might be able to afford, and we must therefore seek the parameters that enable an organization to be modelled. It would be desirable to be able to measure the indicators at least semi-automatically, thus making it possible to trust in the results obtained.

With regard to the bounds of the valid range of values, these bounds should be represented by means of business rules. The depiction of these business rules is addressed during the Methodology.

3.3 HC+.M: Methodology

The third component of the framework is a methodology, HC+.M, which is iteratively and incrementally used to assess the process and to improve the Health Processes by focusing particularly on security and data quality policies.

This methodology is based on Deming's PDCA cycle [Deming 1986] and its objective is to implement a continuous improvement cycle. It consists of five stages - the four that comprise the Deming cycle (see Figure 4), and an initial one with which to set up a working environment. A brief description of each one of these processes is introduced as follows:

- *HC+.M.0. Definition of a working environment:* Before starting the application of the PDCA cycle, it is necessary to obtain the commitment of the top management so that any corrective actions can be supported, estimated, designed, scheduled, budgeted and executed. It is therefore necessary to choose a multidisciplinary team with suitable expertise in the fields of security and data quality.
- *HC+.M.Plan. Definition of an improvement plan:* In this stage, an improvement plan for the selected processes is designed. As part of this improvement plan, the indicators that best satisfy the reasons why the processes need to be improved must also be selected. The aim of the improvement plan is to make changes to the processes so that the values for the indicators will improve. Changes are made in order to obtain adequate values for the indicators - values which should be ranged according to the risks to the processes that should be avoided.

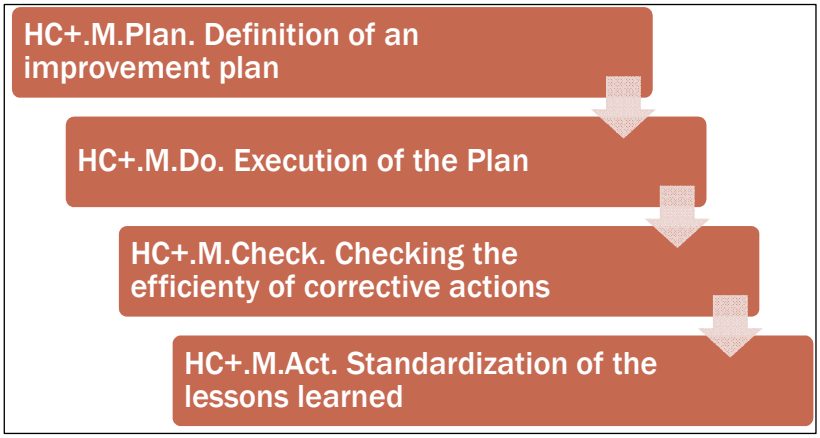

Figure 4: Stages of HC+.M

- *HC+.M.Do. Execution of the plan:* Once the goals of the improvement and the way in which to achieve these results have been defined, the aim of this stage is to execute the plan with the resources provided.
- *HC+.M.Check. Checking the efficiency of the corrective actions:* In order to verify whether the plan has succeeded, a second assessment is conducted. By comparing the new values for the indicators to those required, it is possible to determine the success of the plan. Otherwise, it is necessary to determine the reasons why the goals have not been achieved.
- *HC+.M.Act. Standardization of the lessons learned:* Finally, and from the results obtained, it is necessary to feed back the organizational knowledge with the findings obtained during the execution of the plan. This is done by reviewing the security and data quality sets of organizational policies.

Further details about each of the stages are provided in the following subsections.

3.3.1 HC+.M.0: Definition of a working environment

Before starting the Deming cycle, it is first necessary to identify all of the stakeholders who will be involved in the execution of the plan for the assessment and improvement. As stated previously, the first step is to obtain the commitment of the top management, since this is paramount to the leverage of the plan's efforts. Only when the organizational top management is committed can improvement projects be tackled [Sarsfield 2009].

This stage consists of a set of activities (see Figure 5), which we shall briefly define as follows:

- *0.1. Creation of a working team:* In order to better perform the tasks, it is necessary to form a multidisciplinary team. The members of this team should be chosen according to the nature of the improvements and the scope that could be defined in the project. This is extremely important in health care environments, since a large number of specialists from different sectors are involved. These actors must provide critical knowledge with which to better understand the processes that are to be optimized from different points of view (technical, managerial, clinical).
- *0.2. Depiction of an organizational map of processes:* If one does not already exist (e.g. the health organization has not been awarded a quality certification such as ISO 9001), then it will be necessary to define a map of the most critical processes, or at least those that are susceptible to improvement. As part of this description it is necessary to identify not only input and output products, but also a clear description of the responsibilities that the roles involved will be in charge of, in addition to the data they will use to accomplish their tasks.
- *0.3. Training experts in security:* Security experts will train the rest of the team in the main concepts that the system will implement to obtain the expected improvement, so that the whole team will be able to understand the objective. The new experts are in charge of identifying security lacks in the processes according to the pre-established security policies. This training involves issues of both a managerial and a technical nature: e.g. how to design and implement changes made to the HMIS so that security strategies can become operative.

- *0.4. Training data quality experts:* The stakeholders in charge of data quality concerns must be trained in a similar way to that of the security experts.
- *0.5. Definition of security policies:* The definition of an agreed set of security policies is a key step in defining suitable goals for improvements with regard to the security concerns. The organizational security policies should therefore be addressed in an appropriate manner.
- *0.6. Definition of data quality policies:* As with the security policies, the definition of the data quality policies should be carried out in an analogous manner. It is important to bear in mind that security and data quality are not independent concerns, and that dependencies between the two sets of policies should also be managed.

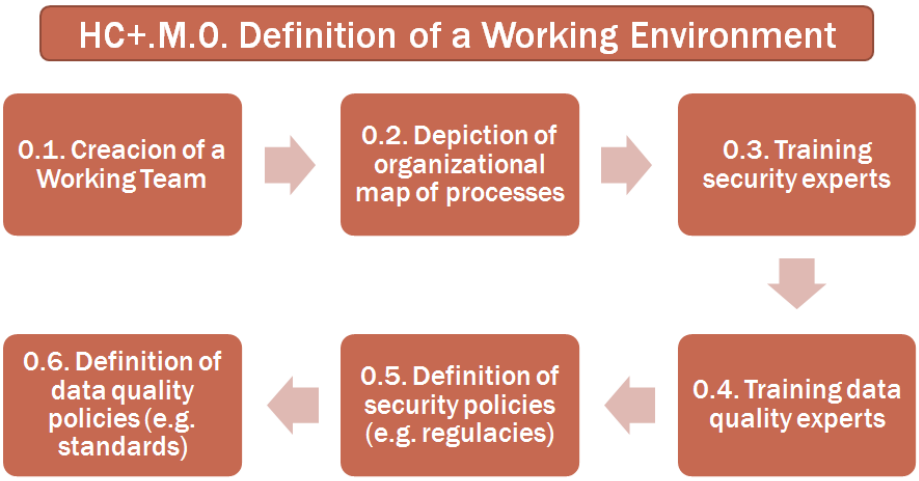

Figure 5: HC+.M.0. Definition of an assessment and improvement environment

3.3.2 HC+.M.Plan: Definition of a improvement plan

In order to guide the improvements and to better estimate a strategy, a depiction of an improvement plan is necessary. We propose that this plan should be designed with the following activities (see Figure 6):

- *P.1. Identification of the "flawed" processes and their dependencies:* The first activity in this stage is to identify the most critical processes and any of their dependencies that might require improvements. A process can be said to be critical when it costs the organization more than expected; these extra-costs may originate from having to resolve unexpected complaints from the organization's customers. It is important to realize that complaints may arise not only because indicators have inadequate values, but also as a result of the violation of security and data quality policies.
- *P.2. Identification of information needs:* Once the flawed processes have been identified, it is necessary to determine the reasons why these processes are not working properly. In this respect, it is possible to model some information needs that could be satisfied by mean of chosen indicators. This strategy

involves asking question according to a predefined set of information needs so that the reason why the processes are not working properly can be qualitatively identified.

- *P.3. First Assessment:* Identification of the indicators that best satisfy the information needs. The identification of measures (indicators) that help to quantitatively describe the previously chosen information needs must take place to best guide how to reach a solution. Every problem should be able to be quantified by means of such measures.
- *P.4. Defining the range of values required/desired for indicators:* Some reasoned reference values for indicators are required in order to better assess how good a process should be. Measured values for indicators that are outside these reference values would represent evidence that something is wrong with the process. These reference values could be expert based and/or data-driven, and should be context-dependent/risk-adjusted.
- *P.5. Analysis of the problem sources in the processes:* Classic tools with which to identify the source of problems applied to the values measured for the indicators are used in this activity, whose objective is to identify where and why the process is not working properly.
- *P.6. Defining a viable plan for the improvements:* The goal of this activity is to establish a viable plan that will resolve the problems found after the analysis as part of Activity P.5. This viability should be based on the risks that can be afforded.

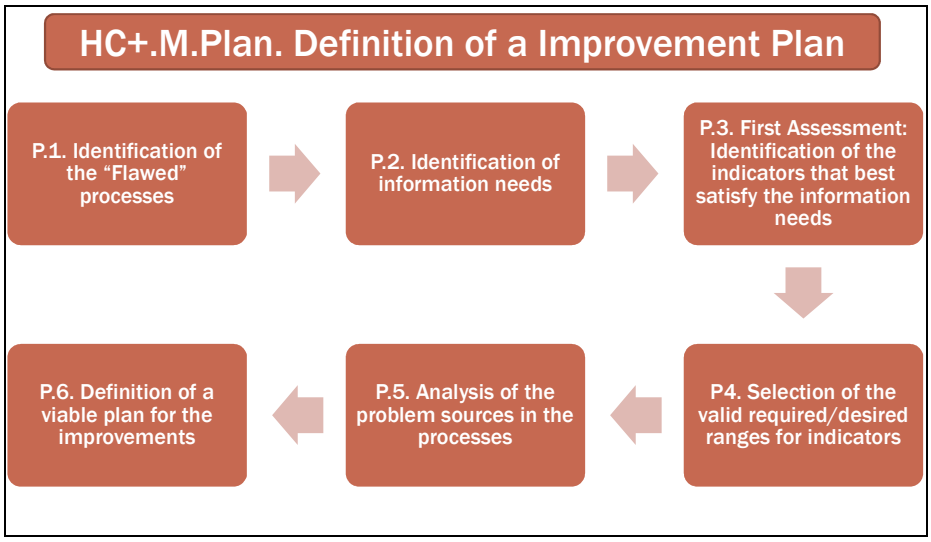

Figure 6: Activities of HC+.M.Plan. Definition of an Improvement Plan

3.3.3 HC+.M.Do: Execution of the plan

Once the plan has been defined, the aim of this stage is to cover its execution. This is related not only to the execution of the activities selected, but also to the provision of resources and the collection of evidence concerning the execution of the plan so that the execution can be managed. Several activities are proposed for this (Figure 7):

- *D.1. Arrangement of the execution environment for the plan:* The main aim of this activity is to prepare the environment in which it is possible to tackle the execution of the improvement plan. This environment is composed of both the human and the material organizational resources.
- *D.2. Provision of the required resources:* Once the resources that are needed to execute the plan have been identified, the aim of this activity is to provide these resources and make them available as they are required. It is highly advisable that there are sufficient instances of the resources, and that their usage can be tracked to permit accountability.
- *D.3. Execution of the plan:* This activity addresses the execution of the improvement plan. While the plan is being executed, some data concerning the usage of the resources and the amount of time dedicated to the tasks is simultaneously generated. This data should be appropriately stored to make it possible to monitor the project and to maintain tracks of the execution in order to identify variations from the established plan. This collected data can be used to enable expert-opinion when planning future improvement plans for other processes.
- *D.4. Analysis of the execution of the plan:* Once the plan has been executed, the aim of this activity is to assess that execution in order to identify whether the improvement goals have been achieved, and whether there have been extra-costs in the usage of the resources.

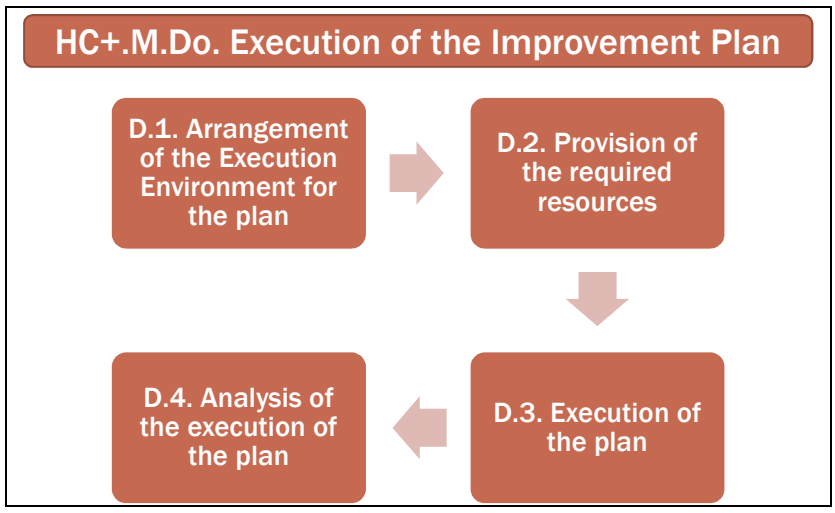

Figure 7: Activities for HC+.M.Do. Execution of the plan

3.3.4 HC+.M.Check: Checking the efficiency of corrective actions

After the execution of the improvement plan, it is time to verify whether the effects of the corrective actions are or are not the required. This verification is based on the comparison of the performance and quality indicators before and after the execution of the improvement plan. Several activities with which to guide this verification are proposed (Figure 8):

- *C.1. Second assessment after the execution of the plan:* In order to make the comparison with the initial situation possible, values for the same indicators must again be collected by following the same measurement methods.
- *C.2. Analysis of the reasons of non-implementation:* In the case of not having achieved the improvement objectives of the plan, it is necessary to analyze the reasons why the plan has not succeeded. These reasons could be based on deficiencies in the improvement plan, on the impossibility of being able to make the required resources available or even on the fact that the process was not really susceptible to improvements. The reasons and their consequences are directly related to the effects that might be caused by the risks that the plan intended to avoid.
- *C.3. Creating an improvement report:* The results of the comparisons from both those plans that have been achieved and those that not have been achieved, along with the accountability of the usage of resources and the deviation with regard to the pre-established schedule are used to create a report in which process improvements that will allow the desired goal to be achieved are proposed.
- *C.4. Sharing the results:* Once the report has been closed and agreed upon by the whole team, the results and the actions to be taken are communicated.

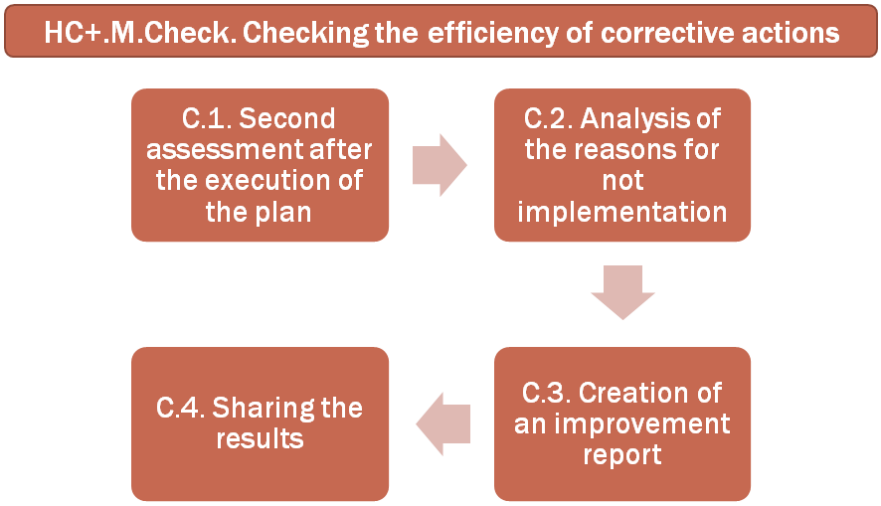

Figure 8: HC+.M.Check. Checking the efficiency of the plan

3.3.5 HC+.M.Act: Standardization of the lessons learned

The improvement report obtained in the previous stage is then used to translate the experiences attained from the execution of the improvement plan to the organizational knowledge. Several activities (see Figure 9) are proposed for this:

- *A.1. Review of security policies:* The existing set of organizational security policies is reviewed in order to introduce or adapt those that exist to the new findings.
- *A.2. Review of data quality policies:* As in the previous activity, the same task is carried out with the set of data quality policies.
- *A.3. Review scorecard of indicators:* It may sometimes occur that the indicators do not satisfy the information needs in their current form, and some changes should therefore be made to adapt them. This activity is aimed at performing this adaptation.
- *A.4. Review of the processes involved:* Finally, the processes affected by the cycle are reviewed and a new phase of the cycle from the HC+ stage. M.Do is begun.

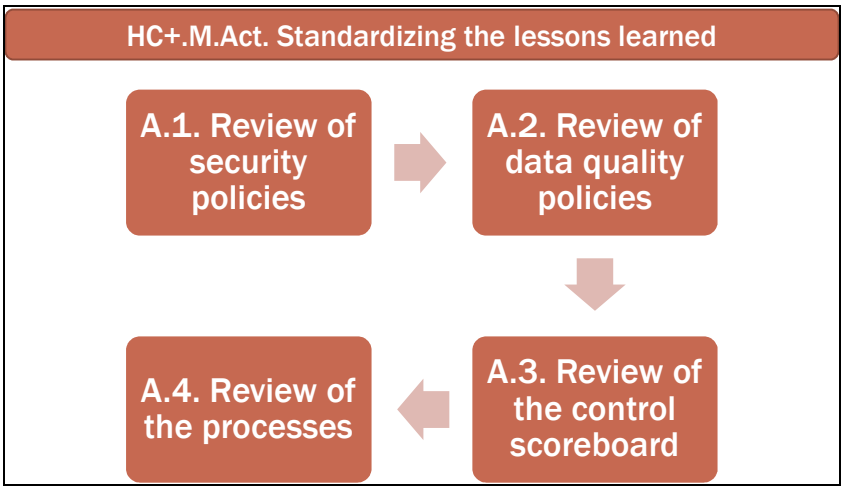

Figure 9: Activities of HC+.M.Act. Standardizing learned lessons

4 Conclusions

In this paper, we have introduced the idea of how the lack of security and data quality concerns can affect organizational healthcare processes, and we have analyzed the problem currently affecting the health sector worldwide; these problems are also increasing in frequency owing to the phenomenon of globalization. This new global paradigm has generated a new challenge which is the semantic interoperability of electronic health records (EHR), e.g. the exchange of patients' medical records between different health information systems (HIS) [Stroetmann VN, Kalra D et al.

2009] and the need to measure and control the quality and security of the data of which an HIS is composed.

We have presented the basis of the methodology that we are developing and which is supported by international standards in the health sector, such as software engineering. This methodology is intended to be a standard that would allow any hospital to discover the failures in the quality and security of the data of which the HIS is formed in a rapid and economic manner, and to identify the processes that cause these failures and respond to them quickly.

This methodology is currently being applied in a case study of one of the classic processes that hospitals have: "shifting the management of patients", and the problems associated with this. This case demonstrates the complexity of processes in hospitals and how they should be addressed one by one in order to understand and implement a methodology that is useful. The case study is also serving to demonstrate that until the study was carried out, the Hospital management was not fully aware of the potential associated with knowledge that was lost in the organization and how necessary it was to have metrics to monitor the security and quality of data. From the point of view of management, the major findings obtained so far have been:

- It is necessary to verify whether the reports are based on information that has been handled incompletely. In view of the problems identified, the opportunity should be created to develop new metrics on the information to be added to the system that will be able to detect malfunctions in medical consultations, or more specifically: low consultation rates, high waiting times, downtime among patients, and so on.
- It is necessary to find a very clear means to improve one of the most challenging processes in the hospital - that of managing consultation and waiting rooms. The proposed solutions involve a process improvement, the increased efficiency of the staff involved and a greater automation of process elements that were formerly far more anarchic and chaotic.

The investigation continued with the application of the complete cycle of the methodology in order to extract different health processes and metrics with which to measure the quality and security of the data included in these processes. These processes have also been verified in different hospitals to ensure that the methodology can be applied in heterogeneous environments.

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