

**DEVELOPMENT OF A PDA-BASED NURSING
DOCUMENTATION APPLICATION FOR HOSPITALS**

By

Isabel Nájera

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Approved by:

José A. Borges, Ph.D.
Member, Graduate Committee

Date

Pedro I. Rivera, Ph.D.
Member, Graduate Committee

Date

Néstor J. Rodríguez, Ph.D.
President, Graduate Committee

Date

Celia R. Colón Rivera, R.N., Ph. D.
Representative of Graduate Studies

Date

Isidoro Couvertier, Ph.D.
Chairperson of the Department

Date

ABSTRACT

The principal objective of this work was the development of a fully-integrated PDA-Based application to manage hospital documentation required by nurses at the point of care. The use of the PDA-Based nursing documentation application has demonstrated to be an important and practical advantage for the nurses. It will allow nurses to access in real-time the updated information on the patients' records at the point of care. The utilization of this technology reduces the time nurses need to record the patients' conditions, and will produce a substantial improvement in their routine tasks including medical error-reduction and time-saving. The PDA-Based nursing documentation application must be considered as an important tool for professional nurses and can be easily implemented in hospitals in Puerto Rico. It can also be a useful test bed for conducting research studies in medical and nursing informatics.

RESUMEN

El principal objetivo de este trabajo fue el desarrollar un sistema completamente integrado para PDA con el fin de manejar la documentación en hospitales requerida por las enfermeras en el punto de cuidado. El uso del sistema de documentación de enfermería en PDA ha demostrado ser una ventaja importante y práctica para las enfermeras. Este permitirá que las enfermeras tengan acceso en tiempo real a la información actualizada de los registros de pacientes en el punto de cuidado. La utilización de esta tecnología reduce el tiempo que les toma a las enfermeras registrar las condiciones de los pacientes, y permitirá producir una mejora substancial en sus tareas rutinarias incluyendo la reducción de errores médicos y ahorro de tiempo. El sistema de documentación de enfermería en PDA debe ser considerado como una importante herramienta para el personal de enfermería y puede ser fácilmente implementado en hospitales de Puerto Rico. Además, puede utilizarse como base para el desarrollo de futuras investigaciones en el campo de la informática médica.

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To my expanding family

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LIST OF ABBREVIATIONS

GPRS	General Packet Radio Service.
GPS	Global Positioning System.
ISO	International Organization for Standardization.
LAN	Local Area Network.
MSS	Mobile Support System.
PC	Personal Computer.
PDA	Personal Digital Assistant.
UPR	University of Puerto Rico.
UPRM	University of Puerto Rico at Mayagüez.
VPN	Virtual Private Networks.

CHAPTER 1

INTRODUCTION

1.1 Justification

The delivery of patient care at hospitals involves generation and assessing information regarding patients' condition. Most of the information is generated and needed at bedside (the point of care). However, patients' records are kept in paper form in most hospitals and are usually located at the nurses station of the clinical unit. Keeping patients' record at the nurses station affects patients' health status documentation because usually they are not necessarily carried out to the point of care while health care is being provided. Consequently, it seems necessary to develop an integrated system of information for the clinical personnel, which allow them to handle data access and transfer much faster, regardless where the data is being accessed or entered. Most important, the system will enable a better management of patient's care by hospital personnel in the long/short term.

Currently, mobile technology exists and is a viable alternative to support clinicians task on a hospital. In particular, Personal Digital Assistant (PDA) technology has experienced a worldwide expansion since these mobile devices present unique characteristics [5], such as small size and light and easy portability, which make them viable for the accomplishment of nursing tasks. It has been reported [2] that these devices have decreased the standard error in the managing of great amounts of information such as the duplication of information, data loss, unclear instructions, omissions and inadequate interpretation of the information. Recent research projects have focused on using the portability advantages of PDAs in the health

care field, in order to improve the health care of patients at the point of care. Even though performance, had been a serious concern about this technology, two studies by Rodriguez et al. [6, 7] demonstrated the viability of this technology for clinical applications in terms of performance and user satisfaction. Also, a recent research conducted at the University of Puerto Rico (UPR) [8] has confirmed similar performance and user satisfaction in comparison with Tablet PCs, but because PDA's superiority in terms of physical attributes they were preferred over the Tablet PCs for nursing documentation. From these reported results [6–8], PDAs were found to be functional and useful to access clinical data and relevant information at the point of care. Motivated by the latest improvements in PDAs technologies and as a logical progression of the ongoing research in medical informatics at the UPR, our research work was direct to develop a full-integrated PDA based nursing documentation application taking as base the nursing documentation application developed by Gilberto Crespo et al. [8, 9].

1.2 Objectives

The main objective of this work was to develop a fully-integrated PDA-Based nursing documentation application for hospitals which allows nurses to control and keep documentation of the patients' condition at the point of care. Several nursing documentation tasks are supported by this application such as: execute and acknowledge medical orders, administration of medication, taking vital signs, pain assessment, initial assessment, daily assessment, recording intake and out, patient position assessment, ulcers assessment, writing nursing notes, reading laboratory results and preparing patient discharge summaries. The application also provides support for documenting patients' transfer from one clinical area to another. In addition, it provides a printing application to produce paper version of the patients' records. Thus, the applications can keep most of the nursing documentation in an electronic patient record system, substituting most of the paper documentation

forms that make up a patient's record, but with the capability of producing papers version when needed.

1.3 Outline

The remainder of this thesis is organized as follows. Chapter 2 provides a literature review on the use of PDAs in health care. Previous research studies relevant to this study are briefly described. Then, Chapter 3 presents a complete description of the interfaces of the PDA-Based nursing documentation application and also, printing reports generated by the printing application. In Chapter 4 is described a usability heuristic evaluation conducted by five evaluators to a previous version of the application. Finally, Chapter 5 presents the conclusions of this research work.

CHAPTER 2

PREVIOUS WORK

2.1 Introduction

Over the years, PDA technology has undergone a considerable growth by improving even more their capabilities. At the same rhythm, also there has been an increase in the number of research projects that focus on using the portability advantages of PDAs in clinical applications. Several of these research reports are showing that PDAs are viable for the implementation of applications to support clinicians' tasks at the point of care. These research projects are relevant to this study and thus in the next sections of this chapter they will be discussed.

2.2 Use of PDAs in health care

Handheld devices have experimented a considerable growth in their technology, such as improving their screen resolution and the inclusion in these devices of new features like wireless connectivity, handwriting and integrated keyboards. Moreover, new PDAs models have incorporated a digital fingerprint detector that brings more security to these devices.

There are several characteristics that PDAs presents and make them perfectly suitable for the needs of mobile professionals [5]. Unlike laptops and/or tablet Personal Computer (PC), they can easily be handled and transported due to their small size and light weight. Besides, PDAs devices include several useful applications in managing personal information such as phone book, notepad, and calendar. Furthermore, with the inclusion of the wireless connectivity they can now have easily access to Internet or to another devices [10]. Currently, the most common operating

system for PDAs is Microsoft Pocket PC [10] but many still use the Palm operating system. There is also another operating system based on the open source Linux [1], however it is not commonly used.

Over a decade handheld devices have been used in health care [5] and due to continuous electronic advances leading to significant technological improvements in their technologies, their use have widely-expanded. Table 2–1 lists some of the medical applications most commonly reported in literature [1]. Currently, the percentage of PDA use in the United States and Canada is approximately 40% for physician and even greater for nurses [1]. PDAs are becoming an indispensable tool for healthcare professionals by enhancing their practice [10], and bringing them greater mobility, real time access to patient’s information, medical error-reducing and time-saving [1]. Due to current advances in wireless technologies, medical professionals can have access to Internet allowing them to consult medical references and databases such as drug databases among others. The most widely used database (over 500.000 users) is eProcatas (www.epocrates.com) [2] which is a drug database that provides a complete drug information for adults and pediatrics which includes dosing indications and contraindications, adverse drug reactions and other vital information.

Often, nurses must perform many tasks with many patients and make clinical judgements within a limited time frame leading to increase errors in tasks execution. Table 2–2 lists the most commonly medication errors [2]. The use of PDAs, with the appropriate applications, will help nurses to reduce the number of errors and improve their work considerably.

2.3 PDA based projects for healthcare

At the DISEM University, Italy, the project Ward-in-Hand [11] based in mobile devices is still in progress. This mobile system allows the access to medical information of patients and hospital records through a wireless infrastructure. Key features

Table 2–1: Common medical applications [1]

ePocrates	Drug reference application that provides over 2600 drugs information (including adults and pediatrics) on dosages, indications and contraindications, drug interactions, adverse reactions, manufacturer, pricing, route of metabolism and pregnancy safety class. Available at http://www.epocrates.com .
MedCalc3000	Medical calculator that provides many medical formulas that can perform a number of calculations. Available at http://www.medcalc3000.com .
LexiDrugs	Drug reference database that provides information about drugs commonly prescribed by dentists and physicians. Available at http://www.lexi.com .
MD Everywhere	Includes EveryCharge (provides electronic charge capture), EveryNote (digitally records voice dictation notes and links them to coded patient encounters), EveryReference (provides medical references) and EveryOrder (enables clinicians to capture and convey orders and prescriptions on the handheld device). Available at http://www.mdeverywhere.com .
PocketChart TM	Provides the ability to capture demographic data, symptoms, diagnosis, creation of care plan, and scripting of medications. Available at http://www.gehealthcare.com/it_solutions/pocketchart.html .
Patient Tracker	A comprehensive patient database that keeps track of patient's vital signs, labs, and medications, and allow creation of to-do lists. Available at http://www.handheldmed.com .

of this project are to provide: hands free fault tolerance and a safety system; security and privacy access to patient information; widely use of the available hardware and software to reduce costs; and to be compatible with the existing systems. Moreover, this system provides support to pen-based and voice interactions.

At the Erasmus Medical Centre in Germany [12], a project is carried out to test the possibilities of remote patient monitoring, which is combined with normal bedside monitoring equipment and central viewing stations at the nurse station. In this project, the cardiologist in duty can also use PDA to monitor patients in the intensive care unit at any time and from wherever he/she is. Pocket WinView is an application developed for PDA that allows remote access to physiological information in near real-time from the patient monitor screens. Also, it provides continuous

Table 2-2: Common medication errors [2]

Patient Information	Improper diagnoses, lab values, potential allergies, drug contraindications, etc.
Drug Information	Dosing miscalculations or ignorance of potentially harmful drug interactions
Drug Ordering	Failed communication, including poor handwriting, name confusion, decimal point errors, metric and U.S. conversion factors, inappropriate abbreviations, ambiguous or incomplete orders
Labeling, Packaging and Drug Nomenclature	Lack of appropriate labeling and errors during transfer
Environmental Stress	Lighting, heat, noise, and interruptions can distract health professionals from properly handling all the information connected to proper drug prescription and dispensation

display of several monitored physiological waveforms including electrocardiogram, invasive blood pressures, respiratory and ventilator curves. The communication is established using Wireless Local Area Network (LAN) and General Packet Radio Service (GPRS).

The MIND PAL (Medical Information Nurse Direct Personal Assistant Link) Telemedicine System project [13] is being developed at Pace University and it has the goal to implement a design that facilitates Phelps Hospitals nurses access to hospice records at the point of care. A prototype is under construction with two different approaches: a PDA interface, designed for easy use, customized to the needs of Phelps Hospital nurses; and a Web based Server interface that provides the same features and functions for the nurses. The PDA interface integrates a Global Positioning System (GPS) system that is used to guide nurses to the patients' house. This interface also makes use of a digital camera to take pictures of the patients' condition for consults with a physician and clinical notes documentation. The PDA interface uses Bluetooth technology to transfer data to a secured local Virtual Private Networks (VPN) network.

MobileNurse [14] was a prototype of mobile nursing information system using PDA, that was originally used for retrieving patients' information, such as physicians' orders and test results at anywhere or anytime. MobileNurse enables nurses to provide point of care support by reducing time-consuming redundant paperwork. It features automating vital sign graphs and pain assessment tool. Also, it has an auto synchronization module to interchange updated information between PDA and Mobile Support System (MSS) consistently. MSS is a unit server located at the nursing station that stores and communicates patient data with PDA. It is being developed at the Seoul National University, Korea and testing at the Clinical Trial Center [14].

Context Aware [15] is a handheld system that extends the instant messaging paradigm by adding context-awareness to support the intensive and distributed nature of information management within a hospital setting. It is funded by UCMexus and will be deployed at IMSS General Hospital in Ensenada, Mexico [15]. The system consists of a context aware client, an instant messaging server, and several autonomous agents. It considers four critical contextual elements that have to be taken in account in supporting the hospital's information management and activity coordination: location, delivery timing, role reliance and artifact location and state. This system provides communication among health care professionals who work in different places and in different times.

At Campus Bio-Medico University of Rome, the Hospital Information System for Students (HISS) project is still under way [16]. In this project, students of Medicine, Nursing and Dietetics were trained to use handheld devices connected through a Wireless LAN to record patients' data. Besides learning this new technology and applying it to freely access teaching resources from any place in the Campus, the students were able to design new user interfaces for accomplishing daily tasks.

Therefore, their goal was to establish interfaces as a basis for the development and implementation of a real solution in the University Hospital.

2.4 PDA studies at the Mayagüez Campus of the University of Puerto Rico

At the Mayaguez Campus of the University of Puerto Rico a group of researchers have conducted various research studies of nurses and physicians interacting with PDA applications. One of these studies [6] compares nurses' interaction with two versions (PDA and Laptop) of a nursing documentation application in terms of efficiency and satisfaction. The results of this study demonstrated that nurses can perform some tasks faster on a PDA than on a laptop, such as viewing vital signs measurements, acknowledging a pending medication order, entering I/O measurements and entering a daily assessment. However, it has also been reported that nurses need more time on PDAs than on laptops, to read or write notes, and to enter a vital sign measurement. Both versions of the nursing documentation application featured a high degree of learnability and similar subjective user satisfaction levels, whereas in terms of completion time, nurses can be as effective with a PDA as with a laptop in performing typical nursing documentation tasks at bed-side with the exception of writing notes. Another study compared physicians' interaction with two versions (PDA and laptop) of an application to access an electronic patient record system in terms of efficiency and satisfaction [7]. The results of this study revealed that physicians are faster when performing tasks that can require text entry or reading on a laptop than on a PDA. However, although physicians are faster on the PDA version when the tasks only require pointing and clicking, physicians are more satisfied in performing their tasks on a laptop than on a PDA. A latest usability study compared nurses interaction with PDA and Tablet PC version of a nursing documentation application [8, 9]. The dependent variables were tasks completion time, number of tasks completed, and user satisfaction. The results of

this study did not show significant differences in completion time of individual tasks between both systems. In addition nurses were satisfied using either versions of the nursing documentation applications. However, it must be noted that nurses prefer PDAs due to its physical aspects that facilitate portability. As a result, it was concluded that PDAs are a better alternative for supporting nursing documentation tasks at bedside than Tablets PCs.

CHAPTER 3

SYSTEM DESCRIPTION

3.1 Introduction

This chapter provides a description of the interfaces of nursing documentation application. In addition it provides a description of the printing application, its interface and the different reports generated by it. Although the nursing application has been tailored to the specific needs of the "Centro Cardiovascular de Puerto Rico y del Caribe", it can be easily adapted to the needs of any hospital. The PDA nursing application was developed in C Sharp using Visual Studio .Net from Microsoft, while the printer application was developed in Java using Eclipse for the interfaces, and JasperReport and iReports for the reports. Both applications use an electronic patient record system database stored on an MS SQL Server 2000.

3.2 Nursing application for PDA

The nursing application for the PDA has been developed for the Windows Pocket PC operating system. To develop the different interfaces, several documentation forms were gathered and interviews were conducted with staff nurses at the "Centro Cardiovascular de Puerto Rico y del Caribe". Once the prototype was developed, it was shown to nurses to get feedback and recommendations. The interfaces were improved based on this feedback and an usability heuristic evaluation. The following sections describes the user interfaces of the different nursing documentation modules.

3.2.1 Login and patient list interface

This is the first interface (See Figure 3–1(a)) that appears in this application where users must enter their username and password to prevent unauthorized use. In case the user entered inappropriate data an error message is displayed as illustrated in Figure 3–1(b). After the user is logged in the application, an interface is displayed with the patient list indicating the patient's name and room number. On the top of this window (See Figure 3–2) appears the name of the user logged on. In addition, a combo box to select a clinical area is provided at the top right of the interface. At the lower left side of the interface ,a *Record* button is provided, which activates a pop-up menu to allow the user access to the different nursing documentation modules: orders, medication and drips administration orders, vitals signs, notes, assessments, input and output measurements, pain, positions, ulcers and levels of glucose. Besides to the *Record* button, another button is provided for login out of the application. Once the user selects a patient, the system displays the Orders interface by default (See Figure 3–3(a)).

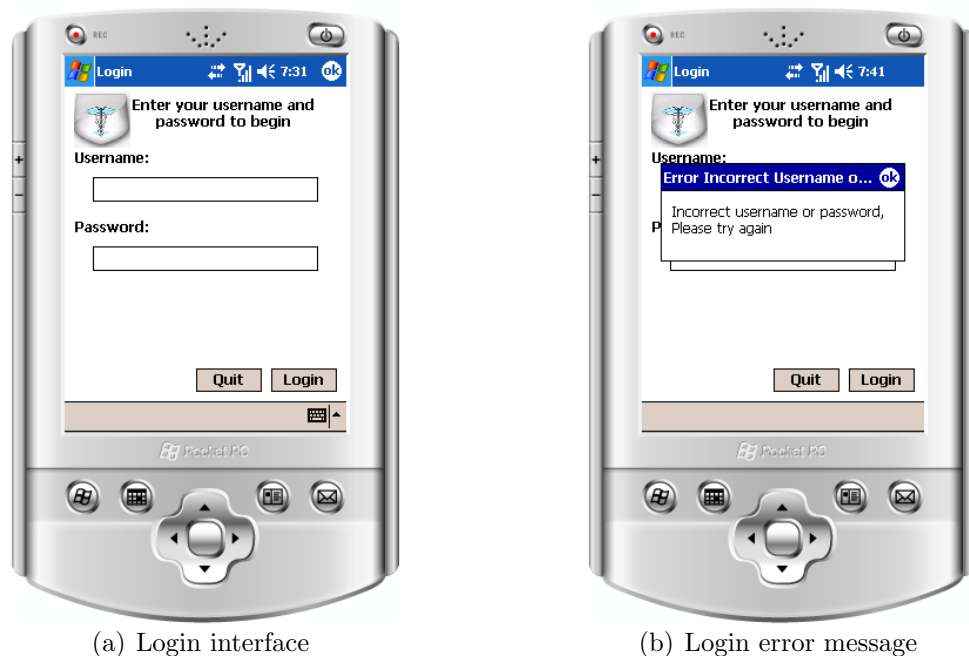


Figure 3–1: Login interfaces

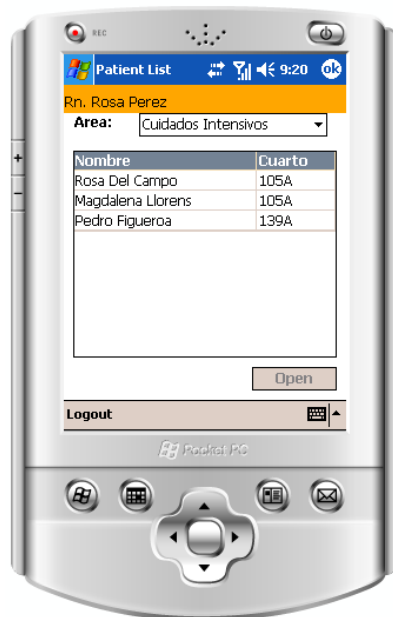


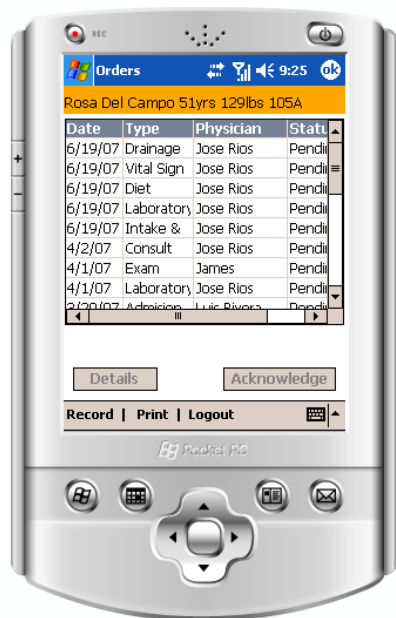
Figure 3-2: Patient list interface

3.2.2 Orders interface

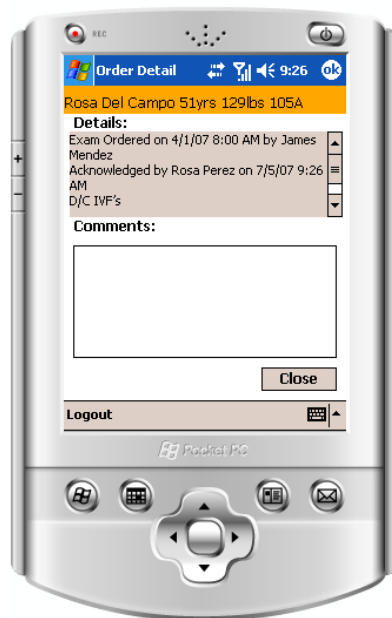
The orders interface displays the physician's orders regarding patient care. The interface shows demographic information of the patient at the top of the interface (See Figure 3-3(a)). This information remains visible in all the nursing documentation modules. Below the patient's information, a list of the physician's orders for the patient is displayed. The list indicates the date ordered, type and status of the order as well as the physician who wrote it. For every list of the system, the users can determine the order in which the content of the list can be viewed by clicking on the label of any column. To view a detailed description of the order the user must select the order from the list and then click on the *Detail* button at the lower left corner (See Figure 3-3(b)).

An order can have two status: pending or acknowledged. A pending order can be acknowledged by a nurse by selecting the order from the list and then clicking on the *Acknowledge* button at the lower right corner of the screen. If the order selected to be acknowledged is a consultation order the window shown in Figure 3-3(c) is displayed. In this interface, the nurse must select the way in which the order was

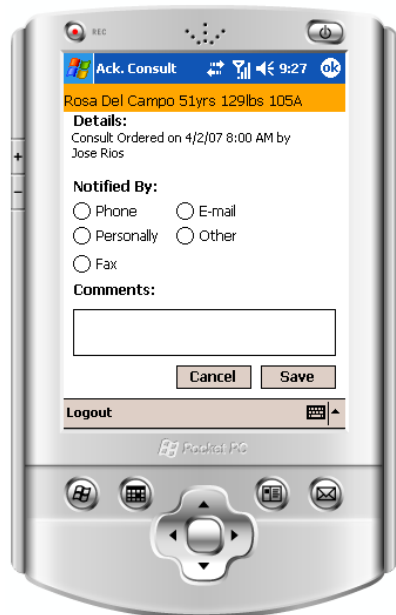
notified and enter any related comment if necessary. For any other type of order, the *Acknowledge* button activates the interface in Figure 3–3(d). In this case the nurse may enter a related comment if necessary.



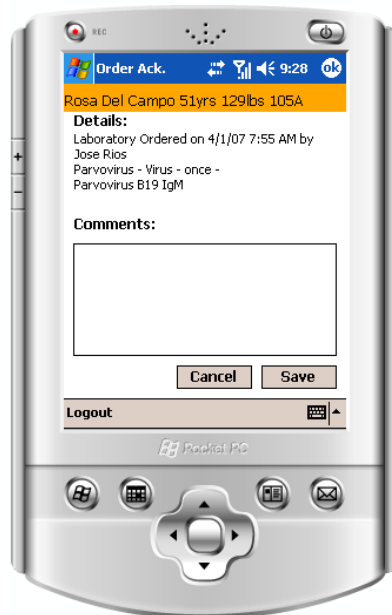
(a) Orders interface



(b) Detail order interface



(c) Consultation acknowledge interface

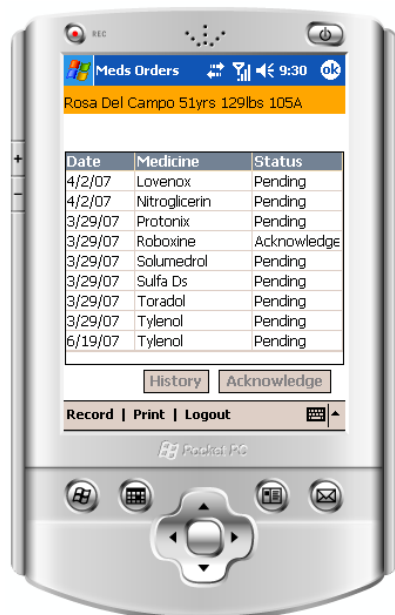


(d) Order acknowledge interface

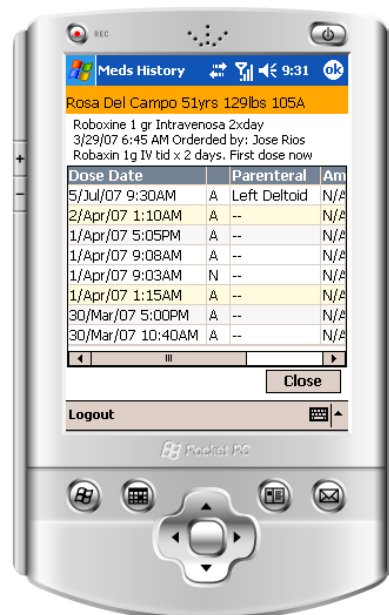
Figure 3–3: Order interfaces

3.2.3 Meds interface

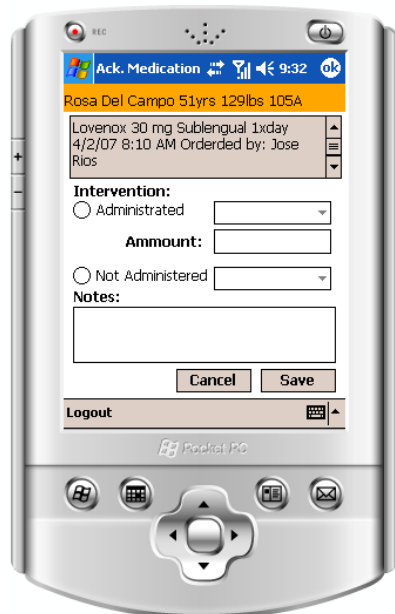
The meds interface displays a list of medication orders that must be administered to a patient (See Figure 3–4(a)). The list indicates the name of the medicine and its status (Administered or Pending). By selecting a medication from the list and clicking on the *History* button the window shown in Figure 3–4(b) is displayed. This window shows the administration history of a medicine: dates and times administered, status of the medication intervention (Administered or Not), how it was administered, and the nurse that administered it. To acknowledge the administration of a medication the nurse selects it from the list and clicks on the *Acknowledge* button that activates the window shown in Figure 3–4(c). This window shows information related to the medication order and allows the nurse to indicate the result of the medication intervention, the way it was administered and the amount administered. It also allows the nurse to enter a note related to the medication administration intervention.



(a) Meds interface



(b) Meds history interface



(c) Meds acknowledge interface

Figure 3-4: Meds interfaces

3.2.4 Drips interface

The Drips interface has the same functionality of the meds interface (See Figure 3–5). Drip medications are those administered through an intravenous line and catheter. However, it is separated from meds interface in order to distinguish drip medications from other medications.

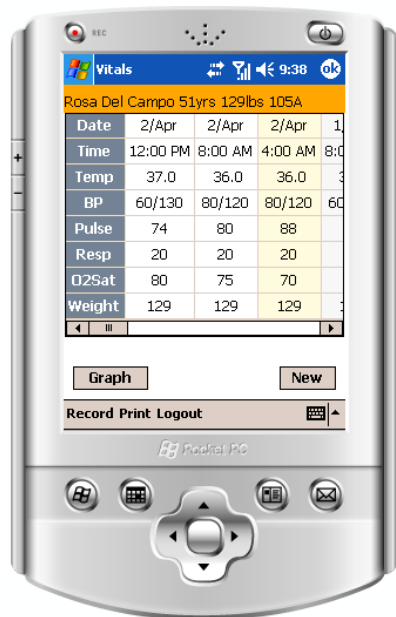


Figure 3–5: Drips interface

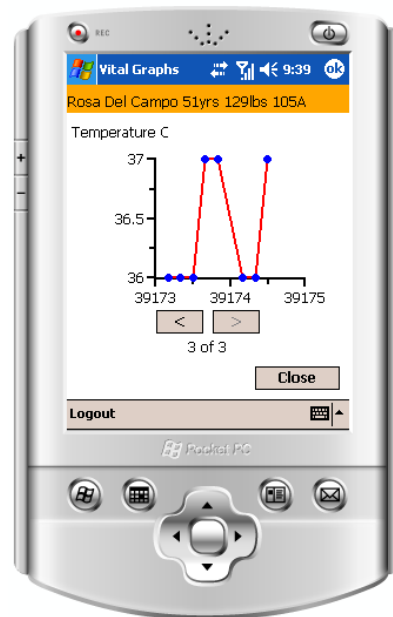
3.2.5 Vitals signs interface

The Vitals signs interface (See Figure 3–6(a)) displays a list with all the vitals signs registered to a patient: temperature (Temp), blood pressure (BP), pulse, respiration rate (Resp), oxygen saturation (O_2 Sat), and weight. Besides, the list shows the date and name of the nurse who registered these measurements. The *Graph* button activates the window in Figure 3–6(b) that shows a graphic view of the vitals sign registered. A nurse can enter new vital signs measurements by clicking on the *New* button at the lower right corner of the screen. This button activates the window shown in Figure 3–6(c). On this window the value for each vital sign can

be entered by clicking on the appropriate text field and using the display keyboard provided.



(a) Vitals interface



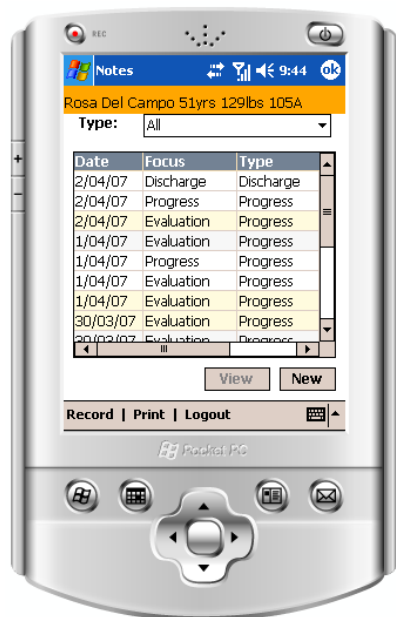
(b) Graphical view of vitals signs

(c) New vitals interface

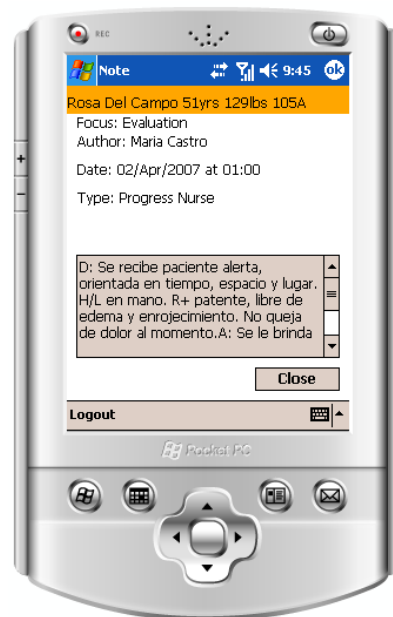
Figure 3–6: Vitals interfaces

3.2.6 Notes interface

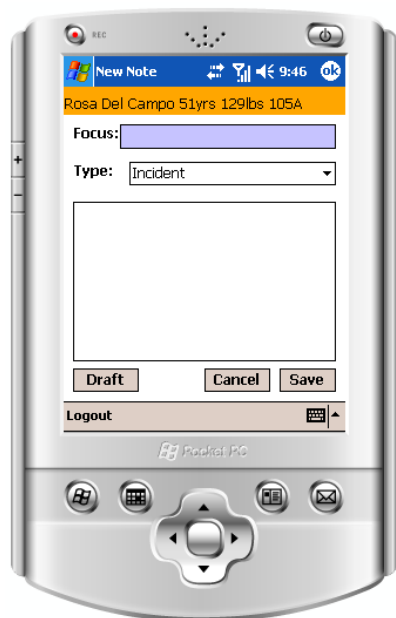
The notes interface shows a list of notes related to the patient condition (See Figure 3–7(a)). The list indicates the date, focus and type of the note, and also the name of the clinician that wrote it. The detailed content of the note can be viewed by selecting the note on the list and clicking on the *View* button. This action opens the window shown in Figure 3–7(b). A new note can be written by selecting the *New* button of the Notes interface. This action opens the window shown in Figure 3–7(c) that provides a text field for specifying a focus for the note, a drop-down menu for selecting the note type and a text field to write the note.



(a) Notes interface



(b) Note details interface

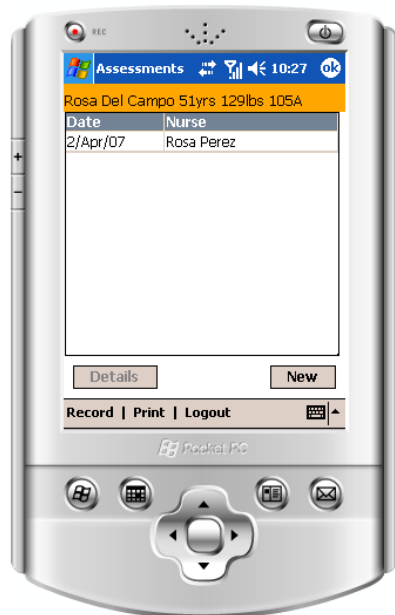


(c) New note interface

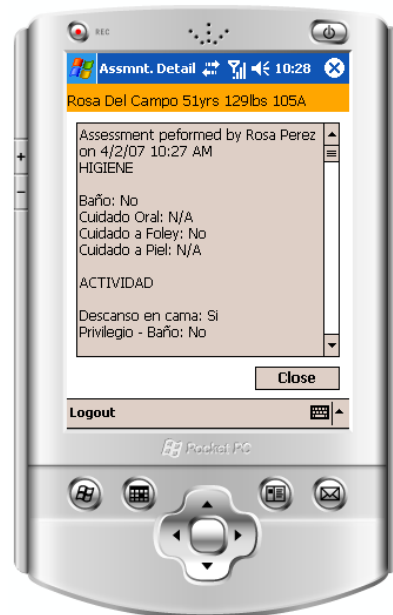
Figure 3-7: Notes interfaces

3.2.7 Assessment interface

The assessment interface displays a list of the assessment areas performed by nurses to a patient (See Figure 3–8(a)), indicating the date and the name of the nurse who documented the assessment. The *Detail* button allows the user to see detailed information of a particular assessment on the list by activating the interface in Figure 3–8(b). The *New* button activates the interface in Figure 3–8(c) where the entrance options are displayed for a particular assessment option. The interface shown in Figure 3–8(c) corresponds to the Hygiene assessment topic. It is possible to select another assessment topic by selecting the option from the combo box in the bottom of the interface or by using the directional. Besides, the user can enter a comment related to any of the assessment topics by selecting the *Note* button (See Figure 3–8(d)). A summary of the assessment options being entered for each assessment area can be viewed by selecting the *Summ* (Summary) button.



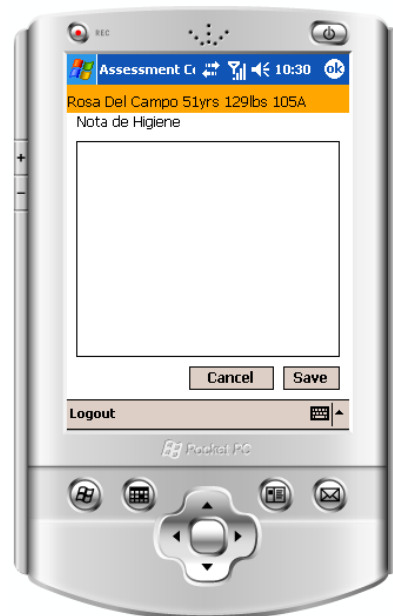
(a) Assessment interface



(b) Detail assessment interface



(c) New assessment interface



(d) Comment assessment interface

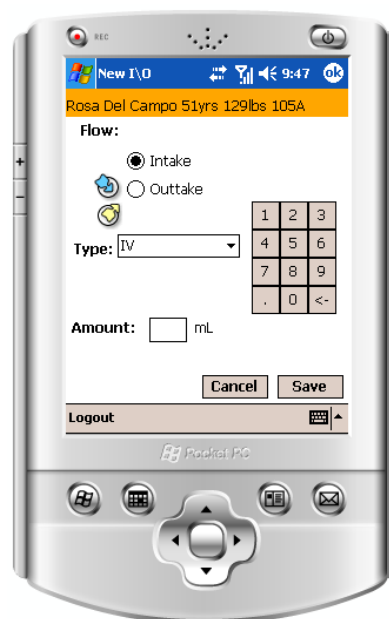
Figure 3–8: Assessment interfaces

3.2.8 Intake and output (I/O) interface

The intake and output interface displays a list of the I/O measurements registered by the nurse according to the intake and output of a patient (See Figure 3-9(a)). Intake and output corresponds to the amount of fluids entered to the body (intake) and the amount of fluids exiting the body (output) in a 24 hour period. This list indicates the date, the name of the nurse who entered it, an icon that indicates whether the measurement was intake or output, and the corresponding amount in milliliters. The list can be filtered by intake or output measurements selecting the appropriate radio button in the top of the interface. It can also be filtered by type or period of time using the combo box located bellow the radio buttons. The total amount of input, output and balance for the selected period is indicated at the bottom of the screen. A new I/O measurement can be entered by clicking on the *New* button at the lower right corner of the screen. This actions opens de window shown in Figure 3-9(b). On this window the nurse can specify the flow (input/output), the type. The amount of I/O is can be entered on the text field provided using the display keyboard provided.



(a) I/O interface



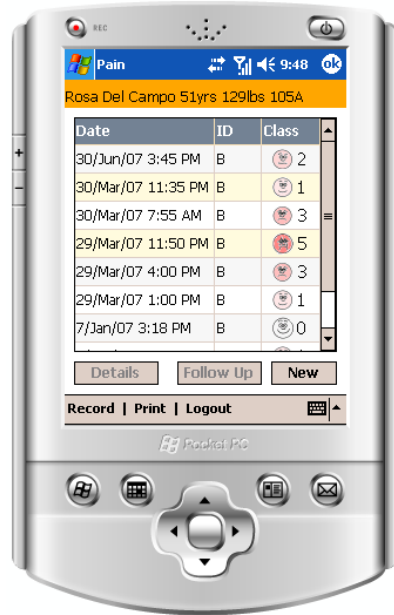
(b) New I/O interface

Figure 3-9: I/O interfaces

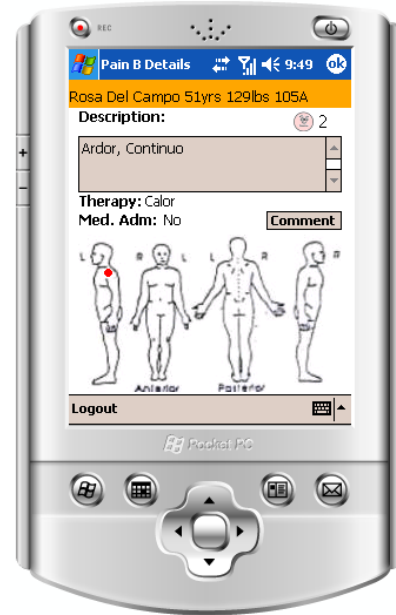
3.2.9 Pain interface

The Pain interface (See Figure 3–10(a)) displays a list summarizing the pain assessments of the patient. The list indicates the date and time of the assessment, the pain ID (a letter that distinguishes a pain location from another) and pain classification, this is the intensity of the pain (a face icon and intensity number). Through the *Detail* button, users can activate the interface in Figure 3–10(b) which displays detailed information of the pain selected. By clicking the *New* button, nurses can enter a new pain assessment through the window shown in Figure 3–10(c). Due to the lack of space on PDA’s screen a new pain assessment requires access to more than one screen. Navigation through these windows is accomplished with the arrow icons placed at the lower left corner of the screen. The classification of the pain is specified with the window shown in Figure 3–10(c). The pain ID is automatically selected. The location of the pain can be specified with the window shown in Figure 3–10(d). The description of the pain is specified with the window shown in figure 3–10(e). Finally the treatment of the pain can be specified with the window shown in figure 3–10(f).

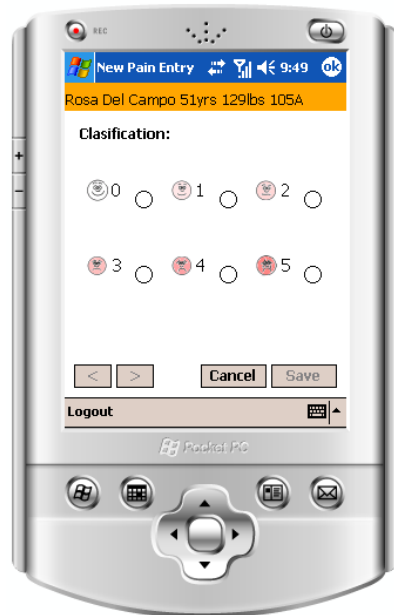
An assessment of existing pain is accomplished by selecting an assessment entry on the pain list window (Figure 3–10(a)) and then clicking on the *Follow up* button at the bottom of that window. This action will open a window like the one shown on Figure 3–10(c). The documentation process is similar to that of a new pain assessment with the difference that the pain location is already established.



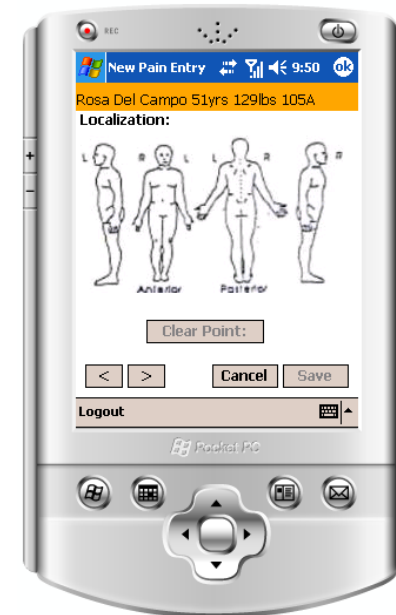
(a) Pain interface



(b) Pain details interface



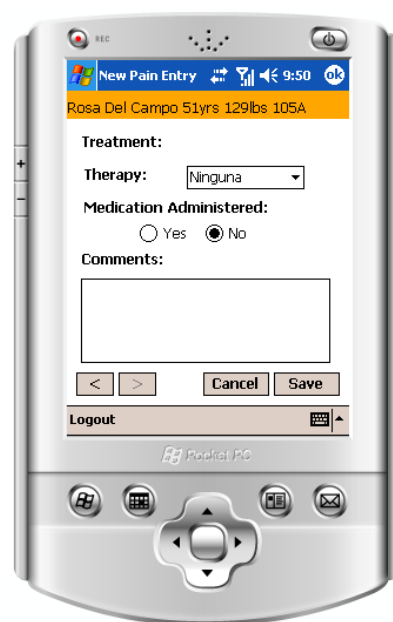
(c) Pain classification interface



(d) Pain location interface



(e) Pain description interface

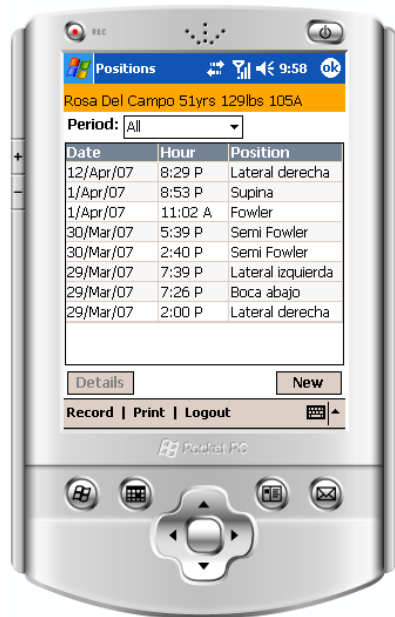


(f) Pain treatment interface

Figure 3-10: Pain interfaces

3.2.10 Positions interface

The interface for the patients position documentation is shown in Figure 3–11(a). It provides a list of the positions in which the patient rests on bed. A drop-down menu at the top allows nurses to specified a period for which the position changes are listed. By selecting an entry on the list and clicking on the *Details* button, the nurse can access detailed information of that entry on a window like the one shown in Figure 3–11(b). Nurses can document the patient’s position by clicking the *New* button at the lower right corner of the screen. This action opens the window shown in Figure 3–11(c) that allows the nurse to specify the position. Clicking on the right arrow at the bottom left corner of the screen opens the window shown in Figure 3–11(d) that allows the nurse to specify the equipment needed to maintain the patient’s position.



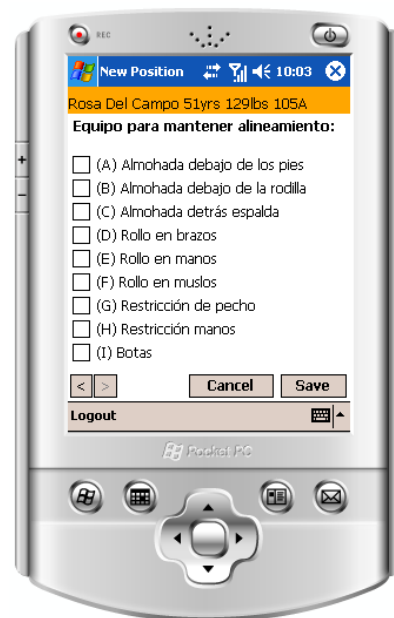
(a) Patients positions interface



(b) Patients position details interface



(c) Patient position type interface

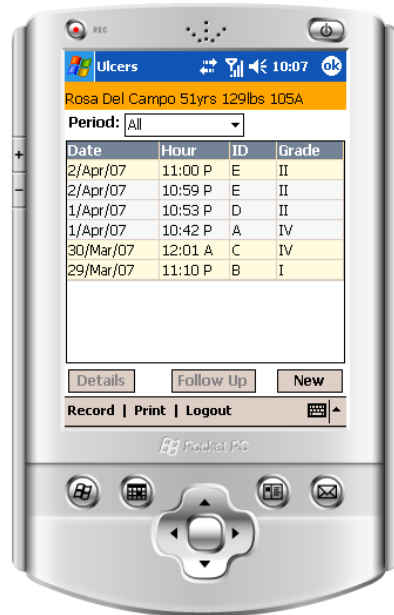


(d) Patient position equipments interface

Figure 3-11: Patient positions interfaces

3.2.11 Ulcers interface

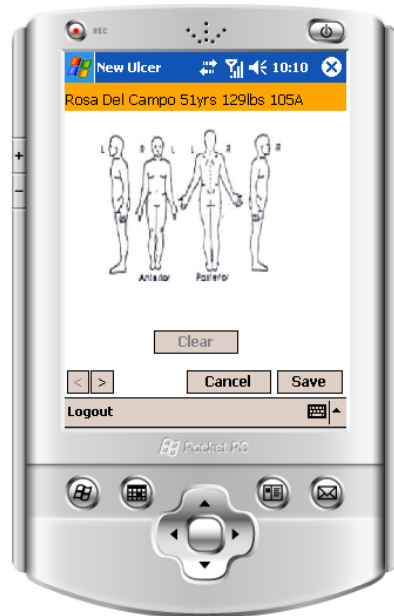
The ulcers assessment interface is very similar to the pain assessment interface (See Figure 3–12(a)). The ulcers assessment consists of information which related to pressure wounds developed by patients who are in complete bed rest or immobilized. It provides a list with assessment data for the patient. Details of an ulcer assessment can be viewed by selecting the appropriate entry on the list and clicking on the *Details* button at the lower left corner of the screen (See Figure 3–12(b)). An assessment of a new ulcer can be entered by clicking on the *New* button on the Ulcers list window. This action opens the window shown in Figure 3–12(c) that allows the nurse to specify the location of the ulcer. With the arrow icons at the lower left corner the user can reach the window shown in Figure 3–12(d) to complete the ulcer assessment. A follow up on a specific ulcer can be accomplished in a similar way of the pain interface, it can be done by clicking on the *Follow up* button of the ulcers list window.



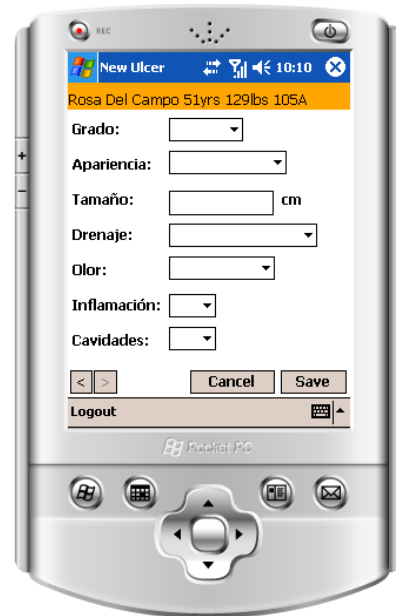
(a) Ulcers interface



(b) Ulcer details interface



(c) Ulcer localization interface

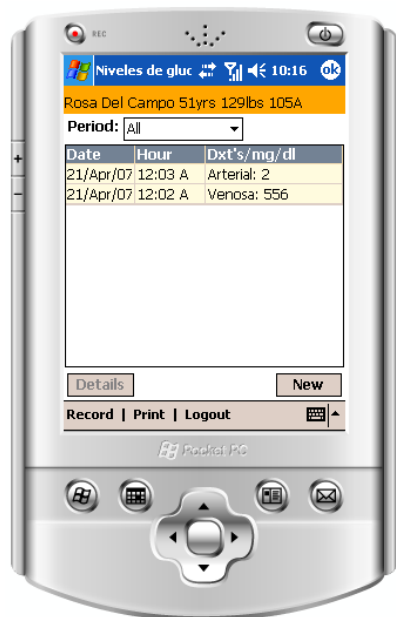


(d) Ulcer features interface

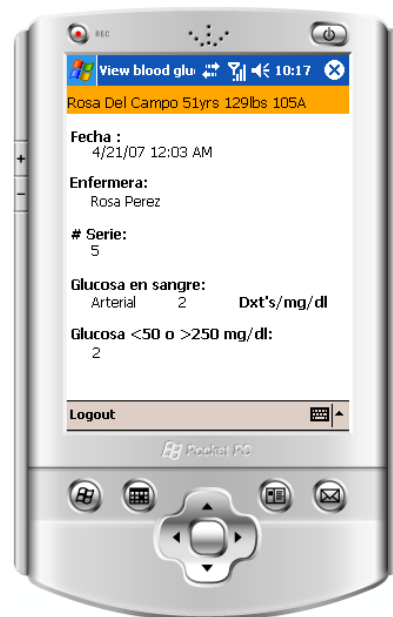
Figure 3-12: Ulcers interfaces

3.2.12 Glucose interface

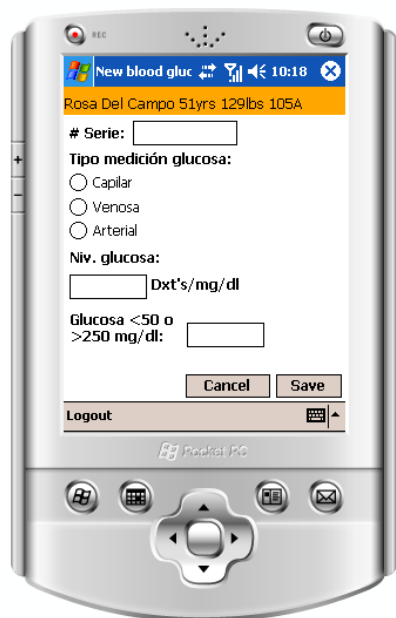
The glucose interface (See Figure 3–13(a)) displays a list indicating the date recorded, hour, source of blood drawn (arterial, venous or capillary), and glucose level result registered to a patient. By clicking in the *Details* button, interface in Figure 3–13(b) is activated showing detailed information for a register selected, it is included the date and name of the nurse who made the register. The user can register a new glucose result by clicking the *New* button which shows the interface in 3–13(c), where the user must enter all the information about glucose measurement including the series number of the device used.



(a) Glucose interface



(b) Glucose details interface



(c) New glucose interface

Figure 3–13: Glucose interfaces

3.3 Printer application

This section describes the print application of the nursing documentation system. This application was implemented as a separate application that is called up by the PDA and desktop versions of the nursing documentation application. The user interfaces for the desktop and PDA versions of the print dialogue window for the print function are presented in figure 3.3 and 3-15 respectively. The print dialogue box provides options for the user to specify one or more reports to print and the period of time desired. The reports that can be printed are: Notes, I/O, Vitals, Pain, Orders, Medications, Drips Medications, Daily Assessment, Ulcers, Patient Positions, and Blood Glucose levels.

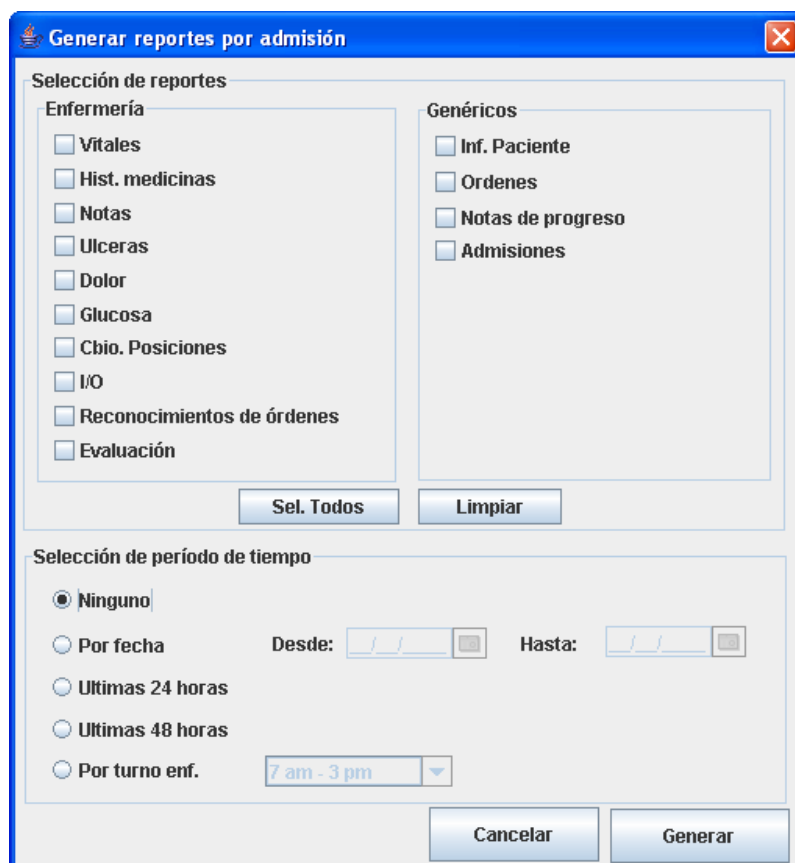


Figure 3-14: Print dialogue window for the desktop version of the Nursing Documentation Application

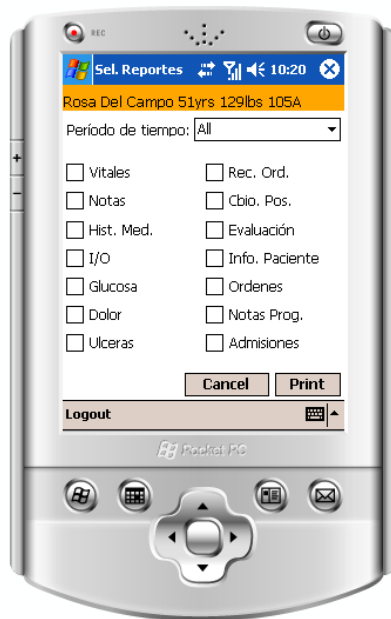


Figure 3-15: Print dialogue window for the PDA version of the Nursing Documentation Application

Individual documentation forms can be also printed from the corresponding documentation window on the PDA. When the user clicks on this button the PDA application request the Printer application to send to the printer a report related to the active screen on that moment. The interaction between the desktop or PDA version and the Printer server is performed via TCP/ IP socket communication (See figure 3-16). The Printer server runs on a specific IP address and has a socket that is bound to a specific port number. The server waits, while is listening to the socket, until the client makes a connection request. The desktop and PDA version (clients) make their print request to this port at the IP address. If the request comes from the PDA version, the Printer server sends the reports demanded directly to the printer. Otherwise, it sends a pdf file to the desktop version which opens it as a print preview before printing.

The reports are intended to provide the information that constitutes the patient's record in paper form. However, since these are produced as pdf files they can

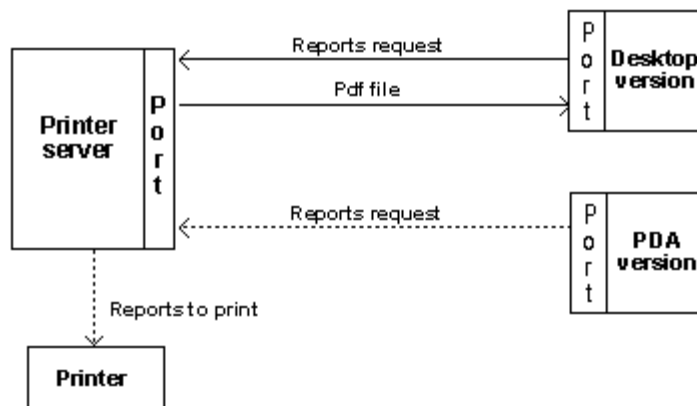


Figure 3-16: TCP/IP communication between Printer server and desktop and PDA versions

be saved in electronic form. The information on the reports is presented as compact as possible and without much of the redundant information that is typically found on the hospital paper-based forms. All reports have the same header (See Figure 3-17) that indicates the type of report, the name of the patient and the period of time that they correspond. All reports have also a footer that indicates the date and time the report was generated, the name of the report and the page number. Examples of each of the report are provided in Appendix A.

Paciente: Rosa Del Campo

Fecha	Dirección	Tipo	Cantidad	Enfermera	Turno
29/06/02 14:43	I	IV	200.0	Rosa Perez	7-3
29/06/02 22:40	I	Other	480.0	Rosa Perez	3-11
Total In: 680.0		Total Out: 0.0	Balance: 680.0		

Fecha	Dirección	Tipo	Cantidad	Enfermera	Turno
30/06/02 06:20	I	IV	1000.0	Maria Castro	11-7
30/06/02 06:20	O	Urine	600.0	Maria Castro	11-7
30/06/02 14:30	I	IV	1000.0	Rosa Jimenez	7-3
30/06/02 14:30	O	Urine	800.0	Rosa Jimenez	7-3
30/06/02 14:30	I	Other	420.0	Rosa Jimenez	7-3
30/06/02 22:31	I	IV	1000.0	Rosa Jimenez	3-11
30/06/02 22:31	O	Urine	600.0	Rosa Jimenez	3-11
30/06/02 22:31	I	Other	800.0	Rosa Jimenez	3-11
Total In: 4900.0		Total Out: 2000.0	Balance: 2900.0		

Fecha	Dirección	Tipo	Cantidad	Enfermera	Turno
01/07/02 06:35	I	IV	1100.0	Rosa Perez	11-7
01/07/02 15:40	I	IV	750.0	Rosa Perez	3-11
01/07/02 15:40	O	Urine	600.0	Rosa Perez	3-11
01/07/02 15:40	I	Other	600.0	Rosa Perez	3-11
01/07/02 22:25	I	IV	52.0	Maria Castro	3-11
01/07/02 22:25	I	Other	240.0	Maria Castro	3-11
Total In: 7642.0		Total Out: 2600.0	Balance: 5042.0		

Fecha	Dirección	Tipo	Cantidad	Enfermera	Turno
02/07/02 06:23	I	IV	102.0	Maria Castro	11-7
02/07/02 12:30	I	IV	200.0	Rosa Jimenez	7-3
02/07/02 12:30	I	Other	320.0	Rosa Jimenez	7-3
Total In: 8264.0		Total Out: 2600.0	Balance: 5664.0		

Fecha	Dirección	Tipo	Cantidad	Enfermera	Turno
22/05/07 18:30	I	PO	50.0	Rosa Perez	3-11
22/05/07 18:31	O	Urine	650.0	Rosa Perez	3-11
Total In: 8314.0		Total Out: 3250.0	Balance: 5064.0		

Figure 3-17: Reports format

CHAPTER 4

USABILITY EVALUATION

4.1 Introduction

The perception that users have on the interfaces are essential for the success of a system [17]. Therefore, user's needs and characteristics must be considered to design interfaces that produce an effective system with a high degree of quality. This goal can be achieved by incorporating usability engineering principles in the lifecycle of the system development. The measurable benefits [17] of this incorporation typically include reductions in training requirements and cost, reduced requirements for software support, greatly improved customer satisfaction, and a clear mapping from computing support to intended work process improvements.

The definition of usability according to ISO 9241, Part 11 [18], is "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use". According to Jakob Nielsen usability involves five attributes of a system [3]: Learnability, Efficiency, User retention over time, Error rate and Satisfaction. Table 4-1 shows a description of these attributes.

Although several usability evaluation techniques exist, heuristic evaluation is a discount usability method that can be applied early in the development process of a user interface. Heuristic evaluation have some unique characteristics that made it an appropriate for the system described in this document: it is a low cost evaluation method; it can be performed with a relatively small number of evaluators; high

flexibility; can be performed by independent evaluators; requires minimal instruction and communication [19].

Table 4–1: Usability attributes [3]

Learnability	How easy it is to learn the main system functionality and gain proficiency to complete the job. Usually assess this by measuring the time a user spends working with the system before that user can complete certain tasks in the time it would take an expert to complete the same tasks. This attribute is very important for novice users.
Efficiency	The number of tasks per unit of time that the user can perform using the system. We look for the maximum speed of user task performance. The higher system usability is, the faster the user can perform the task and complete the job.
User retention over time	It is critical for intermittent users to be able to use the system without having to climb the learning curve again. This attribute reflects how well the user remembers how the system works after a period of nonusage.
Error rate	This attribute contributes negatively to usability. It does not refer to system errors. On the contrary, it addresses the number of errors the user makes while performing a task. Good usability implies a low error rate. Errors reduce efficiency and user satisfaction, and they can be seen as a failure to communicate to the user the right way of doing things.
Satisfaction	This shows a user’s subjective impression of the system.

The heuristic evaluation method proposed by Nielsen [4] involves a group of evaluators examining a user interface and determining if they if it is in compliance with ten usability principles. Table 4-2 presents a description of these principles. The result of the heuristic evaluation is a list of usability errors detected by the evaluators.

Table 4-2: Usability heuristics [4]

Visibility of system status	The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.
Match between system and the real world	The system should speak the users' language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.
User control and freedom	Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Support undo and redo.
Consistency and standards	Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.
Error prevention	Even better than good error messages is a careful design which prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action.
Recognition rather than recall	Minimize the user's memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.
Flexibility and efficiency of use	Accelerators (unseen by the novice user) may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.
Aesthetic and minimalist design	Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.
Help users recognize, diagnose, and recover from errors	Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.
Help and documentation	Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.

4.2 Heuristic evaluation

4.2.1 Procedure

The heuristic evaluation was performed by five evaluators with previous knowledge in the topics of human interaction and usability engineering. They were given a brief description of the application functionality and they were asked to evaluate if the interfaces were in compliance with the ten usability principles. As a result of this evaluation each evaluator wrote down a list with the usability problems encountered. To facilitate the interaction with the interfaces they were given a list of typical nurses' tasks to follow. The list of tasks used for the evaluation is indicated below.

1. Enter to the record of the patient named Rosa del Campo of the intensive care area.
2. Identify height and weight of the patient.
3. Find the more recent temperature of the patient.
4. Insert the following vital signs:
 - (a) Temperature: 37 °C.
 - (b) Blood pressure: 130/90.
 - (c) Pulse: 75.
 - (d) Respiration: 18.
 - (e) O_2 Sat: 90
 - (f) Weight: 130 lbs.
5. Identify the total balance of intake/output measurements.
6. Insert the following intake and output measurements:
 - (a) Intake: PO 50 ml.
 - (b) Output: Urine 650 ml.
7. Localize the progress note written by Dr. Bartolo Colon.
8. Read the latest assessment data registered.

9. Read the latest nurse note registered.
10. Insert a new nurse note with the following information:
 - (a) Focus: Evaluation.
 - (b) Note: "The patient presents fever".
11. Insert a new sharp pain of the patient located on the right knee classification number four, hot treatment and without medicine administration.
12. Read the administration history of the medicine "Roboxine".
13. Acknowledge the most recent consult order indicating phone notifying.
14. Insert a new position change to left lateral without using any equipment.
15. Insert a new red ulcer of grade II located on the right shoulder with an inflammation of 2 cm, without smell, drainage and cavities.
16. Insert a new arterial blood sugar value of 60 mg/dl measured through a equipment with serial number 4422.

4.2.2 Results

Tables 4-3 to 4-7 present the list of usability problems detected by each of the evaluators.

Table 4-3: Usability problems noticed by evaluator 1

- | |
|--|
| <ol style="list-style-type: none"> 1. The room number in the patient list was always the same. 2. The information shown at the header of the interfaces was not readable. 3. While some interfaces showed detailed information by using double click, others did not. 4. Errors were not contemplated in the glucose details interface. 5. Some lists presented information in Spanish and their headers in English |
|--|

Table 4-4: Usability problems noticed by evaluator 2

1. The information shown at the header of the interfaces was not readable.
2. Two languages (Spanish and English) were used in this application.
3. The type of notes called orders can be confused with the orders itself.
4. The menu of the interfaces was not clear; the options were to close together (Record, Print and Log out).
5. The data requested in the new glucose interface was confusing.

Table 4-5: Usability problems noticed by evaluator 3

1. The last column at the list in the orders interface didn't show a descriptive header.
2. The type of order shown at the list in the orders interface was not clear.
3. The information shown at the header of the interfaces was not readable.
4. The status field at orders, meds and drips interfaces was not understandable.
5. The meds and drips interfaces did not allow searching medicine and drips by name.

Table 4-6: Usability problems noticed by evaluator 4

1. The system does not provide for changing erroneous values in several instances.
2. The I/O option in the main menu was not clear.
3. The Record option was not available in the menu of all the interfaces.
4. In the list of notes displayed at the notes interface, it was not clear who was the author of the notes at first sight.
5. The assigned space for showing the details in the meds history interfaces was too small.
6. The keyboards used to insert numbers in the interfaces were different.
7. Cancel or Close are missing in most of the interfaces.
8. Scrolling was not possible in the notes details interface.

Table 4-7: Usability problems noticed by evaluator 5

1. When the keyboard was open in the login interface, the button "Log in" was hidden.
2. The information shown at the header of the interfaces was not readable.
3. Some interfaces showed detailed information when using double click and others did not.
4. The menu of the interfaces was not clear; the options were too close together (Record, Print and Log out).
5. The scale used in the graph in the vitals interface was confusing.
6. The access to the graph button in the vitals interface was not always enabled.
7. It was not clear the option I/O in the main menu.
8. In all the application, there were words in English and others in Spanish in the same interfaces.
9. The meds acknowledge interface was shown by double clicking in the meds orders interfaces; however, it should show the details interface to be coherent with the rest of the application.
10. The application did not contemplate the errors produced by the socket communication in printer interfaces.

4.2.3 Implications for redesign

The results of the heuristic evaluations previously mentioned were taken in consideration for improving the application. Following is a list of the modifications made as a result of the heuristic evaluation:

- Errors related to socket communication were checked and controlled by the application.
- The space to show the order details in the meds acknowledge interface was increased.
- The patient list was modified to show a correct room value.
- The header of the interfaces was modified to show less and more descriptive information.
- The status and order type value at the order list in orders interface were changed to allow the presentation of information more descriptive.
- Scrolling in note details interface was enabled.
- In all the data inputs, a maximum number of characters were added to limit data registering.
- The main menu was modified to clarify the separation among the options by adding space and a symbol among them.

CHAPTER 5

RECAPITULATION AND FUTURE WORKS

The main objective of this work was to develop a fully-integrated PDA-Based nursing documentation application for hospitals which allows nurses to control and keep documentation of the patients' condition at the point of care. This PDA nursing documentation application was developed to run on Windows Pocket PC operating system over a PDA device. The interface of the application was developed using C Sharp, "Visual Studio.Net" from Microsoft. The printer application was developed in Java using Eclipse for the interfaces and the printed reports with JasperReport and iReports. Both the nursing documentation application and the printer applications communicate with an MS SQL Server 2000 database to access the patients' records.

To develop and implement the nursing documentation application described in this document several challenges have been overcome. Given that this project required an updated software, a previous version of the prototype developed with Microsoft Visual Studio 2002 with a MySQL database was migrated to Microsoft Visual Studio 2005 and SQL Server 2000. These changes involved an important and wide review of the existing source codes. To develop the different interfaces, several documentation forms were gathered and interviews were conducted with staff nurses at the "Centro Cardiovascular de Puerto Rico y del Caribe". Once the prototype was developed, it was shown to nurses to get feedback and recommendations. The interfaces were improved based on this feedback and an usability heuristic evaluation.

The use of a PDA-based nursing documentation application has the practical advantage that allows access to the patients' records at the point of care. The application has been tailored to the specific needs of nursing professionals at the "Centro Cardiovascular de Puerto Rico y del Caribe". However, the system has been designed in such a way that can be easily implemented in other hospitals. The system had been developed in order to be in conformity with the usability heuristics defined by Jacob Nielsen [4] and in that way obtain a more powerful product in terms of quality and user's satisfaction. The manner in which the software complies with the usability heuristics is briefly described below:

- Visibility of system status: The system shows through a change of icon that it has performed an action asked by the user. In case the action couldn't be performed the system shows a related error message.
- Match between system and the real world: Since the system was tailored to the "Centro Cardiovascular de Puerto Rico y del Caribe" the language used was based on the forms and recommendations in interviews with the nursing personnel.
- User control and freedom: The interfaces provide a way to exit in case the user wants to cancel an action being performed.
- Consistency and standards: The system maintains consistency in the words used for buttons, positioning of common buttons and menus.
- Error prevention: The system provides controls on the values entered by the user to verify that the values are correct and that required values are entered. The system shows error messages when a data is missing or incorrect.
- Recognition rather than recall: The interfaces have a similar aspect and behavior that makes it easy for the users to interact with them since they can recognize the same behavior through the system.

- Flexibility and efficiency of use: The software provides features such as double clicking to speed up the interaction.
- Aesthetic and minimalist design: The interfaces shows the minimal information required to make a good use of the limitations of the PDAs' screen.
- Help users recognize, diagnose, and recover from errors: The system captures errors and provides error messages to clarify what caused them.
- Help and documentation: Due to the simplicity of the user interfaces online help was not provided.

An essential aspect to take in consideration in order to have a usable and acceptable version of the application is to conduct usability testing. Usability testing needs to be performed with nurses once they gain experience with the system. This testing will help discover usability problems that can only surface on a live system. In addition, it will serve to gather information to improve the functionality of the system.

Another way to improve the prototype presented in this document is to incorporate an alert and reminders systems which can notify nurses on pending orders and actions that need to be taken care of as well as alerts on abnormal condition and risk conditions of the patients. Such a system has been conceptually developed for a desktop version of the system developed by another research assistant of the project [8]. However, due to the limitations of the PDA screen, implementing such a system in a PDA is very challenging.

The PDA application described in this document can be an important tool for nursing professionals in hospitals in Puerto Rico and also it can be a useful test bed for conducting research studies in medical and nursing informatics.

APPENDICES

APPENDIX A

REPORTS EXAMPLES OF THE PRINTER APPLICATION



		Informe de notas de enfermería
		Periodo de tiempo: Ninguno
Paciente:	Rosa Del Campo	
29/06/02 13:00	Admission Nurse (Rosa Perez - 7-3) - Título: Admission	
Se recibe pte. de SE en camilla con personal S.E. IVF patente, lib de edema. No distress respiratorio al momento. Se administra medicamento y tx ordenado. Se orienta a notificar cambios. Se ofrece comodidad, rondas preventivas continuas, se entrega reporte a RN del 3-11 se le da seguimiento.		
29/06/02 15:00	Progress Nurse (Rosa Perez - 3-11) - Título: Evaluation	
Dr. le visita, pte en descanso. Pte no presenta dificultad respiratoria. Con IVF patente DW. 9 150 no presenta infección. Pte no presenta queja al momento. Pte expresa comodidad. Pte binde tx según ordenado. En observación por cambios en turno.		
30/06/02 00:01	Progress Nurse (Maria Castro - 11-7) - Título: Evaluation	
D. Pte. se recibe en descanso. Paciente no presenta dificultad respiratoria. IVF patente de infección. No presenta quejas al momento. Paciente binde comodidad. Paciente binde tx según ordenado. R: En observación por cambio de turno.		
30/06/02 08:00	Progress Nurse (Rosa Jimenez - 7-3) - Título: Evaluation	
Se observa paciente con ambos manos edematosas., movimientos limitados. Paciente sin presentar N/V al momento. Se mantiene bajo observación. Se administra medicamentos según orden médica.		
30/06/02 18:00	Progress Nurse (Rosa Jimenez - 3-11) - Título: Evaluation	
D. Se recibe paciente en descanso en cama barandas. IVF patente. Paciente se observa con ambas manos edematosas. No presenta dificultad respiratoria al momento. Paciente no presenta dolor. A: se administra tx según orden médica. R: se deja paciente en observación.		
30/06/02 23:00	Progress Nurse (Rosa Perez - 11-7) - Título: Evaluation	
D. Recibo paciente alerta y orientada x3 con barandas elevadas. IVF patente. S/S de infiltración. No refiere queja de dolor al momento.		
01/07/02 06:50	Progress Nurse (Rosa Perez - 11-7) - Título: Evaluation	
Paciente estable queda bajo observación al C/O turno 7-3.		
01/07/02 08:00	Progress Nurse (Rosa Perez - 7-3) - Título: Evaluation	
D. Se recibe paciente alerta y comunicativa. Paciente no presenta queja de dolor abdominal, no náusea ni vómitos. A: Se da Tx según ordenado por el médico. R: Continúa paciente bajo observación por cambios en su condición.		
01/07/02 16:00	Progress Nurse (Maria Castro - 3-11) - Título: Evaluation	
D. Se recibe paciente en descanso en cama barandas elevadas. IVF patente (H/L). Paciente no presenta dificultad respiratoria, no dolor al momento. Paciente no presenta náuseas, no vómitos al momento. A: Se administra Tx según orden médica. R: Se deja paciente en observación.		
02/07/02 01:00	Progress Nurse (Maria Castro - 11-7) - Título: Evaluation	
D. Se recibe paciente alerta, orientada en tiempo, espacio y lugar. H/L en mano. R+ patente, libre de edema y enrojecimiento. No queja de dolor al momento. A: Se le brinda comodidad. Se orienta a notificar por cambio y recibe Tx según ordenado. R: Paciente estable al momento queda bajo observación.		
02/07/02 08:20	Discharge (Rosa Jimenez - 7-3) - Título: Discharge	
Se recibe paciente en cama con barandas elevadas IVF patentes. Se observa paciente en descanso y tranquila. Paciente no refiere dolor abdominal. No quejas. Paciente es dada de alta en condición estable, es acompañado a la salida por enfermera.		
22/05/07 18:37	Progress Nurse (Rosa Perez - 3-11) - Título: evaluation	
el paciente presenta fiebre		
22/05/07 18:44	Acknowledge (Rosa Perez - 3-11) - Título: Acknowledge	
Notified By: Phone		
24/05/07 18:13	Informe de notas de enfermería	Página 1 de 1

Figure A-1: Notes report



**Centro Cardiovascular
de Puerto Rico y del Caribe**
 Dr. Ramón M. Suárez Calderón

Informe de I/O
 Período de tiempo: Ninguno

Paciente: Rosa Del Campo

Fecha	Dirección	Tipo	Cantidad	Enfermera	Turno
29/06/02 14:43	I	IV	200.0	Rosa Perez	7-3
29/06/02 22:40	I	Other	480.0	Rosa Perez	3-11
Total In: 680.0		Total Out: 0.0		Balance: 680.0	
Fecha	Dirección	Tipo	Cantidad	Enfermera	Turno
30/06/02 06:20	I	IV	1000.0	Maria Castro	11-7
30/06/02 06:20	O	Urine	600.0	Maria Castro	11-7
30/06/02 14:30	I	IV	1000.0	Rosa Jimenez	7-3
30/06/02 14:30	O	Urine	800.0	Rosa Jimenez	7-3
30/06/02 14:30	I	Other	420.0	Rosa Jimenez	7-3
30/06/02 22:31	I	IV	1000.0	Rosa Jimenez	3-11
30/06/02 22:31	O	Urine	600.0	Rosa Jimenez	3-11
30/06/02 22:31	I	Other	800.0	Rosa Jimenez	3-11
Total In: 4900.0		Total Out: 2000.0		Balance: 2900.0	
Fecha	Dirección	Tipo	Cantidad	Enfermera	Turno
01/07/02 06:35	I	IV	1100.0	Rosa Perez	11-7
01/07/02 15:40	I	IV	750.0	Rosa Perez	3-11
01/07/02 15:40	O	Urine	600.0	Rosa Perez	3-11
01/07/02 15:40	I	Other	600.0	Rosa Perez	3-11
01/07/02 22:25	I	IV	52.0	Maria Castro	3-11
01/07/02 22:25	I	Other	240.0	Maria Castro	3-11
Total In: 7642.0		Total Out: 2600.0		Balance: 5042.0	
Fecha	Dirección	Tipo	Cantidad	Enfermera	Turno
02/07/02 06:23	I	IV	102.0	Maria Castro	11-7
02/07/02 12:30	I	IV	200.0	Rosa Jimenez	7-3
02/07/02 12:30	I	Other	320.0	Rosa Jimenez	7-3
Total In: 8264.0		Total Out: 2600.0		Balance: 5664.0	
Fecha	Dirección	Tipo	Cantidad	Enfermera	Turno
22/05/07 18:30	I	PO	50.0	Rosa Perez	3-11
22/05/07 18:31	O	Urine	650.0	Rosa Perez	3-11
Total In: 8314.0		Total Out: 3250.0		Balance: 5064.0	

24/05/07 18:13

Informe de I/O

Página 1 de 1

Figure A-2: Input/Output report



**Centro Cardiovascular
de Puerto Rico y del Caribe**
 Dr. Ramón M. Suárez Calderón

Informe de niveles de glucosa
 Periodo de tiempo: Ninguno

Paciente: Rosa Del Campo

Fecha	Serie	Nivel de glucosa(Dxt/mg/dl)	Blood Sugar	Enfermera	Turno
21/04/02 00:02	5556	Venosa: 556	8	Rosa Perez	11-7
21/04/02 00:03	5	Arterial:2	2	Rosa Perez	11-7
07/05/02 02:23	265	Arterial:3		Rosa Perez	11-7
15/05/02 13:12	5369	Capilar: 30		Rosa Perez	7-3
20/05/02 07:34	567	Venosa: 40		Rosa Perez	7-3
20/05/02 18:32	86	Venosa: 20		Rosa Perez	3-11
22/05/02 18:50	4422	Arterial:30		Rosa Perez	3-11
23/05/02 22:22	99991	Arterial:25		Rosa Perez	3-11

Figure A-3: Glucose report



Centro Cardiovascular
de Puerto Rico y del Caribe
Dr. Ramón M. Suárez Calderón

Informe de cambios de posiciones

Periodo de tiempo: Ninguno

Paciente: Rosa Del Campo

Equipo para mantener alineamiento:

(A) Almohada debajo de los pies

(B) Almohada debajo de la rodilla

(C) Almohada detrás espalda

(D) Rollo en brazos

(E) Rollo en manos

(F) Rollo en muslos

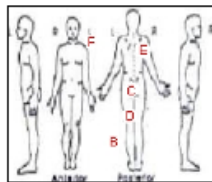
(G) Restricción de pecho

(H) Restricción manos

(I) Botas

Fecha	Posición	Equipo	Enfermera	Turno
29/06/02 14:00	Lateral derecha	A C	Rosa Perez	7-3
29/06/02 19:26	Boca abajo	B D H	Rosa Perez	3-11
29/06/02 19:39	Lateral izquierda	C F G	Rosa Perez	3-11
30/06/02 14:40	Semi Fowler	C D F	Rosa Perez	7-3
30/06/02 17:39	Semi Fowler	A E	Rosa Perez	3-11
01/07/02 11:02	Fowler	A B C D E F G H I	Rosa Perez	7-3
01/07/02 20:29	Lateral derecha	C E F	Rosa Perez	3-11
01/07/02 20:53	Supina	A I	Rosa Perez	3-11
22/05/07 18:46	Lateral izquierda		Rosa Perez	3-11

Figure A-4: Positions report



Loc.	Fecha	Cav.	Inf.	Apariencia	Olor	Drenaje	Tam.	Grado	Enfermera	Turno
A	01/07/02 22:42	Si	No	Escara	Fetido	Purulento	4	IV	Rosa Perez	3-11
B	29/06/02 23:10	No	No	Rojo	Ninguno	Seroso	8	I	Rosa Perez	11-7
C	30/06/02 00:01	Si	No	Escara	Ninguno	Purulento	3	IV	Rosa Perez	11-7
D	01/07/02 22:53	No	No	Escara	Fetido	Ninguno	7	II	Rosa Perez	3-11
E	02/07/02 22:59	No	No	Escara	Fetido	Purulento	7	II	Rosa Perez	3-11
E	02/07/02 23:00	No	No	Costra	Fetido	Purulento	3	II	Rosa Perez	11-7
F	22/05/07 18:48	No	Si	Rojo	Ninguno	Ninguno	2	II	Rosa Perez	3-11

Figure A-5: Ulcers report

Paciente: Rosa Del Campo

Fecha	BP	Pulso	O2Sat	Peso	Resp	Temp	Enfermera	Turno
22/05/07 18:25	90/91	18	96	130	18	37.0	Rosa Perez	3-11
29/06/02 11:40	110/70	80	70	129	20	37.0	Rosa Perez	7-3
29/06/02 16:00	100/80	88	75	129	20	36.0	Rosa Perez	3-11
29/06/02 20:00	110/70	88	80	129	20	36.0	Maria Castro	3-11
30/06/02 00:30	140/80	74	85	129	18	37.0	Maria Castro	11-7
30/06/02 04:00	110/70	78	70	129	19	37.0	Maria Castro	11-7
30/06/02 08:00	110/70	70	75	129	20	36.0	Rosa Jimenez	7-3
30/06/02 12:00	110/70	80	80	129	20	36.0	Francis Vega	7-3
30/06/02 16:00	130/90	85	85	129	20	36.0	Rosa Perez	3-11
30/06/02 20:00	130/80	80	70	129	20	35.0	Rosa Perez	3-11
01/07/02 00:30	120/80	95	75	129	20	36.0	Rosa Perez	11-7
01/07/02 00:30	130/80	80	85	129	57	36.0	Francis Vega	11-7
01/07/02 04:00	120/80	88	80	129	20	36.0	Maria Castro	11-7
01/07/02 08:00	140/90	80	85	129	20	36.0	Maria Castro	7-3
01/07/02 12:00	130/80	90	70	129	20	36.0	Rosa Jimenez	7-3
01/07/02 16:00	140/80	88	75	129	20	37.0	Rosa Jimenez	3-11
01/07/02 20:00	110/80	80	80	129	20	37.0	Rosa Jimenez	3-11
02/07/02 04:00	120/80	88	70	129	20	36.0	Francis Vega	11-7
02/07/02 08:00	120/80	80	75	129	20	36.0	Francis Vega	7-3
02/07/02 12:00	130/80	74	80	129	20	37.0	Rosa Perez	7-3

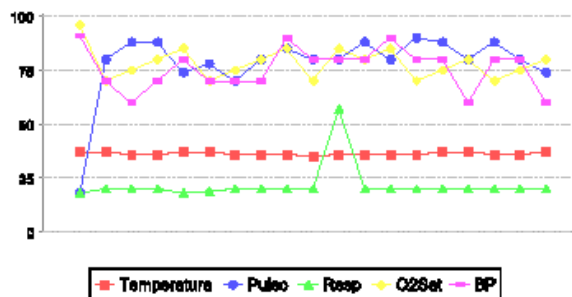


Figure A-6: Vitals report



**Centro Cardiovascular
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 Dr. Ramón M. Suárez Calderón

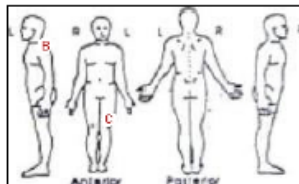
Informe de reconocimientos de órdenes
 Periodo de tiempo: Ninguno

Paciente: Rosa Del Campo

Fecha	Médico	Tipo	Estado	Fecha Rec.	Enfermera	Turno
29/06/02 11:00	Jose Rios	Laboratory	Pending	29/06/02 11:00	Rosa Perez	7-3
29/06/02 11:00	Jose Rios	Consult	Pending	29/06/02 11:00	Rosa Perez	7-3
29/06/02 11:00	Jose Rios	X-Ray Study	Pending	29/06/02 11:00	Rosa Perez	7-3
29/06/02 11:30	Luis Rivera	Consult	Pending	29/06/02 11:30	Rosa Perez	7-3
29/06/02 11:30	Luis Rivera	Laboratory	Pending	29/06/02 11:30	Rosa Perez	7-3
29/06/02 11:30	Luis Rivera	Laboratory	Pending	29/06/02 11:30	Rosa Perez	7-3
29/06/02 11:30	Luis Rivera	Laboratory	Pending	29/06/02 11:30	Rosa Perez	7-3
29/06/02 11:30	Luis Rivera	Generic	Pending	29/06/02 11:30	Rosa Perez	7-3
29/06/02 11:30	Luis Rivera	Laboratory	Pending	29/06/02 11:30	Rosa Perez	7-3
29/06/02 23:30	Luis Rivera	Laboratory	Pending	29/06/02 23:30	Rosa Perez	11-7
29/06/02 23:30	Luis Rivera	Activity	Pending	29/06/02 11:40	Rosa Perez	7-3
29/06/02 23:30	Luis Rivera	Medicine	Pending	29/06/02 11:40	Rosa Perez	7-3
29/06/02 23:30	Luis Rivera	Admision	Acknowledge	22/05/02 12:05	Rosa Perez	7-3
29/06/02 23:30	Luis Rivera	Diagnostic	Acknowledge	21/05/02 06:05	Rosa Perez	11-7
29/06/02 23:30	Luis Rivera	Vital Sign	Acknowledge	20/05/02 21:06	Rosa Perez	3-11
29/06/02 23:30	Luis Rivera	Diet	Pending	29/06/02 11:40	Rosa Perez	7-3
01/07/02 07:55	Jose Rios	Laboratory	Acknowledge	21/05/02 21:14	Rosa Perez	3-11
01/07/02 08:00	James Mendez	Exam	Acknowledge	20/05/02 19:05	Rosa Perez	3-11
02/07/02 08:00	Jose Rios	Consult	Acknowledge	22/05/02 18:44	Rosa Perez	3-11

Figure A-7: Acknowledge report

Paciente: Rosa Del Campo



Loc.	Fecha	Terapia	Clas.	Adm. med.	Enfermera	Turno
B	30/06/02 23:36	Ninguna	1	No	Rosa Perez	11-7
	Hombro y brazo izquierdo					
B	30/06/02 15:45	Ninguna	2	Si	Rosa Jimenez	3-11
	Hombro y brazo izquierdo					
B	30/06/02 07:55	Frio	3	Si	Rosa Jimenez	7-3
	Hombro y brazo izquierdo					
B	29/06/02 23:50	Ninguna	5	Si	Maria Castro	11-7
	Hombro y brazo izquierdo					
B	29/06/02 16:00	Ninguna	3	No	Rosa Perez	3-11
	Hombro y brazo izquierdo					
B	29/06/02 13:00	Ninguna	1	No	Rosa Perez	7-3
	Hombro y brazo izquierdo					
B	07/01/02 15:18	Ninguna	0	No	Maria Castro	3-11
	Hombro y brazo izquierdo					
B	07/01/02 07:33	Ninguna	1	No	Rosa Perez	7-3
	Hombro y brazo izquierdo					
C	22/05/07 18:38	Calor	4	No	Rosa Perez	3-11

Figure A-8: Pain report

 Centro Cardiovascular de Puerto Rico y del Caribe Dr. Ramón M. Suárez Calderón		Informe de historial de medicinas
		Periodo de tiempo: Ninguno
Paciente: Rosa Del Campo		
.9NSS/DW - Periodo: 06/29/2002-07/01/2002 - Frec: cada 2hr - Ruta: Intravenosa - Dosis: 1000cc - Médico: Luis Rivera		
29/06/02 00:05	Rosa Perez (11-7)	Administrada:
29/06/02 17:30	Francis Vega (3-11)	Administrada:
30/06/02 02:07	María Castro (11-7)	Administrada:
30/06/02 10:05	Rosa Jimenez (7-3)	Administrada:
30/06/02 18:12	María Castro (3-11)	Administrada:
01/07/02 02:30	Rosa Perez (11-7)	Administrada:
Tylenol - Periodo: 06/29/2002-06/30/2002 - Frec: cada 6hr - Ruta: Sublingual - Dosis: 500mg - Médico: Luis Rivera		
01/07/02 08:20	Rosa Perez (7-3)	Administrada:
01/07/02 17:45	María Castro (3-11)	Administrada:
Protonix - Periodo: 06/29/2002-07/02/2002 - Frec: cada día - Ruta: Intravenosa - Dosis: 40mg - Médico: Jose Rios		
01/07/02 02:33	Rosa Perez (11-7)	Administrada:
01/07/02 10:35	Rosa Perez (7-3)	Administrada:
Toradol - Periodo: 06/29/2002-06/29/2002 - Frec: ahora - Ruta: Intravenosa - Dosis: 30mg - Médico: Jose Rios		
29/06/02 23:30	Rosa Perez (11-7)	Administrada:
Suiza Ds - Periodo: 06/29/2002-07/02/2002 - Frec: cada 4hr - Ruta: Sublingual - Dosis: 1lb - Médico: Jose Rios		
30/06/02 10:40	María Castro (7-3)	Administrada:
30/06/02 21:10	Rosa Perez (3-11)	Administrada:
01/07/02 09:05	Rosa Perez (7-3)	Administrada:
01/07/02 21:12	María Castro (3-11)	Administrada:
02/07/02 08:55	Francis Vega (7-3)	Administrada:
Roboxline - Periodo: 06/29/2002-07/01/2002 - Frec: por 2 días - Ruta: Intravenosa - Dosis: 1gr - Médico: Jose Rios		
30/06/02 10:40	María Castro (7-3)	Administrada:
30/06/02 17:00	María Castro (3-11)	Administrada:
01/07/02 01:15	Rosa Perez (11-7)	Administrada:
01/07/02 09:03	Rosa Perez (7-3)	Administrada:
01/07/02 09:08	Rosa Perez (7-3)	Administrada:
01/07/02 17:05	María Castro (3-11)	Administrada:
02/07/02 01:10	Rosa Perez (11-7)	Administrada:
Solumedrol - Periodo: 06/29/2002-07/01/2002 - Frec: cada 6hr, por 2 días - Ruta: Intravenosa - Dosis: 40mg - Médico: Jose Rios		
30/06/02 15:00	María Castro (3-11)	Administrada:
30/06/02 21:05	Rosa Perez (3-11)	Administrada:
24/05/07 18:13 Informe de historial de medicinas Página 1 de 1		

Figure A-9: Medication administration report



**Centro Cardiovascular
de Puerto Rico y del Caribe**
Dr. Ramón M. Suárez Calderón

Informe de órdenes

Periodo de tiempo: Ninguno

Paciente: Rosa Del Campo

Fecha	Tipo	Médico	Estado
29/06/02 06:45	Medicine Sulfia Ds - 06/29/2002-07/02/2002 - cada 4hr - Sublingual - 1lb Sulfia DS 1 tab PO BID	Jose Rios	Pending
29/06/02 06:45	Medicine Robaxina - 06/29/2002-07/01/2002 - por 2 dias - Intravenosa - 1gr Robaxin 1g IV tid x 2 days. First dose now	Jose Rios	Pending
29/06/02 11:00	Laboratory SED RATE - Others - una vez - Sed Rate today	Jose Rios	Pending
29/06/02 11:00	Medicine Solumedrol - 06/29/2002-07/01/2002 - cada 6hr. por 2 dias - Intravenosa - 40mg Solumedrol 40mg IV q 6h x 2	Jose Rios	Pending
29/06/02 11:00	Consult Rheumatology consult Dr. Suárez	Jose Rios	Pending
29/06/02 11:00	X-Ray Study X-ray left shoulder	Jose Rios	Pending
29/06/02 11:30	Laboratory PABO - Others - una vez - Mono test	Luis Rivera	Pending
29/06/02 11:30	Laboratory SMA - Others - una vez - SMA 20/60	Luis Rivera	Pending
29/06/02 11:30	Laboratory SED RATE - Others - una vez - SED RATE	Luis Rivera	Pending
29/06/02 11:30	Laboratory U/A - Others - una vez - U/A	Luis Rivera	Pending
29/06/02 11:30	Medicine Tylenol - 06/29/2002-06/30/2002 - cada 6hr - Sublingual - 500mg Tylenol 500mg P.O @6H PRN fever	Luis Rivera	Pending
29/06/02 11:30	Generic Notify Dr. Mendez, Room Number	Luis Rivera	Pending
29/06/02 11:30	Consult Clinical interview by resident on duty	Luis Rivera	Pending
29/06/02 17:20	Medicine Protonix - 06/29/2002-07/02/2002 - cada dia - Intravenosa - 40mg Protonix 40mg IV qd	Jose Rios	Pending
29/06/02 23:20	Medicine Toradol - 06/29/2002-06/29/2002 - ahora - Intravenosa - 30mg Toradol 30mg IV Now	Jose Rios	Pending
29/06/02 23:30	Laboratory CBC - Blood Bank - una vez - CBC and diff	Luis Rivera	Pending
29/06/02 23:30	Activity Ad libitum	Luis Rivera	Pending

24/05/07 18:13

Informe de órdenes

Página 1 de 2

Figure A-10: Orders report


 Centro Cardiovascular de Puerto Rico y del Caribe Dr. Ramón M. Suárez Calderón		Informe de evaluaciones
Paciente: Rosa Del Campo		Periodo de tiempo: Ninguno
Fecha: 23/05/2007 20:31:34 Ent: Rosa Perez - Turno: 3-11 HIGIENE Baño: N/A Cuidado Oral: N/A Cuidado a Foley: N/A Cuidado a Piel: No		
ACTIVIDAD Descanso en cama: N/A Privilegio - Baño: N/A Cambio Posición: N/A Ambulancia: N/A Silla: No ROM: Si		
PULMONAR Succión: N/A Cuidado a Traq: N/A Espirometría: N/A Toser/Resp. Profundo: No		
SEGURIDAD Banda IO: N/A Barandas Elevadas: N/A Timbre al Alcance: N/A Frenos Ajustados: N/A Posición ajuste de cama: No Restricciones: No Tiempo de Descanso de Restricciones: N/A		
EQUIPO IV Pump: N/A Enteral Pump: N/A Matress de Aire: No Medias Antiembolicas: No		
MENTAL Estado: Aleria Letárgico Orientado en: Persona Tiempo		
NEUROLÓGICO Responde a estímulo: Verbal: Si Táctil: Si Dolor: Si Reacción pupilar:		
24/05/07 18:13	Informe de evaluaciones	Página 1 de 2

Figure A-11: Assessment report

APPENDIX B

ASSESSMENT INTERFACE PANELS

REC

New Assessment 10:29

Rosa Del Campo 51yrs 129lbs 105A

Higiene

	Si	No	N/A
Baño:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cuid. Oral:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cuid. a Foley:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cuid. a Piel:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Summ. Note < > Higiene

Cancel Save

Logout

Pocket PC

Figure B-1: Hygiene panel

REC 10:30

New Assessment

Rosa Del Campo 51yrs 129lbs 105A

Actividad

	Si	No	N/A
Descanso en cama:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Privilegio - Baño:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cambio Posición:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ambulancia:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Silla:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
ROM:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Summ. Note < > Actividad

Cancel Save

Logout

Pocket PC

Figure B-2: Activity panel

REC 10:31

New Assessment

Rosa Del Campo 51yrs 129lbs 105A

Pulmonar

	Si	No	N/A
Succión:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cuidado a Traq.:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Espirometría:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Toser/Resp. Prof.:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Summ. Note < > Pulmonar

Cancel Save

Logout

Pocket PC

Figure B-3: Pulmonary panel

REC 10:31

New Assessment

Rosa Del Campo 51yrs 129lbs 105A

GI

Si No N/A

Cbio. de Línea TNG: ☐ ☐ ☐

Cardíaco

Monitoreo: ☐ ☐ ☐

Cotejo de alarmas: ☐ ☐ ☐

Dieta: low protein diet

Tolerada: ☐ ☐ ☐

Summ. Note < > GI/Ca/Dieta

Cancel Save

Logout

Pocket PC

Figure B-4: GI and Cardiac panel

REC 10:32

New Assessment

Rosa Del Campo 51yrs 129lbs 105A

IV

IV:

Cbio. Línea: ☐ Si ☐ No ☐ N/A

Cbio. Vendaje: ☐ Si ☐ No ☐ N/A

Cotejo Pat: ☐ Si ☐ No ☐ N/A

IV:

Cbio. Línea: ☐ Si ☐ No ☐ N/A

Cbio. Vendaje: ☐ Si ☐ No ☐ N/A

Cotejo Pat: ☐ Si ☐ No ☐ N/A

Summ. Note < > IV

Cancel Save

Logout

Pocket PC

Figure B-5: IV panel

REC 10:32

New Assessment

Rosa Del Campo 51yrs 129lbs 105A

Seguridad

	Si	No	N/A
Banda IO:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Barandas Elevadas:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Timbre al Alcance:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Frenos Ajustados:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pos. Ajust. de Cama:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Restricciones:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Tpo. de Descanso de Restricciones:

Summ. Note < > Seguridad

Cancel Save

Logout

Figure B-6: Security panel

REC 10:33

New Assessment

Rosa Del Campo 51yrs 129lbs 105A

Equipo

	Si	No	N/A
IV Pump:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Enteral Pump:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Matress de Aire:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Medias Antiemb.:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Summ. Note < > Equipo

Cancel Save

Logout

Figure B-7: Equipment panel

REC 10:33

New Assessment

Rosa Del Campo 51yrs 129lbs 105A

Cambio Vendaje

Tipo: Si No N/A

Lugar: ☐ ☐ ☐

Aislamiento

Tipo: ☐ ☐ ☐

Plan de Cuidado

Revisión: ☐ ☐

Summ. Note < > CV/Aisl./PC

Cancel Save

Logout

Figure B-8: Bandage Change, Isolation and Care's Plan panels

REC 10:34

New Assessment

Rosa Del Campo 51yrs 129lbs 105A

Mental

☐ Alerta ☐ Letárgico

☐ Estuporoso ☐ Comatoso

☐ Otro

Orientado en:

☐ Persona ☐ Lugar

☐ Tiempo ☐ Desorientado

Summ. Note < > Mental

Cancel Save

Logout

Figure B-9: Mental panel



Figure B-10: Neurological panel



Figure B-11: Respiration panel



Figure B-12: Cardiac panel



Figure B-13: Central Line panel

REC 10:36

New Assessment

Rosa Del Campo 51yrs 129lbs 105A

Gastrointestinal

Abdomen:

Peristalsis: ☐ Presente ☐ Ausente

Eliminación:

Ostomia: ☐ Si ☐ No

Tubo NG: ☐ Si ☐ No

Tubo OG: ☐ Si ☐ No

Summ. Note < > GI

Cancel Save

Logout

Pocket PC

Figure B-14: Gastrointestinal panel

REC 10:36

New Assessment

Rosa Del Campo 51yrs 129lbs 105A

Genitourinario

Orina:

Color:

Foley: ☐ Si ☐ No

Secre. Vag/Pene: ☐ Si ☐ No

Summ. Note < > GU

Cancel Save

Logout

Pocket PC

Figure B-15: Genitourinary panel

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