

## Refereed papers

# Implementation of an electronic medical record system in previously computer-naïve primary care centres: a pilot study from Cyprus

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### ABSTRACT

**Background** The computer-based electronic medical record (EMR) is an essential new technology in health care, contributing to high-quality patient care and efficient patient management. The majority of southern European countries, however, have not yet implemented universal EMR systems and many efforts are still ongoing. We describe the development of an EMR system and its pilot implementation and evaluation in two previously computer-naïve public primary care centres in Cyprus.

**Methods** One urban and one rural primary care centre along with their personnel (physicians and nurses) were selected to participate. Both qualitative and quantitative evaluation tools were used during the implementation phase. Qualitative data analysis was based on the framework approach, whereas quantitative assessment was based on a nine-item questionnaire and EMR usage parameters.

**Results** Two public primary care centres participated, and a total of ten health professionals served

as EMR system evaluators. Physicians and nurses rated EMR relatively highly, while patients were the most enthusiastic supporters for the new information system. Major implementation impediments were the physicians' perceptions that EMR usage negatively affected their workflow, physicians' legal concerns, lack of incentives, system breakdowns, software design problems, transition difficulties and lack of familiarity with electronic equipment.

**Conclusion** The importance of combining qualitative and quantitative evaluation tools is highlighted. More efforts are needed for the universal adoption and routine use of EMR in the primary care system of Cyprus as several barriers to adoption exist; however, none is insurmountable. Computerised systems could improve efficiency and quality of care in Cyprus, benefiting the entire population.

**Keywords:** Cyprus, electronic medical record, primary care

## Introduction

Electronic medical records (EMRs) have long been introduced into medical practice and they have proven cost-effective in different clinical settings. In addition to economic benefits, EMRs contribute significantly to the improvement of the quality of care.<sup>1</sup> Primary care constitutes a pivotal specialty in the clinical management of patients within a healthcare system. The use of an EMR in primary care is of paramount importance for the effective and timely management of patients.<sup>2</sup>

The computer-based EMR has been shown by several studies to be an essential technology tool for health care,<sup>3</sup> modernising the management of medical information and contributing to high-quality patient care and efficient patient management.<sup>4</sup> However, significant barriers impede wide-scale adoption of electronic tools, making it essential for pilot testing before larger scale implementations.<sup>5,6</sup>

### Box 1 The Cyprus primary care system

- Cyprus Primary Health Care Services cover the majority of the population of the island (approximately 700 000 people) although the system is currently under development
- The Cyprus Primary Health Care sector functions on an income-based system and is funded by the State. A specific segment of the population, based on low income criteria, have free access to health care through the public primary care services
- The primary care centres operate without practice managers; there is no list-based service; patient records are linked to patients' IDs; however, few services are linked to computerised records
- Primary healthcare professionals are compensated based on monthly salaries and there are no performance incentives. The directors of each primary care centre are nominated among physicians based on their seniority
- Some of the centres maintain an appointment-based scheduling system, while other centres provide services on a first-come, first-served basis

Cyprus is currently moving forward to introduce a universal healthcare coverage system for the entire population. The use of the EMR in the clinical setting has been considered a cornerstone component for the successful implementation and effective management of patients at all levels of the healthcare services system

in general, and in primary care in particular. At the moment, public primary care services in Cyprus are characterised by underuse of information technology, during a period when healthcare reform is focusing on primary healthcare enhancement and development of the discipline of General Practice/Family Medicine (GP/FM) within the national system. Furthermore, there is currently very limited use of EMR in the primary care clinical setting of the public services sector.

Within the above-published framework, the Cyprus Ministry of Health collaborated with the Department of Social Medicine, University of Crete, with the aim of evaluating the effectiveness of a multifaceted intervention. The development of an EMR system was an important component of our study. Furthermore, the assessment of the EMR system in public primary care services in a previously computer-naïve environment constituted added value for our study. The primary objective of our pilot study was to introduce and evaluate the implementation of an electronic medical record system tailored to primary care professional needs in selected public primary care centres. A secondary objective was the development and evaluation by the end users of a Greek Windows<sup>TM</sup>-based EMR system in relation to the episode of care, using the International Classification of Primary Care (ICPC-2-R).<sup>7-10</sup>

## Methods

### Setting

The study was conducted in Nicosia, the capital of Cyprus, in one urban and one rural public primary healthcare centre. The urban and rural primary healthcare centres served a population of about 25 000 and 15 000 people, respectively.

### Participants

All primary care physicians and nurses from both healthcare centres (five physicians and five nurses) participated in the study as evaluators of the EMR system's performance. In addition, nine randomly-selected patients of each gender (a total of 18 patients) underwent personal interviews in order to provide detailed feedback on their experience with the EMR system. The implementation of the EMR constituted the first of two parts of a quality improvement intervention project in the public primary care services of Cyprus. The second part consisted of the implementation of clinical guidelines for chronic diseases.

## EMR system and software

The introduction of the EMR system consisted of the provision of personal computers for the secretaries, nurses and physicians at each participating primary care centre along with a laser printer and broadband internet access. Among many other software programs, TransHis was selected after comparison with other software programs (such as PHCCIS, Fakelos, and GNUmed operating in Greece or elsewhere) on the electronic interface, content and process, based on defined criteria for appropriateness, efficiency, and feasibility for general clinical practice.<sup>11–14</sup> TransHis was used as a prototype to create an EMR system, named Primary Care Health Records (PCHR); we used the ICPC-2-R,<sup>10</sup> the International Classification of Diseases (ICD-10),<sup>15</sup> and the Anatomical Therapeutic Chemical (ATC).<sup>16</sup> Microsoft Windows™ was used as the operating system, as TransHis uses a cross-platform compatible programming language, open source database system and a network protocol supporting multiple users. All computers were connected through transmission control protocol/internet protocol (TCP/IP) in a local network, and simultaneous access to the EMR was allowed through password identification and different user profiles. A firewall machine connected with an asymmetrical digital subscriber line (ADSL) allowed encrypted remote access for EMR updates and user support through PCHelpWare.<sup>17</sup>

TransHis's mini-dataset and interface was used for direct coding of each patient's reason for encounter, diagnostic and result interventions in ICPC-2-R. Diagnosis was double-coded in ICPC-2-R and ICD-10. New and customised functions for Cyprus included: patient/encounter registration, chronic diseases, repeat medication, electronic printed prescriptions, user-customised forms for entering patient/visit data, reports from Fast-Report generator (see Figure 1),<sup>18</sup> access to medical information, and reminders based on medical guidelines. Special software was included to identify software errors and misuses and send them in real time to the developer. Detailed description of the creation process and content of the EMR system has been described elsewhere.<sup>19</sup> During the implementation phase, various changes were accomplished in order to meet physicians' and nurses' needs. Prescription information (see Figure 2), changes in the electronic interface, and interactive features for laboratory testing (see Figure 3) were among the most significant improvements.

## Data collection

The evaluation of the EMR system in the public primary care centres was based on information collected through a multitude of methods intermittently over a period of 18 months. Information on the primary

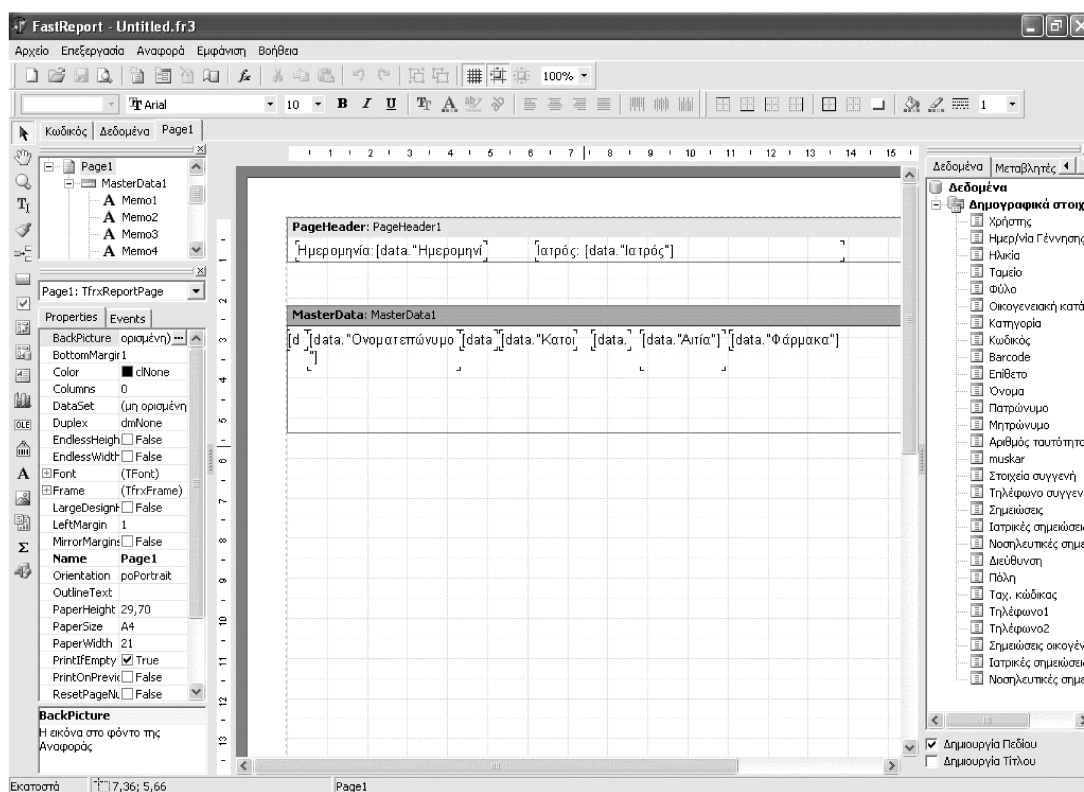


Figure 1 A screen capture from TransHis representing the Fast-Report generator

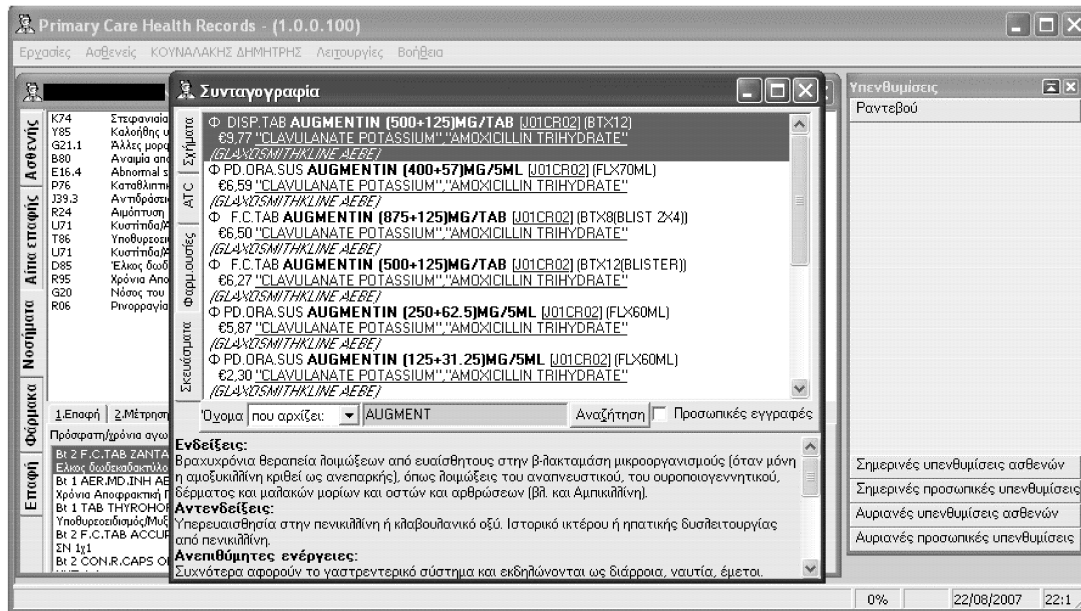


Figure 2 A screen capture from TransHis showing the EMR system prescription information that was readily available to physicians

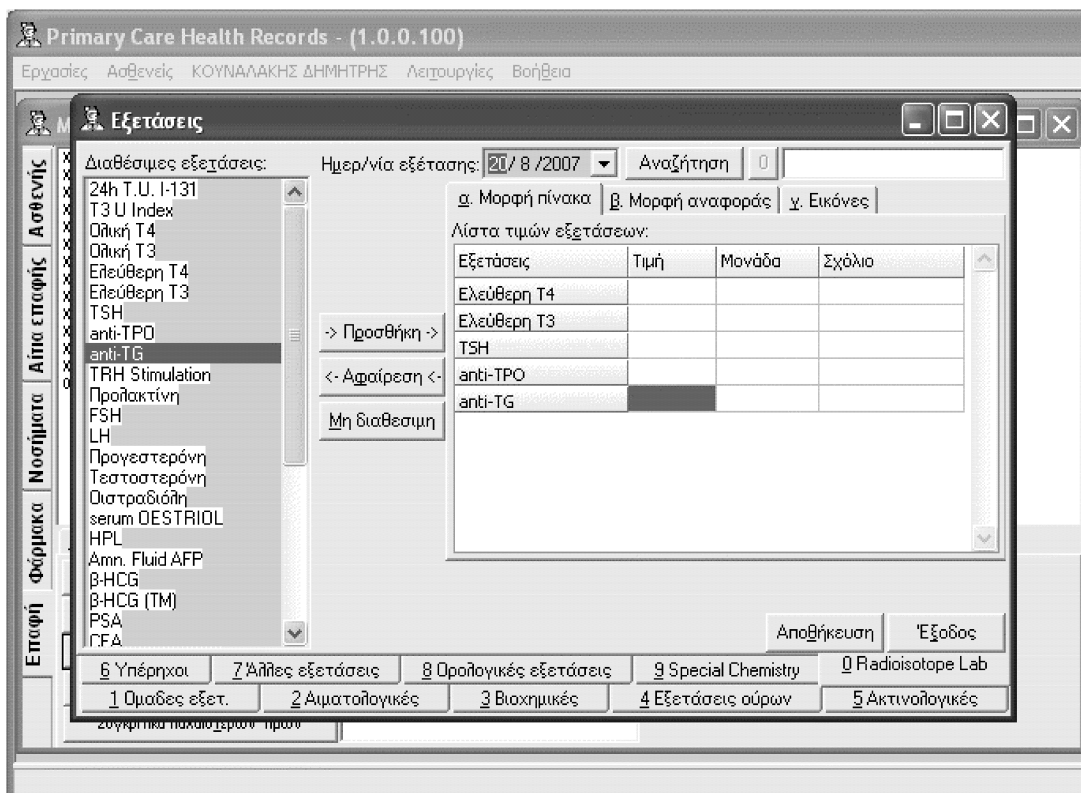


Figure 3 A screen capture from TransHis showing the EMR system interactive feature for laboratory testing orders

care physicians' and nurses' perceptions regarding the use of an EMR in clinical practice was obtained through consensus-building meetings during the preparedness phase of the study. Furthermore, the principal

investigator (PI) and a project facilitator visited both primary care centres on a monthly basis in order to provide periodic training for the participating physicians and nurses, support software implementation,

and complete monthly structured written assessments. Monthly written assessments were used to document the users' satisfaction and progress with the EMR adoption, the implementation barriers and any measures taken to overcome them, the number of hours spent on both on-site and off-site activities, and the plan for each following month. Outreach visits that were not planned were documented in detail with respect to the above described structure. Personal structured interviews were grouped into seven thematic categories as described below.<sup>20</sup> Questions focused on the familiarity of health professionals with computer use, on the EMR user's expectations, the practicality of EMR use, potential impact on the delivery of care, organisational support, comparison with previous paper-based practices, and identified barriers.

Personal interviews with each participating physician and nurse were conducted at six months into the EMR system implementation, and at the end of the follow-up period at 18 months. These interviews included ten semi-structured questions allowing interviewees to respond in their own words, and a nine-item Likert scale focusing on a broad spectrum of EMR use and implementation components. In addition, a focus group of all EMR evaluators (physicians and nurses) was organised at the same intervals (six and 18 months). Finally, personal interviews of 18 patients with chronic diseases and repeated visits to both participating primary care centres, during the EMR implementation phase, were also conducted by the PI at the end of the study period in order to assess the patients' perspective on the introduction of EMR in the primary care setting.

## Analysis of data

Data were collected in a systematic way and entered into a computerised database. Quantitative statistical analyses were performed using standard statistical packages. Statistical significance was determined by  $P < 0.05$ . Audio tapes of face-to-face interviews and focus groups were transcribed and a framework approach analysis was performed based on the five steps: familiarisation, identifying a thematic framework, indexing, mapping and interpretation.<sup>21</sup>

## Results

### Participants

A total of ten health professionals (five physicians and five nurses) participated as evaluators of the pilot implementation study. The vast majority of the primary

care physicians and nurses in the public sector in Cyprus are female; therefore, it happened that all evaluators of our EMR program in the two public primary care centres were female. The mean age of physicians was 52 years (age range 45–56), and 40 years for nurses (age range 31–44). In addition, 18 patients (six from the rural centre and 12 from the urban primary care centre) also participated as evaluators, the mean age of patients being 65 years (age range 60–73). Over the 18-month study period, two programme facilitators conducted a total of 18 scheduled visits to each primary care centre lasting approximately 90 minutes per visit. A total of 20 unscheduled visits lasting approximately 120 minutes per visit were also performed to support software upgrading and resolve software and internet connection breakdowns.

### Qualitative data

The systematic analysis of monthly narrative reports, personal interviews and focus groups resulted in a wealth of valuable information; the most important findings are presented below along with the seven thematic categories that emerged from the analysis of the qualitative data. The role of the facilitators in the preparation and implementation phase scored highly in the evaluation and was also reported to be very useful. Access to online guidelines through the EMR system itself and the readily-available electronic medical references through electronic medical databases was valued by the health professionals as a useful and important tool. In addition, the reminder system for periodic laboratory testing for patients with chronic diseases was an important component of improved delivery of quality care and was reported by the physicians and nurses as extremely useful though not fully developed.

Overall, the vast majority of the physicians and nurses were satisfied with the EMR system implementation ( $n=9$ ); however, some complaints were presented, while the EMR components were not fully used. Firstly, most physicians from the urban primary care centre reported that EMR usage negatively affected their workflow, decreasing their productivity, especially at the introductory phase. Moreover, the software was frequently reported to have breakdowns with inadequate information technology (IT) support, poor interface usability and non-user-friendly interactive features. With respect to organisational support, limitations included the lack of timely technical support and increased workload due to the continued parallel use of paper-based records for fear of legal complications in relation to the EMR documentation. In addition, the use of the EMR was limited due to the lack of organisational changes such as the introduction of an advance-notice appointment scheduling system,

adequate human resources coverage and lack of performance incentives. Furthermore, two out of five physicians complained that the EMR was limiting their ability to document important information. Finally, the absence of previous experience of computer use in clinical practice was reported as a significant barrier.

The patients provided valuable feedback on the implementation of the EMR in the public primary care clinics ( $n=18$ ). Patients thought that the EMR system was a strong sign of modernisation of primary care delivery, along with a perception of improved care from both a scientific as well as an organisational perspective ( $n=16$ ). One of the most important comments was the patients' belief that medical records could not be lost in the future and medication errors could be limited. An indicative excerpt from a patient follows:

'I feel that now they are looking after me in a better way. I have a feeling of security that my records and blood test

results will not be lost. In addition, I am satisfied that my doctor has everything in the computer to help him avoid any mistakes with my treatment.'

Interestingly, no negative or derogatory comment was reported from patients with respect to the EMR implementation.

### Quantitative data

In Table 1 we present the quantitative assessment of different components of the EMR system from the health professionals/evaluators based on a nine-item Likert scale. In general, Likert scale scores were higher and closest in agreement between the primary care professionals at the end of the 18-month implementation phase compared with the first six-month assessment. The use of guidelines, continuous audit and feedback and the presentations and lectures provided by the programme facilitators were rated with the

**Table 1** Assessment scores of the 9-item Likert scale of healthcare professionals for the EMR implementation\*

Questions	6 months			18 months		
	Mean	Median	IQR	Mean	Median	IQR
1 How important is the use of clinical guidelines for patient care services?	4.6	5.0	1.0	4.8	5.0	0.0
2 To what extent do you apply the clinical guidelines of selected diseases? (diabetes, hypertension)	4.2	4.0	1.0	4.4	4.0	1.0
3 How helpful are the lectures and presentations of the Principal Investigator, the facilitators and the other health professionals?	4.6	5.0	1.0	4.7	5.0	1.0
4 How helpful is the use of the electronic medical record for patient care?	3.2	3.5	2.0	3.6	4.0	1.0
5 How satisfied are you with the specific computer software? (interface usability, interactive features)	3.2	3.0	2.0	3.6	4.0	1.0
6 How useful do you find the reminder system of the EMR?	4.0	4.0	2.0	4.4	4.0	1.0
7 How useful do you find the facilitator's visits to your practice?	4.5	5.0	0.0	4.6	5.0	1.0
8 How useful is the component of continuous audit and feedback?	4.3	4.5	1.0	4.4	5.0	1.0
9 How satisfied do you feel with your participation in the intervention?	3.8	4.0	2.0	4.2	4.0	1.0

\* The Likert scale was based on a five-point assessment in which 1 corresponded to the lowest level and 5 to the highest positive level.

highest scores. It is promising that healthcare professionals rated many items much higher at the end of the 18-month follow-up period including the use of EMRs, the usefulness of the facilitators' visits, the electronic reminder system and most importantly their satisfaction for participating in the programme. Average ratings of all items are higher at the end of the 18-month period compared with the first assessment.

The estimated cost for the pilot implementation of the EMR in the two public primary care centres in Cyprus was relatively low, and certainly would not serve as a rate-limiting step in further expanding such a programme across the island. In particular, the cost of the hardware and software for the whole study was estimated at approximately €20 000 and €7000, respectively. The cost of the additional equipment was €5000 per healthcare centre. Finally, the cost of training and surveillance was estimated at about €30 000, summing up to a total of €62 000.

## Discussion

Our study is one of the first attempts to introduce an EMR system in the public primary healthcare services in Cyprus. Our study was introduced in a timely manner since a broad selection of EMR software is available for primary care physicians; however, most of the EMR systems do not support a classification for diseases and drugs, nor do they provide a direct coding interface for minimising the time needed to use the EMR. Overall, the development and evaluation of the EMR system in a previously computer-naïve environment was rated relatively highly by the healthcare providers (physicians and nurses) as well as the patients, using both qualitative and quantitative tools. The most popular features of the EMR system included the laboratory ordering and surveillance reminders, the electronic prescribing, and the electronic diagnostic coding based on ICPC-2-R and ICD-10. Identified barriers such as the software and organisational deficiencies were related to lack of an appointment-based scheduling system at the primary care centres, while increased workload impeded the full exploration of EMR benefits.

Although our EMR used a computer interface that did not require the doctors to learn the rubrics of the classification by heart, nor to spend a lot of time on coding, it did demand an initial effort to learn the system. After the initial period, the EMR fulfilled the initial demand for minimal time needed for keeping a mini-dataset of information for each patient encounter. A medical-oriented patient record with limited freetext fields and direct coding by the physician is in conflict with the need for freetext and the power of

expression available in paper medical records.<sup>22</sup> However, the use of clinical interface terminologies is a proposed method for a better interaction between physicians and EMR software, but it requires previous experience with the use of terminologies to build up a clinical interface terminology for local language and content uses.<sup>23</sup> Furthermore, novice users request different EMR interface characteristics than experienced users, and they are uncertain concerning the best preferred workflow in an EMR software they are going to use.<sup>24</sup> Changes in requested usability features and workflow from our EMR's users were expected as they became more experienced over time.

Some physicians reported 'poor usability' and 'non-user-friendly interface features' and this finding surprised us, since our EMR system was selected based on certain criteria of appropriateness. This makes us believe that usability improvements are still needed following the workflow of its use; it also needs to allow for the different needs of both novice and experienced users. It is also questionable whether an EMR system should be created for local needs or with multiple pathways in its workflow in order to support different methods of use.

Furthermore, the parallel use of paper-based practices due to legal concerns from the physicians, and the lack of adequate incentives were significant limiting factors for the full adoption of the EMR. Finally, the cost of implementation proved to be relatively low. Previously reported financial concerns from physicians regarding the EMR such as high up-front cost of EMR implementation, slow and uncertain financial payoffs, and high physician time cost were not found in our study because of the centralised financial management of public primary care services in Cyprus.<sup>12</sup> Other important barriers, such as difficulties with technology, software deficiencies, lack of incentives, inadequate technical support, and legal concerns reported in our study as well as in other studies, may be successfully resolved in a systematic way.<sup>6,25-28</sup>

Several findings of our study are worth further comment. First, according to patient interviews, no negative or derogatory comment was reported with respect to the EMR implementation, indicating that Cypriot patients are likely to welcome a universal EMR system in Cyprus public primary care centres without major concerns such as those reported in other studies.<sup>6,13,29</sup> In addition, the estimated cost of our pilot study and calculations on the return on investment, according to international experience, clearly shows that the implementation of a universal EMR system in the Cyprus public primary healthcare system will effectively drive down the cost of health care, while it would likely also reduce costly and preventable medical errors.<sup>30-32</sup> Furthermore, the role of facilitators in our study proved to be very helpful and was also rated high on the quantitative evaluation,<sup>33</sup>

suggesting that efforts to implement EMR in previously computer-naïve environments require outside promoters, in contrast to other countries where experienced and computer-literate insiders play the most important role in similar processes.<sup>34</sup> In addition, user satisfaction rating (physician and nurses) for the EMR implementation was relatively high: an encouraging sign, supporting future EMR implementation in subsequent years in Cyprus.<sup>35</sup> Finally, the process of engaging physicians and nurses at the preparedness phase in computer activities, consensus-building and the provision of strong organisational support, were found to be an important factor for successful EMR implementation.

Based on our study findings, certain strategies can be recommended in order to overcome the above described adoption barriers in future efforts for universal EMR implementation. First, we would like to highlight the need for subsidies and performance incentives for healthcare professionals, such as practice-based incentive programmes by the government,<sup>36</sup> and particularly pay-for-performance incentives, that could help promote wide-spread EMR adoption.<sup>17,37</sup> Additionally, other factors are also important for widespread EMR use, such as close communication and interaction between primary care and hospital EMR systems, as well as organisational and administrative changes in both settings, removal of legal barriers, and greater use of selected key EMR features.

Furthermore, the use of EMR – not paper – by the majority of physicians in particular settings for most of their daily tasks is also of paramount importance to promote quality improvement.<sup>20,38</sup> It is also useful to note that periodic changes and continuous evaluation of EMR is needed in order to meet healthcare providers' needs, since user satisfaction is important for the successful implementation of the EMR. Countries such as the USA, with a long tradition in information technology, have only recently managed to reach a 20–25% adoption of EMR by family physicians, estimating that EMR adoption will reach its maximum market share in 2024 in small practice settings.<sup>39</sup> This is indicative of the existing barriers for universal adoption of such programs, and despite Cyprus' small size, future efforts for universal EMR adoption will likely require concerted and long-term continuous efforts for the achievement of a widespread positive outcome.

A number of limitations of our study are worth noting. First, due to limited resources, the EMR system was implemented in a small number of primary care centres with few physicians and nurses serving as system evaluators. The small number of evaluators and our qualitative approach limited our study's generalisability; however there are indications of the directionality of changes and improvements observed. Existing international standardised EMR evaluation tools such as validated questionnaires were not used;

however, the EMR solution was specified based on user requirements and expectations.

In summary, our results demonstrate that the implementation of an EMR system in Cyprus is feasible, with a relatively high acceptance rate and utilisation by both physicians and nurses serving in previously computer-naïve public primary care centres. A common finding with other EMR-based studies is that information systems are often designed considering the technical development advantages without capturing the proper user requirements based on actual system users. Surprisingly enough, the patients in Cyprus were the most enthusiastic welcomers of the EMR system, with no legal, ethical or other concerns. Moreover, our EMR system, based on the episode of care, exhibited comparatively low implementation cost, while it was specifically developed to accommodate a future broad-scale introduction of the EMR in Cyprus public primary care centres, tailored to physicians' and nurses' needs. More systematic efforts are needed towards the above-suggested strategies in order to promote the routine use of the EMR in the public primary care centres of Cyprus. Several adoption barriers exist; however, no single factor proved to be insurmountable. Certainly, further studies are required in order to assess the effect of the EMR on physicians' performance and quality of care. Finally, a universal computerised system supporting Cyprus public primary care services could improve efficiency and quality of care leading to significant health gains for the entire population.

#### AUTHORS' CONTRIBUTIONS

CL and AP conceived of the idea and supervised the project. GS prepared and validated the questionnaires, performed the monthly visits, and the interviews, and collected and analysed the data. GS supervised the project implementation and the statistical analyses. DKK developed and TZ supported the EMR system. All authors reviewed and interpreted the data analyses. GS wrote and ESS contributed to the first draft of the manuscript. All authors contributed to the writing of the manuscript. All authors read and approved of the final version of the manuscript.

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#### CONFLICTS OF INTEREST

None.

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