

## HERMES'02

**Action Lines** - System and Services for the citizen, Health, Intelligent environment for citizen centred health management, Intelligent collaborative environments supporting continuity of care.

### THE USE OF SMART CARDS IN HEALTH CARE Turhan Tunali\* Şule Yıldırım\* Tayfun Dalbastı\*\*

#### ABSTRACT

*In this article, the use of smart cards in health care is proposed. The increase of quality in patient service, the increase of accuracy of the information circulating in hospitals and the decrease in costs can be supplied by hospital automation systems. The integration of smart card use in the existing/prospective automation systems should be viewed as an essential part of hospital automation systems as far as its benefits both to the service providers and the patients are concerned in example uses.*

#### 1. Introduction

In today's world, the need for automation systems in hospitals and medical centers gain more importance each day. The purpose of the automation systems is to increase the accuracy and the speed of knowledge circulation which will lead to better service for patients and increasing response (work) efficiency of hospital personnel. The ultimate idea for hospital automation systems is to accomplish a network in/among hospitals that obtains, stores, analyzes/processes and uses patient information. There can be many sources that the information related to the patients can be obtained from including patient himself (i.e. symptoms of a suspected illness, body temperature), results of tests applied to patients (i.e. blood type tests), online patient monitoring systems (i.e. arm bands, accelerometer etc.), doctors' diagnosis for patient illnesses and previously stored patient information. The analysis of the obtained information for use is the scope of many scientific fields (i.e. medicine, statistics, information technologies [1] etc.). The storage and the sharing of the obtained/analyzed/processed information is in the scope of information technologies and expert systems. All these systems will help to evaluate a patient from previously stored information in case of his consultation to a hospital/health center again. It's important to be able to retrieve a patient's previous information and act accordingly in addition to the new symptoms of a suspected illness(es).

On the other hand, a person might be registered in different information systems. However, the privacy constraints of each system imply that it is very difficult to access to all information sources [2]. It may exist a lot of information about the same person, but it is not physically gathered on the same spot or not reachable by all intervening parties. Each information system stores a lot of data about persons which are often similar (e.g. names, addresses, occupations, etc. with many discrepancies). For example, in an information system, Mrs Can is tagged as a medical student at Ege University, whereas in another she is registered with another feature. It's important to be able to supply the sharing of information between different parties without ignoring privacy constraints.

---

\* International Computer Institute, Ege University, Bornova, Izmir, Turkey,  
[tunali@ube.ege.edu.tr](mailto:tunali@ube.ege.edu.tr), Professor and Director, [yildirim@ube.ege.edu.tr](mailto:yildirim@ube.ege.edu.tr), Research Assistant.

\*\*Neurosurgery Department, Ege University, Bornova, Izmir, Turkey, [dalbasti@bornova.ege.edu.tr](mailto:dalbasti@bornova.ege.edu.tr), Assistant Professor.

It's also important to be able to access patient specific information such as blood type, currently existing diseases, allergies to specific substances, etc. at consultation time. It's widely known that parents can easily forget whether a child is allergic to a medicine (i.e. penicillin) in case of which incorrect prescriptions are applied. It's highly possible to ignore this kind of information in hospitals where the number of patients per doctor is high.

These problems can be solved by increasing the capabilities of hospital automation systems with intelligent storage, retrieval and inferencing mechanisms. In addition, the experience and improving patient service quality of some countries show us that using a portable media for each patient to store patient specific information is an essential part of a hospital automation system. The patient can carry the media with him/her anywhere and any time. It is presented to the doctor at the time of consultation and stores on it various health aspects such as administrative profile, medical folder (containing in particular the emergency medical data) and follow up of blood transfusions, vaccinations, etc.

The media selected for the above purposes should be cheap, easy to use, carry and update with new information and shouldn't get damaged easily. The media we propose is "smart cards" [3] whose successful applications can also be found in our country in transportation systems and telecommunication systems. We'll refer to such cards as "health cards".

Since some medical data will be carried on a health card, in case of an emergency, a doctor or paramedic if equipped with a smart card reader could quickly learn a patient's blood type, allergies, medications and medical conditions if he/she suffers from high blood loss as a result of a car accident. If needed, additional data could be available to health care professionals at web sites.

Administrative patient information such as name, age, phone number etc., will be retrieved easily and quickly in case of emergency situations as well. Also, patients are not always reliable on remembering what kind of medicare he/she previously had. In addition, it might be hard for a doctor to access a patient's previous medicare (i.e. some surgery results kept in another hospital). This might result in ignoring some important facts about a current medicare that depend on previous ones. For example, a patient who suffered from "Ulcer perforation" previously might not be applied stomach scintigraphy in order not to hurt his/her intestines in case of a repeating acidity in stomach.

With smart cards, health care institutions can improve patient service and reduced costs, while still protecting patients' rights to health care information confidentiality. Smart cards can:

- Identify clients and store important health and treatment data.
- Provide patients and health care institutions a convenient way to carry data between systems or to sites without systems.
- Reduce records maintenance costs.

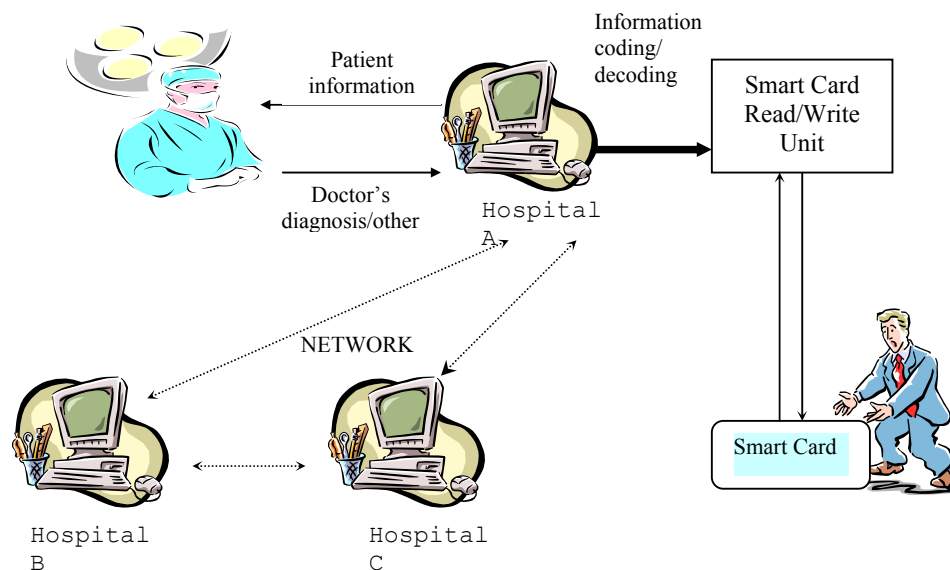
The high-technical features of a smart card system integrated in a hospital automation system can allow patients to apply for some social security benefits on line or fill in forms electronically with a digital certificate carried on the card. Each chip card can contain a digitized photograph of each patient, enabling clinic personnel to verify that the cardholder is the person entitled to receive a specific medicine for example. Also, it's possible to allow individuals to test their own blood cholesterol levels and to store the results on a smart card and at a Web site.

Many software companies are developing smart card systems that links patients, emergency response teams, general practitioners, hospitals and pharmacies. In the future it is

anticipated smart card readers will be located at health care facilities, including hospitals, doctors surgeries, mobile emergency units (ambulances) and pharmacies.

## 2. The Proposed System

The proposed system is given in Fig. 1. In the figure, a single computer represents a network of computers in a hospital. There's a smart card read/write unit attached to the computer to record/delete information from a smart card. The information retrieval/recording/deletion rights can be supplied by a security mechanism. The patient smart card includes such essential medical information as the patient's name, physician, medical conditions and medications. In addition, the chip contains encrypted code that points to more complete patient information on a Web server [4, 5]. As a result, related documentation (i.e computerized tomography or films), test results can be retrieved from related units/departments if more information about a previous treatment is needed. For example, when a doctor figures out that there was a previous surgery from a patient's smart card, he/she might want to see related test results, films and computerized tomography (CT) related to the surgery. Also, when a patient hands a pharmacist his or her chip card, the pharmacist will call up the medications the patient is taking and make sure any new prescription can be taken safely with the existing medications. These additional information can be in a network database (preferably with access rights [6]) or as in the form of paper documentation if not yet recorded into a database. The accuracy of the information obtained by the use of smart cards with the above procedure is obviously high. Patient, who is not dependable, is not required to be the source of information. If extra/related documentation is kept in a network database instead of in paper form, the accuracy and the speed in the circulation and retrieval of electronic information will be even higher. For instance, although the patient might have had an operation in hospital B, the details of it can be accessed by the doctors in hospital A in Fig.1. These network can be enlarged to incorporate inter-city or inter-country information [7]. In inter-country case, it will be necessary to use World Health Organization codes for illnesses/surgeries/medicine so that a doctor will understand the same thing from a health card whether in Turkey or in France. This system can take the place of country specific health cards.



**Fig. 1.** The Proposed SmartCard System in a Network

A whole hospital automation system should meet the following criteria:

-First registration, patient file creation.

- Work up daily observations.
- Bed-side operations and transactions
- Radiodiagnostic images.
- Access possibilities (confidentiality included)
  - .To enter data during bed-side operations by using a small terminal. To submit this data to cure tables and patient file in off-line mode.
  - .To access the card information that consult the hospital with their smart cards.
  - .To access patient files by a modem/network.
- Health insurance policies should be integrated in the system.
- Online data report by the patient himself/herself should be allowed.

From a patient side, each patient will have a smart card and will be able to do remote access including voice access. For example, a patient dialing his protocol number should be able to obtain information that he/she needs.

The administration side is generally concerned with the maintenance of statistical information and patient follow-up. Smart cards will expedite the delivery of medical care while reducing administrative time and costs because they provide accurate information, decrease the likelihood of harmful drug interactions, improve provider/patient relationship and provide a private and secure information storage system. Various entities from different administrative domains exchange data (e.g. hospitals, pharmacies, and insurance companies). It is not only the exchange of the document itself that matters, but also the sequence and semantic syntactic relationship between these documents along with complete organizational procedures have importance. Security in particular can be affected in this way.

The medical side includes patient information access, monitoring, remote access, radiological diagnosis. The doctors wouldn't just note down the current information on a paper or to a computer. The information that he/she needs some tests for a patient might be made to reach the nurses by the system. It might be possible to give an alarm when a patient needs extra care.

### **3. The Advantages of Using the Proposed System**

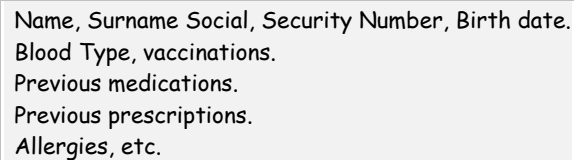
- Smart cards give patients and providers access to patient data, which can be held on the patient's smart card or on an Internet server.
- The smart card-based health care system will make it possible to access all the information at one central location from any place in real time.
- The system eliminates redundant procedures such as filling out forms.
- Doctors can use their own cards, together with a patient card, to submit online claims for treatment. Insurance company employees use their cards to access claims data.
- The number of duplicate tests will be reduced. If a patient's blood type, allergies and illnesses are stored on a card, without testing once again, a medicine that causes allergy will not be applied to a patient.
- A smart card carried by each doctor, nurse, pharmacist, lab. technician or other professional controls how much data that an individual can access. That allows a patient to give his cardiologist access to his heart-related test results, while limiting his dentist only to information regarding dental work. At the same time, he can let everyone authorized to read the card know that he is diabetic.
- Smart cards include/made to include a digital certificate so that a doctor asked for patient data, for instance, can be certain that the individual seeking the information is who he/she claims to be.
- The system can incorporate drugstores in by putting prescription data on the card. Such an information will help to figure when a patient used a specific medicine previously.

- Different kind of medicine can be used for an illness. If one is figured out to not work by keeping medicine information on the card and by drugstore connection, another one can be applied.
- The analysis of medicine usage for various medicine types can be possible.
- Card usage will prohibit usage of wrong medicine. If a patient gives a doctor wrong information about a previously experienced allergy to be kind “X” but actually it was of type “Y” and wants the previously used medicine again, this will lead to use of wrong medicine for the wrong allergy type.
- In small districts (in Sağlık Ocakları) where it's difficult to maintain information about childrens (such as inoculation types and times), a smart card system will lead accurate access of such information.

#### 4. Feasibility of Smart Cards for Use As the Media for Patient Information Storage

Storing medical information in an electronic format raises concerns about patient privacy and confidentiality. It is recognized that a security breach of electronic medical records might involve hundreds of thousands of records and go unnoticed. However as mentioned previously, microprocessor chip smart cards offer excellent security features as this type of technology has been used in banking for many years and has never been breached. In addition, the patient record is partitioned, so that the individual name and address is in one area, and the medication he or she takes is in another. That would make it hard for anyone who breaks into a Web server to connect medication data with a patient identity.

The cost of read/write unit is low. It's easy to use. The information fields on a smart card can be as follows:



Name, Surname Social, Security Number, Birth date.  
 Blood Type, vaccinations.  
 Previous medications.  
 Previous prescriptions.  
 Allergies, etc.

**Fig.2.** A sample smart card data

Smart Cards are also used in the following areas successfully:

- Cashless refuelling, shopping, booking, phone calls.
- Data carrier for the transportal and postal system.
- User specific software supplements.
- Timely data collection
- Route data collection, tachnograph.
- Access systems for homebanking, personal computer, security areas.

The issues to be handled in a smart card system are:

- 1) Internet protocols to access common patient databases [8].
- 2) Secure and intelligent network patient record access [9, 10, 11].
- 3) Data encryption on smart cards.
- 4) Representation of data on smart cards.
- 5) Generating databases and adaptation of existing databases for smart card use.

## 5. Conclusion

The realization and use of the proposed system will increase the quality of medicare of patients. Although a completely automated system will be the focus point of above proposed system in a long period, the support and use of smart cards is a vital part of it. There is a research ongoing on smart cards in International Computer Institute [12]. We propose to design and realize smart card use in health care with a pilot study in Ege University, Neurosurgery department. This can be extended to inter-departments and inter-hospitals. The combination of smart cards, health care and the Internet is a promising development that is supposed to accelerate. There are already ongoing successful implemenations in health sector [13,14].

## References

- 1) Van Gennip E.M.S.J., Talmon J.L., *Assessment and Evaluation of Information Technologies in Medicine*, IOS Press, Amsterdam 1995, <http://www.vatam.unimaas.nl/atim/>.
- 2) R. Beuscart and P. Paradinas. *Smart Cards for Health Care*, in Telematics in Medicine, Elsevier Science Publishers B.V., North-Holland, 1991.
- 3) P. Peyret. RISC-Based, *Next-Generation Smart Card Microcontroller Chips*, in proceedings of CardTech'94, Washington D.C., U.S.A., April 1994.
- 4) E. Gordons and G. Grimonprez. *A card as element of a distributed database*, IFIP WG 8.4 Workshop, P.Paradinas and G. White : The portable office. Microprocessor cards as elements of distributed offices, Ottawa, Canada, 1992.
- 5) P. Paradinas. *The CQL Database Smart Card*, GMD, Smart Card Workshop, Darmstadt, Germany, February 1994.
- 6) L. Guillou, J-J. Quisquater, and M. Ugon. *The Smart Card : A standardised Security Device Dedicated to Public Cryptology*, Ed G. Simmons : Contemporary Cryptology, IEEE-Press, 1992.
- 7) Markwell D. editor, *Healthcards Interoperability of Healthcard Systems*, G7 Interoperability Specification, G7 GII SP6, 1996, <http://www.clinical-info.co.uk/euhci.htm>.
- 8) S. Kent and R. Atkinson, *Security Architecture for the Internet Protocol*, Technical Report Request for Comments 2401 IETF, November 1998.
- 9) [Methods and Protocols for Secure Key Negotiation Using IKE - Borella](#) (Correct) Michael S. Borella 3Com Corp. 1800 West Central Rd. Mount Prospect, IL 60056 USA Phone: (847) 342-6093 Fax: (847) 222-0573 Email: mike [borella@3com.com](mailto:borella@3com.com)
- 10) [Protecting Key Exchange And Management Protocols Against Clogging Attacks - Rolf Oppliger](#) Swiss Federal Office of Information Technology and Systems (BFI) IT Security Group Monbijoustrasse 74, CH-3003 Berne, Switzerland [rolf.oppliger@mbox.bfi.admin.ch](mailto:rolf.oppliger@mbox.bfi.admin.ch)
- 11) Security Concepts For Corporate Networks - Rolf Oppliger Dieter Hogrefe University of Berne Institute for Computer Science and Applied Mathematics Langgassstrasse 51 CH-3012 Berne, Switzerland Tel. +41 31 631 49 03 Fax. +41 31 631 39
- 12) Gemplus. *CQL Card and Language Reference Manual*, Gemplus, 1992.
- 13) Slovene Smart- card and IP Based Health-Care Information System Infrastructure Jamova 39, 1101 Ljubljana, Slovenia
- 14) Struif B. editor, *German Health Professional Card Specification* (Physicians), GMD, July 1999, <http://sit.darmstadt.gmd.de/cgi-bin/sit-frame/sica?link=/SICA/workshop.html>.