

Survey on the Status of the Hospital Information Systems in Portugal

L. Velez Lapão

Instituto Nacional de Administração, Oeiras, Portugal, and
Centre for Research in Health Information Systems and Technologies, FMUP, Porto, Portugal

Summary

Objectives: To diagnose the hospital information systems' situation in Portugal.

Methods: Developing a survey on HIS department heads.

Results: Several weaknesses were identified in most HIS departments, such as substantial lack of people and of qualifications to deal with HIS challenges. The Nolan and McFarlan Matrix helped assess the SNS IS maturity at stage 3, characterized by the generalized lack of IS integration.

Conclusions: The results are very relevant to explain the many delays (and conflicts) in implementing HIS and therefore the actual status of HIS in Portugal. The most successful cases of HIS implementation were recognized as related to the existence of an active CIO. Complexity theory can further define guidelines for the development of HIS that help keep the navigation towards "smart healthcare".

Keywords

Hospital information systems, hospital information systems management, survey, CIO, complexity

Methods Inf Med 2007; 46: 493–499

doi:10.1160/ME9055

1. Introduction

Today's healthcare technologies allow easy and fast detection of tumors, aligning a small catheter to the heart to clean arteries, and destroying kidney calcifications without touching the skin. Nevertheless, simple things like distributing the right medicines at the right place or making sure the surgeon operates on the right side of the organ could represent a big challenge [1]. The progress has been slow. Healy [2] considers that healthcare information systems (IS) are simply following a logistic curve, evolving like other industries only lagging behind. The report "To Err is Human" [3] launched the debate about the importance of using IS in healthcare to avoid many human errors. But the introduction of IS in a healthcare environment requires carefully addressing information management models and the integration of the organization information infrastructure [4]. In 2001, the report "Crossing the Quality Chasm: A New Health System for the 21st Century" [5] identified weaknesses in the design and safety of healthcare IS. Today, there is some evidence that most Portuguese healthcare units, which have for historical reasons a set of IS "islands", present evident signs of inefficiency, lack of interoperability between existing systems and weak IS integration with healthcare processes. Therefore, a survey was developed to diagnose the hospital information systems (HIS) situation in Portugal in terms of strategies, tactics and operations of IS to support hospital services. Most HIS surveys have looked for the understanding of the use and the interaction of users [7-9]. Here, the aim is the understanding of the role of people and of management in the development of strategy for HIS.

2. Research Methods

The survey was deliberately built to collect information about HIS in seven areas to feed the, adapted to healthcare, Nolan Maturity Matrix [6] with the information to evaluate the Portuguese HIS' stage of maturity:

- HIS strategy and relation to hospital strategy;
- characterization of the HIS organization;
- HIS technology and architecture;
- HIS departments head participation in hospital management;
- level of skills and training;
- governance model and management style;
- physician, nurse and citizen participation.

The survey took place between May and July 2005, directed to the 73 SNS (National Healthcare System) hospitals, and geographically located in continental Portugal, Azores and Madeira islands [10]. In order to reach a deeper and coherent understanding of the HIS situation the survey was sent directly to HIS department's heads (HISDH). The results were then aggregated in an Excel database and exported and analyzed with SPSS. In the first case, descriptive statistical analysis was used; in the case of SPSS, tests were used to support inductive statistical analysis. The composition of the Excel database was done according to the survey structure.

3. Survey Results

3.1 Sample and HIS Department Heads Characterization

From the 73 surveys sent, 30 complete answers were obtained representing the sample of responses from HISDH, which correspond to 41% of the Portuguese hospital's universe. 24 out of 30 answers arrived during the first month. During the two following months the non-respondents were contacted by telephone and asked to reply within one month. Furthermore, while contacting the non-respondent, besides motivating further responses, the reason why they had not answered was collected. From the many reasons, two were more frequent: the non-existence of a HISDH (the function is being done by an external person) and the HISDH is always busy, not having the time to answer.

3.2 Geography and Hospital Dimensions

The answer's distribution reveals that the sample is very close to the actual distribution of hospitals described by Rodrigues [10]. In the sample, 6.7% of the hospitals have more than 1000 beds, 10% between 500 and 1000 beds, 13.3% between 300 and 500 beds, 16.7% between 200 and 300 beds, 20% between 100 and 200 beds, and 33.3% less than 100 beds. The hospitals with between 300 and 500 beds were the lowest respondents. Surprisingly, the smaller hospitals (<100 beds) were the best repliers.

3.3 Sample Sex and Age Distribution

From the survey it was found that 77% of the respondents were male and only 23% were female. This was somewhat expected, since most HISDH tend to be men like in other industries [11]. The survey also revealed that 70% of HISDH were aged between 26 and 45, and that 27% were over 46.

3.4 Sample HIS Department Heads Skills and Job Distribution

Globally 36% of the HISDH have no university degree whatsoever and if one assumes the non-respondents in this question to share this situation (due to not feeling comfortable with the situation of not having a degree) then we reach 47%. Both results are surprising given the importance of information to run a hospital. From the HISDH with a degree, 30% have a post-graduation degree, revealing that this profession seems to require continuing studies. These results contrast with the reality of healthcare professionals where everyone needs to have a degree and most have post-graduate degrees. The typification of degrees shows that most (23%) of the HISDH have a degree in management, 20% in engineering and 7% in social sciences, such as economy or psychology.

From the responses to the question on the "time on the job", only 27% have stood in the position of HISDH for more than five years. 43% have been in the position less than three years and 17% less than one year. 30% have been in the position between three and five years. These results show that most professionals have had little time on the job. Time is important; one needs at least one year to know a hospital structure and organization and any strategic plan will take a couple of years before the impact can be seen [12]. Other cases show the importance of some strategic stability for the development of a HIS [13]. Rodrigues [10] identifies that the number of HIS personnel (everyone working with IS, from management to operations) in the whole Ministry of Health (also including hospitals) has risen from 246 (in 1993) to 348 in 1998, meaning a growth of 41.5%, which is lower than the 81.6% growth in other areas. These numbers mean an average three to four HIS persons per hospital. With the data from the survey one could adjust the values of 1998 to 2004. The survey identifies there has been a decrease in the rate of professionals being admitted since 2000, from 22.5% to 10% in 2003. This phenomenon can be understood by the pressure to reduce budgets. The ratio between the number of HIS personnel and

the total number of hospital staff can be an interesting measure of resources applied in IS. Comparing the survey numbers with the reality in the USA [14] and Marburg (Germany) [15] one may find that the ratio of the largest Portuguese hospital (HSM) is still only half way compared with Germany and a fourth from the USA's average (Fig. 1).

3.5 HIS Strategy and its Relationship with Management

HIS strategy was analyzed in terms of evolution over time, leadership and board relationships. 40% of HISDH said that they felt there was no strategy defined when they entered the organization, 36% acknowledged a "cost reduction strategy" and 23% mentioned a "quality of service improvement strategy". 56% of the latter acknowledged that the strategy was focused on a specific clinical area, like ophthalmology or oncology. Comparing with today's strategies, only 7% still expressed that there is no strategy, 67% said the hospital is following a "cost reduction strategy", and 46% acknowledged a strategy focusing on improving service quality. Today, 71% of those betting on quality said that they are now focusing on a specific clinical area. When analyzing the motivation to change strategies, 30% mentioned that the change was due to the change of board teams and 27% due to the change of board legal status (they became an enterprise like organizations) although the other 30% mentioned that they felt no change. Finding out how the link between the strategy definition and the operational action was established, 10% considered that there was no real link between strategy and operation, they only analyzed and compared production data from clinical departments; 13.3% did not find any link but nevertheless, each clinical department had defined its own goals. 53.3% confirmed that a relationship exists in the definition of production goals, 10% mentioned that the link is established within a quality framework covering all clinical departments and 3.3% said they were using a Balanced Scorecard instead.

3.6 HIS Organization Maturity and Working Methodologies

In the cases of hospitals belonging to the SNS, the organizational structure and board constitution is still defined by law and it is a political process [10]. The survey also covered the use of management indicators (MI). In 56.7% of the cases MI are used in association with a quality framework. 73.3% said that they have adopted the financial indicators from the Healthcare Management Institute (IGIF), 80% revealed that they indeed use some operational indicators and 36.6% use performance indicators. Project management is known to be very important for the success of any HIS implementation [13, 16, 17]. The survey indicates that 40% of the HISDH did not use project management in their project's implementations. Nevertheless, from those who said yes to the use of project management tools (i.e., 33.3%), only 3% said that they are using them every time. 7% said they had only used them a few times and 10% only in projects with external firms. 10% added that only a few managers know how to use them effectively. The survey also identified that 50% of the HISDH manage all the projects of the department, which makes sense if one realizes that most departments have a lack of people. These results are very relevant to explain the many delays (and conflicts) in implementing HIS and therefore the actual status of HIS in Portugal.

The success factors regarding the implementation of HIS are, in 26% of the cases, the participation of physicians and nurses, followed by user training (17%), and proper planning (16%), board leadership comes next with 13%, and CIO leadership (with 12%) is the last of the "top 5". Other factors were considered: professional project management (6%), the existence of a quality framework in place (4%) and "on job" training (4%).

3.7 HIS Performance in the Hospitals

Regarding the use of hospital management applications, most HISDH (53.3%) con-

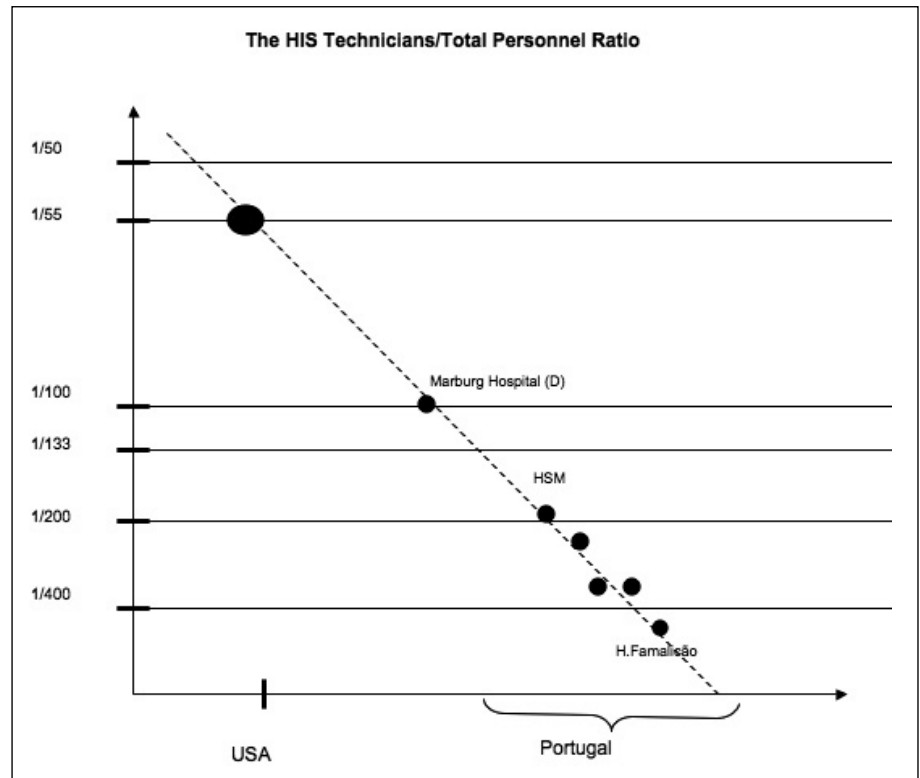


Fig. 1 The ratio between HIS personnel and hospital professionals in three countries

firmed that they have an *Enterprise Resources Planning* (ERP) system and 36.7% mentioned that they mostly use Microsoft *Office* (*Word* and *Excel*) to support their management operations. Only 6.7% said that they use a different application for management. When asked about integration of information for management purposes, 50% of HISDH said there is none. The maturity stage is so low that only 43.3% confirmed that they have management reports available in paper, only 6.7% confirmed to have management reports available on the Intranet, 43.3% said they have some sort of information integration and only 6.7% said they are implementing "integration engines" to allow them to access data and produce timely management reports. Concerning the participation of HISDH in the management processes of the hospital, 53.3% expressed that they participate strongly by developing IS solutions to improve hospital processes. Only 53.3% confirmed that they produce an annual business plan, 16.7% said they only answered to requests and 56.7% explained that the HIS department is simply

a help desk. 30% said that HIS department is just managing outsourcing services.

Regarding the investment in HIS, the survey shows that there is a positive evolution with 63.3% saying that they have been growing with investment rates of more than 5% per year and 30% explaining that their growth is slower, between 1 and 5% per year. This picture reveals a clear increase in the development of HIS though most of the money is still going to hardware. When looking for the level of interaction between hospitals and society, one can look for the evidence of signals of the new paradigm of "citizen centered ehealth", and one might look for the types of relationship with communities. Most hospitals (83%) are betting on the Internet and 87% on newspaper articles to divulge hospital activities.

The survey results also identified that 73.3% of HIS departments perform "patient management" functions, 66.7% perform "networking and servers management" functions and 63.3% perform "clinical applications" function. In 56.7% there is a "help desk" function and 50% of HIS de-

Table 1 Correlation between bed number and “HISDH’s qualifications”

| Qualification \ Bed number | Less than undergraduate | Undergraduate | Technical degree | University degree | Post-graduation | PhD | Total |
|----------------------------|-------------------------|---------------|------------------|-------------------|-----------------|-------|--------|
| <200 | 1 | 4 | 2 | 3 | 2 | 1 | 13 |
| | 7.7% | 30.8% | 15.4% | 23.1% | 15.4% | 7.7% | 100.0% |
| 200-399 | 1 | 0 | 0 | 2 | 2 | 2 | 7 |
| | 14.3% | | | 28.6% | 28.6% | 28.6% | 100.0% |
| 400-699 | 0 | 1 | 0 | 2 | 0 | 1 | 4 |
| | | 25.0% | | 50.0% | | 25.0% | 100.0% |
| ≥700 | 0 | 0 | 0 | 0 | 1 | 1 | 2 |
| | | | | | 50.0% | 50.0% | 100.0% |
| Total | 2 | 5 | 2 | 7 | 5 | 5 | 26 |
| | 7.7% | 19.2% | 7.7% | 26.9% | 19.2% | 19.2% | 100.0% |

partments also include the “hospital statistical” function (mostly in the cases where this function does not belong to the planning department). The function of “data security” is only considered in 40% of hospitals. In 36.7%, HISDH is also responsible for the telecommunications network (which is more often included in the hospitality or in the engineering departments). From these results, the basic functions of HIS departments can be identified: “servers and networking” and “patient management and clinical systems”. It is also understandable that functions like telecommunications, data security, statistics and electronic equipments could be integrated in HIS services because they are relevant to the HIS performance and to the management of information.

In both Europe and the USA, the communication protocol HL7 has been debated due to its relevance for the HIS integration process [8]. In Portugal, there are only a few known cases of HL7 utilization [18]. HISDH were asked about their knowledge of the HL7 framework and only 40% confirmed. A datacenter is a basic but critical element of HIS infrastructure. Although the technology is mostly simple it requires a careful project and management. Again, the survey shows surprising results, where the typical (63%) data room in a hospital is just a room containing several servers. Only 23% confirmed to have a “datacenter”.

Worrisome is that 7% of the answers have said that data is still located in the department’s computers. As far as HIS maintenance is concerned, most hospitals (70%) chose a combined system, both internal and outsourcing, specially because they have no internal staff to do so. Even though, there are still 23% stating they do it all internally. In Portugal there is no record of the use of complete outsourcing solution (although it is a usual situation in the USA [14]).

As the survey revealed a significant lack of skills to deal with HIS it was important to check what is being done in terms of training. In most cases (67%), a training department defines the training of HIS technicians. In 13% of the cases training is actually defined by the Board and only in 17% it is decided by HISDH (usually included in the annual plan). Another basic element of HIS network infrastructure is data protection and security levels. In a report from the Portuguese Commission for Data Protection and Security in Healthcare it is shown that the situation is far from being acceptable, which matches our data [19].

3.8 Healthcare Professionals Participation in the HIS Development

The perspective of HISDH was chosen because of its stake and expected impartial view on user’s level of software utilization.

There were two reasons for this: firstly, as part of a diagnosis, and secondly, because of its relevance to understand the evolution of HIS needs. When identifying the most needed applications a clear fragmentation was revealed. They mainly focus on “core” operational applications like PACS, clinical management, logistics, laboratories and emergency sorting. From this perspective, physicians mainly use (47%) SAM (a SNS medical support system), 20% use PACS and 13% use SONHO (a SNS administrative management system). As far as managers, they mostly (50%) use SONHO, 43% use RHV (a SNS administrative human resources management tool), and 37% use SIDC (a SNS accountability system).

3.9. Crossing Hospital Dimension and Qualifications Variables

As a working hypothesis, “hospital beds number” (dimension) and “HISDH’s qualifications” variables were crossed with SPSS. It is assumed that the number of beds can be a link to the complexity of the hospital. As a first order approach, one can consider the number of beds as a variable for the complexity dimension of the hospital. The variable “HISDH’s qualifications” is relevant because it could link performance to the hospital’s ability to respond to complexity. The “number of beds” is subdivided into four levels and “qualifications” is subdivided into six levels. Crossing these two variables it is possible to see (Table 1) that smaller hospitals are the ones with the less qualified HIS personnel (45% of those without degree) and larger hospitals are those which have more qualified personnel (e.g., 100% of HIS heads with post-graduation). These results show significant correlation between bed number and “HISDH’s qualifications”.

3.10 HIS Department Strengths and Weaknesses

HISDH were asked about their perception of their strengths and weaknesses as teams. Top five strengths were (in parenthesis the percentage, this was a multi-response question):

- “technical skills” (66.7%);
- “motivation and teamwork environment”(63.3%);
- “organization model” (46.7%);
- “hardware” (36.7%);
- “software” (16.7%).

Top five weaknesses were:

- “hardware” (66.7%);
- “number of professionals” (53.3%);
- “software” (46.7%);
- “strategy” (43.3%);
- “technical skills” (43,3%).

These results show that the top strengths are related to the teamwork environment, technical skills and their organization (remember that an average HIS team has three to four elements) to respond to hospital demands. On the other hand, the top five weaknesses are technical skills (which also seem to be a strength, but are they not enough for the challenges ahead?), lack of proper hardware and software, lack of adequate HIS

Table 2 HIS department head job designation (in total and in percentage)

| Job designation | Total | Percentage |
|---------------------------------|-------|------------|
| Director | 6 | 20% |
| Co-ordinator | 5 | 17% |
| Informatics technician | 3 | 10% |
| Financial director | 2 | 7% |
| Head of informatics. | 1 | 3% |
| Systems administrator | 1 | 3% |
| Head of finance and informatics | 1 | 3% |
| Head of division | 1 | 3% |

strategy and last but not the least, the small number of professionals.

Another key variable is HISDH job designation. The results were as follows (Table 2).

The survey identified only 40% true entitled department’s heads (20% with the position of director, 17% as co-ordinators

and 3% as head of departments). The remaining 60% were mere technicians that just supplied a basic service (i.e. without the proper skills to perform the job) or even people accumulating with other non-IS functions like a chief medical officer or a financial director.

3.11 Portuguese HIS Maturity Level

With all this information it is now possible to complete the Nolan matrix, which allows us to assess the HIS maturity level (Table 3). The case analyzed here is presented in bold.

The Nolan matrix characterizes the average SNS hospital at stage 3, with a couple of items still in stage 2, meaning that there are no organizational conditions to further develop HIS. The SNS hospitals lack in maturity and therefore lack the proper skills to overcome the challenges posed by HIS. In order to reach stage 4, the use of more

Table 3 Nolan Maturity Matrix of SNS hospitals

| | Stage 1 | Stage 2 | Stage 3 | Stage 4 | Stage 5 | Stage 6 |
|----------------------|--|--|---|--|---|--|
| Strategy | <i>Hardware and software acquisition</i> | IT audition: satisfying the needs of users | IS top-down planning | Integration, coordination and control | Business opportunities focus | Looking for strategic advantage and monitoring |
| Structure | No structure | IS group | IS department | Information centers focused on services | Strategic business unit | CIO centralized coordination |
| Systems | Ad hoc, non-integrated, mostly operational systems Focused on financial applications and little maintenance | Many applications, many gaps Repeated systems and operational. Still mainly financial systems Many areas not covered Painful maintenance | Mainly centralized non-controlled user systems Most business parts covered Database systems non-integrated | Decentralized, with some control but lacking coordination Ad hoc decision systems IT is basically integrated | Decentralized systems with central control and coordination Business-focused DSS Some strategic systems IS integration | Interoperability systems linked to suppliers and clients New IS products integrating internal and external data |
| Shared values | Very few | Technical worship | Senior managers show some interest in IS | Cooperation with business managers | Looking for opportunities and innovation | Interactive planning and networking |
| Skills | Mostly technical | Systems development methodologies, often seriously at odds with the business | IS department head believes he knows the business Project management is required | Organizational integration Users know how the IS works Business management leadership in cooperation with the business | IS manager – member of a senior management team IS director knows the business | All senior managers understand IS and its potential IS director (CIO) as a board member |
| Style | Distant | Do not disturb | Delegate and control | Democratic dialogue | Negotiation | Business team |
| People | Programers | System analysts | IS planners and managers and DB administrators | Business analysts and information resources managers | Business team | Interactive business team |

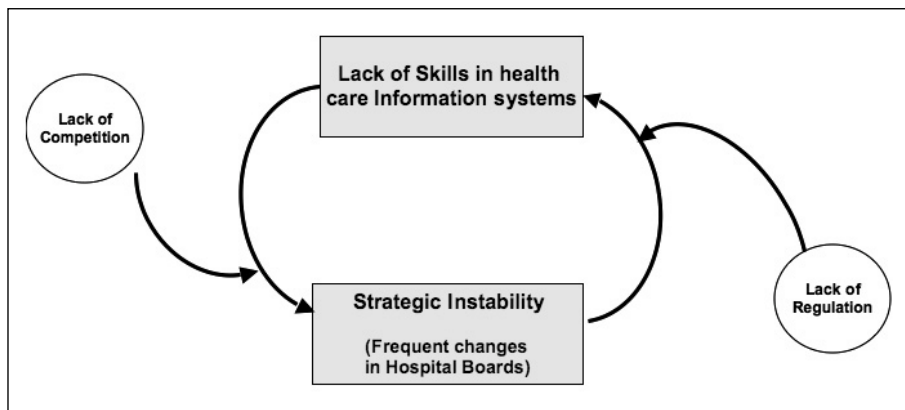


Fig. 2 The “vicious circle” disturbing HIS developments

sophisticated tools and personnel is expected to allow for the “departments” to evolve into an “IS Business Unit”. Another relevant characteristic of stage 4 is the fulfillment of the integration process and a more co-operative working culture focused on the delivery of quality services.

The survey also helped in identifying the best performing HIS departments and their characteristics. Four cases were identified where the characteristics of the head of HIS department matched those attributed to a Chief Information Officer (CIO)[20]:

- They all have a university degree and a post-graduate degree (not necessarily in HIS).
- They are open to other suggestions and have an excellent relationship with other healthcare professionals; they show a rather dense social network within the hospital.
- They show leadership skills, which help them organize their department.
- Some strategic stability was found, mostly due to the strong relationship with the board of directors, in some cases even with a regular presence in their meetings.
- They have denoted meaningful negotiation skills regularly used in their relationships with the vendors, showing openness to bolder projects using new technologies.
- They base their work on a, at least a “draft” of, HIS strategic roadmap.
- They show conscience of the barriers, difficulties and complexity.
- They look for opportunities to improve their hospital with partnerships (univer-

sities, INA, other hospitals, vendors, etc.), i.e. with a good external social network.

Therefore, there is evidence for one to conclude that, if the head of HIS behaves like a CIO, it becomes more likely to have a more developed HIS.

Survey data was also used to fill the McFarlan matrix to check applications’ portfolio balance [21]. The results show that the SNS applications’ portfolio is somewhat unbalanced: There is a generalized lack of basic support applications, namely a proper ERP system (with HR functionalities, materials and stocks management) and a commonly shared Intranet. In terms of “operational” applications, there is a lack in clinical management applications despite a significant effort during the last years [22].

4. Challenges: From Complexity towards “Smart” Healthcare

In short, one might see the HIS problem as a “vicious circle” (Fig. 2). The circle is fed by both the lack of action of the HISDH (either due to lack of skills or lack of conditions) to lead and promote a HIS plan and the lack of co-ordination from the board of hospital directors (either due to some strategic instability or lack of knowledge). This stable “vicious circle” must be broken to allow for HIS to develop. The cycle can therefore be

interrupted in four ways, which could be seen as clues to help define global HIS policies:

- 1) Improving regulation quality;
- 2) Improving competition in the HIS market;
- 3) Improving HIS managers’ skills and co-operative actions
- 4) Promoting hospital board’s strategic stability.

The survey results presented here show that the medical informatics environment in Portugal is facing a clear challenge to improve people’s IS education. Furthermore, when the theory of complexity is applied in healthcare, some interesting answers will be reached. Hospitals are complex organizations and healthcare professionals and managers need to cope with this complexity accordingly [23, 24]. As far as the government policies are concerned, this requires the existence of an adequate regulatory body able to define (and follow the international best practices) the “basic rules” of action. At the operational level, highly qualified professionals are needed to act accordingly. Following this is the way to “Smart Healthcare”, an “integrated and well managed healthcare IS resources”, where the role of the CIO is critical to ensure good focus and implementation [25, 26].

5. Conclusions

Understanding the critical importance of HIS to help transform healthcare in Portugal, a survey was done that revealed some aspects that need careful attention: The lack of qualified IS personnel and the low level of maturity of HIS were the most significant. In order to reach the next stage, interoperability and more sophisticated HIS teams are needed to be able to deal with the challenges ahead.

References

1. Berwick DM. The Double Edge of Knowledge. *The Journal of the American Medical Association* 1991; 266: 841-842.

2. Healy JC. EU-Canada e-Health Initiative. EU-Canada Meeting – Montreal, Quebec, Canada, 2000.
3. IOM Report. To Err is Human. Institute of Medicine; 1999.
4. Lenz R, Kuhn KA. Integration of Heterogeneous and Autonomous Systems in Hospitals. *Data Management & Storage Technology*; 2002.
5. IOM Report. Crossing the Quality Chasm: A New Health System for the 21st Century. Institute of Medicine; 2001.
6. Nolan RL. Managing the advanced stages of computer technology key research issues. *The Information Systems Research Challenge. Proceedings (McFarlan FW, ed.). Boston: Harvard Business School Press; 1987.*
7. Aylin P. Analysis of Hospital Episode Statistics for the Bristol Royal Infirmary Inquiry. 1999.
8. Kuhn KA, Giuse DA. From hospital information systems to health information systems – problems, challenges, perspectives. *Methods Inf Med* 2001; 40 (4): 275-287.
9. Hamborg KC, Vehse B, Bludau HB. Questionnaire Based Usability Evaluation of Hospital Information Systems. *Elect J Inform Syst Evaluation* 2004; 7 (1).
10. Rodrigues L (co-ordinator). *Compreender os recursos humanos na saúde. Apifarma, Edição Colibri*; 2002.
11. IDC. Report on IT Human Resources 2004. IDC (in Portuguese); 2004.
12. Duran XP. Hospital Clínic de Barcelona Information System. Portuguese Institute of Medicine. May 2006.
13. Ash JS, Stavri PZ, Dykstra R, Fournier L. Implementing Computerized Physician Order Entry: the importance of special people. *Int J Med Informatics* 2003; 69: 235-250.
14. Smaltz D. Antecedents of CIO effectiveness: A role-based perspective. *Information and Management Science (PhD Thesis). Florida State University*; 1999.
15. Lenz R. Interoperability in Hospital Information Systems. DESIS 2006 – INA Report; 2006.
16. Chittick PK, Persaud DD. Project Management: An Essential Tool for the Implementing Integrated Information Technology in Healthcare. *Healthcare Management Forum* 2002; 15 (2).
17. Lapão LV, Grilo A. Desenvolvimento de uma Metodologia para Implementação Incremental de Projectos de Sistemas de Informação para Unidades de Saúde, *Proceedings of the 3rd Conference on Public Administration. Lisbon, November 2005.*
18. Lapão LV, Tavares LV, Pereira MJ. Hospital Information Systems Integration Leadership Strategy for a Portuguese Central and University Hospital. In: Engelbrecht R et al. (eds.). *Connecting Medical Informatics and Bio-informatics. IOS Press; 2005.*
19. CNPD, Relatório de Avaliação da Protecção de Dados Pessoais nos Hospitais, da Comissão Nacional de Protecção de Dados Pessoais, 2004.
20. Broadbent M, Kitzis ES. The new CIO Leader: Setting the Agenda and Delivering Results. Harvard Business School Press, 2005.
21. McFarlan F. Information Technology Changes the Way You Compete. *HBR* 1984; 62 (3).
22. Lapão LV. Smart Healthcare: The CIO and the Hospital Management Model in the context of Complexity Theory (PhD Thesis). Technical University of Lisbon. September 2006.
23. Plsek P, Wilson T. Complexity sciences: Complexity, leadership, and management in healthcare organisations. *BMJ* 2001; 323: 746-749.
24. Kauffman S. *At Home in the Universe: The Search for the Laws of Self-Organization and Complexity.* OUP; 1998.
25. Nohr C. Evaluation of Electronic Health Record Systems. *IMIA Yearbook of Medical Informatics* 2006 (Haux R, Kulikowski C, editors). *Methods Inf Med* 2006; 45 (Suppl 1): 107-113.
26. Ash JS, Fournier L, Stavri PZ, Dykstra R. Principles for a Successful Computerized Physician Order Entry Implementation. *AMIA 2003 Symposium Proceedings*; pp 36-40.

Correspondence to:

Lúis Velez Lapão
 A/ Head of Healthcare Systems
 Instituto Nacional de Administração
 Palácio dos Marqueses de Pombal
 2784-540 Oeiras
 Portugal
 E-mail: luis.lapao@ina.pt