

**A Comparative Study of Nurses
Accessing Electronic Patient Record Systems with PDAs and Tablet PCs**

by

Gilberto Crespo Pérez

A thesis submitted in
partial fulfillment of the requirements
for the degree of

Master of Science

in

Computer Engineering

University of Puerto Rico
Mayagüez Campus
2005

Approved by:

Néstor J. Rodríguez, PhD.
President, Graduate Committee

Date

Jose A. Borges, PhD.
Member, Graduate Committee

Date

Javier Arroyo-Figueroa, PhD.
Member, Graduate Committee

Date

Isidoro Couvertier, PhD.
Department's Director

Date

Celia R. Colón Rivera, R.N, PhD.
Representative of Graduate Studies

Date

Abstract

The main objective of this study was to identify potential usability problems, interaction differences, advantages, and disadvantages of two versions of a nursing documentation system: PDA and Tablet PC. A comparative study of tasks completion was made between these systems. The dependent variables of this study were tasks completion time, number of tasks completed, and user satisfaction. No significant differences were found in completion time of individual tasks between both systems. Significant differences in user satisfaction ratings for the use of the stylus, weight, and portability were found. No significant differences were found in the satisfaction of the nurses with interaction and system aspects between the two nursing documentation versions. The results of the study support the conclusion that PDAs are a better alternative for supporting nursing documentation tasks at bedside than Tablet PCs.

Resumen

El objetivo principal de este estudio fue identificar los posibles problemas de utilización, diferencias en interacción, ventajas y desventajas de dos versiones de un sistema para documentación de enfermería: PDA y Tablet PC. Se realizó un estudio comparativo sobre la terminación de tareas entre ambos sistemas. Las variables dependientes de este estudio fueron tiempo para completar las tareas, número de tareas completadas y satisfacción del usuario. No se encontró diferencias significativas en el tiempo de completar las tareas individuales entre ambos sistemas. Se encontraron diferencias significativas en el grado de satisfacción del usuario para el uso del “stylus”, el peso, y la portabilidad. No se encontró diferencias significativas en la satisfacción de las enfermeras con la interacción y los aspectos del sistema entre las dos versiones de documentación de enfermería. Los resultados de este estudio apoyan la conclusión de que las PDAs son una mejor alternativa para el apoyo de las tareas de documentación de enfermería en el lugar de cuidado que las Tablet PCs.

© Gilberto Crespo Pérez, 2005

No part of this thesis may be reproduced, in any form or by any means, without written permission from the author.

To

Dalynés Reyes Colón, whose words of wisdom and
unconditional support helped and inspired me
throughout the years of my Master's Studies and in my
personal life. Also, to myself.

Acknowledgements

At this point I have probably reached the most complex part of this endeavor, my acknowledgements. It is a very delicate part for any possible omissions I may incur of significant persons or entities. To any of them I must express my sincere apologies and regret.

The fundamental persons for this research were my mentors, Dr. Néstor Rodríguez, my advisor, for his help, advice, and guidance throughout my master studies; Dr. José A. Borges and Dr. Javier Arroyo, members of my graduate committee, for their advice and guidance during this process; and Dr. Celia R. Colón Rivera for helping me to understand nurses' tasks. All of you were instrumental for the pertinence and value of my work. Likewise fundamental were the National Science Foundation (Grant EIA 99-77071) and the Center of Excellence in Industrial Software Development (InduSoft), a component the Puerto Rico Industrial Development Corporation (PRIDCO), which are gratefully acknowledged for their economic support.

I met a group of nursing and medicine professionals, including administrators, nurses, and doctors who must remain anonymous as an agreement for the study. I now know each one of you, and now you know me. Thanks to all the nurses at the “Centro Cardiovascular de Puerto Rico y del Caribe” and the Advanced Cardiology Center at Mayagüez, for their availability for interviews and facilitating us with nursing documentation materials. Your participation is acknowledged and greatly appreciated.

A special acknowledgement goes to one of my colleagues, Eng. Carlos G. Pérez, for his dedication, and for teaching me how to think as a computer engineer. Thanks to Mr. Pablo Rebollo for his invaluable help with network and computer configuration. My

recognition goes to coworkers Carlos Martínez, Aixa A. Ardín, and Elizabeth Córdova, for their help with the PDA and database programming.

I love my immediate family and relatives, whose time I borrowed in order to complete my work. I hope to be able to spend more quality moments with you from now on. Thanks for your understanding.

I hope that my long time friend, Daly, and her father, Prof. Néstor Reyes-Reyes, will have to read only one more time the dozens of pages you have read; only this time, no reaction is requested. To them and all of those who have had the unique opportunity to observe my temper during this period, my excuses. And do not worry, it has nothing to do with the thesis, it is a factory option, which I hope can be recalled and fixed.

My sincere thanks to all of you.

Table of Contents

	Page
Abstract.....	ii
Resumen.....	iii
Acknowledgements.....	vi
Table of Contents.....	viii
List of Tables.....	x
List of Figures.....	xi
List of Acronyms.....	xiii
List of Appendixes.....	xiv
Chapter 1, Introduction.....	1
1.1 Justification.....	1
1.2 Objectives.....	2
1.3 Outline.....	3
Chapter 2, Previous Work.....	4
2.1 Introduction.....	4
2.2 The Use of Portable Devices in Health Care.....	4
2.3 Clinical Applications for Portable Devices.....	6
2.4 Usability Studies of Portable Devices in Health-Care.....	8
Chapter 3, System Description.....	11
3.1 Introduction.....	11
3.2 Tablet PC Prototype.....	12
3.2.1 Login and Patient Selection Interfaces.....	12
3.2.2 Nursing Documentation Interfaces.....	14
3.2.2.1 Orders Interface.....	15
3.2.2.2 Meds Interface.....	17
3.2.2.3 Drips Interface.....	19
3.2.2.4 Vitals Interface.....	20
3.2.2.5 Notes Interface.....	21
3.2.2.6 Assessment Interface.....	23
3.2.2.7 Intake/Output Interface.....	24
3.2.2.8 Pain Interface.....	26
3.3 PDA Prototype.....	29
3.3.1 Login and Patient Selection Interfaces.....	29
3.3.2 Nursing Documentation Interfaces.....	31
3.3.2.1 Orders Interface.....	31
3.3.2.2 Meds Interface.....	32
3.3.2.3 Drips Interface.....	34

3.3.2.4 Vitals Interface.....	34
3.3.2.5 Notes Interface.....	36
3.3.2.6 Assessment Interface.....	37
3.3.2.7 Intake/Output Interface.....	39
3.3.2.8 Pain Interface.....	40
Chapter 4, User Testing and Results.....	43
4.1 Introduction.....	43
4.2 Methodology.....	43
4.2.1 Objective.....	43
4.2.2 Systems.....	43
4.2.3 Participants.....	44
4.2.4 Experimental Design.....	44
4.2.5 Statistical Analysis.....	50
4.2.6 Results.....	51
Chapter 5, Discussion.....	61
Chapter 6, Conclusions.....	66
Bibliography.....	69
Appendixes.....	71

List of Tables

	Page
Table 4.1 Participants Profile.....	46
Table 4.2 Means and Standard Deviations for Completion Times of Each Task.....	52
Table 4.3 Number of Participants that Completed Each Task.....	53
Table 4.4 Average Satisfaction Ratings of Individual Interaction Aspects.....	54
Table 4.5 Average Satisfaction Ratings of Individual System Aspects.....	55
Table 4.6 Average Satisfaction Rating for Physical Aspects of the PDA and Tablet PC	57
Table 4.7 Elements that the Participants Found More Difficult To Use/Do	59
Table 4.8 Elements that the Participants Found Easier to Use/Do	60

List of Figures

	Page
Figure 3.1 Login Window.....	13
Figure 3.2 Patient List Window.....	14
Figure 3.3 Orders Tab Interface.....	15
Figure 3.4 Acknowledge Order Window.....	16
Figure 3.5 Acknowledge Consultation Order Window.....	17
Figure 3.6 Medication Tab Interface.....	18
Figure 3.7 Acknowledge Medication Order Window.....	19
Figure 3.8 Drips Tab Interface.....	19
Figure 3.9 Vitals Tab Interface.....	20
Figure 3.10 New Vitals Window.....	21
Figure 3.11 Notes Tab Interface.....	22
Figure 3.12 New Note Window.....	22
Figure 3.13 Assessment Tab Interface.....	23
Figure 3.14 New Assessment Window.....	24
Figure 3.15 Intake/Output Tab Interface.....	25
Figure 3.16 New Intake/Output Window.....	26
Figure 3.17 Patient Pain Tab Interface.....	27
Figure 3.18 New Pain Window.....	28
Figure 3.19 Login Interface.....	30
Figure 3.20 Patient List Window.....	30
Figure 3.21 Orders Interface.....	30
Figure 3.22 Order Detail Window.....	30
Figure 3.23a Consultation Acknowledge Window.....	31
Figure 3.23b Order Acknowledge Window.....	31
Figure 3.24 Medications Interface.....	33
Figure 3.25 Medication Administration History Window.....	33
Figure 3.26 Medication Acknowledge Window.....	33
Figure 3.27 Drips Interface.....	33
Figure 3.28 Vitals Interface.....	35
Figure 3.29 Vitals Graph Window.....	35
Figure 3.30 New Vitals Window.....	35
Figure 3.31 Notes Interface.....	36
Figure 3.32 Notes Detail Window.....	36
Figure 3.33 New Note Window.....	37
Figure 3.34 Assessment Interface.....	38
Figure 3.35 Assessment Details Window.....	38
Figure 3.36 New Assessment Window.....	39
Figure 3.37 Assessment Comment Window.....	39
Figure 3.38 I/O Interface.....	40
Figure 3.39 New I/O Window.....	40
Figure 3.40 Pain Management Interface.....	41

Figure 3.41 Pain Detail Window	41
Figure 3.42a Pain Classification Window	41
Figure 3.42b Pain Location Window	41
Figure 3.42c Pain Description Window	42
Figure 3.42d Pain Treatment Window	42
Figure 4.1 Overall Average Completion Times	51
Figure 4.2 Completion Times for Each Task on the PDA and Tablet PC Versions	53
Figure 4.3 Number of Participants that Completed Each Task on Each Version of the System	54
Figure 4.4 Average Satisfaction Ratings for Individual Interaction Aspects	55
Figure 4.5 Average Satisfaction Ratings for Individual System Aspects	56
Figure 4.5 Overall Average Satisfaction Ratings for Physical Aspects of the PDA and Tablet PC Computers	56
Figure 4.6 Average Satisfaction Ratings for Individual Physical Aspects	58
Figure 4.7 Average User Satisfaction Ratings for Each Version of the System	59
Figure 5.1 PDA Screen for Listing Notes	62

List of Acronyms

CARIS	Cardiology Information System
CCU	Coronary Care Unit
GUI	Graphical User Interface
HIPAA	Health Insurance Portability and Accountability Act
HIS	Hospital Information System
I/O	Intake/Output
MSSQL	Microsoft Structure Query Language
PDA	Personal Digital Assistant
UPRM	University of Puerto Rico at Mayagüez
VA	Veteran's Administration

List of Appendixes

	Page
Appendix A: Cuestionario 1	72
Appendix B: Hoja de Consentimiento	73
Appendix C: Orientación	74
Appendix D: Data Collection – PDA.....	75
Appendix E: Observations - PDA.....	76
Appendix F: Data Collection - Tablet PC.....	77
Appendix G: Observations - Tablet PC	78
Appendix H: Cuestionario 2	79
Appendix I: Nurses Tasks.....	81
Appendix J: Información Personal.....	83

Chapter 1, Introduction

1.1 Justification

Up to day, hospitals in Puerto Rico, as well as in the United States, keep their patients' records in paper form. This practice produces some problems that affect information management effectiveness. In addition, handwriting may produce errors due to misunderstanding of written information, which may compromise the patients' health. In order to overcome these problems, some medical institutions (about 5% in the USA [Bates03]) implemented different technologies that may help to improve information management. However, due to the fact that a majority of patients' information is collected at bedside, the technology used in most health-care centers do not provide effective tools to perform this task.

Personal Digital Assistants (PDAs), as well as Tablet PCs, are two technological devices with potential for accessing and capturing clinical data at bedside. According to [Rosenbloom03] Tablet PCs increase the portability of access to data, although they have yet to be refined and popularized. In addition, they stated that the most portable device for the medical information at the point-of-care is undoubtedly the personal digital assistant (PDA).

Both platforms are portable, allow information access and collection at bedside and possess different data entry methods. In addition, there are several applications available for different tasks such as: order entry (drugs, studies, and laboratory tests), collecting clinical information, and access patient record (results of laboratories and studies, vitals, notes, intake and output fluids, and others). These medical applications

may improve physicians and nurses' effectiveness and productivity at point-of-care, as well as the quality of patient care.

A review of the literature reveals that there are no formal studies comparing the use of PDAs and Tablet PCs for accessing electronic patient records. We believe that such a study could help determine which of the two technologies fits better for collecting and accessing clinical information at the point-of-care. Thus, a study to compare nurses' interaction with PDAs and Tablet PC applications for accessing electronic patient records is proposed.

1.2 Objectives

The main objective of this thesis was to conduct a usability study to compare the use of PDA and Tablet PC-based application to support nurses' tasks at point-of-care. To achieve this goal we developed nurses' graphical user interfaces for accessing electronic patient records with PDAs and Tablet PCs to conduct studies of nurses' interaction with them. These graphical user interfaces were developed based on usability engineering principles.

Once a graphical user interface prototype was developed and implemented, a comparative study was made between the PDA-based system and the Tablet PC one. This study compared both systems by means of performance parameters, such as time to complete tasks and the number of tasks completed, and also in terms of subjective user satisfaction. In addition, the study served to discover interaction problems encountered by users.

1.3 Outline

A literature review on previous work associated with the use of PDAs and Tablet PCs in healthcare environment is provided in Chapter 2. Similarly, Chapter 3 presents a complete description of each of the interfaces available for TablePC-based and PDA-based systems. Chapter 4 offers a detailed description of the methodology, which consists of interaction studies conducted with nurses, and the results obtained from these tests. Chapter 5 presents the discussion of the results. Finally, the conclusions of the studies, as well as some suggestions for future works, are presented in Chapter 6.

Chapter 2, Previous Work

2.1 Introduction

In recent years, the use of PDAs and Tablet PCs in healthcare has expanded. These new technologies allow greater speed and effectiveness to compile patient's information, to process drugs and clinical laboratories prescriptions, and to calculate drugs' doses, as well as to access databases of drugs information. At the same time, these technologies reduce the risk of errors during treatment of patients. The process to integrate this technology to the area of medicine has required, and still requires, continuous research that allows improvement of these and other devices. This chapter reviews current literature regarding these technologies, giving emphasis on identifying other potential roles for PDAs and Tablet PCs at point-of-care, and primary issues concerning to their medical applications, as well as their software capabilities and limitations.

2.2 The Use of Portable Devices in Health Care

There are many reasons that justify why medicine encourages investigations on the potential market and role of portable devices in clinician medical practice. Analysts predicted that by 2004, 20% of the physicians were going to be using handheld devices for e-prescribing, ordering, and checking lab tests, capturing charges, and dictating notes [Fischer03]. Likewise, according to a Harris Interactive Poll, about 18% of the nation's physicians reported using personal digital assistants (PDAs) as a fundamental part of their professional duties [Ying03]. This poll also estimated that physician's usage of PDAs will increase nearly 50% by 2005.

The most important reason to look for new technologies to help clinicians do their job is the fact that between 44,000 and 98,000 people die annually in U.S. hospitals as a result of medical mistakes -- more than half of them preventable [Rosenbloom03]. These medical errors included medication dosage miscalculations and drug ordering, labeling, packaging, and nomenclature problems. Trying to overcome some of these errors, the Veteran's Administration (VA) has taken effective measures through electronic system controls and implementation [Rosenbloom03]. Over a five-year test period at two VA hospitals in Kansas, the medication error rate dropped 70%, setting a precedent for new and innovative medical error-prevention systems nationwide.

Technological devices can improve effectiveness and productivity in health-care centers. Although they are still in its early stages, PDAs and Tablet PCs are devices used in some institutions. For example, James R. Barret [Barret02] developed a survey based on structured interviews trying to identify both, what medical residents find useful about PDAs, as well as those issues that prevent or dissuade residents from using PDAs. They wanted to identify what kinds of programs are currently used and considered valuable by physician residents. The results of this survey were used to identify potentially valuable tools and features for future residents, and to identify features either that frustrate residents, or that cause residency programs to discourage PDAs use. In addition, they wanted to identify software tools that may increase resident's productivity in clinical environment. Initial findings of the survey suggested that there is a high use of PDAs. According to the survey, among the uses of PDAs, the top four were: to keep some patient information, as medical calculators, medical references, and personal organizers.

2.3 Clinical Applications for Portable Devices

Literature reviews show that clinical applications for portable devices are used for several purposes, the most important being drug references, pharmacopoeias, medical calculators, and patient trackers among others. PDA drug and pharmacopoeias databases are useful resources for medical professionals. In [Adatia03], they found a survey of internists by the American College of Physicians-American Society of Internal Medicine, which identifies that 80% of handheld owners use their devices to access drug information. Another finding was that several major American teaching hospitals routinely supply their physicians with PDAs preloaded with drug and medical referencing applications [Rosenbloom03].

Healthcare providers regularly make medical calculations that affect patient care decisions. These calculations include physiological parameters, severity indices, drug dosages, and decision support tools [Adatia03]. In addition, handheld devices have been used to monitor patient's health and to maintain medical staff informed about patient condition. Among applications available for medical staff, there is Mobil-Nurse [Choi00], which provides nurses with support information as needed. This includes tools for managing the patient's demographic information, checking the physicians' prescriptions, and record the nursing care plans, including consults, discharges, clinical tests, and transfers among others. In addition, Eizen Kimura [Kimura03] developed a nursing care support system using PDAs with wireless and barcode reader, with the goal to minimize the costs of deployment, maximize the ease of operation, and adapt to existing features and tasks of nursing care. They found that this system foreshorten the learning curve time and is effective as terminals for nursing care support. However, they

planned to do research with the new nursing task path using the combination of mobile terminal and barcode system, since there are reports that showed that side effects may occur on bringing in barcode system.

Another application for computers running MS Windows operating system is CARIS (Cardiology Information System), developed at the LUMC Department of Cardiology. It contains all data regarding catheterizations, pacemaker implants and follow-up, clinical and interventional waiting lists, and other information [van der Velde01]. In addition, data in separate information systems can be viewed after selecting the patient's ID in CARIS. CARIS consists of a database server and various applications built with Borland Delphi. It is connected to all clinical information systems in the Cardiology department and to the Hospital Information System (HIS). The Coronary Care Unit (CCU) application comprises modules for admission of the patient, daily report, hemodynamic status, diagnosis coding, and final discharge-report. The CARIS user interface has been designed to make necessary typing efforts as small as possible: almost all information can be entered via radio-buttons and drop-down lists. Once all the data has been entered, the program automatically generates a report when the user clicks the Report button. Finally, when the patient is discharged, all sub-reports can be assembled into a final discharge letter, which can be modified with Microsoft Word. According to ET van der Velde [van der Velde01], the combination of a well-designed application with a versatile, portable device has been shown to enhance the cardiologist's access to all critical information for optimal patient care at the CCU.

As noted, the use of handheld technology in the health-care environment has become popular in recent years. These technology devices allow greater speed and

effectiveness in collecting patients' demographic information, process drugs and clinical laboratories prescriptions, and to calculate drugs doses, among other features. In addition, they are useful in ambulatory settings, where rapid access to information and efficient data entry into electronic medical records are essential [Berner04]. At the same time, these technologies reduce risk of errors during treatment of patients.

2.4 Usability Studies of Portable Devices in Health-Care

Portable devices offer portability and mobile access to needed information anytime and anywhere in a clinical setting [Chen04, Chen05]. By using these technologies, clinicians improve their tasks as these devices provide access to rapid physicians prescribing of, collecting clinical data, and accessing the patients' records at point-of-care via wireless technologies.

Studies conducted by The University of Puerto Rico at Mayagüez [Rodríguez02], have demonstrated that a graphical-base interface can reduce the time it takes physicians to complete some typical tasks on an electronic patient record system, when compared with a text-based interface. Previously, a study by John Staggers [Staggers00] also determined which type of display interface would be optimal for user efficiency, effectiveness, and satisfaction in system use. The study compared the differences in nurses' response times, error rates, and satisfaction ratings when they used a text-based interface and a prototype graphical user interface (GUI) to perform nurses' documentation tasks. The results of this study indicated that, for nurses' documentation, a GUI prototype significantly improved performance response times, error rates, and satisfaction ratings compared with an existing text-based interface for nurses across clinical areas within an enterprise system. In addition, the GUI prototype was learned

more quickly for navigation and order management tasks. However, in another study [Rodríguez04] it was found that physicians are faster on laptops than on PDAs when performing tasks such as text entry and reading; although they are faster on PDAs when performing tasks that only require pointing and clicking. Still, physicians were more satisfied with the actions performed on the laptop than on the PDA. From this study, it was concluded that the small screen and the text input methods of the PDA are vital elements of the user interface that affect physicians' performance and user satisfaction.

The current PDA applications available have some limitations for managing the complete electronic medical records [Fischer03]. In [Stausberg03], a study comparing paper-based with electronic patient records confirms this limitation. From this study, they concluded that medical professionals should be aware of the possible discrepancies between paper and electronic information and look toward combining information from both records whenever appropriate. Two usability studies of nurses and physicians interacting with PDAs and Laptops [Rodríguez03, Rodríguez04] demonstrated that writing notes is significantly slow on PDAs as compared to Laptops. However, nurses can be as effective with PDAs as with Laptops in performing typical nursing documentation tasks at bedside, with the exception of writing notes [Rodríguez03].

Tablet PCs can be valuable in the clinical area due to their portability and large screen. However, these devices have some drawbacks. In a study conducted by Jian Chen [Chen05] many users stated the Tablet PC is either too heavy or too cumbersome to use in a standing position. These statements indicated that many users would prefer smaller devices for this type of application. According to Chen, the PDA might be too small to effectively display a reasonable amount of information, but a smaller Tablet PC

might work well, since the attribute that users most like about the Tablet PC is its portability. Similar results were found by Christopher L. Andon [Andon04] who concluded that it is still unclear whether or not current generation tablet computers can be useful in health-care settings. He stated that it is necessary to optimize software for touch screen interaction, and to integrate it with health-care information systems for improved usability of Tablet PCs. No more studies related to other usability issues of Tablet PCs have been found, which indicates that this field is in its early stages of research.

Chapter 3, System Description

3.1 Introduction

In this chapter, we describe the user interfaces of two versions of a nursing documentation application (Tablet PC and PDA) of an electronic patient record system. These applications allow nurses to access vital information of patients in a hospital and document their condition. Due to the portable feature of the two versions and their wireless connectivity the review and documentation of the patient's condition can be accomplished at the point-of-care.

The first phase in the development of the two versions of the nursing documentation applications was a redesign of previous versions for desktop computers and PDAs developed by Viviam Murillo [Murillo03] and Yajaira Soler [Soler03] respectively. The Tablet PC version was developed in Java using the developer environment JBuilder Developer, Tenth edition, from Borland Enterprise. This version was developed by the author of this thesis in collaboration with University of Puerto Rico at Mayagüez (UPRM) graduate student Carlos Pérez. The PDA version was developed in C Sharp using Visual Studio.Net from Microsoft Corporation. UPRM graduate student Carlos Martínez and undergraduate student Aixa Ardín developed this version. These two applications use an MSSQL (Microsoft Structure Query Language) database manager from Microsoft Corporation to store and retrieve the patient's clinical information in a database. Both applications use the standard IEEE 802.b to communicate with the database server.

The design of the graphical user interfaces for the two platforms was guided by the usability engineering attributes of learnability, efficiency and satisfaction.

Learnability is a usability attribute that indicates the ability of users to learn how to use an application and achieve productive work. Efficiency is the usability attribute that indicates the level of productivity that can be achieved with a user interface. Satisfaction is the usability attribute that indicates how much the users like to use an application. To make all of these attributes possible with the systems, we followed all the usability-engineering guidelines.

The user interfaces were specially designed to minimize text input. With the exception of notes and comments, the information can be entered by pointing and clicking objects in the interfaces. For text input the PDA and Tablet PC provided handwriting recognition and a virtual keyboard that can be displayed at the bottom of the screen.

In section 3.2, we describe all details of the user interfaces of the Tablet PC version. Similarly, in section 3.3, we describe the user interfaces of the PDA version.

3.2 Tablet PC Prototype

This section describes the Tablet PC interfaces. The interfaces were developed for tablets running Microsoft Tablet PC operating system. However, this version can also run on desktop PCs running MS Windows operating system.

3.2.1 Login and Patient Selection Interfaces

The first interface of the system (See Figure 3.1) is where the user, in this case a nurse, enters the username and password to validate his/her identity, preventing unauthorized use of the system. After a valid username and password are entered, the system displays the patients' list window shown in Figure 3.2. This interface shows in the top header the name of the logged user and a drop-down menu for selecting a clinical unit

within the hospital. In addition, there is a Logout button, which can return the system to the logging interface (See Figure 3.1). Below the header, there is a list of patients that can be selected by double clicking the row, or by selecting the record and pressing the Open button at the lower right corner. The icons that appear to the right side of the patient's room number represent reminders to the nurses on pending tasks for that patient.

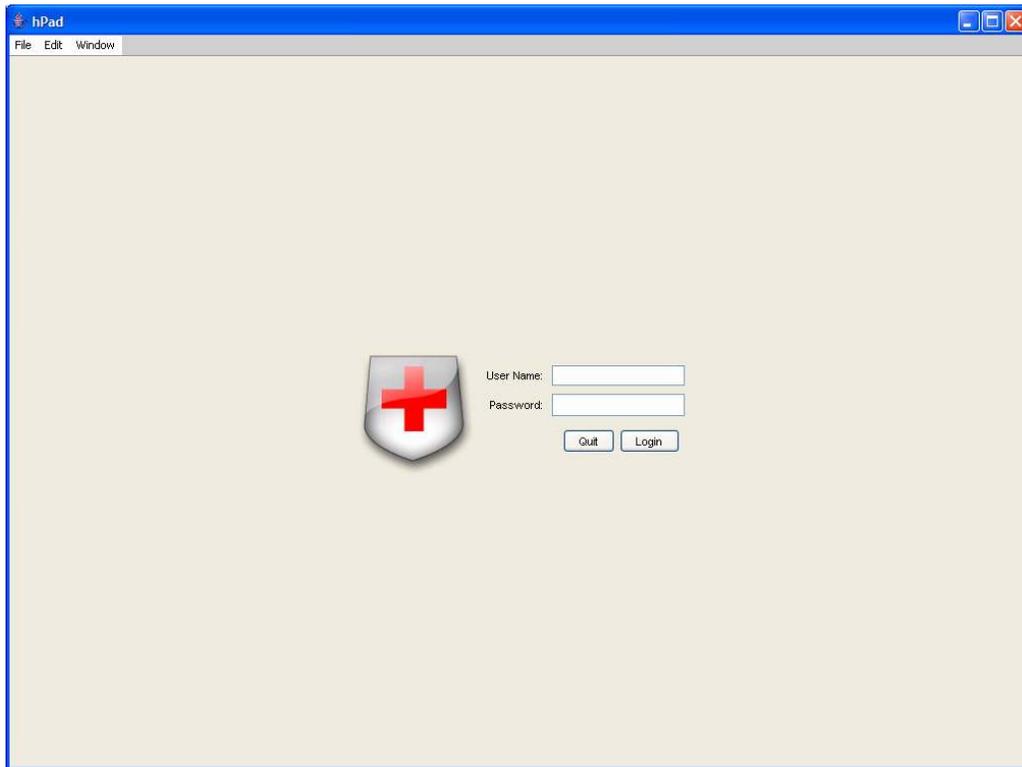


Figure 3.1 Login Window

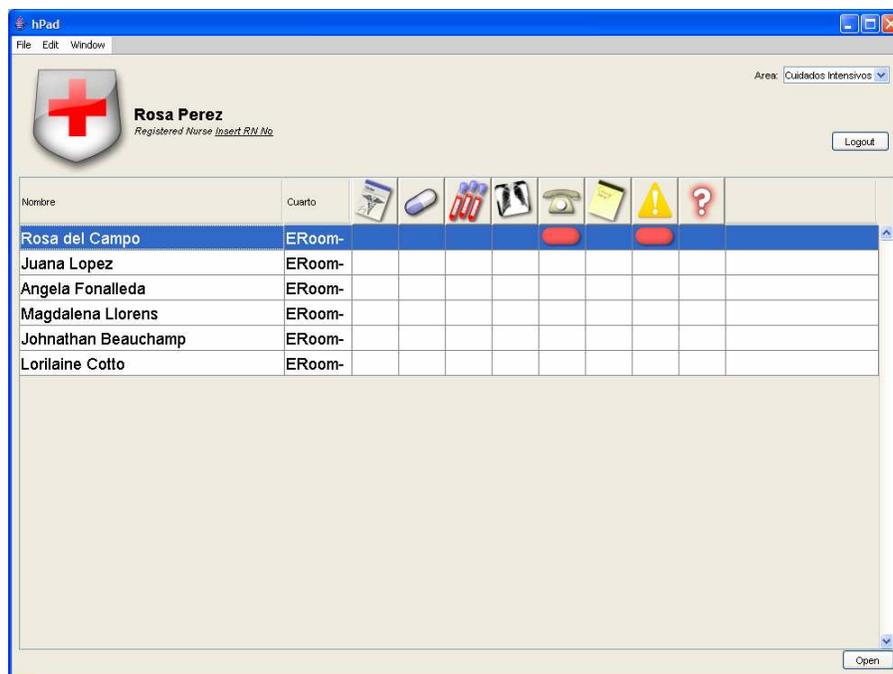


Figure 3.2 Patient List Window

After a patient record is opened, the system displays the interface shown in figure 3.3. This interface is described in the following section. Here the user can view all the record by navigating through a series of tabs (Orders, Meds, Drips, Vitals, Notes, Assessment, I/O (Intake/Output), and Pain) that show particular information about the patient's health condition.

3.2.2 Nursing Documentation Interfaces

The upper left corner of the heading of the nursing documentation interface provides information on the patient's name, sex, age, weight, height, doctor's name, account, and record number (See Figure. 3.3). On the right side of the heading, there are diagnoses fields, as well as some alerts and reminders representing special needs and precautions. This heading is static and does not change when the user navigates through the tabs. The demographic information is always visible to the user. Below the window heading, the interface provides a series of tabs that provide access to the nursing

documentation functions: handling physicians' orders, medication administration, recording vital signs, writing nurses' notes, documenting patient assessment, recording intake and output (I/O) measurements and pain assessment. The interfaces related to these tabs are described in next subsections.

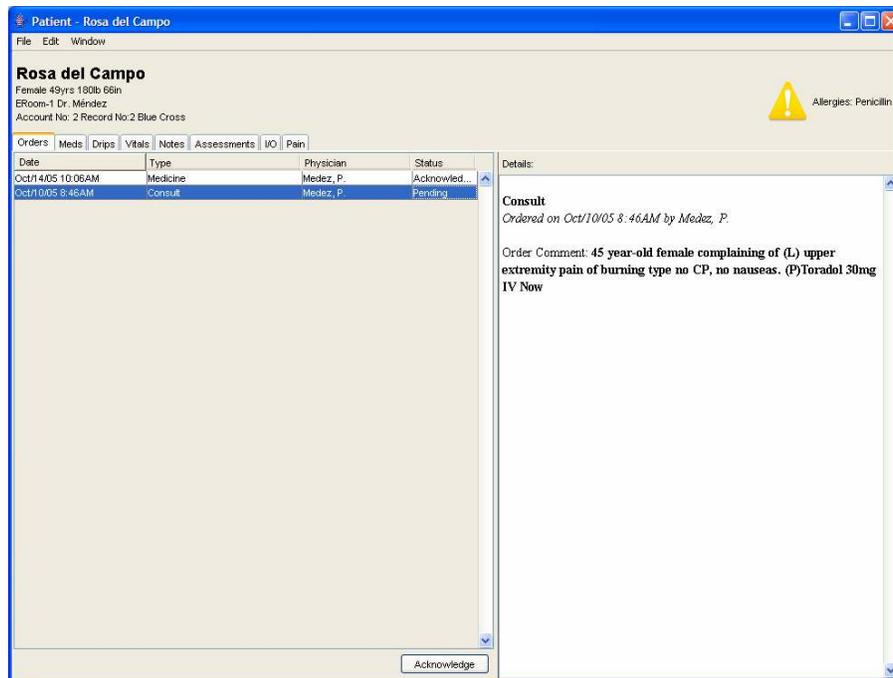


Figure 3.3 Orders Tab Interface

3.2.2.1 Orders Interface

The orders interface shown in figure 3.3 displays two panels. The first one, on the left of the window, presents a list of orders made by physician. The list indicates the date of the order, the type of order, the physician who made the order, and the order status. Initially, the information in the list is sorted by date, but the user can sort it in ascending or descending order by clicking any criteria in the table (Date, Type, Physician, and Status). The lists on other tab interfaces exhibit a similar behavior.

The details of each order can be displayed on the right panel by selecting the order on the list. At the bottom of the list there is an Acknowledge button that can be activated when the user selects an order which status is pending. By pressing the Acknowledge button, the system respond with an acknowledge window like to the one shown in figure 3.4. The acknowledge window provides a description of the order and a text field for nurse to write a note related to the order being acknowledge. If the order is a consultation order the acknowledge window shown in figure 3.5 is displayed. This window provides options for the nurses to indicate the way the physician was notified of the consultation request. Once an order is acknowledge its status changes from pending to acknowledged.

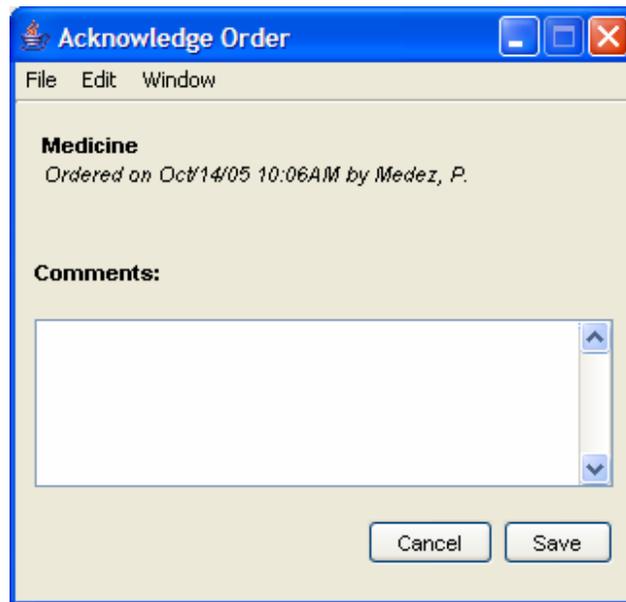


Figure 3.4 Acknowledge Order Window

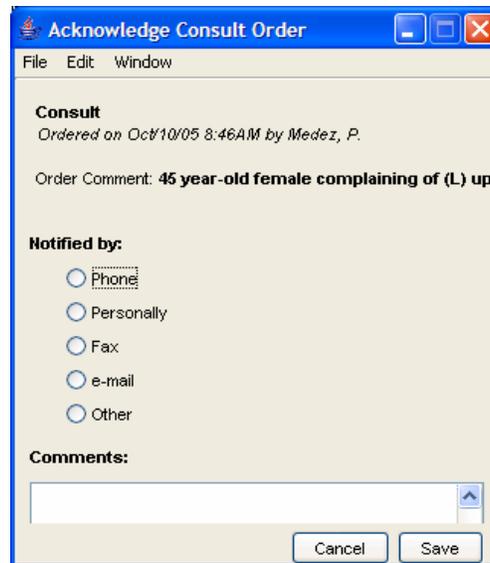


Figure 3.5 Acknowledge Consultation Order Window

3.2.2.2 Meds Interface

The medications (Meds) tab displays two panels (See Figure 3.6). The first one, on the left half of the window, presents a list of medication orders. The list indicates the medicine name, the next dose to be administered, and the order status. When a medication is selected from the list, details of the order are displayed on the top area of the right panel. The medication administration history is displayed as a list below the medication details. Information related to the administration of a medication dose is displayed on the medication detail area at the top of the right panel when an administration record is selected from the medication history list.

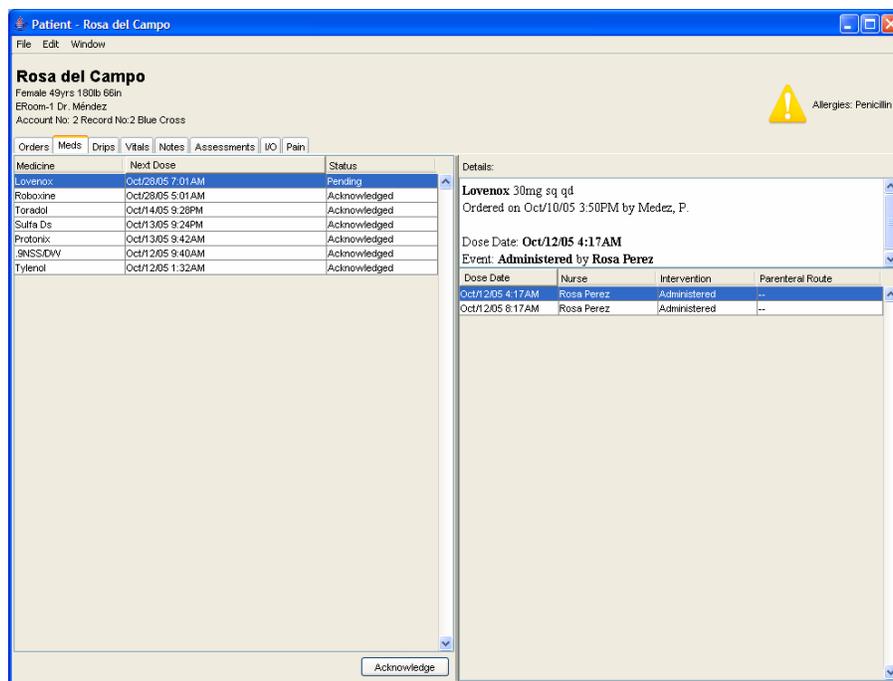


Figure 3.6 Medication Tab Interface

At the bottom of the left panel, there is an Acknowledge button, which can be activated by selecting a pending medicine order on the left table. By pressing the Acknowledge button, the system displays the Acknowledge Medication Order window shown in figure 3.7. The medication acknowledge window provides the detailed information of the medication order, options for indicating the result of the medication intervention, and a text field for writing nurses' comments related to the medication administration.

Acknowledge Medication Order

File Edit Window

Details:

Lovenox 30mg sq qd
Ordered on Oct/10/05 3:50PM by Medez, P.

Intervention:

Administered Parenteral Route: N/A
 No Administered Reason: According to Norm

Comments:

Cancel Save

Figure 3.7 Acknowledge Medication Order Window

3.2.2.3 Drips Interface

The Drips interface is essentially identical to the Meds interface (See Figure 3.8). It was included to distinguish drip medications from other medications.

Patient - Rosa del Campo

File Edit Window

Rosa del Campo
Female 49yrs 100lb 66in
ERoom-1 Dr. Méndez
Account No: 2 Record No:2 Blue Cross

Allergies: Penicillin

Orders | **Meds** | Drips | Vitals | Notes | Assessments | IO | Pain

Medicine	Next Dose	Status
Nitroglicerina	Mar/3/06 4:05PM	Pending

Details:

Ordered on Jun/22/05 4:25PM by Medez, P.
Order Comment:
Dose Date: Oct/28/05 9:04AM
Event: Not Administered by Rosa Perez
Reason: According to Norm

Dose Date	Nurse	Intervention	Parenteral Route
Oct/28/05 9:04AM	Rosa Perez	Not Administered	--

Acknowledge

Figure 3.8 Drips Tab Interface

3.2.2.4 Vitals Interface

The Vitals interface displays two panels (See Figure 3.9). The right panel presents a list of vitals measurements: temperature (Temp), blood pressure (BP), pulse, respiration rate (Resp), O₂ saturation (O₂Sat), and weight. In addition, the list indicates the date the vitals were recorded, and the name of the nurse who recorded them. Graphical versions of four of the vital signs can be displayed on the right had side panel. The user has the option of viewing a graphic of temperature, pulse, blood pressure, and respiration by selecting one of the radio buttons at the top of the panel. In addition, the user can select a specific point in the graph and the system will display a tool tip indicating the value of the selected point and the date it was collected.

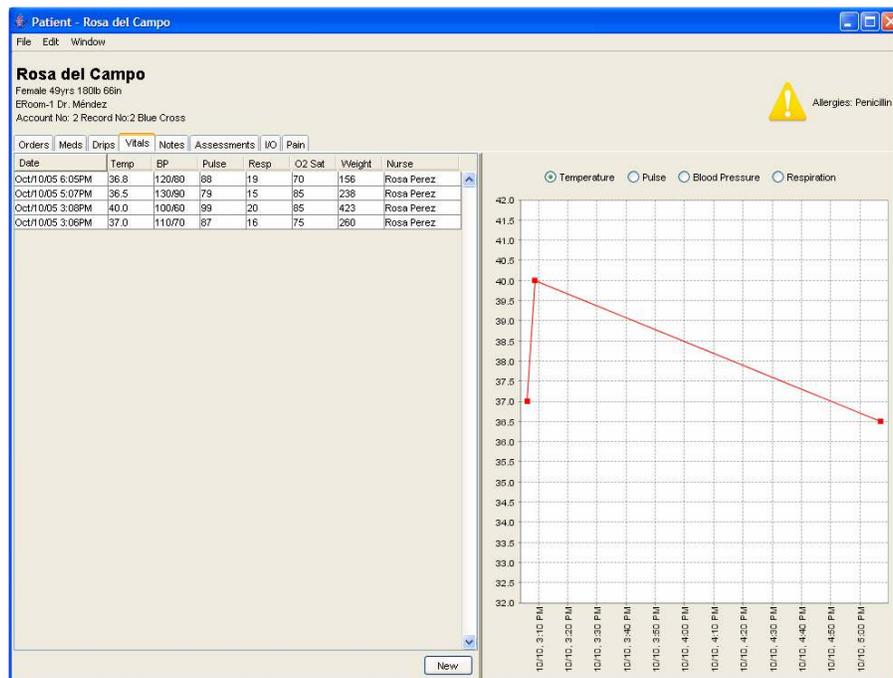


Figure 3.9 Vitals Tab Interface

A new set of vital measurements can be entered by clicking on the New button at the right bottom corner of left panel. When the New button is selected, the system

displays a window for entering vital signs like the one shown in figure 3.10. The vital sign values can be entered on the text fields provided using the keyboard on the left side of the window or using any standard device for numeric input. Once the new vital signs are saved they are displayed on the list of the left panel.

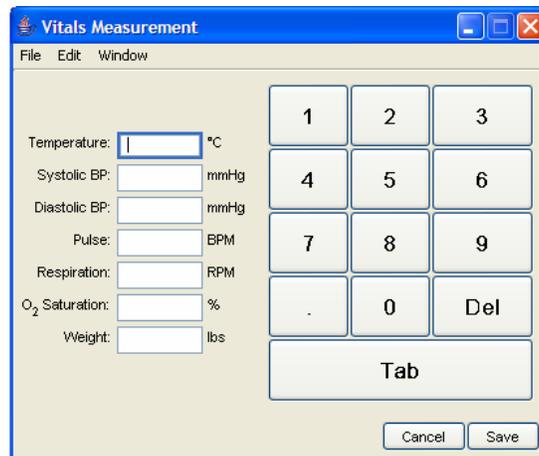


Figure 3.10 New Vitals Window

3.2.2.5 Notes Interface

The Notes interface displays two panels (See Figure 3.11). The right side panel provides a list of notes about the patient's condition, written by physicians, nurses and other clinicians. The list indicates the date at which the note was written, the title of the note, the author of the note, and the note type. The text of the note can be viewed on the right side panel by selecting the note on the list of the left side panel.

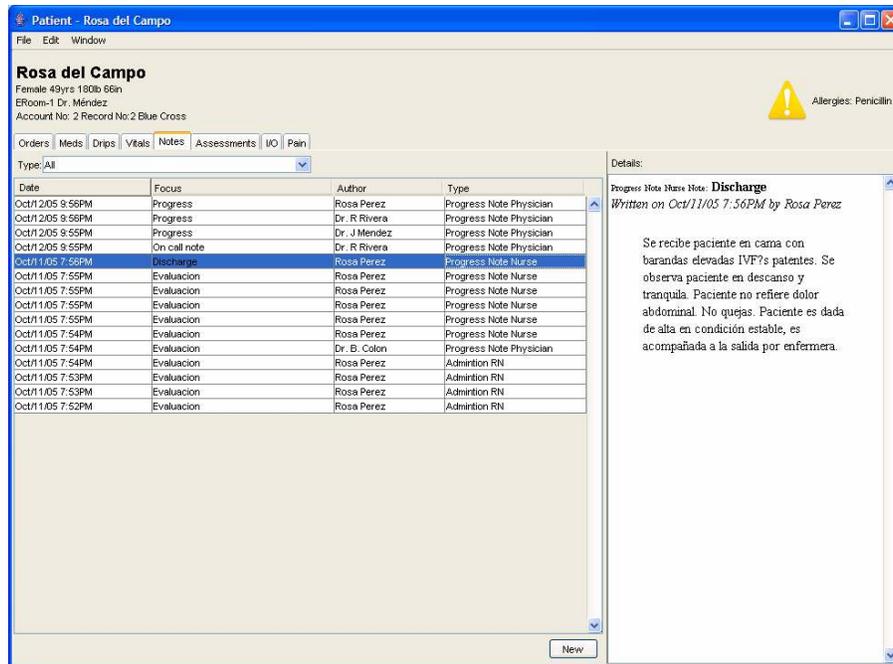


Figure 3.11 Notes Tab Interface

A new note can be entered by clicking at the New button located at the lower right side corner of the left panel. When the new button is selected the window shown in figure 3.12 is displayed. This window provides a drop-down menu for specifying the note type and a text field for specifying a note title.

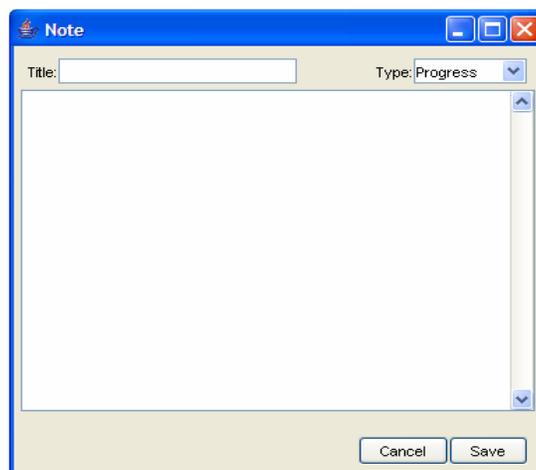


Figure 3.12 New Note Window

3.2.2.6 Assessment Interface

The Assessment tab displays two panels (See Figure 3.13). The left side panel displays a list of the assessments made to the patient. The list provides the date the assessment was done and the name of the nurse that did it. The details of an assessment can be displayed on the right side panel by selecting the assessment on the list on the left panel.

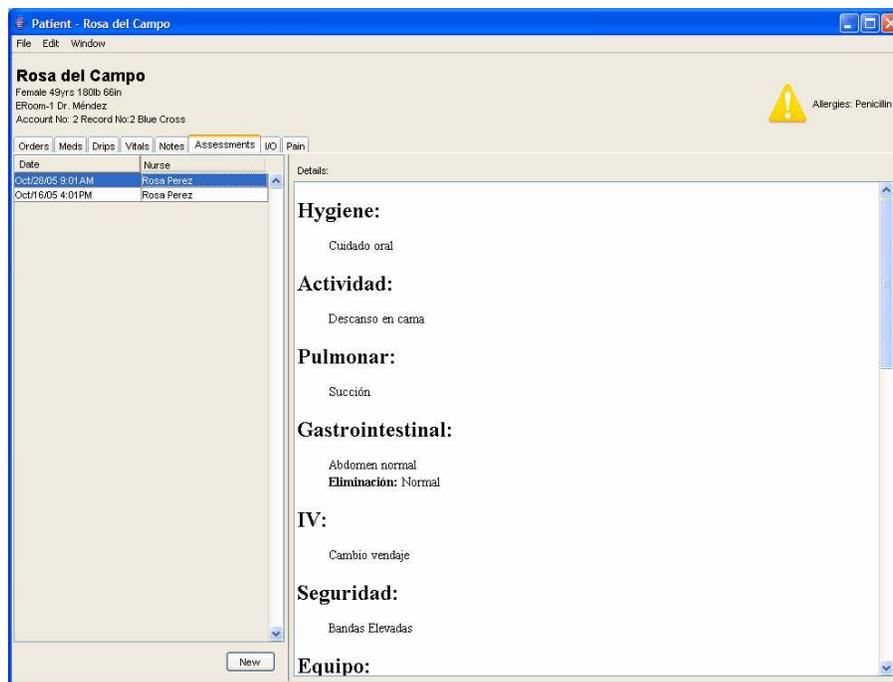


Figure 3.13 Assessment Tab Interface

A new assessment can be entered by selecting the New button at the right bottom corner of the left panel. The window shown in figure 3.14 is displayed when the New button is selected. This window is divided in three panels. The left panel provides a list of assessment topics. When the user selects a particular topic by clicking at it or by pressing the Next and Previous buttons, the assessment options for that topic are displayed at the center panel. The options are normally provided in the form of buttons,

radio buttons and drop-down menus. A text field is always provided at the bottom of the center panel for nurses to enter a note related to the particular topic being assessed. The information entered in the center panel is displayed on the right side panel. This panel continuously displays the information entered for all the assessment topics as it is being added.

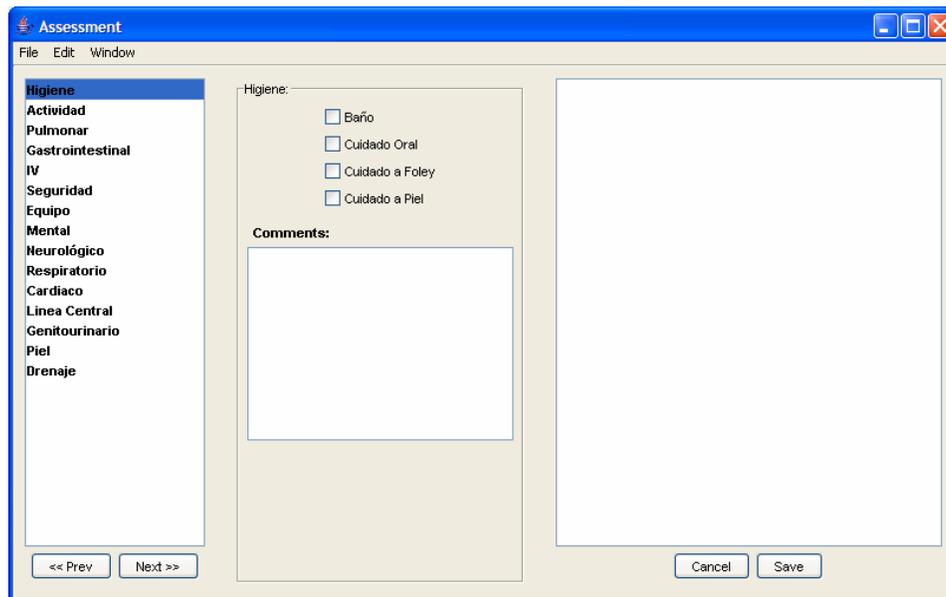


Figure 3.14 New Assessment Window

3.2.2.7 Intake/Output Interface

The intake/output (I/O) interface consists only of one panel (See Figure 3.15). This panel displays a list of recorded I/O measurements that indicates the date the I/O measurement was recorded, a symbol that indicates whether the measurement was intake or output, the amount in milliliters and the name of the person that recorded it. The type of measurements listed can be selected with the radio buttons at the left side of the panel above the list. The user can choose to view all the values recorded or just intake or output. The user can also choose to display measurements recorded during a specific

period of time with the drop-down menu provided at the right side of the panel above the list. The total amount of input, output and balance for the list of measurements displayed is indicated at the bottom of the panel.

Patient - Rosa del Campo
 Female 49 Yrs 1 03lb 66in
 ERoom-1 Dr. Méndez
 Account No: 2 Record No: 2 Blue Cross

Orders | Meds | Drips | Vitals | Notes | Assessments | **IO** | Pain

Show: All In Out Type: All Types Period: All Measurements

Date	Type	Dir	mL	Nurse
Oct/28/05 9:01AM	IV		200.0	Rosa Perez
Oct/28/05 9:01AM	Urine		600.0	Rosa Perez
Oct/28/05 5:01AM	IV		1000.0	Rosa Perez
Oct/28/05 5:01AM	Urine		800.0	Rosa Perez
Oct/28/05 1:01AM	Urine		600.0	Rosa Perez
Oct/13/05 7:46PM	Urine		600.0	Rosa Perez
Oct/13/05 7:46AM	IV		480.0	Rosa Perez
Oct/13/05 6:47AM	IV		750.0	Rosa Perez
Oct/11/05 7:47PM	IV		200.0	Rosa Perez
Oct/11/05 7:46PM	Urine		1000.0	Rosa Perez

In: 2630.0 mL Out: 3600.0 mL Balance: Out 970.0 mL

New

Figure 3.15 Intake/Output Tab Interface

A new value of intake/output can be recorded by selecting the New button at the lower right side of the panel. When the New button is selected the system displays the window shown in figure 3.16. With this interface the user indicates if the value to be recorded is an input or an output and its type. The value can be entered with the keyboard provided in the window or with any standard text input modality provided.

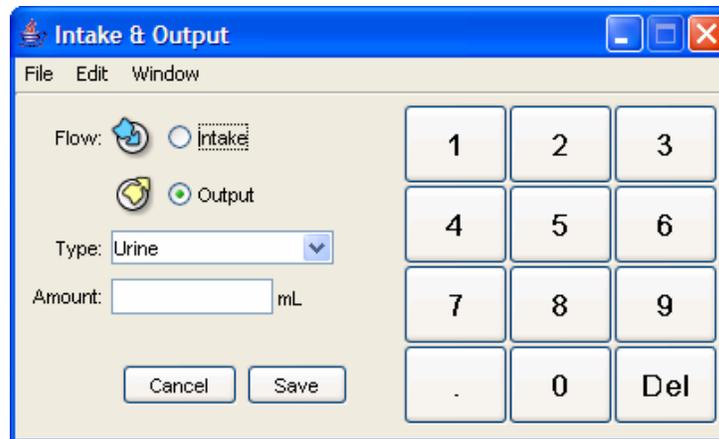


Figure 3.16 New Intake/Output Window

3.2.2.8 Pain Interface

The pain assessment interface consists of two panels (See Figure 3.17). The left side panel displays a list of pain assessment. The list indicates the date the pain assessment was done, the pain ID, and the pain classification (the intensity). Detailed information of a pain assessment recorded can be displayed at the right panel by selecting it from the list on the left panel.

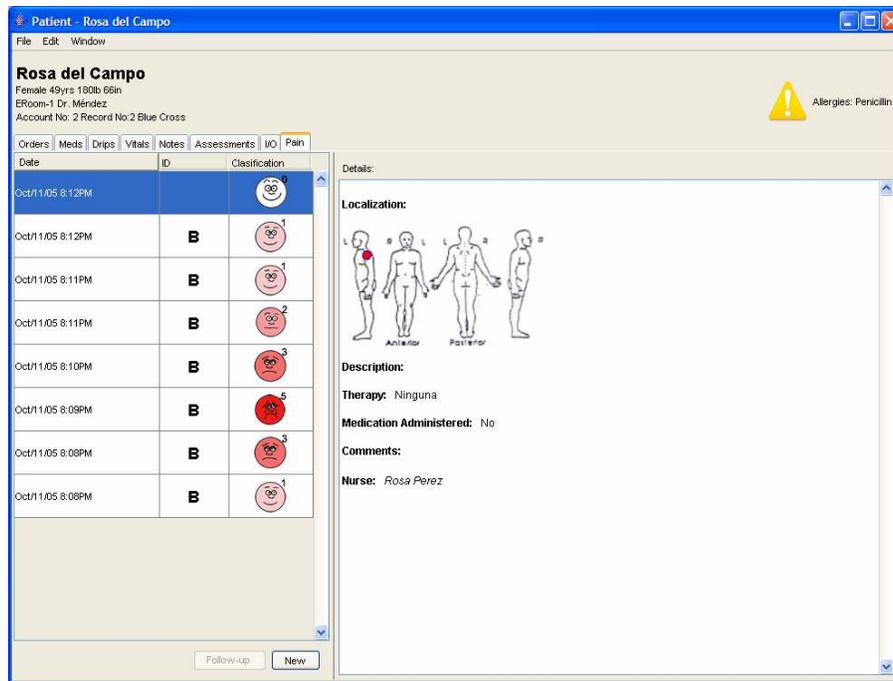


Figure 3.17 Patient Pain Tab Interface

A new pain assessment can be accomplished by selecting the New button at the lower right corner of the left panel. When this button is selected the window shown in figure 3.18 is displayed with a new Pain ID at the top right corner of the window. The window provides options for specifying the pain level (Classification), its location, its description, the treatment being used to lower the pain and additional comments regarding the pain. The pain location can be specified by pointing and clicking on the specific area of the body image presented at the upper right corner.

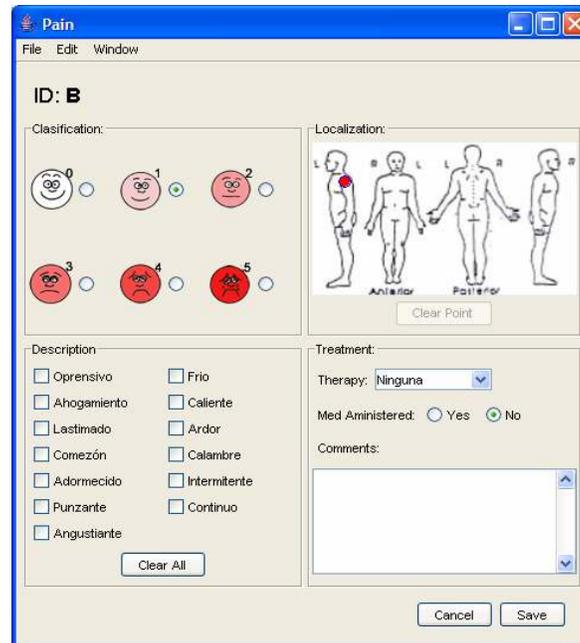


Figure 3.18 New Pain Window

Follow-ups to an existing pain can be accomplished by selecting an entry of that pain on the list at the left panel of the Pain Tab Interface and then selecting the Follow-up button at the lower right corner of the left panel. This action will display a window identical to the New Pain Window (See Figure 3.18) but with the Pain ID of the pain being followed up.

3.3 PDA Prototype

This section describes the interfaces implemented for the PDA prototype of the nursing documentation application. This version was developed for running on any PDA with the Window Pocket PC operating system.

3.3.1 Login and Patient Selection Interfaces

The login interface (See Figure 3.19) is very similar to that of the Tablet PC version (See Figure 3.1). The patient list interface is also very similar to that of the Tablet PC, with the exception that it does not displays reminders of pending tasks for the patients (See Figure 3.20).

After a patient is selected from the Patient List Window a screen like the one shown in figure 3.21 is displayed. This first screen corresponds to the Orders interface (similar to the Orders Tab Interface of the Tablet PC version). Other documentation interfaces (Meds, Drips, Vitals, Notes, Assessment, Intake/Output and Pain) can be displayed from the pop-up menu that is activated when the Window button at the lower left corner of the screen is selected. All the documentation screens feature a line with the patients name and some demographic information at the top of the screen.



Figure 3.19 Login Interface



Figure 3.20 Patient List Window



Figure 3.21 Orders Interface



Figure 3.22 Order Detail Window



Figure 3.23a Consultation Acknowledge Window



Figure 3.23b Order Acknowledge Window

3.3.2 Nursing Documentation Interfaces

3.3.2.1 Orders Interface

The Orders interface (See Figure 3.21) displays a list of physician's orders. The list entries indicate the date of the order, the type, the physician who made the order, and the order status (A=acknowledge, P=Pending). Initially, the information in the list is sorted by date, but the user can sort it by any criteria in the table (Date, Type, Physician, and Status) by clicking at the desired criteria label. The lists on other documentation interfaces exhibit a similar behavior.

The Detail button at the lower left corner of the screen activates a windows with detailed information about the order (See Figure 3.22) The Acknowledge button at the right of the Detail button activates an acknowledge window. For a consultation order the window shown in figure 3.23a is displayed. For any other order the window shown in

figure 3.23b is displayed. These two windows have similar functionality as the acknowledge windows for the Tablet PC version (See Figures 3.4 and 3.5).

3.3.2.2 Meds Interface

The Meds interface displays a list of medication orders (See Figure 3.24). The list indicates the name of the medication and its status (A=Acknowledge, P=Pending). The medication administration history can be view by selecting the History button at the bottom of the screen. This action displays the window shown in figure 3.25. This window has a similar function to the medication administration history panel (the right panel) of the Meds Tab Interface (See Figure 3.6). A medication can be acknowledged by selecting the medication on the Meds Interface and then activating the Acknowledge button. This action displays the window shown in figure 3.26. This widow has a similar function as the Medication Acknowledge window of the Tablet PC version (See Figure 3.7).



Figure 3.24 Medications Interface



Figure 3.25 Medication Administration History Window



Figure 3.26 Medication Acknowledge Window



Figure 3.27 Drips Interface

3.3.2.3 Drips Interface

The Drips interface is essentially identical to the Meds interface (See Figure 3.27). It was included to distinguish drip medications from other medications.

3.3.2.4 Vitals Interface

The Vitals interface displays a list of the vital signs measurements listed by date with the most recent first (See Figure 3.28). Contrary to the lists of many other interfaces, the vital signs list grows horizontally. Thus, it requires horizontal scrolling for viewing non-recent values recorded. A graphical view of the vital signs can be viewed by activating the Graph button at the bottom of the screen (See Figure 3.29). A new set of vital signs can be entered by selecting the New button at the bottom of the screen. This action displays the window shown in figure 3.30, which is similar in function to the New Vital Window of the Tablet PC version (See Figure 3.11).

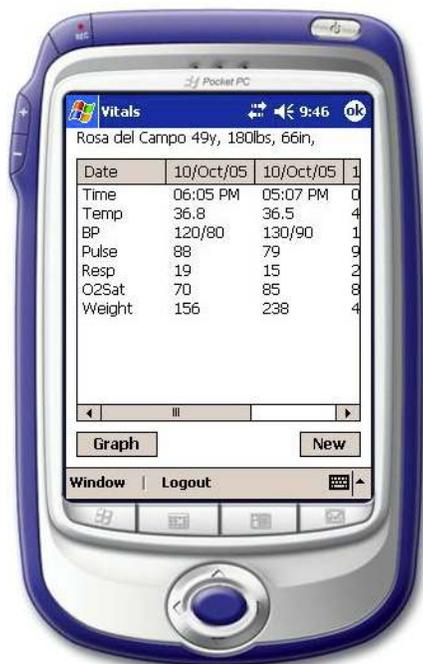


Figure 3.28 Vitals Interface

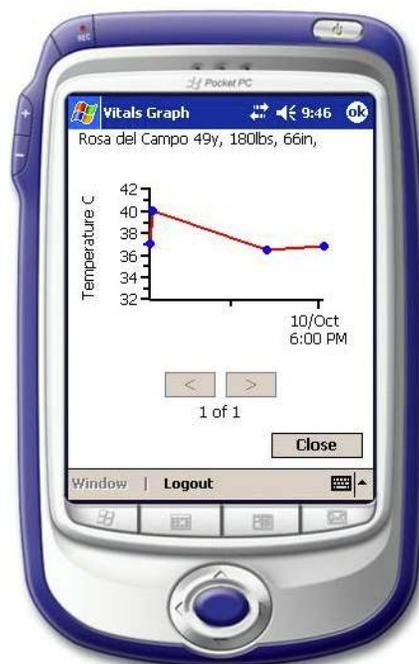


Figure 3.29 Vitals Graph Window

Figure 3.30 New Vitals Window

3.3.2.5 Notes Interface

The Notes interface displays a list of notes about the patient's condition (See Figure 3.31). The list indicates the date the note was written, its focus, the person who wrote it, and the note type. Due to the limitations of the PDA screen the user needs to perform a horizontal scrolling to view all the information for each entry on the list. The detailed content of a note can be viewed by selecting it from the list and then selecting the Open button at the bottom of the screen. This action displays the window shown in figure 3.32. To create a new note the user selects the New button on the Notes interface. This action opens the window shown in figure 3.33. This window has a similar functionality as the New Medication window of the Tablet PC version (See Figure 3.12).

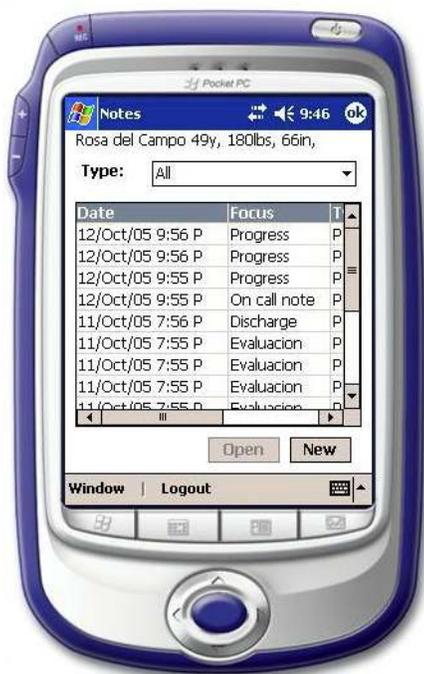


Figure 3.31 Notes Interface



Figure 3.32 Notes Detail Window

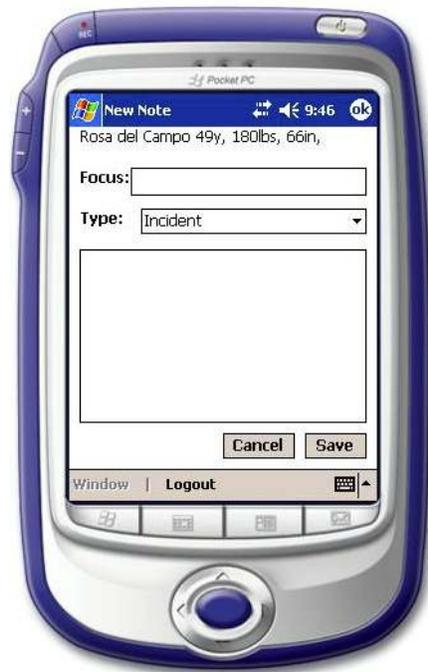


Figure 3.33 New Note Window

3.3.2.6 Assessment Interface

The Assessment interface displays a list of assessment as shown in figure 3.34. The list indicates the date the assessment was done and the nurse who developed it. The details of an assessment can be view by selecting the assessment from the list and selecting the Detail button at the bottom of the screen. This action activates the window shown in figure 3.35. By selecting the New button at the bottom of the Assessment interface a window for entering a new assessment can be displayed (See Figure 3.36). This window displays assessment options for a particular assessment topic. The options are normally provided in the form of buttons, radio buttons and drop down menus. The window shown in figure 3.36 corresponds to the Hygiene assessment topic. The options for other assessment topics can be entered by selecting the option from the drop-down menu above the Cancel and Save buttons or by using the directional arrows to the left of the drop-down menu. The user can enter a comment related to any of the assessment

topics by selecting the Cmt button (See Figure 3.37). A summary of the assessment options and comments being entered for each topic can be viewed by selecting the Summ button (See Figure 3.35).



Figure 3.34 Assessment Interface



Figure 3.35 Assessment Details Window



Figure 3.36 New Assessment Window



Figure 3.37 Assessment Comment Window

3.3.2.7 Intake/Output Interface

The Intake/Output interface (See Figure 3.38) is very similar to the Intake/Output of the Tablet PC version (See Figure 3.15). The main difference is that it requires horizontal scrolling for viewing all the information on the list of I/O measurements. The interface for entering a new I/O value (See Figure 3.39) is similar to the I/O interface of the Tablet PC version (See Figure 3.16).



Figure 3.38 I/O Interface



Figure 3.39 New I/O Window

3.3.2.8 Pain Interface

The pain management interface (See Figure 3.40) displays a list of pain assessments that indicates the date the pain assessment was done, the pain ID, and the pain classification (the intensity). Detailed information of a pain assessment recorded can be displayed on a window (See Figure 3.41) by selecting Details button at the bottom of the screen. A new pain assessment can be made by selecting the New button at the bottom of the Assessment interface. This action displays a window like the one shown in figure 3.42a that provides options for entering a pain level (Classification). The directional arrows at the bottom left corner can be used to display other pain assessment options: location (See Figure 3.42b), description (See Figure 3.42c) and treatments and comments (See Figure 3.42d).



Figure 3.40 Pain Management Interface



Figure 3.41 Pain Detail Window



Figure 3.42a Pain Classification Window



Figure 3.42b Pain Location Window



Figure 3.42c Pain Description Window



Figure 3.42d Pain Treatment Window

Chapter 4, User Testing and Results

4.1 Introduction

One of the most fundamental usability measuring methods is user testing [Nielsen93]. This method is an important part of the software development cycle that addresses user interface design. More often, it provides direct information about potential problems related to the user interaction with the interface.

The purpose of this chapter is to describe and present the results of a usability test in which nurses interacted with two versions of a nursing documentation system. One of the versions ran on a Tablet PC and the other on a PDA.

4.2 Methodology

4.2.1 Objective

The main objective of the usability test presented here was to identify potential usability problems, interaction differences, advantages, and disadvantages of two versions of a nursing documentation system: PDA and Tablet PC.

4.2.2 Systems

The study described in the next sections was conducted using the PDA and Tablet PC versions of the nursing documentation system described in the previous chapter. Both systems are focused on inpatient settings. The Tablet PC version was implemented on a Gateway tablet and running Windows XP Tablet PC operating system. Sections 3.2 and 3.3 provide a more detailed description of the Tablet PC interfaces. The pointing device used for this version was a stylus. For text input, the Tablet PC's soft keyboard (displayed at the bottom of the Tablet screen) was used. The PDA version was

implemented on a Hewlett Packard, iPaq model 5500, and running Microsoft Pocket PC operating system. Sections 3.1 and 3.3 provide a more detailed description of these interfaces. The pointing device used for this version was a small stylus. For text input, the PDA's soft keyboard (displayed at the bottom of the screen) was used.

4.2.3 Participants

A group of 20 staff nurses from a major hospital in San Juan, Puerto Rico, participated in the study. They were selected on a first-come first-served basis from those that responded a call for participation. A profile of the participants is presented in table 4.1 on page 46. Their experience as staff nurses (*Work Exp.*) ranged from 1 to 27 years (*Mean*=12.3 years). Their experience with computers (*Comp. Exp.*) ranged from 0 to 9 years (*Mean*=4.6 years). On average, they used computers on their job (*Comp. Use*) for 3.3 hours per day. None of the participants had prior experience with the systems (*ESUIOI*) used for the study or with any similar application. Also, none of them had experience using PDAs (*PDA Exp.*) or Tablet PCs (*Tablet Exp.*). They were compensated for their participation.

4.2.4 Experimental Design

Before beginning the test, participants were asked to fill out a questionnaire about their work experience and their experience using computers (See Appendix A). They were asked to sign a letter of consent (See Appendix B). An orientation script (See Appendix C) was read to them. The script explained the objectives of the test, participants' role in the test, and test development.

It also pointed out that their participation was voluntary and that they could stop the test whenever they wanted to. Finally, the script clarified that all user information, as well as their participation, would remain anonymous.

Table 4.1 Participants Profile

Subject ID	Gender	Age	Eye Glasses for:		Work Exp. (yrs)	Comp. Exp. (yrs)	Comp. Use (hrs)	ESUIOI	Tablet Exp. (yrs)	PDA Exp. (yrs)
			Read	Computer						
H1	F	31	Yes	Yes	3	4	8	No	0	0
H2	F	30	Yes	Yes	8	0	5	No	0	0
H3	F	44	Yes	Yes	20.83	3	0	No	0	0
H4	F	40	Yes	Yes	6.5	0	0	No	0	0
H5	F	39	Yes	Yes	16	0	4	No	0	0
H6	F	N	Yes	Yes	16.83	6	2	No	0	0
H7	F	51	Yes	Yes	21	7	2	No	0	0
H8	M	37	No	No	1	1	0.5	No	0	0
H9	F	40	Yes	Yes	15	8	7	No	0	0
H10	F	47	Yes	Yes	27.4	9	6	No	0	0
T1	F	44	Yes	Yes	3.83	2	4	No	0	0
T2	F	N	No	No	13	0	0	No	0	0
T3	F	30	No	No	10.4	7	1	No	0	0
T4	F	33	No	No	12	6	2	No	0	0
T5	F	41	Yes	Yes	6.6	0	0	No	0	0
T6	F	39	No	No	20	3	2	No	0	0
T7	F	33	No	No	10	0	0	No	0	0
T8	F	33	No	No	11.1	0	2	No	0	0
T9	F	41	No	No	17	3	1	No	0	0
T10	F	28	No	No	7.5	0.25	0	No	0	0

N = Participant do not provide the information.

A tutorial on how to use the nursing documentation system on each version (PDA and Tablet PC) was given to each of the participants before performing the test on each of the systems. The tutorial for the PDA version took an average of 18 minutes, while the tutorial for the Tablet PC took an average of 13 minutes. In each tutorial, participants were given an explanation on how to work with each of the functions and user interfaces of the system. Then, they were allowed to use the system by themselves and were guided to practice using each of the functions of the system. After completing the tutorial for each version of the system, they were asked to perform 13 tasks standing up. The tasks were identical for both versions. The tasks were:

1. Indicate patient's age and weight. Say them aloud.
2. Indicate the most recent registered patient's temperature.
3. Look for the most recent nurse note and read it aloud.
4. Acknowledge any pending medication order as administered.
5. Enter the following set of vitals signs:

Temp: 37.0° C;

BP: 130/90;

Pulse: 71

RR: 18

O₂ Sat: 96%;

6. Indicate the total balance of intake/output of fluids in the last 24 hours.
7. Look for a Dr. Colón note.
8. Enter the following patient assessment information.

Hygiene: Oral care

Activity: Rest in bed

Pulmonary: Suction

Gastrointestinal: Abnormal abdomen, presents diarrhea

Security: Raised bed rails

Mental: Alert and conscious of everything

Neurological: Responds to verbal, tactile, and pain stimuli

Pupillary reflex in both eyes

Respiratory: Clear lungs

Cardiac: Normal veins and cardiac sounds

Genitourinary: Diminished output, light yellow urine

Skin: Pink, hydrated, lukewarm, intact, presents edema

9. Enter the following I/O information:

Intake PO: 50 ml

Output Urine: 650 ml

10. Enter the following text as a note:

Patient presents fever and a large lung mass on left upper lobe consistent on CT with multi-focal pneumonia

11. Enter the following patient's pain information.

Classification: Four

Location: Right frontal shoulder

Description: Hurt

Therapy: Massage

Administered medicine

12. Look for most recent physician consult order and acknowledge it as that was notified by phone.
13. Show where is indicated in the record the reason why a dose of Roboxine was omitted.

To balance for the learning effect, ten of the participants performed the tasks first on the PDA version and then on the Tablet PC version. The other ten participants performed the tasks first on the Tablet PC and then on the PDA. While the participants performed the tasks, two experimenters were taking timing and writing observations about the participant's interaction. The forms used for collecting data and observations for each participant are presented in Appendixes D to G.

After performing the tasks on both systems, users were asked to complete a subjective user satisfaction questionnaire (See Appendix H). Among other things, participants were asked to rate nine interaction aspects, five system aspects and five physical aspects of each system using a one-to-seven scale (one being poor and seven being excellent). The rated aspects were the following:

Interaction Aspects:

- I1. Look up patient information
- I2. Acknowledge medication orders
- I3. Acknowledge consult order
- I4. Enter vitals signs
- I5. Document intake/output
- I6. Document patient assessment
- I7. Document pain assessment

I8. Read a note

I9. Write a note

System Aspects:

S1. Record organization

S2. Trustworthiness of information

S3. Precision of Information

S4. Accessibility of information

S5. System security

Physical Aspects:

P1. Use of the stylus

P2. Use of the screen keyboard

P3. The screen

P4. The weight

P5. The portability

In addition, participants were asked to rate their level of satisfaction with each system, and to indicate which system they would prefer for doing their nursing documentation. Finally, they were asked to mention things they found easy and/or difficult to use in each version, and to comment on any particular thing they wished to, regarding each version.

4.2.5 Statistical Analysis

The dependent variables of this study were task completion time, number of tasks completed, and subjective user satisfaction. The dependent-samples t test was used to compare the time each user took to complete each task. The Wilcoxon signed ranks test

with an α -level of .05 was used to compare the number of task completed and user satisfaction.

4.2.6 Results

A dependent-samples t test did not reveal a significant difference between the average time it took the participants to complete all the tasks on the PDA ($Mean=656.2$, $SD=191.7$) and the Tablet PC ($Mean=667.3$, $SD=215.6$). Differences in the average completion time for all the tasks can be appreciated in figure 4.1.

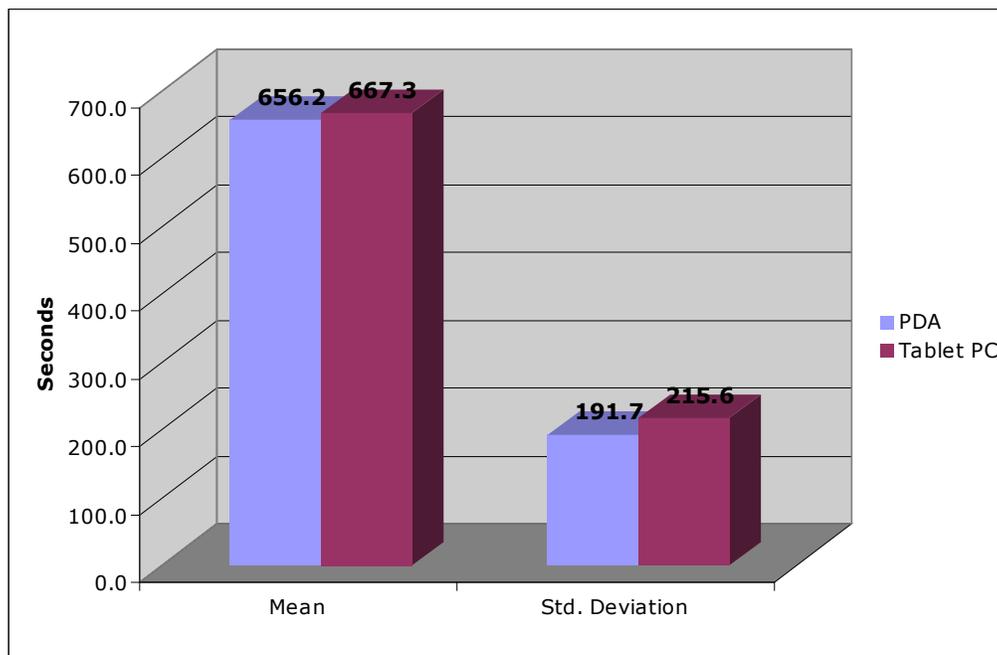


Figure 4.1 Overall Average Completion Times

The average times and standard deviations for the completion time of individual tasks are presented in table 4.2. The differences in the average completion time for each of the tasks can be appreciated in figure 4.2. A dependent-samples t test only revealed a significant difference on the average time it took the participants to complete task seven

(*Look for a Dr. Colón note*) on the PDA and the Tablet PC, $t(19) = 5.43$, $p < .05$. The participants were significantly faster on the Tablet PC than on the PDA.

Table 4.2 Means and Standard Deviations for Completion Times of Each Task.

Tasks	PDA Version		Tablet PC Version	
	Mean (seconds)	SD (seconds)	Mean (seconds)	SD (seconds)
1	4.95	5.907	11.85	13.256
2	8.65	8.080	4.80	4.396
3	22.60	7.458	30.10	27.386
4	17.25	15.269	21.25	17.423
5	31.95	11.048	41.90	40.918
6	27.40	23.959	38.20	29.516
7	27.80	17.884	5.80	4.514
8	193.75	83.318	182.55	52.486
9	36.30	17.254	44.35	22.205
10	190.45	64.916	208.70	75.500
11	39.25	22.417	35.00	14.309
12	24.70	26.567	24.45	25.601
13	31.15	30.240	18.30	9.609

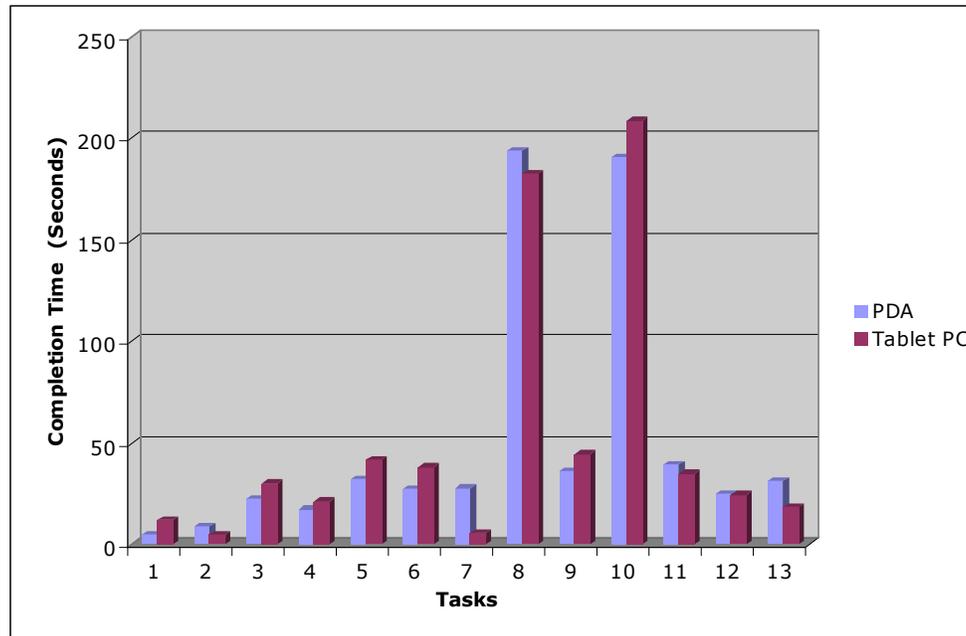


Figure 4.2 Completion Times for Each Task on the PDA and Tablet PC Versions.

A linear regression analysis indicated that no learning effect was evidenced by the participants from the PDA to the Tablet PC or from the Tablet PC to the PDA.

The participants were able to complete the majority of the tasks. Wilcoxon signed ranks tests did not reveal significant difference in the total number of tasks completed by the participants. The participants completed an average of 12.0 tasks on the PDA and 11.7 on the Tablet PC. No significant differences were found in task completion for individual task on the PDA and the Tablet PC. A summary of the number of participants that completed individual tasks is presented in table 4.3. The relative differences in the number of tasks completed can be appreciated in figure 4.3.

Table 4.3 Number of Participants that Completed Each Task

	Task												
	1	2	3	4	5	6	7	8	9	10	11	12	13
PDA	20	20	18	18	19	17	17	17	20	19	19	17	19
Tablet PC	19	20	17	16	19	18	20	17	17	17	20	13	20

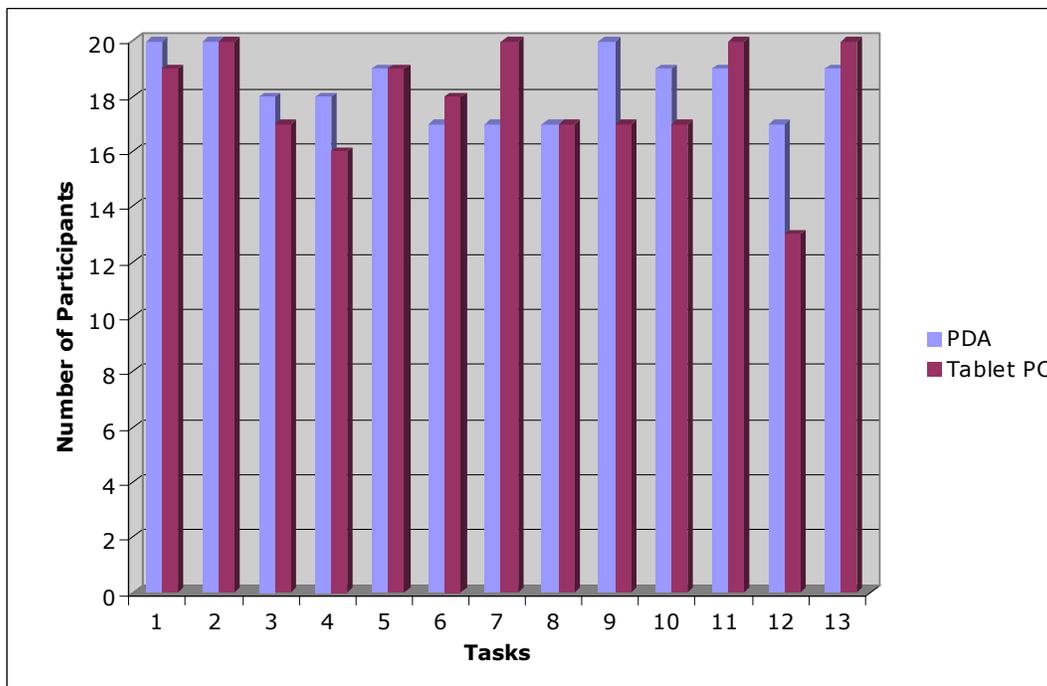


Figure 4.3 Number of Participants that Completed Each Task on Each Version of the System

Wilcoxon tests did not reveal a significant difference in the average overall satisfaction rating given to the nine interaction aspects I1-I9 considered (See Section 4.2.4). The overall average satisfaction rating for the PDA was 6.5 and for the Tablet PC was 6.7. The average rating given to each of the interaction aspects for the PDA and the Tablet PC are summarized in table 4.4. The relative differences in the average satisfaction rating given each of the interaction aspects can be appreciated in figure 4.4.

Table 4.4 Average Satisfaction Ratings of Individual Interaction Aspects

	I1	I2	I3	I4	I5	I6	I7	I8	I9
PDA	6.45	6.42	6.53	6.65	6.75	6.5	6.68	6.47	6.44
Tablet PC	6.421	6.6	6.6	6.8	6.8	6.58	6.8	6.7	6.65

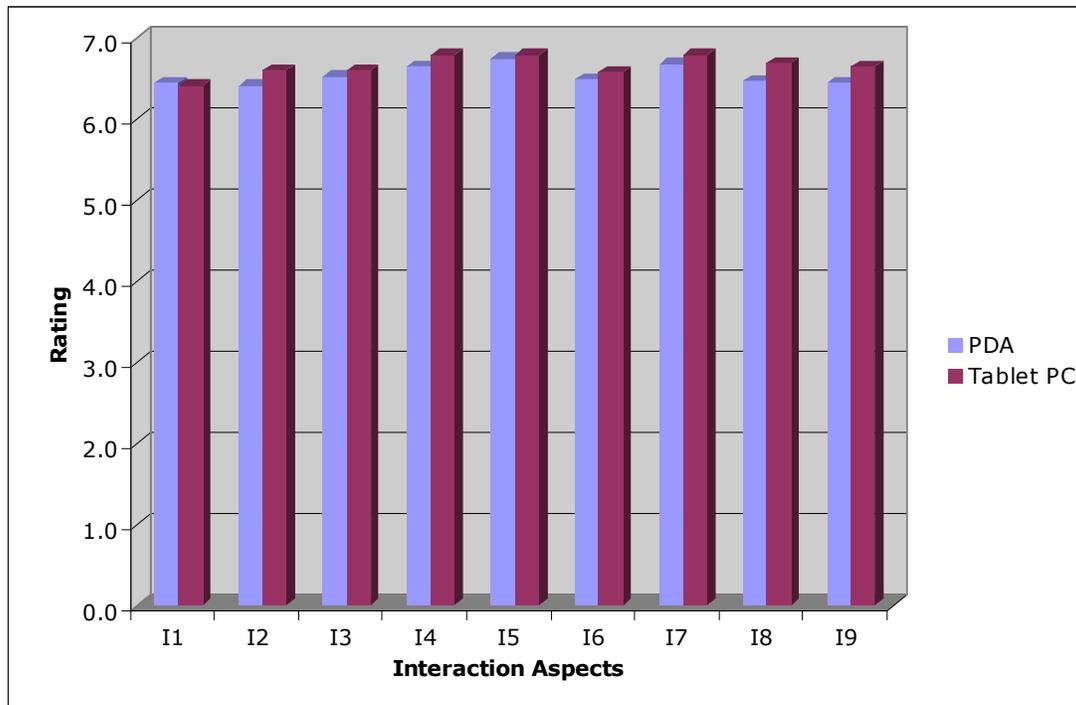


Figure 4.4 Average Satisfaction Ratings for Individual Interaction Aspects

Wilcoxon tests did not reveal a significant difference in the overall average satisfaction rating given to the 5 system aspects S1-S5 considered (See section 4.2.4). The overall average satisfaction rating for the PDA and the Tablet PC was 6.8. The average rating given to each of the system aspects for the PDA and the Tablet PC are summarized in table 4.5. The relative differences in the average satisfaction rating given each of the system aspects can be appreciated in figure 4.5.

Table 4.5 Average Satisfaction Ratings of Individual System Aspects

	S1	S2	S3	S4	S5
PDA	6.789	6.89	6.84	6.63	6.65
Tablet PC	6.75	6.8	6.75	6.8	6.65

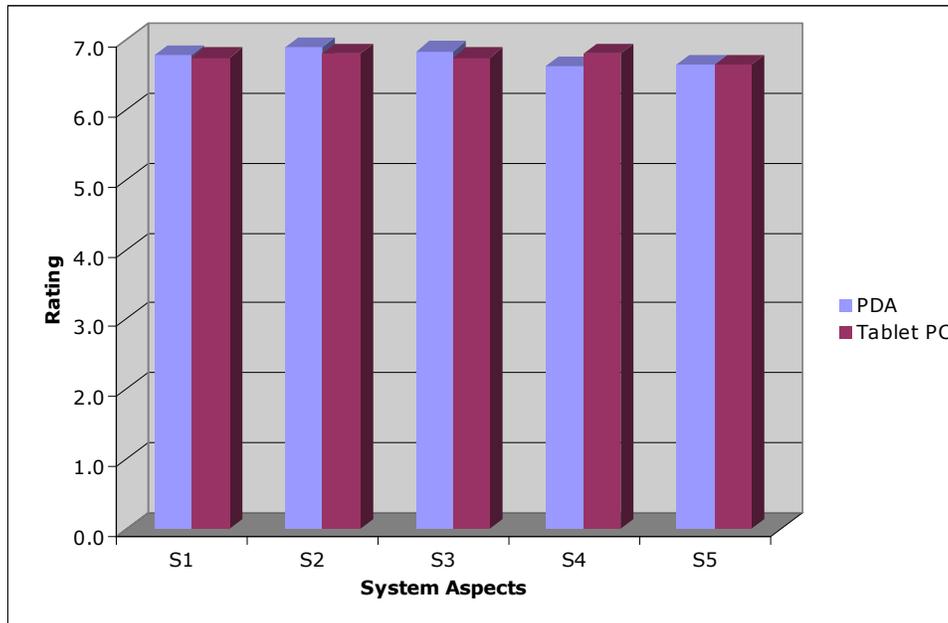


Figure 4.5 Average Satisfaction Ratings for Individual System Aspects

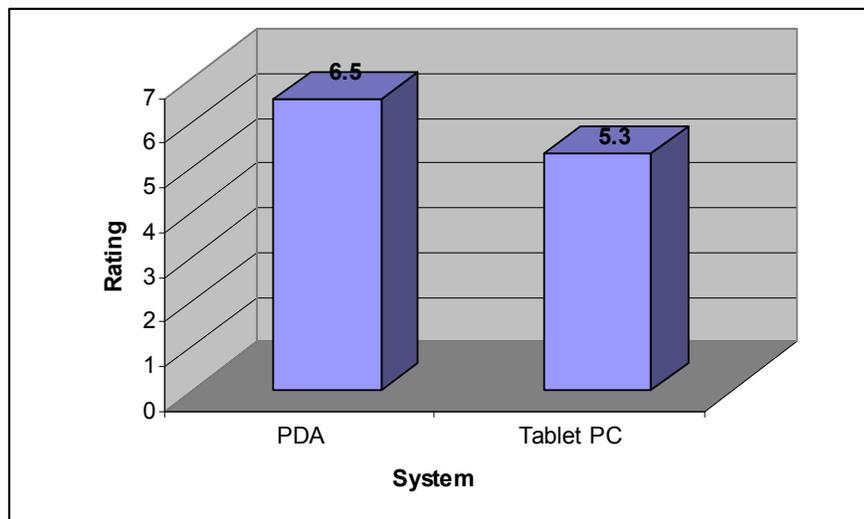


Figure 4.5 Overall Average Satisfaction Ratings for Physical Aspects of the PDA and Tablet PC Computers

A Wilcoxon test revealed a significant difference in overall satisfaction with the five physical aspects (P1-P5) considered (See Section 4.2.4). The participants were more

satisfied with the PDA computer (*Average Rating* = 6.6) than with the Tablet PC computer (*Average Rating* = 5.2). Wilcoxon tests also revealed significant differences in user satisfaction rating for physical aspects P1 (use of the stylus), P4 (weight) and P5 (portability). The participants were more satisfied with the use of the stylus on the PDA (*Average Rating* = 6.7) than on the Tablet PC (*Average Rating* = 6.2). The participants were more satisfied with the weight of the PDA (*Average Rating* = 6.5) than with the weight of the Tablet PC (*Average Rating* = 4.1). Finally, the participants were more satisfied with the PDA portability (*Average Rating* = 6.6) than with the Tablet PC portability (*Average Rating* = 3.5). The average ratings given to each of the physical aspects of the computers are summarized in table 4.6. The relative differences in satisfaction ratings for physical aspects can be appreciated in figure 4.6

Table 4.6 Average Satisfaction Rating for Physical Aspects of the PDA and Tablet PC

	P1	P2	P3	P4	P5
PDA	6.74	6.61	6.37	6.55	6.6
Tablet PC	6.22	6.06	6.53	4.05	3.47

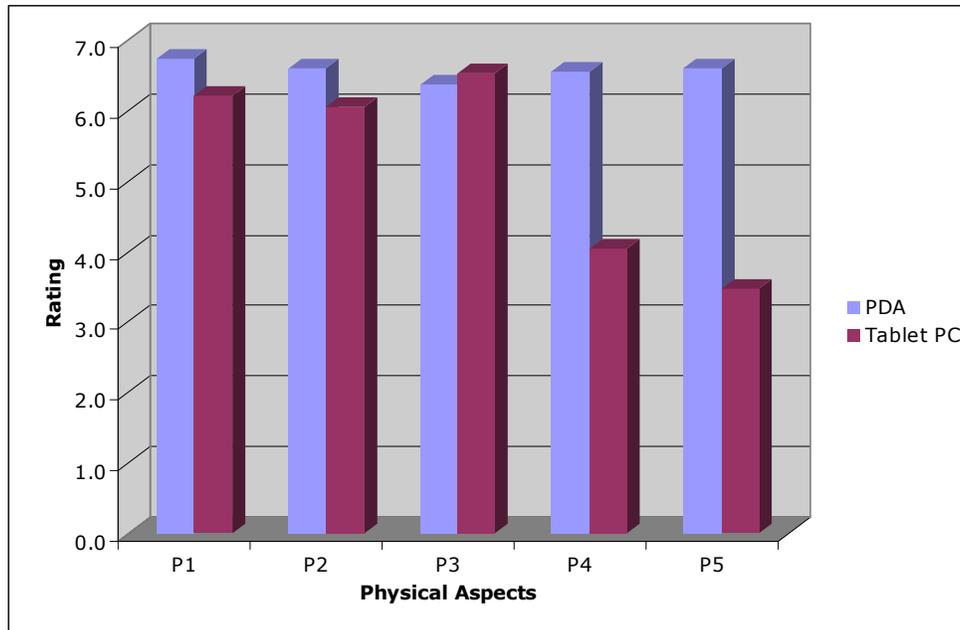


Figure 4.6 Average Satisfaction Ratings for Individual Physical Aspects

No significant differences were found in the overall satisfaction rating given by the participants to each version of the nursing documentation systems. The average satisfaction rating for the PDA version was 6.8 and 6.0 for the Tablet PC. However, the majority of the participants preferred the PDA over the Tablet PC version for performing their nursing documentation tasks. Fourteen participants indicated that they preferred the PDA version, five preferred the Tablet PC, and one preferred both.

The open-end section of the survey (See Appendix H) provided interesting insights of what issues were of most concern to the participants, regarding each version of the system. The elements that they found more difficult to use are shown in table 4.7. In Tablet PC, the more negative/difficult element was its weight. In a similar way, table 4.8 shows the elements that participants found easier to use. Some participants found that entering vitals and I/O measurements were the easier tasks to do in both systems.

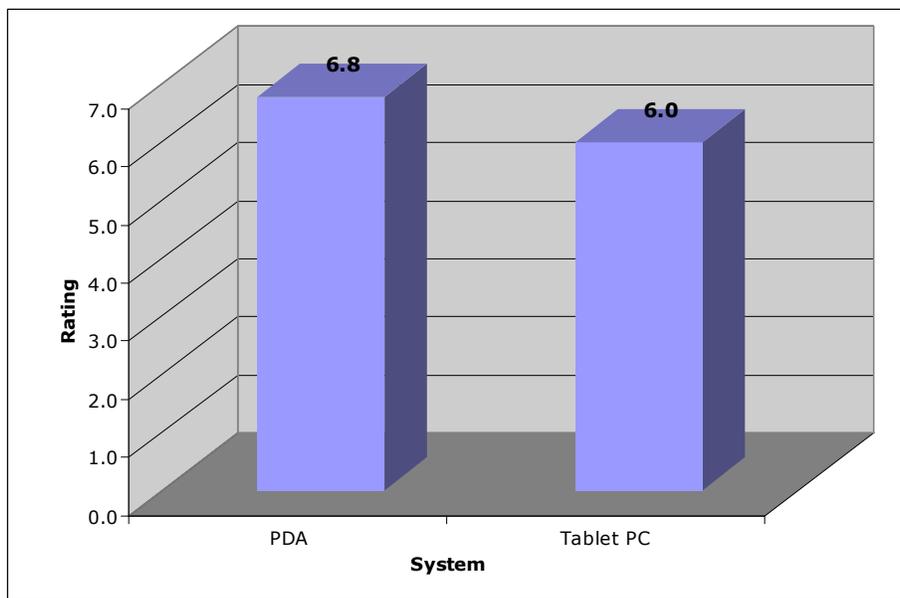


Figure 4.7 Average User Satisfaction Ratings for Each Version of the System

The open-end section of the survey (See Appendix H) provided interesting insights of what issues were of most concern to the participants, regarding each version of the system. The elements that they found more difficult to use are shown in table 4.5. In Tablet PC, the more negative/difficult element was its weight. In a similar way, table 4.6 shows the elements that participants found easier to use. Some participants found that entering vitals and I/O measurements were the easier tasks to do in both systems.

Table 4.7 Elements that the Participants Found More Difficult To Use/Do

Comment	Frequency	
	PDA	Tablet PC
1. Looking for a consult order	1	0
2. Device weight	0	12
3. The use of the stylus	0	1
4. Assessment	1	1
5. Too much navigation through the windows	1	0
6. Form factor of the device	0	2
7. Font size	1	1
8. Keyboard	1	1

Table 4.8 Elements that the Participants Found Easier to Use/Do

Comment	Frequency	
	PDA	Tablet PC
1. Entering Vitals Signs	2	2
2. All information displayed in one window	0	1
3. Entering Intake/Output measurements	2	2

Chapter 5, Discussion

The results of the study described in the previous chapter indicate that there is not a significant difference in the overall time it took nurses to complete tasks with the PDA and with the Tablet PC. This is a very surprising result because it contradicts our expectations that nurses would be faster using a larger user interface than a smaller one. These results are consistent with the results of the study by Rodríguez et. al. [Rodríguez03]. In that study, when the task of writing a note was not considered, nurses were able to complete nursing tasks in similar overall times on the PDA and on Laptop. However, and contrary to the present study, in [Rodríguez03] study significant statistical differences were found in the time it took nurses to complete various individual tasks. These differences in individual tasks were mainly due to the input modalities used on each system. For tasks requiring numeric and textual input, a display soft keyboard was used for the PDA, while the standard keyboard was used for the laptop. For pointing and clicking, a stylus was used for the PDA, and a touchpad for the laptop. Nurses were significantly faster on the PDA on tasks requiring pointing and clicking. However, they were faster on the laptop for tasks requiring numeric and textual input.

In the present study the input modalities used for the PDA and the Tablet PC systems were the same. The results revealed significant differences only in one of the thirteen tasks. This is a very strong indication that for interactions requiring the use of a stylus, the screen size and resolution is not a factor in nurses' performance. Nurses can look for information, document, read, and write as fast on a PDA as they would on a Tablet PC.

The only task for which nurses resulted significantly faster on the Tablet PC than on the PDA was task number seven. This task required the nurses to look for a note written by a specific physician. In order to find the note on the PDA, the nurses had to perform horizontal and vertical scrolling because the note was hidden below the list of notes initially displayed, and the name of the physician was hidden on a column to the right. Due to the small size of the screen, only eight notes can be visible, and only their dates and focus could initially be displayed (See Figure 5.1).

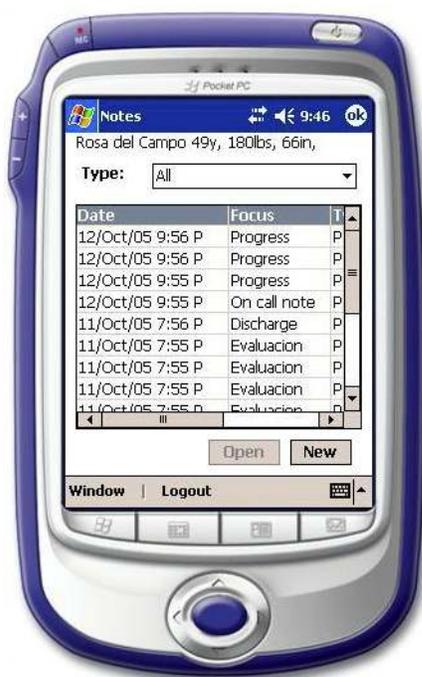


Figure 5.1 PDA Screen for Listing Notes

A correlation analysis was performed to determine if a correlation exist between the overall time it took nurses to complete the tasks on each system and their age, years of work experience, years of experience using computers, daily use of computers, daily use of computers on the workplace, and the use of glasses for reading and using

computers. The analysis only revealed a correlation between the nurses' age and the overall time it took to complete the tasks on both systems. Younger nurses tend to take shorter times in completing tasks.

No significant differences were found in the number of tasks completed by the nurses on the PDA and Tablet PC versions of the nursing documentation systems. The nurses that participated in the study were able to complete the large majority of the tasks on both systems, even though they did not have any prior experience using PDAs or Tablet PCs and that both versions of the nursing documentations were new to them. They completed an average of 12.0 tasks on the PDA and 11.7 on the Tablet PC. These results are very encouraging considering that their exposure to the two nursing documentation versions was only through the short tutorials they took before performing tasks (18 minutes for the PDA and 13 minutes for the Tablet PC). These results indicate that the PDA and Tablet PC nursing documentation systems are very easy to learn. The obvious implication of this finding is that nurses will require minimal training to learn how to use the systems. Similar results were found in the [Rodríguez03] study. On that study nurses were also able to complete most of the nursing documentation tasks after being given very short tutorials.

There were five tasks that at least two participants were not able to complete on each system (T3, T4, T6, T8, and T12). For tasks T4, T6, T8, and T12 the participants were asked to "*document*" something specific. It seems that the use of the word "document" in the text describing the task was interpreted by some of the nurses as requiring them to enter the Notes tab. This appears to create confusion in some of the nurses to the point that they did not find the way to complete the task successfully.

Nurses expressed similar high levels of satisfaction with the documentation activities performed in the PDA and Tablet PC systems. No significant difference was found on the overall ratings they gave the systems for interaction aspects I1-I9. The results also did not revealed significant differences among individual interaction tasks.

Nurses also expressed similar high levels of satisfaction with the system aspects of the PDA and Tablet PC applications. No significant difference was found on the overall ratings they gave each version for system aspects S1-S5. Also, the results did not revealed significant differences among individual system aspects. Nurses were very satisfied with the organization of the record, the system security, and the information trustworthiness, accessibility, and precision on both systems.

The results did reveal significant differences in the nurses' satisfaction with the physical aspects of the two systems. They were significantly more satisfied with the physical aspects of the PDA than of the Tablet PC. Specifically, they were more satisfied with the use of the stylus, the weight, and the portability of the PDA. The weight of the Tablet PC was the physical aspect that most nurses (12 out of 20) indicated that was difficult to handle. Many of them expressed discomfort in holding the Tablet PC in a standing position during the test session. This result is consistent with the studies conducted by Jian Chen [Chen05] and Christopher L. Andon [Andon04]. In these studies the users stated that the Tablet PC was either too heavy or too cumbersome to use in a standing position.

Among the dependent variables, satisfaction with the physical aspects was the only one that evidenced significant differences between the two versions of the nursing documentation system considered in this study. It seems that these aspects were the

deciding aspects on the nurses' preference of the systems. Fourteen of the nurses indicated that they preferred the PDA version for performing nursing documentation tasks while only four preferred the Tablet PC.

Chapter 6, Conclusions

The results of the study indicate that there are no significant differences in the time it takes nurses to complete typical nursing tasks on a PDA and on a Tablet PC. Nurses are as fast on the PDA as on the Tablet PC. The results also indicate that there are no significant differences in nurses' satisfaction with both versions of the nursing documentation application. These results support the conclusion that it is possible to design PDA-based nursing documentation applications that allow nurses to achieve similar performance and satisfaction levels as with a Tablet PC-based application. The small screen size and display resolution of the PDAs are not factors that limit nurses' performance and satisfaction in comparison to Tablet PCs.

Nurses were significantly more satisfied with the physical aspects of the PDA than those of the Tablet PC. Specifically, nurses were more satisfied with the use of the stylus, weight, and portability of the PDA. Thus, we can conclude these three physical aspects are factors that influence nurses' satisfaction with a system.

A correlation was found between the nurses' age and overall time it took them to complete the tasks on both systems. The correlation analysis indicates that younger nurses tend to take shorter times in completing the tasks. Thus, age seems to be a factor that influences nurses' performance. A decrease in psychomotor ability with increasing age may be a factor for the reduced performance but more correlation studies must be conducted in order to sustain this finding.

The graphical user interfaces of the PDA and Tablet PC were designed following usability engineering principles. Most of the information could be entered by pointing and clicking. In addition, each version of the system was developed in such a way that

every aspect followed a logical order, making the systems as intuitive and user friendly as possible. As a result, nurses that participated in the study, without having any experience using PDAs, Tablet PCs, or electronic patient record systems, were able to complete most of the tasks with just a short tutorial of the systems. The study demonstrated that both versions of the nursing documentation system exhibited a high degree of learnability. Thus, we can conclude that nurses are able to learn to use PDA-based and Tablet PC-based nursing documentation application with relative ease and minimal training. It is reasonable to expect that task completion times, percentage of task completed, and user satisfaction will increase as participants gain experience with the applications.

Considering that satisfaction with the physical aspects of the systems was the only dependent variable for which a significant difference was found in favor of the PDA, that fourteen out of twenty participants selected the PDA over the Tablet PC for performing nursing documentation tasks, and the relatively low costs of the PDA, we can conclude that PDAs are a better alternative for supporting nursing documentation tasks at bed side than Tablet PCs.

In order to determine how much improvement is possible to be reached, other usability studies should be conducted in the future. For example, a PDA/Tablet PC system can be installed in a hospital unit to conduct a similar study as the one presented in this document after the nurses have had a year of experience with the system. In addition, similar studies should be conducted with physicians interacting with applications that support typical physicians' tasks at bedside. Finally, similar studies must be conducted but with nurses and physicians from different healthcare centers and different care units in order to have a more diversified population.

Regarding the graphical user interface (GUI), many important features were left out of the present implementation. These features are the incorporation of printing and supplemental language options capabilities. In addition, an interface for a Kardex should be implemented. This is the interface that summarizes important patient information used during transition from one shift to other. Another important feature that should be considered is the use of speech recognition capability, which could help in transcription of nurses' notes and to overcome the time consuming task of text entry through virtual keyboards. Finally, serious consideration should be given to the conversion of the bedside applications to a web based applications. This will allow systems to be updated and maintained without any installation on client computers.

Bibliography

- [Adatia03] Adatia, Feisal and Philippe L. Bedard. "Palm reading: 2. Handheld software for physicians". *Canadian Medical Association Journal*. (March 18, 2003), vol. 168 (6), pp. 727-724.
- [Andon04] Andon, Christopher L. "Usability Analysis of Wireless Tablet Computing in an Academic Emergency Department". Capstone Project. Master Thesis, Oregon Health and Science University, 2004.
- [Barrett02] Barrett, James R., Scott M. Strayer, and Jane R. Schubart. "Assessing the Personal Digital Assistant Uses and Needs of Medical Residents". *Proc. of the AMIA Symp.* (2002).
- [Bates03] Bates, DavidW., Mark Ebell, Edward Gotlieb, John Zapp, and H. C. Mullins. "A Proposal for Electronic Medical Records in U. S. Primary Care". *Journal of American Medical Informatics Association*. (2003), vol. 10 (1), pp. 1-10.
- [Berner04] Berner, Eta S., Grant T. Savage, Thomas K. Houston, Eric S. Williams, Myra A. Crawford, and Midge N. Ray. "Impact of Patient Feedback on Residents' Handheld Computer Use: A Multi-Site Study". *Medinfo*. (2004), pp. 582-586.
- [Chen04] Chen, Elizabeth S., Eneida A. Mendonça, Lawrence K. McKnight, Meter D. Stetson, Jianbo Lei, and James J. Cimino. "PalmCIS: A Wireless Handheld Application for Satisfying Clinician Information Needs". *Journal of American Medical Informatics Association*. (Jan-Feb 2004), vol. 11 (1), pp. 19-28.
- [Chen05] Chen, J., Narayan, M.A., and Pérez-Quiones, M.A., "The Use of Hand-held Devices for Search Tasks in Virtual Environments". *Proc of the IEEE VR2005 workshop on New Directions in 3DUI*, 15-18, Germany, March 2005.
- [Choi00] Choi J, Hyun S, Chun J, Lee S, Shi D, Kim D. "Implementation of Mobile Computing System in Clinical Environment: MobileNurse". *Proc. of the AMIA Symp.* (2000).
- [Fischer03] Fischer, Sandra, Thomas E. Stewart, Sangeeta Mehta, Randy Wax, and Stephen E. Lapinsky. "Handheld Computing in Medicine". *Journal of the American Medical Informatics Association*. (March-April 2003), vol. 10 (2), pp. 139-149.
- [ISO93] International Standards Organization. ISO CD 9241-11. Guidelines for specifying and measuring usability. (1993).
- [Kimura03] Kimura, Eizen, Yasuki Onozaki, Yoshikazu Shizui, and Masato Ohnishi. "Development of Nursing Care Support System using PDA with Wireless and Barcode Reader". *Proc. of the AMIA Symp.* (2003).

- [Murillo03] Murillo, Viviam L., “A Study of Physicians’ Interaction with Paper-based, Character-based and Graphical-based Patient Record Systems”. Master Thesis, University of Puerto Rico at Mayagüez, 2003.
- [Nielsen93] Nielsen, J. “Usability Engineering”. Academic Press A Harcourt Science and Technology Company. 1993.
- [Rodríguez02] Rodríguez, Néstor J., José A. Borges, Viviam Murillo y Johanna Ortiz. “A Study of Physicians Interactions with Text-Based and Graphical-Based Electronic Patient Record Systems”. Proc of the 15th IEEE Symp. on Computer-Based Medical Systems (2002).
- [Rodríguez03] Rodríguez, Néstor J., José A. Borges, Yajaira Soler, Viviam Murillo y Celia R. Colón Rivera. “PDA vs. Laptop: A Comparisson of Two Versions of the Nursing Documentation Application”. Proc of the 16th IEEE Symp. on Computer-Based Medical Systems. (2003).
- [Rodríguez04] Rodríguez, Néstor J., José A. Borges, Yajaira Soler, Viviam L. Murillo, D. Z. Sands, “A Usability Study of Physicians Interaction with PDA and Laptop Applications to Access an Electronic Patient Record System”, 17th. IEEE International Symposium on Computer-Based Medical Systems. (2004).
- [Rosenbloom03] Rosenbloom, Mark. “Medical Error Reduction and PDA’s”. International Pediatrics. (2003), vol. 18 (2), pp. 69-77.
- [Soler03] Soler, Yajaira, “A Usability Study of Physicians’ and Nurses’ Interaction with PDA and Laptop Applications to Access an Electronic Patient Record System”. Master Thesis, University of Puerto Rico at Mayagüez, 2003.
- [Staggers00] Staggers, Nancy, David Kobus. “Comparing Response Time, Errors, and Satisfaction Between Text-based and Graphical User Interfaces During Nursing Order Tasks”. Journal of American Medical Informatics Association. (Mar-Apr 2000), vol. 7 (1), pp.164-176.
- [Stausberg03] Stausberg, Jürgen, Dietrich Koch, Josef Ingenerf, and Michael Betzler. “Comparing Paper-based with Electronic Patient Records: Lessons Learned during a Study on Diagnosis and Procedure Codes”. (2003), vol. 10 (5), pp.470-477.
- [van der Velde01] van der Velde, ET, C Brobbel, TA Witteman, DE Atsma, MJ Schali, HJ Spruij, J Bosmans, MH Baljon. “Application of Handheld Computers of Mobil Access to a Cardiology information System”. Computers in Cardiology. (2001), vol. 28, pp. 157-160.
- [Ying03] Ying, Alan. “Mobile Physician Order Entry”. Journal of Healthcare Information Management. (2003), vol. 17 (1), pp. 58-63.

Appendix

Appendix A: Cuestionario 1

Masculino__ Femenino __

Edad: ____

Posición o puesto que ocupa: _____

Tiempo que lleva trabajando como enfermera: ____ años y ____ meses

Usted utiliza espejuelos o lentes de contacto para:

¿Leer? __ Sí __ No

¿Usar las computadoras? __ Sí __ No

¿Cuál es su mano dominante? __ Derecho __ Izquierda __ Ambas

Favor de contestar las preguntas abajo mencionadas para ayudarnos a entender su trasfondo y experiencia.

1. ¿Por cuánto tiempo usted ha estado utilizando computadoras personales?
____ años y ____ meses
 2. ¿En un día típico, con cuánta frecuencia utiliza las computadoras? ____ horas
 3. ¿En un día típico, con cuánta frecuencia utiliza las computadoras para realizar su trabajo?
____ horas
 4. ¿Usted ha utilizado un sistema electrónico de récord médico en otra institución de cuidado médico? __ Sí __ No
- Si su respuesta a la pregunta anterior es No, continuar con la pregunta 6.*
5. ¿Por cuánto tiempo usted ha utilizado sistemas electrónicos de récord médico en otras instituciones? ____ años y ____ meses
 6. ¿Ha tenido o tiene experiencia utilizando PDAs? __ Sí __ No
- Si su respuesta a la pregunta anterior es no, continuar con la pregunta 10.*
7. ¿Por cuánto tiempo usted ha estado utilizando PDAs? ____ años y ____ meses
 8. ¿En un día típico, con cuanta frecuencia utiliza PDAs? ____ horas
 9. ¿Con cuál(es) PDA(s) usted tiene o ha tenido experiencia?
 - a. iPAQ
 - b. Palma
 - c. Otra: _____
 10. ¿Usted tiene experiencia utilizando Tablet PCs? __ Sí __ No
 11. ¿Por cuánto tiempo ha estado utilizando Tablet PCs? ____ años y ____ meses
 12. ¿Con cuál(es) Tablet PC(s) usted tiene o ha tenido experiencia?
 - a. Gateway
 - b. Toshiba
 - c. Otra: _____
 13. ¿En un día típico, con cuánta frecuencia utiliza Tablet PCs? ____ horas
 14. ¿En un día típico, con cuánta frecuencia utiliza Tablet PCs para realizar su trabajo?
____ horas

Appendix B: Hoja de Consentimiento

Como parte de un proyecto de investigación sobre record médicos electrónicos estamos realizando unas pruebas de interacción de enfermeras con dos sistemas electrónicos de documentación de enfermería. Uno de los sistemas es un Asistente Personal Digital (PDA por sus siglas en inglés) y el otro es una computadora portátil conocida como “Tablet PC”. El propósito del estudio es determinar las ventajas y desventajas de ambos sistemas de documentación cuando un(a) enfermera(o) interactúa con los mismos.

A las personas que participen en el estudio se les solicita que llenen un cuestionarios sobre su experiencia profesional y utilizando computadoras. Luego se les solicita que realizan una serie de tareas en cada uno de los sistemas electrónicos. Finalmente, los/las participantes llenaran un cuestionario sobre su interacción con los sistemas electrónicos. La identidad de los/las participantes será protegida y solamente los/las investigadores/as tendrán acceso a la información recopilada.

Yo, _____, voluntariamente consiento a participar en el estudio antes descrito. Se me ha orientado sobre el propósito y procedimiento del mismo. Entiendo que puedo abandonar este estudio en el momento que así lo desee y que se garantiza mi confidencialidad.

Firma del Participante

Fecha

Appendix C: Orientación

Saludos, mi nombre es Néstor Rodríguez y él es Gilberto Crespo. Nosotros vamos a trabajar con ustedes en la sesión de hoy. Voy a explicarles la razón por la que le pedimos que estuviera aquí hoy.

Vamos a realizar unas pruebas a unos sistemas de récord médicos electrónico en computadoras portátiles como “estas”. Para poder hacer esto, necesitamos su ayuda. Usted realizará algunas tareas típicas con el sistema de récord médico y quisiéramos que las realizara como usted lo hace normalmente. Esto significa que usted intentará trabajar a la misma velocidad y concentración con que siempre lo ha hecho. Haga lo mejor posible, pero no se preocupe por los resultados. Ésta es una prueba de los sistemas electrónicos, no de usted. Los sistemas todavía están en una versión prototipo, por lo que puede ser que no trabajen como usted espera. Usted puede hacer preguntas en cualquier momento, pero puede que no se las contestemos, puesto que éste es un estudio de los sistemas electrónicos y necesitamos ver cómo se desempeñan cuando una persona como usted está trabajando sola con ellos.

Durante la sesión de hoy, pediremos que usted llene algunos formularios y que conteste algunas preguntas. Es importante que usted conteste con toda honestidad. Nuestro papel aquí es descubrir ventajas y desventajas de los sistemas electrónicos desde el punto de vista de ustedes.

Mientras usted está trabajando, nosotros estaremos cerca para tomar algunas notas y tiempos. Utilizaremos un código para referirnos a usted en el análisis de la información recopilada, de manera que su participación sea anónima.

¿Tiene alguna pregunta?

Entonces, comencemos con la sesión.

Appendix D: Data Collection – PDA

Task	Description	Comp.	Time
1	Indique en voz alta la edad y peso del paciente.		
2	Indique la temperatura del paciente registrada más recientemente.		
3	Busque la nota de enfermería más reciente y léala en voz alta.		
4	Documente como administrados cualquier tipo de medicamento pendiente de administración.		
5	Anote los siguientes signos vitales del paciente:		
6	Indique el balance total de entrada y salida de fluidos en las últimas 24 horas.		
7	Busque la nota escrita por el Dr. Colón.		
8	Documente el estimado del paciente con la siguiente información:		
9	Anote las siguientes cantidades de I/O:		
10	Escriba el siguiente texto como una nota de progreso con un enfoque de evaluación:		
11	Documente un nuevo dolor del paciente con la siguiente información:		
12	Busque la orden de consulta médica más reciente y documéntela indicando que el médico fue notificado por teléfono.		
13	Muestre dónde en el record se indica por qué razón se omitió una dosis del medicamento Roboxine.		

_____ Comienza

_____ Tutorial PDA

_____ Prueba Tablet

_____ Cuestionario 1

_____ Prueba PDA

_____ Cuestionario 2

_____ Orientación

_____ Tutorial Tablet

_____ Termina

Appendix E: Observations - PDA

Task	Description	Observations
1	Indique en voz alta la edad y peso del paciente.	
2	Indique la temperatura del paciente registrada más recientemente.	
3	Busque la nota de enfermería más reciente y léala en voz alta.	
4	Documente como administrados cualquier tipo de medicamento pendiente de administración.	
5	Anote los siguientes signos vitales del paciente:	
6	Indique el balance total de entrada y salida de fluidos en las últimas 24 horas.	
7	Busque la nota escrita por el Dr. Colón.	
8	Documente el estimado del paciente con la siguiente información:	
9	Anote las siguientes cantidades de I/O:	
10	Escriba el siguiente texto como una nota de progreso con un enfoque de evaluación:	
11	Documente un nuevo dolor del paciente con la siguiente información:	
12	Busque la orden de consulta médica más reciente y documéntela indicando que el médico fue notificado por teléfono.	
13	Muestre dónde en el record se indica por qué razón se omitió una dosis del medicamento Roboxine.	

Appendix F: Data Collection - Tablet PC

Task	Description	Comp.	Time
1	Indique en voz alta la edad y peso del paciente.		
2	Indique la temperatura del paciente registrada más recientemente.		
3	Busque la nota de enfermería más reciente y léala en voz alta.		
4	Documente como administrados cualquier tipo de medicamento pendiente de administración.		
5	Anote los siguientes signos vitales del paciente:		
6	Indique el balance total de entrada y salida de fluidos en las últimas 24 horas.		
7	Busque la nota escrita por el Dr. Colón.		
8	Documente el estimado del paciente con la siguiente información:		
9	Anote las siguientes cantidades de I/O:		
10	Escriba el siguiente texto como una nota de progreso con un enfoque de evaluación:		
11	Documente un nuevo dolor del paciente con la siguiente información:		
12	Busque la orden de consulta médica más reciente y documéntela indicando que el médico fue notificado por teléfono.		
13	Muestre dónde en el record se indica por qué razón se omitió una dosis del medicamento Roboxine.		

_____ Comienza	_____ Tutorial Tablet	_____ Prueba PDA
_____ Cuestionario 1	_____ Prueba Tablet	_____ Cuestionario 2
_____ Orientación	_____ Tutorial PDA	_____ Termina

Appendix G: Observations - Tablet PC

Task	Description	Observations
1	Indique en voz alta la edad y peso del paciente.	
2	Indique la temperatura del paciente registrada más recientemente.	
3	Busque la nota de enfermería más reciente y léala en voz alta.	
4	Documente como administrados cualquier tipo de medicamento pendiente de administración.	
5	Anote los siguientes signos vitales del paciente:	
6	Indique el balance total de entrada y salida de fluidos en las últimas 24 horas.	
7	Busque la nota escrita por el Dr. Colón.	
8	Documente el estimado del paciente con la siguiente información:	
9	Anote las siguientes cantidades de I/O:	
10	Escriba el siguiente texto como una nota de progreso con un enfoque de evaluación:	
11	Documente un nuevo dolor del paciente con la siguiente información:	
12	Busque la orden de consulta médica más reciente y documéntela indicando que el médico fue notificado por teléfono.	
13	Muestre dónde en el record se indica por qué razón se omitió una dosis del medicamento Roboxine.	

Appendix H: Cuestionario 2

Utilizando la escala de 1 a 7 que se provee adelante, donde 1 es pobre y 7 es excelente, indique su apreciación sobre los siguientes aspectos en cada sistema. Circule el número que mejor refleje su apreciación.

	Sistema PDA	Sistema Tablet PC
1. Buscar información en el record del paciente	(pobre) 1 2 3 4 5 6 7 (excelente)	(pobre) 1 2 3 4 5 6 7 (excelente)
2. Documentar órdenes de medicamentos	(pobre) 1 2 3 4 5 6 7 (excelente)	(pobre) 1 2 3 4 5 6 7 (excelente)
3. Documentar orden de consulta médica	(pobre) 1 2 3 4 5 6 7 (excelente)	(pobre) 1 2 3 4 5 6 7 (excelente)
4. Anotar signos vitales	(pobre) 1 2 3 4 5 6 7 (excelente)	(pobre) 1 2 3 4 5 6 7 (excelente)
5. Documentar I/O	(pobre) 1 2 3 4 5 6 7 (excelente)	(pobre) 1 2 3 4 5 6 7 (excelente)
6. Documentar estimado del paciente	(pobre) 1 2 3 4 5 6 7 (excelente)	(pobre) 1 2 3 4 5 6 7 (excelente)
7. Documentar dolor.	(pobre) 1 2 3 4 5 6 7 (excelente)	(pobre) 1 2 3 4 5 6 7 (excelente)
8. Leer una nota	(pobre) 1 2 3 4 5 6 7 (excelente)	(pobre) 1 2 3 4 5 6 7 (excelente)
9. Escribir una nota	(pobre) 1 2 3 4 5 6 7 (excelente)	(pobre) 1 2 3 4 5 6 7 (excelente)
10. Organización del record	(pobre) 1 2 3 4 5 6 7 (excelente)	(pobre) 1 2 3 4 5 6 7 (excelente)
11. Confiabilidad de la información	(pobre) 1 2 3 4 5 6 7 (excelente)	(pobre) 1 2 3 4 5 6 7 (excelente)
12. Precisión de la información	(pobre) 1 2 3 4 5 6 7 (excelente)	(pobre) 1 2 3 4 5 6 7 (excelente)
13. Accesibilidad de la información	(pobre) 1 2 3 4 5 6 7 (excelente)	(pobre) 1 2 3 4 5 6 7 (excelente)
14. Seguridad del sistema	(pobre) 1 2 3 4 5 6 7 (excelente)	(pobre) 1 2 3 4 5 6 7 (excelente)

Utilizando la escala de 1 a 7 que se provee adelante, donde 1 es pobre y 7 es excelente, indique su apreciación sobre los siguientes aspectos de las computadoras portátiles utilizadas en la prueba realizada. Circule el número que mejor refleje su apreciación.

	Sistema PDA	Sistema Tablet PC
1. Uso de la pluma de escribir	(pobre) 1 2 3 4 5 6 7 (excelente)	(pobre) 1 2 3 4 5 6 7 (excelente)
2. Uso del teclado de pantalla	(pobre) 1 2 3 4 5 6 7 (excelente)	(pobre) 1 2 3 4 5 6 7 (excelente)
3. La pantalla	(pobre) 1 2 3 4 5 6 7 (excelente)	(pobre) 1 2 3 4 5 6 7 (excelente)
4. El peso	(pobre) 1 2 3 4 5 6 7 (excelente)	(pobre) 1 2 3 4 5 6 7 (excelente)
5. Cargarla	(pobre) 1 2 3 4 5 6 7 (excelente)	(pobre) 1 2 3 4 5 6 7 (excelente)

Utilizando la escala de 1 a 7 que se provee donde 1 es poca y 7 es mucha, indique su nivel de satisfacción con cada sistema. Circule el número que mejor refleje su satisfacción.

Sistema PDA: (poca) 1 2 3 4 5 6 7 (mucha) Sistema Tablet PC: (poca) 1 2 3 4 5 6 7 (mucha)

Indique cuál(es) elemento(s) de los sistemas, si alguno, usted encontró difícil de utilizar.

En el sistema PDA:

En el sistema Tablet PC:

Indique cuál(es) elemento(s) de los sistemas, si alguno usted encontró fácil de utilizar.

En el sistema PDA:

En el sistema Tablet PC:

¿Cuál de los dos sistemas preferiría tener disponible para realizar su labor de documentación de record de pacientes?

__PDA __Tablet PC.

En el espacio que sigue escriba cualquier comentario o sugerencia que desee hacer sobre su experiencia con los dos sistemas con que interacción.

Appendix I: Nurses Tasks

1. Indique en voz alta la edad y peso del paciente.
2. Indique la temperatura del paciente registrada más recientemente.
3. Busque la nota de enfermería más reciente y léala en voz alta.
4. Documente como administrados cualquier tipo de medicamento pendiente de administración.
5. Anote los siguientes signos vitales del paciente:

Temperatura: 37.0 ° C

Presión: 130/90

Pulso: 71

Respiración: 18

Saturación de oxígeno: 96%

6. Indique el balance total de entrada y salida de fluidos en las últimas 24 horas.
7. Busque la nota escrita por el Dr. Colón.
8. Documente el estimado del paciente con la información que se provee a continuación para cada renglón en letras negritas. Documente solo lo que se indica para cada renglón.

Higiene: cuidado oral

Actividad: descanso en cama

Pulmonar: succión

Gastrointestinal: abdomen anormal, presenta diarrea

Seguridad: barandas elevadas

Mental: alerta y orientado de todo

Neurológico: responde a estímulos verbal, táctil y dolor

Reacción pupilar en ambos ojos

Respiratorio: pulmones claros

Cardiaco: venas normales, sonidos cardiacos normales

Genitourinario: egreso disminuido, orina color amarillo claro

Piel: rosada, hidratada, tibia, intacta, presenta edema

9. Anote las siguientes cantidades de I/O:

Ingreso: PO: 50 ml

Egreso: Orina: 650 ml

10. Escriba el siguiente texto como una nota de progreso con un enfoque de evaluación:

El paciente presenta fiebre y una masa grande pulmonar en el lóbulo superior izquierdo consistente en ct con neumonía multi-focal.

11. Documente un nuevo dolor del paciente con la siguiente información:

Clasificación: 4

Localización: hombro derecho frontal

Descripción: lastimado

Terapia: masaje

Se administra medicamento

12. Busque la orden de consulta médica más reciente y documéntela indicando que el médico fue notificado por teléfono.
13. Muestre dónde en el record se indica por qué razón se omitió una dosis del medicamento Roboxine.

Appendix J: Información Personal

Nombre: _____ Masculino Femenino

Posición o puesto que ocupa: _____

Seguro Social: _____

Dirección postal: _____

Correo electrónico: _____

Teléfonos: _____