Preliminary Results from the Deployment of Integrated Teleconsultation Services in Rural Crete

CE Chronaki[1], PJ Lees[1], N Antonakis[2], F Chiarugi[1], G Vrouchos[3], G Nikolaidis[3], M Tsiknakis[1], SC Orphanoudakis[1,4]

[1]CMI-HTA, Institute of Computer Science, FORTH, Heraklion, [2]Primary Care Center of Anogia, Anogia, [3]ICU and Cardiology Departments, Venizelio-Pananio Hospital, Heraklion, [4]Computer Science Department, University of Crete, Crete, Greece

Abstract

Teleconsultation services for cardiology patients have been installed and are in routine use since December 2000, connecting a primary health center in rural Crete to a regional hospital. Since efficiency and effectiveness are key factors in the acceptance of the service, integration of the services with the primary health record, support of clinical protocols and guidelines, and continuous evaluation of the services are primary foci of the overall effort.

This paper discusses our evaluation approach and presents preliminary results from the utilization of the service between December 2000 and June 2001. The presented results are encouraging, suggesting that the wide deployment of the service will benefit not only the patient, but also the GPs, the cardiologists, and the health care system.

1. Introduction

In the context of HYGEIAnet, the regional health telematics network of Crete, integrated teleconsultation services based on clinical protocols are being developed to support the remote screening of patients with suspected heart problems, aiming not only to benefit the patient but also to contribute to the optimum use of healthcare resources.

The teleconsultation architecture is based on WebOnCOLL, a web-based collaboration infrastructure that manages episode folders (TCFs) as shared workspaces [1]. Each teleconsultation session is associated with a TCF that includes administrative information as well as relevant clinical data. Administrative data in the TCF include timestamps associated with each clinical object and the history of interaction among the people involved in the session. Furthermore, access logs register follow-up access to the teleconsultation data.

Medical information comprises medical multimedia documents, such as reports, digitized x-rays, biosignals, ECGs, progress notes, etc., in a standard format such as DICOM, HL7/CDA, and SCP-ECG. Furthermore, clinical documents are linked to the health record to facilitate the automatic retrieval of clinical data based on the selected clinical protocol. The teleconsultation protocol was designed by a working group of information technology specialists, general practitioners (GPs), and cardiologists. For about a year the services ran on a trial basis to facilitate the education of physicians and validate the teleconsultation protocol in practice.

From the beginning of the project, special emphasis was given to the continuous assessment of the service. The objective was to identify any shortcomings and where possible, to take immediate action. The use of episode folders and the application service provider (ASP) approach in the deployment phase contributed to that effect. Section 2 provides some background to the evaluation approach. Then, section 3 presents preliminary results from the evaluation of the service and section 4 places these results in the context of our future plans. Finally, section 5 concludes the paper.

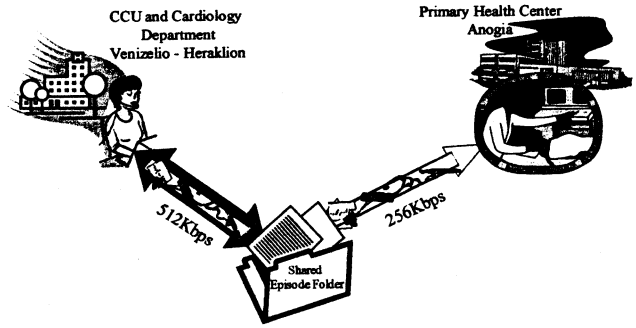

Figure 1. Evaluation setting for the telemedicine service

2. Evaluation approach

Continuous assessment, evaluation, and advancement of the telemedicine platform is the only way to provide innovative telemedicine services of high quality that measurably improve over time. Our evaluation approach is based on the work of NLM/IOM [2], to address issues related to the quality, accessibility, cost, and acceptability

0276-6547/01 $17.00 © 2001 IEEE

of services.

Quality is the degree to which health care services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge. Thus, it was necessary to identify a number of quantitative metrics that should be continuously monitored. As shown in fig. 2, the literature has identified technical capacity, diagnostic accuracy, diagnostic impact, therapeutic impact, and patient outcome as measurable dimensions of quality in telemedicine services [2].

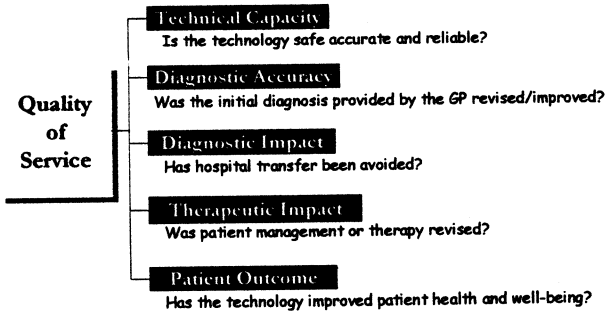

Figure 2. Dimensions of quality in teleconsultation

Technical capacity examines whether the technology used is safe, accurate, and reliable. Related questions concern the integrity of the transmitted medical information. For instance, how does the ECG transmitted to the cardiologist compare to the original?

The WebOnCOLL platform, building on the existing regional information infrastructure and the work of standards, provides robust, safe, and reliable mechanisms for collaborative access to the shared episode folder. Regarding the integrity of transmitted ECGs, ECGs are digitally acquired, stored in the SCP-ECG standard, and transmitted reliably to the other end. Shared access to the episode folder further ensures the accuracy of the data.

Diagnostic accuracy examines whether teleconsultation contributes to a correct diagnosis. Specific questions address how the diagnosis of the GP is affected by the teleconsultation.

Diagnostic impact examines the degree to which teleconsultation is an adequate replacement to a face-to-face consultation. In other words, after the consultation with the specialized cardiologist, is it still necessary to refer the patient to a central hospital?

Therapeutic impact examines whether teleconsultation influences patient management or therapy. For example, does teleconsultation contribute to modifications of the drug treatment administered to the patient?

Finally, *patient outcome* examines whether teleconsultation improves a patient's health and well-being. A relevant question is whether a patient whose case is discussed via cardiology consultation has a better health outcome. Note that while technical capacity, diagnostic accuracy, diagnostic and therapeutic impact involve processes of care, patient outcome refers to health outcomes. Unfortunately, solely on the basis of episode folder analysis it is not possible to identify objective measures for patient outcomes. One could make some qualitative remarks, such as those in section 3, but for quantitative results, controlled trials would be necessary.

Accessibility refers to the timely receipt of appropriate care. In the context of teleconsultation, accessibility refers both to the availability of the technology platform, and to the availability of the consulting cardiologist.

The regional network, the WebOnCOLL server, the directory services of the regional information infrastructure, the computer systems at the primary health center and the CCU of the regional hospital comprise the technological platform. Questions related to the availability of the technological platform are mean time between faults and mean time to recovery for each component.

The **cost** of care is the economic value of resource use associated with the pursuit of defined objects or outcomes. However, the operational cost of teleconsultation is beyond the scope of this paper.

Acceptability refers to the degree to which patients, clinicians, or others are satisfied with a service or willing to use it.

Continuous refinement of the teleconsultation protocol following suggestions by the end-users, contributes to increased acceptability by the end users. An additional advantage is the ability to personalize the environment to suit their aesthetical and operational tastes. One of the primary concerns of the steering group is the development of flexible and adaptable protocols incorporating knowledge for evolving clinical protocols and guidelines. Additionally, the working group is continually revaluating the teleconsultation protocol against real episodes, in an effort to minimize data entry by providing presets for the most common options.

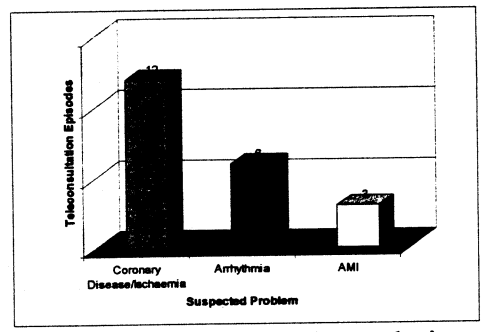

Figure 3. Common causes for teleconsultation

3. Preliminary results

During the period December 2000 to June 2001 the teleconsultation, service was used for a total of 21 episodes involving 19 different patients (see fig. 3). These represented approximately 10% of the total cardiac

patients seen in the health care center while the system was in operation.

Eleven of the patients were men and eight were women with an average age of 65. All but four of them were aged over 65 years.

As shown in fig. 3, the most frequent reason for teleconsultation was suspected coronary disease/ ischaemia, with 12 episodes (10 patients), next was arrhythmia with 6, and there were also 3 cases of suspected acute myocardial infarction. In all cases, the GP submitted a teleconsultation request with the ECG of the patient and relevant clinical data. The request always includes the name, gender, age, height, and weight of the patient, cardiac history, medication, as well as systolic/diastolic blood pressure. Frequently, the GP also added relevant lab results, such as cardiac enzymes, and subjective observation during the clinical examination. Two cases involved a patient with a pacemaker and two others a patient that refused to visit the hospital. Although 21 episodes and an operational period of 6 months are not sufficient to draw statistically significant conclusions, they provide interesting indications on quality and accessibility, which are consistent with large-scale evaluations in the US [3].

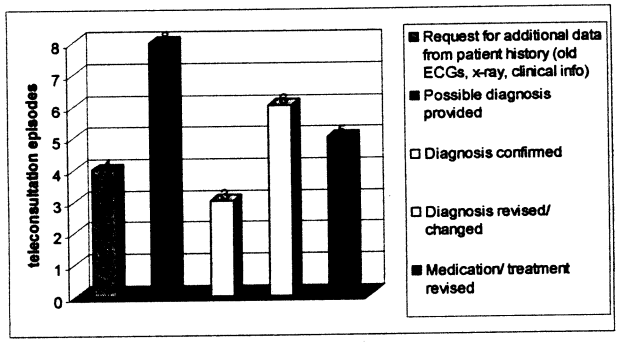

Figure 4. Diagnostic accuracy of the teleconsultation

3.1. Quality

Regarding the diagnostic accuracy of the teleconsultation, in five episodes a confirmed diagnosis was provided, in eight episodes, there was a possible or tentative diagnosis, while in four cases further data were requested (fig. 4): in three cases additional data concerning old ECGs, in one case x-ray, and in another case clarifications of the patient's medical history.

No patient suffered any negative effects as a result of the teleconsultation, but rather, they benefited through prompt evaluation and modification of drug therapy where necessary (12 cases) and avoidance of hospital visit in the majority of cases. In one case, where the patient went to the hospital anyway, the teleconsultation diagnosis was verified.

Teleconsultation had a rather strong diagnostic impact (fig. 5): only in nine cases was the patient immediately transferred to the hospital. Since the health care center is in a remote location and all the patients seen would normally have been sent to hospital for evaluation, this represents a clear saving of both time and cost. Furthermore, when transfer to hospital was required, the cardiologists received relevant clinical information prior to the patient's arrival and provided directions regarding patient management. In one case, the GP had access to detailed directions on how to treat an acute episode of myocardial infarction while on transfer to the nearest CCU.

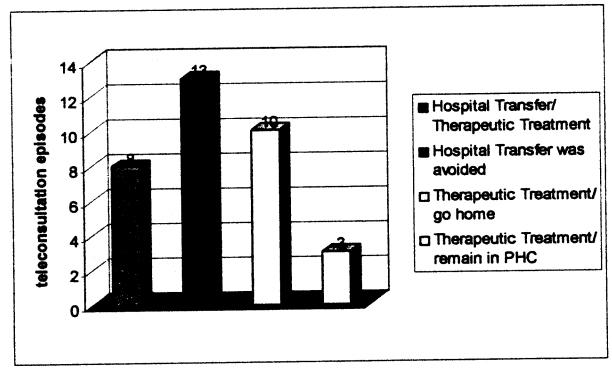

Figure 5. Diagnostic impact of the teleconsultation

Another two cases gave a different view of the therapeutic impact of teleconsultation: the patients refused to be referred to the hospital despite the GP's advice. In those cases, the cardiologist proposed a revised drug treatment and the recording of a follow-up ECG in the primary health center. Specifically, the data collected show that the therapeutic impact of the teleconsultation was significant. In cases where the cardiologist was able to provide only a possible diagnosis, additional diagnostic examinations were suggested (fig. 6). Follow-up ECGs and cardiac enzymes were the most frequently suggested (8 and 6 cases respectively). Note that ECGs, x-rays, and cardiac enzymes are examinations routinely carried out in the primary care center, while most of the other examinations suggested (Stress Test, Echo, Holter) require booking ahead of time in the district hospital. Thus, these preliminary results suggest that teleconsultation saves the patient a lot of time and trouble, an important issue for people of limited mobility.

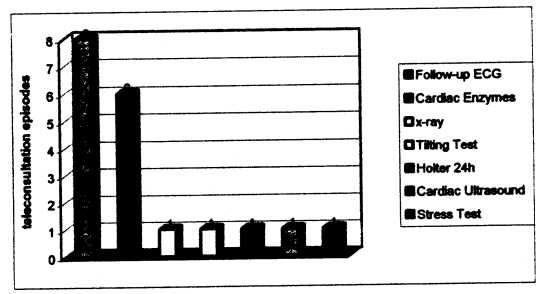

Figure 6. Suggested further diagnostic examinations

3.2. Accessibility

In the evaluation period, the technical platform was mostly available. In the 6-month period, we had three major faults in the primary health center and 1 in the CCU department. The most serious of them was hard disk failure and the system was up again in less than a week. The primary health center was connected to the backbone with a 256 Kbps leased line, which allowed acceptable quality of videoconference in addition to access to the shared episode folder. The regional hospital is connected to the frame-relay backbone via a 512 Kbps leased line. In the 6-month period, although the software is relatively robust, and the users well trained, we had occasional software failures. In every case, the problem was corrected within 1 hour. Network problems were harder to fix, since in some cases we had to contact the network service provider. Experience has shown that the teleconsultation infrastructure requires ¼ of an administrator to ensure round the clock availability of the technological platform.

Regarding accessibility of a specialized cardiologist, although the application in the cardiology center indicates the receipt of a new episode with an auditory signal, contacting a cardiologist was initially a problem. This problem was solved with the generation of an SMS to the mobile phone of the cardiologist on call.

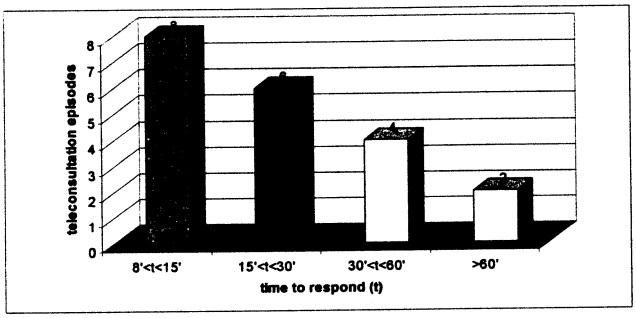

Figure 7. Time to submit diagnostic report.

3.3. Acceptability

Regarding acceptability by cardiologists, the application recorded the time that a cardiologist opened the episode folder and the time the diagnostic report was submitted. As shown in fig. 7, in 8/21 cases, it took the contacted cardiologist less than 15 minutes to review the data in the request and send back a signed diagnostic report. Initially, the cardiologists were afraid that teleconsultation would take a lot of time from their regular duties. The tuning of the teleconsultation protocol to their own preferences, combined with the low volume and significance of teleconsultation episodes eased their fear. Furthermore, since difficult episodes were likely to be transferred to them, they liked the fact that they were notified ahead of time.

On the other side of the wire, GPs welcomed the ability to receive a second opinion on difficult cases and refine their own diagnosis and therapeutic method. The time to submit a request was minimal, since most of the relevant data were automatically extracted from the electronic health record.

4. Discussion & future plans

In view of these preliminary finding we have already started the deployment of the service between a district hospital, a large primary health center and its community offices, which are located in remote areas of high tourist attraction. At the same time, we continue the effort of tuning the teleconsultation protocol to various suspected problems. On the technology side, we are working on the incorporation of additional functionality, such as stethoscopes and real-time monitoring of vital signs.

5. Conclusions

In conclusion, these preliminary findings are extremely encouraging and suggest that teleconsultation can benefit not only the patients, but also GPs and cardiologists by fostering their collaboration and serving as a continuous education tool. We believe that these results justify the deployment of the teleconsultation system in more primary health care centers, particularly those in remote areas.

Acknowledgements

The work reported in this paper has been supported in part by the PICNIC project (IST-1999-10345) and the project "Crete – a telematics center" funded by the INTERREG II program. The authors would also like to thank Fokion Logothetidis for comments and Anthi Strataki for her contribution on issues related to the quality of telemedicine services.

References

[1] Chronaki CE, Kostomanolakis SG, Lelis P, Lees PJ, Chiarugi F, Tsiknakis M. Integrated Teleconsultation Services In Cardiology. Computers in Cardiology 2000; 27:275-278

[2] Field MJ, Editor. Telemedicine: A guide to assessing telecommunications in Health care. Committee on Evaluating Clinical Applications of Telemedicine, Institute of Medicine, 1996

[3] Office of Rural Health Policy. Health Resources and Services Adminstration Exploratory Evaluation of Rural Applications of Telemedicine. Office of Rural Health Policy. Final Report, 1997.

Address for correspondence.

Catherine E. Chronaki
CMI-HTA, Institute of Computer Science, FORTH,
PO 1385, Heraklion, Crete, GR 71110, Greece
chronaki@ics.forth.gr.