

# Application of Handheld Computers for Mobile Access to a Cardiology Information System

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## Abstract

*Patient care at the Coronary care Unit (CCU) can be greatly improved by direct access to an especially tailored electronic patient record system (EPR). Current systems are based on large, non-portable workstations or PC's; present information systems are global applications not specifically designed for registration and data retrieval at the bedside.*

*As part of the on-going development of our Cardiology Information System ("CARIS") we have developed dedicated modules to support the clinical care process at the CCU. The user interface has been specifically designed to make necessary typing efforts as small as possible. Instead of on standard PC's, the applications run on so-called Web-tablets (Siemens SIMpad<sup>®</sup>). The SIMpad solution was preferred above keyboardless Notebooks (Fujitsu Stylistic<sup>®</sup>) or palm-sized organizers (Palm<sup>®</sup>).*

## 1. Introduction

An electronic patient record system (EPR) is an essential tool to support patient care. The ability to access all information about patients anywhere through the hospital has been shown to greatly enhance daily routine of the cardiologist.

A nation-wide project, EPDCAR (= EPR in Cardiology), sponsored by the Dutch government, seeks to develop standard building modules (software components) for an EPR that can be used in all collaborating hospitals.

### 1.1. History

The Cardiology Information System (CARIS), developed at the LUMC department of Cardiology contains all data regarding catheterisations, pacemaker implants and pacemaker follow-up, clinical and interventional waiting lists, and other information. In addition, information in separate dedicated information

systems (ECG management system, DICOM image servers) can be viewed after selecting the patient's ID in CARIS. Access to CARIS and other systems is possible at various locations in the department: in the outpatient clinic, cathlab, at the CCU and in the cardiologist's office.

## 1.2. Inside CARIS

CARIS consist of a database server (Oracle) and various applications built with Borland Delphi. CARIS is connected to all clinical information systems in our Cardiology department (ECG's, images, hemodynamics) and to the Hospital Information System (HIS).

## 2. The project: CARIS - CCU

We have recently developed a module in CARIS for support of the medical care process at the CCU. The new CCU application comprises modules for admission of the patient (history, physical exam, ECG report, medication), daily report, hemodynamic status, diagnosis coding and final discharge-report.

### 2.1. User interface

The user interface has been especially designed to make necessary typing efforts as small as possible: almost all information can be entered via 'radio-buttons' and 'drop-down' lists (Fig 1).

When all data has been entered, the program automatically generates a report when the user clicks the 'Report' button (Fig 1, bottom).

Finally, when the patient is discharged, all sub-reports can be assembled into a final discharge letter (Fig 2). Note that nothing of the discharge letter has been actually typed in; everything has been entered via buttons and drop-down lists. The cardiologist can now modify the automatically generated discharge letter using Microsoft Word, after which it will be sent to the Hospital Information System (and then to the referring physician).

**Angina Pectoris Data**

hetero anamnese     sinds 6     uren     datum 1-1-2001

ongeveer     dagen  
 tenminste     weken  
 op     maanden  
 jaren

Klacht:  toenemend     drukkende     druk op de     borst     midsternaal  
 stabiel     stekende     pijn     rug     links op thorax  
 klemmende     brandende     buik     rechts op thorax  
 zeurende     tussen schouderbladen

Uitstraling:  Nee     linker schouder     kaak    Vegetatieve verschijnselen:  Nee  
 linker arm     rechter schouder     rug     misselijk  
 rechter arm     beide schouders     brakken  
 beide armen     keel     zweten

Klacht treedt op:  bij lichte inspanning     in rust    Relatie inspanning:  Ja    Na staken van de inspanning  minuten  
 bij zware inspanning     na de maaltijd     Nee    is de klacht verdwenen binnen:  uur  
 inspanning en rust     emotie     verdwijnt niet

Classificatie klacht:  I    Maximale duur:  Continu, of 20     Minuten    Frequentie klacht:  gelijk    1    keer  
 II     Uren     meer dan     per dag  
 III     Dagen     minder dan     per week  
 IV     ongeveer     per maand  
 per jaar

Effect nitroglycerine:  niet gebruikt    Sinds 6 uur heeft patient toename van klemmende pijn op de borst midsternaal  
 geen    met uitstraling naar beide armen en keel. Tijdens deze klachten heeft de patient  
 gering    vegetatieve verschijnselen, te weten zweten. De klachten treden op in rust. De  
 goed    klacht is te classificeren als klasse II uit IV NYHA. Er is geen duidelijke relatie  
    met inspanning. Duur van de klacht is maximaal 20 minuten. De frequentie van  
    optreden van de klacht is gelijk aan 1 keer per week. Nitroglycerine s.l. heeft

Report    Report + OK  
Cancel    OK

Figure 1. CARIS-CCU "Angina Pectoris" data entry form

**Cardiology Information System - [CCU data]**

Form: P Patient    Birth date: 30-08-2055    0000/7990

General    Anamnesis    End    ...

**Cardiale VG**    Reden van opname  
Pijn op de borst

**Algemeen VG**    Voorgeschiedenis cardiaal  
2000 april : Angina pectoris  
2000 mei : CAG: HS distaal 40% stenose, RDA wandonregelmatigheden, RCX wandonregelmatigheden, MO zit dicht

**Angina pectoris**    Voorgeschiedenis niet cardiaal  
1998 : appendectomie  
1986 : anemie

**Kolagengenees**    Anamnese  
Er zijn geen klachten van orthopnoe, nycturie, perifeer oedeem en claudicatio intermittens.

**Patiënt**    Risico factoren  
Bekende risicofactoren voor hart en vaatziekten: hypertensie, positieve familie geschiedenis, roker en plotse dood in familie, generatie : 2

**Collaps**    Overige tracti  
Overige tractusanamnese:  
- Koorts sinds twee weken.  
- Hoest  
- Het sputum is : geel  
- Dyspnoe d'effort, klasse III uit IV NYHA

**Aanvullend**    lichamelijk onderzoek

**Risico factoren**

**Overige tracti**

**ECG beschrijving**

18-09-2001

SERVER NAME = ORATEST.WORLD    Current User = TAWITTEMAN

Figure 2. CARIS-CCU "Final Discharge Report"

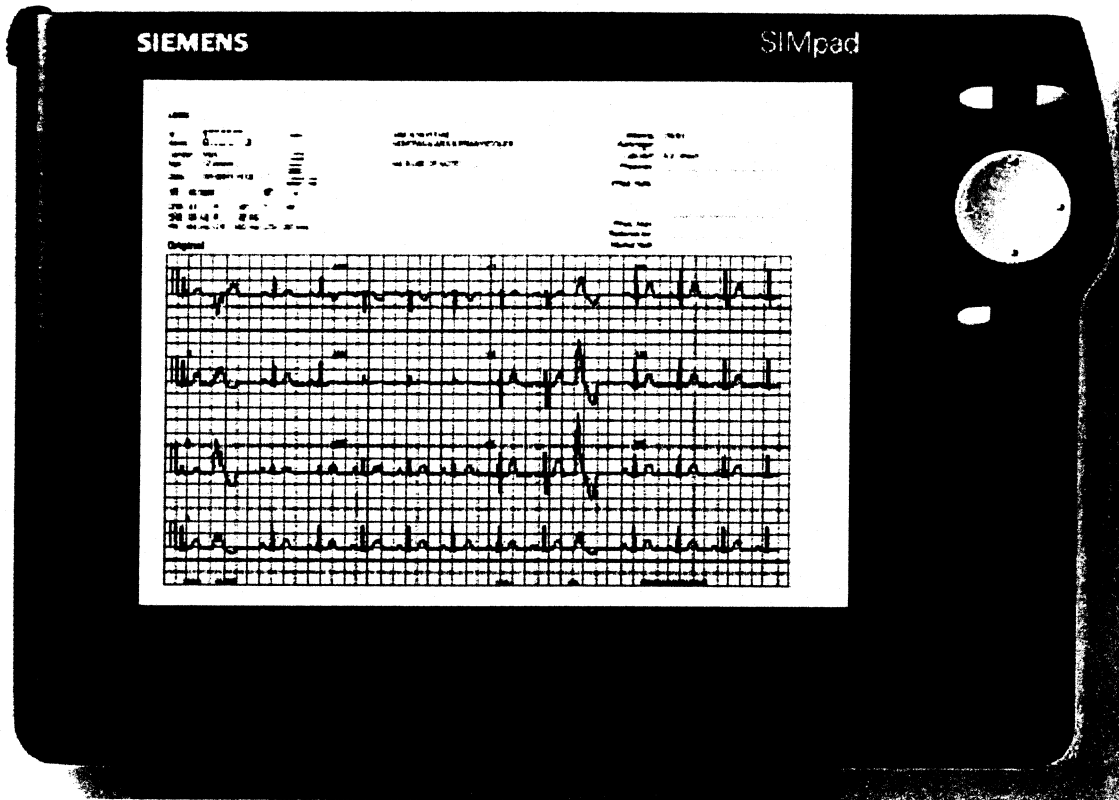


Figure 3. Siemens SIMpad Web-tablet, showing ECG report (in PDF format)

## 2.2. Devices for mobile access

Especially at the CCU, where cardiologists frequently move from patient to patient, mobile access to the EPR (CARIS) is greatly desired.

Therefore, we have investigated the possibilities and benefits of various mobile devices for data-access and data entry. We have compared regular notebooks, notebooks without keyboard (Fujitsu Stylistic<sup>®</sup>), and Windows-CE based Web-tablets (Siemens SIMpad<sup>®</sup>). We have also considered using palm-sized organizers (Palm<sup>®</sup>), but their small, low-resolution screen (160x160) did not seem fit for this application, where the cardiologists want to see detailed clinical information.

## 2.3. Device of choice

In practice, cardiologists liked the Siemens SIMpad (Fig 3) best because of its small size and quick response. The Siemens SIMpad only measures 26x18 cm, and weighs 950 gram. The Fujitsu Stylistic is a

little bit larger, but much heavier (1.5 kg). Moreover, since the Stylistic is a true PC with a hard-disk, it is more prone to theft, should be handled much more carefully, and also important, is much more expensive.

## 2.4. Wireless network connection

The Siemens SIMpad (and also the Fujitsu Stylistic) is connected to our hospital local area network via a wireless LAN connection (IEEE 802.11b). For this project, a number of wireless LAN base-stations have been installed on the CCU.

In addition to the built-in security of the 802.11b wireless LAN specifications (which are known to be not as secure as originally stated<sup>1,2</sup>) additional security measures are taken to ensure patient's privacy.

## 2.5. Client/server set-up

As mentioned before, the Siemens SIMpad is a Windows CE device. The CARIS application is a normal Windows (98/NT/2000) application. Instead of creating a Windows-CE version of CARIS, we decided to use a Windows Based Terminal (WBT) set-up, using Citrix technology. The actual program(s) run(s) a dedicated WBT server, while the Windows CE device only runs the WBT client.

## 3. Future plans

In close collaboration with the EPDCAR project, mentioned above, we are currently re-building the CARIS database and applications into a true three-tier architecture. This means it will be much easier to migrate to a fully web-based CARIS. Benefits of that are e.g. better options for access to a central database (CARIS) from other hospitals in a multi-center set-up. In addition, the web-based CARIS can be run directly on the Siemens SIMpad web-tablet, instead of via a WBT set-up.

## 4. Conclusions

The combination of a well-designed application with a versatile, very portable notepad-like device has been shown to greatly enhance the cardiologist's access to all information that is critical for optimal patient care at the CCU. Not only alphanumeric data is available, but also e.g. ECG's (Fig 3).

## References

- [1] ANSI/IEEE Std 802.11, Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer Specifications, 1999 Edition, <http://standards.ieee.org/getieee802/>.
- [2] Borisov N, Goldberg I, Wagner D. In: Intercepting Mobile Communications, The Insecurity of 802.11, UC Berkeley, Zero Knowledge Systems, 2000, <http://www.isaac.cs.berkeley.edu/isaac/wep-faq.html>.

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