

# Innovative Practices in the Emergency Medical Services in Crete

Angelina Kouroubali<sup>1</sup>, Dimitris Vourvahakis<sup>2</sup>, Manolis Tsiknakis<sup>3</sup>

<sup>1,3</sup>eHealth Laboratory, Institute of Computer Science, Foundation for Research & Technology-Hellas, P.O. Box 1385, Vassilika Vouton, GR-711 10, Heraklion, Crete, Greece, <sup>1</sup>[kouroub@ics.forth.gr](mailto:kouroub@ics.forth.gr), <sup>3</sup>[tsiknaki@ics.forth.gr](mailto:tsiknaki@ics.forth.gr)

<sup>2</sup>National Center for Emergency Care (EKAB), Heraklion, Crete, Greece, [dvourvahis@hygeianet.gr](mailto:dvourvahis@hygeianet.gr)

Pre-hospital emergency care plays a vital role in saving human lives making it an important part of the health care sector. Efficiency and effectiveness of operations is crucial especially when dealing with life-threatening situations that require immediate and specialised response. In Crete, the National Centre for Emergency Care has established several innovative practices to improve public services, manage appropriately and effectively its resources, and provide timely and effective care at the point of need. To achieve excellence, a pre-hospital emergency management system has been developed and implemented in collaboration with the Foundation for Research and Technology – Hellas. The pre-hospital information system is part of HYGEIAnet, the integrated regional health information network in Crete. This paper presents an overview of the innovative practices established at the National Centre for Emergency Care unit in Crete with a particular focus on triage protocols, pre-hospital information management system and educational practices, focusing on management of change and impact on performance.

## Keywords

Emergency care, emergency care information systems, telemedicine, triage protocols.

## 1. Introduction

Pre-hospital Emergency Care services and ambulance services are the first point of contact for patients suffering from emergency conditions. Their role in health care outcomes for a number of emergency conditions is indisputable. In the case of cardiac arrest, for example, the time between collapse and initiation of CPR and defibrillation is claimed to be an important determinant of the probability of survival [1,2]. Emergency care services are involved in the selection of the appropriate hospital for each patient, where hospitals may differ in their quality and in the technologies available for emergency care [3]. Medical care, transportation and management of hospital resources contribute to the quality of services pre-hospital emergency centres provide to the public.

In Greece, the regional units of the National Centre for Emergency Care (EKAB) are publicly funded and operated by regional directors. Across regions, a wide variation exists in terms of emergency care services. In the region of Crete, the EKAB unit of Heraklion coordinates and manages the provision of emergency care services for the island. Personal initiative has led to the development and implementation of several innovative activities that play a significant role in improving management of emergency episodes and quality public services.

This paper presents these innovative practices and highlights their impact on performance for effective and efficient provision of emergency care practices. Innovative practices include the pre-hospital emergency care management system of HYGEIAnet, the development and

implementation of triage protocols for prioritising and managing calls, and emergency care education and training activities. The paper concludes with key factors involved in managing change that accompanies implementation of innovation in daily practice.

## **2. The National Centre for Emergency Care (EKAB), Crete**

The National Centre for Emergency Care (EKAB) is the only public health organisation in Greece offering pre-hospital care for chronic and emergency cases. In addition to its ambulatory function, EKAB provides educational services to the medical community through the Pre-hospital Emergency Medicine program, and to the general public through training on basic CPR and life support. EKAB is divided in a central unit located in Athens and 11 regional units located throughout Greece.

The EKAB unit of Crete (EKAB Crete), Greece's largest island, consists of a central unit located in Heraklion, and three peripheral units in the remaining three districts of Crete: Rethymnon, Chania and Lassithi, providing accident and emergency services for Crete's four districts. EKAB Crete covers a geographical area of over 8,336 square kms and services a resident population of more than 500,000. EKAB Crete operates the following types of ambulances:

1. Basic life support ambulances (BLS) appropriate to respond to any type of episode and secure the support of vital functions.
2. Advanced life support ambulance (ALS) equipped with defibrillator to provide specialized vital support
3. Mobile unit of emergency care with equipment similar to an intensive care unit (breathing support, monitor)

Daily and for 24 hours a day, there are 5 fully equipped ambulances with a doctor (mobile units) and 13 BLS and ALS ambulances operating throughout Crete. Ambulances also operate in primary care clinics located in rural areas throughout Crete.

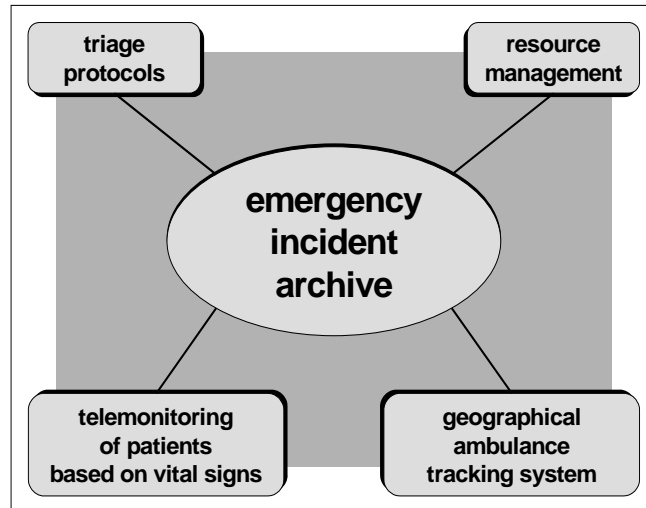
EKAB Crete consists of the dispatch centre and the ambulance service. The central dispatch centre located at Heraklion coordinates and manages the ambulance service in each of the four districts of the island, Chania, Rethymnon, Heraklion and Lassithi. The dispatch centre (DC) in Heraklion, is unique in Greece, for using a pre-hospital emergency care management system. EKAB Crete staff includes, doctors trained in pre-hospital emergency care, 120 paramedics, 13 operators/dispatchers, 5 technicians, and 11 administrative personnel.

### **2.1 EKAB Crete Dispatch Centre**

The dispatch centre (DC) in any organization related to emergency episodes, such as fire, police, and emergency care departments, should, in addition to accepting calls and dispatching available resources, evaluate calls in terms of their severity in order to manage available resources in the best possible way. Early interventions can directly affect emergency services in handling time critical events. Chances of survival are reduced for every minute that passes without treatment. Immediate response rate has been determined to within eight minutes of the emergency call [4]. For these cases the speed of ambulance response plays a significant role in the chance of recovery. The need for a rapid ambulance response is crucial for all patients facing life-threatening situations. Computerised systems can greatly assist Emergency Departments in the effective and efficient handling of resources. The EKAB Crete dispatch centre is the only DC in Greece that uses information technologies for triage, coordination and management of resources. The incoming emergency calls are no longer logged on paper. Rather, call information is directly input in electronic cards and triage protocols are used to assist dispatchers in episode evaluation.

IASO, the computerized pre-hospital emergency care management system, is part of the HYGEIAnet, the Regional Health Information Network in Crete, developed by the Foundation

for Research and Technology-Hellas, Institute of Computer Science (FORTH-ICS) [5]. The FORTH-ICS project “Pre-hospital Health Emergency Management System” started in 1996. Its goal was to improve the National Centre for Emergency Care (EKAB) through the use of state-of-the-art information and communication technologies. IASO has been in operation daily since 1997. It provides solutions for geographical tracking of ambulance cars and mobile units, optimal use of available resources, acquisition, transmission, analysis and storage of vital signs for patient tele-monitoring, and an electronic emergency incident archiving, currently containing more than 50,000 records, and medical triage protocols for prioritization of emergency calls.



**Figure 1** Services provided in the context of the pre-hospital health emergency management system.

More specifically, the system consists of the following applications:

#### **Operator/Dispatcher application**

It allows creating, completing and printing the electronic “Incident Card”. Based on specific algorithms (online triage protocols), it offers help with regard to incident severity estimation and the selection of the most appropriate resources (e.g., ambulance car or mobile unit). The application keeps track of all incidents being dispatched or waiting to be dispatched displaying them in a list.

#### **Doctor application / telematics subsystem**

Mobile units are equipped with appropriate technology to obtain and transmit vital signs and ECGs directly to the Doctor’s application at the dispatching centre allowing for remote monitoring and management of the patient within the ambulance. Using the “Clinical Evaluation Card”, the doctor may record all relevant details for patient’s condition and therapeutic actions throughout the incident. The application within the mobile unit almost automatically acquires and transmits vital signs and ECG requiring minimum crew involvement to allow the crew to concentrate fully on the patient. The telematics subsystem stores all vital signs and the electrocardiograph of an emergency patient handled by the Mobile Unit. There are two mobile units equipped with telematics subsystem in Heraklion, one in the HC of Moires, one in Rethumnon, and one in Chania.

#### **Administrative application**

This subsystem applies advanced data analysis methods to the contents of the emergency incident archive, in order to support administrative decisions with regard to, among others, staff hiring, training and scheduling, as well as the acquisition of specific equipment.

## GPS/GIS

The dispatching centre operates a GPS satellite GIS system that depicts the exact position of the ambulance and allows the dispatchers to know the exact position of the ambulance and co-ordinate its movement. Most of the ambulances are equipped with this system.

## Triage Protocols

Among the high volume of calls being received by the Dispatching Centre it is essential to prioritise patients into an order of clinical need. Giving importance to this area of pre-hospital care is a key aspect in the "chain of survival" [6]. To differentiate urgent from non-urgent calls it is important to implement a triage mechanism to effectively manage ambulatory resources. Usually, most knowledge involved in assessing emergencies by telephone is heuristic. Dispatchers say they can "feel" when something is wrong. This vague notion of an emergency prevents the knowledge from being similar across the dispatchers. It also complicates the evaluation of the process of emergency handling.

There is a strong need for protocols, both for dispatchers and for management. Thakore, McGugan et al [7] have shown that ambulance dispatchers could have reduced the number of immediate response needed by at least 23% simply by identifying patients who did not actually need hospital admission, and that 55% of calls for emergency ambulances are not eligible for an immediate response. One of the initial goals for the organisational change of EKAB Crete was the development and implementation of triage protocols to be used by operators/dispatchers in the dispatch coordination centre at Heraklion.

Until recently, in Crete, the triage of emergency calls was based on the experience of operators and the emergency care knowledge of the doctor that happened to be present during the management of some episodes. To assist operators/dispatchers in prioritising calls and provide important information to the public, special protocols were developed for several emergency situations. Protocols already used in other emergency medical services were studied and, based on those, a set of new protocols was designed and adapted to the Greek needs and mentality. It was important to take into consideration not only the mentality of the caller but also the mentality of the dispatcher who handles the calls and evaluates the episode's severity, as well as the emergency doctors' mentality, who are involved with the management and co-ordination of care.

Protocols were designed to be simple and easy to use and were developed in collaboration with experienced dispatchers and emergency care doctors. Throughout development, they were clinically tested to make the necessary changes and additions. Protocol categories cover a wide range of emergency episodes according to established needs including allergies, heart and respiratory failure, stroke, multi-trauma, abdominal and thoracic pain, labour, haemorrhage handling and others. In preparation for the 2004 Athens Olympic Games, protocols for addressing mass casualty and radiobiochemical incidents were also developed. Patient triage is the cornerstone in the medical management of a mass casualty incident [8]. By assigning treatment priorities to physical and psychiatric casualties, an otherwise unmanageable medical situation can be systematically broken down into manageable components [9]. Patient triage is a dynamic process involving repeated reassessment of the patient until the patient has received definitive treatment [8]. There are additional beneficial implications in correctly identifying emergency conditions that include the chance of patient survival through the use of telephone instructions such as CPR. Bystander first aids such as CPR are not frequently undertaken at the scene of an episode [10]. Correct identification can lead to a substantial rise in the numbers of bystanders undertaking essential, and potentially lifesaving, interventions through telephone instructions, which can significantly improve survival [11].

EKAB Crete triage protocols contain specific instructions to assist in the exact evaluation of each incident and a special section with the title "remember" that includes specialised instructions to the dispatchers for each category of emergency call. Special attention is given to instructions that the dispatcher can provide to the public in order to help in the assessment

of the patient's condition. These instructions are given to the caller after assuring him/her that the ambulance is on its way. In the meantime, the dispatcher is urged to call for further instructions in case the condition of the patient worsens.

After establishing the exact location of the incident and noting the phone number of the caller, the dispatcher asks key triage questions such as:

1. Tell me what the problem is (Tell me exactly what happened).
2. Is s/he conscious?
3. Is s/he breathing?

Based on the answers of the respondent, the dispatcher attributes a severity score to the call and categorizes it into the following colour categories:

- Red: immediate response with a mobile unit with a doctor
- Orange: immediate response with a special ambulance (defibrillator)
- Yellow: immediate response with a simple ambulance
- Green: delayed response

A negative answer to "is s/he breathing?" or an indication that the patient is suffering agonising breathing along with a negative answer to "is s/he conscious?" indicates a severity score of red or orange requiring the immediate response of a mobile unit. In each case, specific instructions are given to the caller and to the crew of the ambulance for the initial handling of the episode.

It is unlikely that the level of compliance with a system of call prioritisation would lead to a 100% accurate detection of the actual patient's condition. Incomplete or inaccurate information provided by the caller or dispatch errors may cause the call to be inaccurately triaged [12]. However, it has been shown that changing to a priority-based system could save lives, not only by getting ambulances faster to those who really need them, but also by reducing the number of ambulance vehicle accidents [7]. In Crete, the consistent use of IASO and its resources has greatly contributed to minimising inappropriate management of incoming calls. More specifically use of the pre-hospital emergency system has:

- Assisted the dispatching centre with effective use and efficient management of its resources.
- Improved services offered to the public.
- Provided legislative coverage for the decisions taken by the dispatchers.
- Developed "professional memory" for DC staff.

One of the operators/dispatchers summarizes the general feeling at the Dispatch Centre:

"The success of the dispatcher's work is based 60-70% on the protocol, the rest is its personal characteristics such as experience, knowledge, way of speech, knowledge of legislation and continuous education and on the high quality standards we have as a section. There is a huge difference between our section and the rest of Greece. We are well informed. Independent to our experience, we go through specialised education for operators and dispatchers and we pass an examination for protocol knowledge."

## **2.2 Pre-hospital emergency education and training**

Pre-hospital health emergency interventions involve both professional and non-professional health operators necessitating the provision of proper training for everyone. In addition to the pre-hospital emergency care system, EKAB Crete has established another innovative practice that involves mandatory continuous education for doctors, crew and dispatchers. Training focuses on recognition and appropriate handling of emergency situations to improve public service, to offer legislative coverage for employee decisions, and to create the new generation of dispatchers for the purposes of the service. In addition, weekly presentations of interesting emergency cases have been established among doctors and crew.

Education and training activities include continuous education for BLS ambulances and Mobile Units, training on triage protocols, special training on disaster recovery, education activities for the public for basic life support and doctor's training under the Emergency Medicine program. Education and training activities have also been ongoing since 1996. Recently, EKAB Crete has published a book with detailed information on emergency care protocols that will be distributed and used in every emergency care unit throughout Greece.

It has been generally accepted in Crete, that continuous education has greatly enhanced the impact of information services on the overall quality of care. It is only now that the Central Governing Unit of the National Centre for Emergency Care plans to establish similar educational practices to the rest of its units throughout Greece.

Traditional emergency care training, however, is not without drawbacks. Braslow [13] has noted that only 36% of trainees were still rated competent in CPR after two months of having completed classroom training. Being aware of the limitations of traditional emergency care training has led to the participation in a dedicated project (Project JUST, [www.justweb.org](http://www.justweb.org)), co-funded by the European Commission, with the objective to design and develop a complementary training course for non-professional health emergency operators. Advance technology techniques were used to support the traditional learning phase and improve the retention capability of the trainees. Capability for self-learning, benefits of user-system interactions, and extensive use of multimedia were taken into consideration for the deployment of a hybrid technological solution, the Web/CD, which presents the optimal integration between the two media.

Extensive usability testing and clinical trials were conducted to assess the effect of continuous training through the use of technology. Findings suggest that the technology agrees with the style and practice of 'novice' users rather than 'expert' users. Overall, it has been noted that there was a dramatic improvement for all trainees after attending the course. In conclusion, the pilot phase indicates that significant benefits and performance improvements can be achieved through the innovative use of modern information and communication technologies for the effective re-engineering of organizational processes and the continuous improvement of knowledge and skills.

## **2.3 Management of Change**

Several authors [14-17] deal with the difficult issue of encouraging medical personnel to become hands-on users of clinical information systems at the point of health care delivery. Since the mid-nineties, lists of recommendations and strategies for practitioners have been published to help with implementation of information systems [18-20]. Despite these recommendations, following an ideal recipe has not proven particularly useful [21]. To encourage change, a major part of implementation initiatives concentrates on removing resistance through educational programmes, establishment of new priorities and patterns of behaviour. Experience has shown, however, that a linear view of governance that assumes the ability to identify logical links between cause and effect has resulted in comprehensive prescriptions that do not work [22, 23].

An alternative view of change emerges when treating health care systems as complex adaptive systems [24, 25] where change is treated as an inherent capacity of organisations and a process of self-organisation. The reorganisation of EKAB Crete required a series of changes. However, contrary to implementation initiatives elsewhere, it did not involve a governmental enforcement or an explicit implementation strategy. The implementation of information systems at the dispatch centre was a pilot initiative based on collaboration between the Foundation for Research and Technology-Hellas and the Crete Unit of EKAB. Technologies were disseminated aspiring to the good will and interest of emergency service staff. The implementation was essentially organic while use of the available technologies relied solely on the decision of the end users. Implementation methods focused on loose control, encouragement of innovation, and direction setting. These methods have been shown to produce faster results than the traditional plan and control mentality [26].

International experience has isolated three fundamental factors that are crucial for an implementation effort to succeed over time [27]. These factors are (a) a champion that persists with the deployment and diffusion of systems, (b) a length of time of a minimum 5-6 years and (c) significant financial grants to support and maintain the effort. Change in Crete emergency services supports these findings. FORTH has been a major champion in advancing and promoting health care systems and innovative services to the region of Crete. In addition, the strong and visionary leadership of the Director in EKAB Crete has been crucial for the acceptance and daily use of innovative technologies. Change has been incremental but steady, with initiatives dating back to 1996. Financial support, the third major component of successful implementations, has been mainly from R&D funds brought in by FORTH. National funding has been largely lacking in Crete. Only recently, the regional authorities have recognized the importance of information systems in EKAB and have begun to financial support a small part of the effort. Ongoing funding for development, maintenance and support of new technologies is fundamental in assisting the continuous process of change. FORTH throughout the years has provided ongoing support for end-users and maintenance of systems and services, major pillars for the implementation effort. In addition, factors identified to enhance self-organisation include incentives, education, leadership, and culture.

### **Incentives**

Incentives play a critical role towards creating the initial critical mass of users required for successful deployment and diffusion. In the case of EKAB Crete, a political and strategic decision was taken not to offer financial incentives for using innovative technologies. Implementation efforts should rely on incentives that could last throughout the years without being dependent on financial support [28]. Innovative technologies focused on improving and facilitating daily practice, providing strong research tools to enhance clinical trials and epidemiological studies.

### **Education**

One of the major components involved in successful implementation of information systems is education. Hands-on practice and on-the-job training during the first days of operation was essential to facilitate integration of the computer into the actual workday. High priority was placed on demonstrating the usefulness of the technology and the way it supports individual services and work performance. Many of the technologies revolutionised practice offering possibilities unavailable through traditional health care. Continuing education also played an important role in highlighting the importance of integrating technology into daily practice. In addition, education and training in emergency care practices have greatly contributed to the overall quality and exceptional performance of EKAB Crete. Doctors and staff feel adequately prepared to face the high emotional stress usually present in emergency episodes.

### **Leadership**

In Crete, the natural tendency of agents to change had been greatly influenced through leadership. Individuals as leaders, mentors, change agents and consolidators made a huge difference to the deployment and use of HYGEIAnet [26]. The Director of EKAB Crete has recognised the usefulness of HYGEIAnet technologies and has closely collaborated with FORTH in the development and implementation of innovative practices. His role has been crucial not only for the dissemination and use of information technologies but for the reorganisation and innovative practices in pre-hospital emergency care throughout the island. He exerts strong visionary leadership that inspires and motivates colleagues. His presence has created a strong interdisciplinary team inspired with collaboration and drive for excellence. Leadership is particularly important for public health care organizations in Greece to incorporate innovative practices that are often delayed within the lines of bureaucracy.

## **Culture**

Consumer demands for information and participation in decision-making will eventually transform the nature of clinical management and the respective roles of providers and patients in ways that could not be anticipated [29: 766]. Physicians will have to comply with these new trends to accommodate changing consumer demands. These realisations became important for Crete as more and more people were familiar with information technology and access the Internet. The implementation strategy focused on creating a critical mass of stakeholders who engaged personally with the available technologies. As Lyytinen and Hirschheim [30] have pointed out implementation is rarely solely a success or a failure. Similarly, while EKAB Crete innovation practices are well received by most health care employees and patients, lack of appropriate public policies, legislation, and funding has the effort standing on loose ground.

## **2.4 Impact on performance**

The introduction of innovative practices of a computerised pre-hospital emergency care system and continuing education in Crete has completely transformed traditional care and improved performance minimising inappropriate management of incoming calls.

Notably, no traditional approach was able to provide the type and quality of services enabled through the pre-hospital emergency care management system described earlier. On-going evaluation indicates benefits for both patients and health professionals [28]. HYGEIAnet pre-hospital services have been integrated into daily practice resulting in cost containment, improved quality of care and easier management of emergency episodes and material and medical staff resources. In addition, evaluation of pre-hospital emergency services revealed a substantial improvement in the accuracy of classifications of emergency cases. Overall, information systems and continuing education have had a significant impact in the quality of care delivered.

## **3. Conclusions**

The main contribution of this paper is to present the innovative practices adopted at the National Emergency Care Unit of Crete and highlight their importance in effective and efficient management of emergency incidents. Taking this implementation effort as a model and through close examination of change processes and innovative practices could facilitate similar implementation efforts in other regions. Information technologies and educational practices are essential for the timely and effective management of emergency episodes. Protocol triage, management of resources and continuous education of staff are contributing factors to the improvement of public services to assist patients in life threatening emergency situations.

## **Acknowledgements**

The authors would like to thank the developers and administrators of the eHealth laboratory at FORTH-ICS, and operators/dispatchers, doctors and administrators at EKAB Crete for their contribution in the implementation of innovative practices at the pre-hospital emergency care sector of Crete.



## References

1. Fischer M, Fischer NJ, Schuttler J. One-year survival after out-of-hospital cardiac arrest in Bonn city: outcome report according to the "Utstein style". *Resuscitation* 1997;33(3):233-243.
2. Cummins RO, Ornato JP, Thies WH, Pepe PE. The American Heart Association Subcommittee on Advanced Cardiac Life Support. "Improving survival from sudden cardiac arrest: the 'chain of survival' approach,". *Circulation* 1991;83(5):1832-1847.
3. Athey S, Stern S. The Adoption and Impact of Advanced Emergency Response Services. In. Sloan School of Management; 1998.
4. Committee NE. Review of ambulance performance standards: London: HMSO; 1996.
5. Tsiknakis M, Katehakis D, Orphanoudakis SC. An open, component-based information infrastructure for integrated health information networks. *International Journal of Medical Informatics* 2002;68(1-3):3-26.
6. America NloHotUSo. Emergency medical dispatching: rapid identification and treatment of acute myocardial infarction. Chicago: NIH Publications; 1994.
7. Thakore S, McGugan EA, Morrison W. Emergency ambulance dispatch: is there a case for triage? *J R Soc Med* 2002;95(3):126-129.
8. Nocera A, Garner A. AUSTRALIAN DISASTER TRIAGE: A COLOUR MAZE IN THE TOWER OF BABEL. *ANZ J Surg* 1999;69(8):598-602.
9. Vayer J, Ten Eyck R, Cowan M. New concepts in triage. *Annals of Emergency Medicine* 1986;15:927-930.
10. Clawson J, Cady G, Martin R, et al. Effect of a comprehensive quality management process on compliance with protocol in an emergency medical dispatch center. *Annals of Emergency Medicine* 1998;32:578-584.
11. Heward A. Telephone CPR: the problems and pitfalls. *Resuscitation* 2001;55:61.
12. Heward A, Damiani M, Hartley-Sharpe C. Does the use of the Advanced Medical Priority Dispatch System affect cardiac arrest detection? *Emerg Med J* 2004;21(1):115-118.
13. Braslow A, Brennan RT, Newman MM, Bircher NG, Batcheller AM, Kaye W. CPR training without an instructor: Development and evaluation of a video self-instructional system for effective performance of cardiopulmonary resuscitation. *Resuscitation* 1997;34:207-220.
14. Kaplan B. The medical computing 'lag': perceptions and barriers to the application of computers to medicine. *International Journal of Technology Assessment in Health Care* 1987;3(1):123-136.
15. Kaplan B. Reducing barriers to physician data entry for computer-based patient records. *Topics in Health Information Management* 1994;15(1):24-34.
16. Tanriverdi H, Iacono CS. Diffusion of telemedicine: A knowledge barrier perspective. *Telemed J* 1999(5):223-244.
17. Tonnesen AS, LeMaistre A, Tucker D. Electronic medical record implementation barriers encountered during implementation. In: *AMIA Annual Symposium*; 1999; 1999. p. 624-626.
18. Ash J. Organizational factors that influence information technology diffusion in academic health sciences centers. *Journal of the American Medical Informatics Association* 1997;4(2):102-111.
19. Lorenzi NM, Riley RT, Blyth AJC, Southon G, Dixon BJ. Antecedents of the people and organizational aspects of medical informatics: Review of the literature. *Journal of the American Medical Informatics Association* 1997;4(2):79-93.
20. Ash J, Gorman P, Lavelle M, Lyman J, Fournier L. Investigating physician order entry in the field: Lessons learned in a multi-center study. In: *MedInfo 2001*; 2001; London, U.K.: International Medical Informatics Association; 2001. p. 1107-1111.
21. Pare G, Elam JJ. Introducing information technology in the clinical setting. *International Journal of Technology Assessment in Health Care* 1998;14(2):331-343.
22. Beer M, Eisenstat RA, Spector B. The critical path to corporate renewal. Boston, MA: Harvard Business School Press; 1990.
23. Smith MY, Stacey R. Governance and cooperative networks: an adaptive systems perspective. *Technological forecasting and social change* 1997;54:79-94.
24. Plsek PE, Kilo CM. From resistance to attraction: a different approach to change. *The Physician Executive* 1999;November-December:40-42.
25. Plsek PE, Greenhalgh T. Complexity science: The challenge of complexity in health care. *BMJ* 2001;323:625-628.
26. Kouroubali A. Implementation of Health Care Information Systems: Key Factors and the Dynamics of Change. Cambridge: University of Cambridge; 2003.

27. Iakovidis I, Wilson P, Healy JC, editors. E-Health: Current Situation and Examples of Implemented and Beneficial E-Health Applications: IOS Press, Amsterdam; 2004.
28. Tsiknakis M, Kouroubali A, Vourvahakis D, Orphanoudakis SC. Implementing a Regional Health Information Network: Impact on health care performance and the management of change. *Advances in Health Care Management* 2005;5:(Forthcoming).
29. Coye MJ, Detmer DE. Quality at a Crossroads. *The Milbank Quarterly* 1998;76(4):759-769.
30. Lyytinen K, Hirschheim R. Information systems failures -a survey and classification of the empirical literature. In: Zorkoczy PI, editor. *Oxford Surveys in Information Technology*. Oxford: Oxford University Press; 1987. p. 257-309.